Canadian Injury Prevention Resource

An evidence-informed guide to injury prevention in Canada

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Introduction

The Canadian Injury Prevention Curriculum (CIPC) was first introduced in 2004 by the Canadian Collaborating Centres for Injury Prevention (CCCIP), supported by funding from Health Canada. This curriculum was developed in response to the need for training and certification in injury prevention, considering the growing awareness regarding the burden of injury in Canada. A one-day workshop run in Alberta titled Injury Prevention 101 was the foundation for the CIPC. Injury Prevention 101 provided practitioners with the knowledge and skills necessary to develop and evaluate injury prevention programs. The CCCIP recognized that this type of strategy used across Canada could help establish a stronger network of injury prevention practitioners, encourage a more scientific, evidence-based approach to the selection of intervention strategies, and ensure adequate dissemination and evaluation of programs.

The field of injury prevention has grown significantly in Canada over the past 60 years. The number of practitioners trained with the CIPC is nearing 1500 and through collaboration within this growing network, it became evident that there is a need for a resource dedicated to injury prevention in Canada. Through feedback from the network, it was important that this resource reflect the Canadian experience. Further, it would address the realities of prevention within a Canadian social and political context, as well as the diverse geography and populations including Canada's distinct Aboriginal population. Participants of the CIPC also identified the need for a resource to support their learning and practice of injury prevention. Due to Canada's size, there was also the need to create an accessible resource for injury prevention practitioners and other professionals across an extremely large geographical area; therefore, the most appropriate and cost effect format for this resource would be on-line.

Sixty-one authors from across Canada, representing a range of disciplines, were invited to provide a comprehensive overview of each of the areas of injury prevention highlighted in this resource. The resulting synthesis covers important facets of injury prevention research, policy and programming, all of which encompass the art and science of injury prevention.

A multi-disciplinary editorial committee with representatives from across Canada provided on-going direction and guidance to the development of the resource. Funding support came from the CCCIP and the Public Health Agency of Canada and overall management and coordination of the resource was provided by Parachute.

This resource is organized into an introduction and four sections.

Section 1 provides an overview and describes the need for an injury prevention resource within the broader public health context in Canada. In this introductory section, the successes and challenges in the field of injury prevention in Canada will be discussed, the relationship between unintentional and intentional injury will be presented, and the burden of injury in Canada will be described.

Jason's Story*

Why is Jason in the hospital?
Because he has a bad infection in his leg.

But why does he have an infection?
Because he has a cut on his leg and it got infected.

But why does he have a cut on his leg?
Because he was playing on a poorly maintained playground next to his apartment building and there was some sharp broken edges there that he fell on.

But why was he playing on a playground with old, broken equipment?
Because his neighbourhood is kind of run down. A lot of kids play there and there is no one to supervise them.

But why does he live in that neighbourhood?
Because his parents can't afford a nicer place to live.

But why can't his parents afford a nicer place to live?
Because his Dad is unemployed and his Mom is sick.

But why is his Dad unemployed?
Because he doesn't have much education and he can't find a job.

But why...?

Section 2 covers the Canadian Good Practice Model, which is a model that describes how to identify community injury issues, address priority issues, and develop, implement and evaluate injury prevention programs. Case studies are used throughout this section to illustrate the use of the Model.

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* Toward a Healthy Future: Second Report on the Health of Canadians. Retrieved from: http://www.phac-aspc.gc.ca/ph-sp/determinants/index-eng.php on July 15, 2015

Section 3 describes the influence of the determinants of health on injury, and the mechanisms of injury.

Section 4 focuses on specific injury topics written by leading Canadian experts. These experts provide brief overviews of each injury topic and highlight the current state of evidence regarding interventions wherever possible. These overviews are meant to be a starting point to understanding specific injury issues, and are not meant to be used as the only source of evidence.

Due to the magnitude of the injury issue and its effect on the health status of a population, injury prevention is now largely defined as a public health issue. However, public health is only one piece of the injury prevention puzzle and there are diverse approaches to addressing this important health issue (see Jason's Story). The goal of this resource is to prepare many individuals with a basic understanding of the field of injury prevention. The CCCIP and the authors who have contributed to this first injury prevention resource in Canada believe that by creating a 'critical mass' of knowledgeable practitioners we will leverage resources to build a sustainable infrastructure for injury prevention in Canada.

1.1

Kathy Belton, Ph.D. (c)

Pamela Fuselli, M.Sc.

The Journey To Date: The Canadian Context

Introduction

Injury is a major public health issue in Canada as it is the leading cause of death for Canadians between the ages of one and 44 years.[1] Canada has some unique challenges when it comes to injury prevention. Injury rates are four to five times higher in Canada's First Nations and Inuit populations, compared to rest of the country. It is a vast country with some sparsely populated, underdeveloped regions, and concentrations of highly urban areas with dense populations. This diverse geography presents a unique challenge to the development and delivery of injury prevention programs.

Early Beginnings of Injury Prevention in Canada

While the field of injury prevention was introduced as early as 1913[2] it has only been over the last 60 years that injury prevention efforts have been somewhat coordinated and systematic in Canada. Initially, injury prevention activities in Canada were focused on children and adolescents. The 'Accident Prevention Committee' by the Canadian Paediatric Society was established during the 1960s and the 1st national conference on childhood injuries was held in 1981. The release of the first edition of the Health of Canada's Children by the Canadian Institute of Child Health in 1989 profiled injuries as a major cause of death and hospitalization and led to development of the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) which was the first injury surveillance system in Canada. The CHIRPP was launched by Health Canada in 1990, and continues to document the number,

types, and circumstances of injuries mainly in children, presenting to the emergency rooms at select hospitals across Canada.

Interest Grows Provincially and Nationally

The late 1980s and early 1990s was an active time in the development of injury-related programs, resources and collective action to prevent injury across Canada. Several foundational injury prevention national organizations were established such as Safe Kids Canada, SMARTRISK, ThinkFirst Canada, Safe Communities Canada and the Canadian Agricultural Safety Association. Provincial organizations established during this time were the Saskatchewan Prevention Institute (previously known as The Saskatchewan Institute on Prevention of Handicaps), Injuries Manitoba – Preventing Adolescent and Child Trauma (IMPACT) and Alberta's Injury Prevention Centre (IPC). The award winning HEROES, a multi-media injury prevention program for adolescents developed by the IPC, captured attention and acted as a catalyst for school-based injury prevention action in Alberta and across the country. In May, 1991 Canadian injury control experts met in Edmonton to develop injury control objectives for Canada for the Year 2000. This was the first time that experts working across injury types and ages, came together to work on common goals. The number one recommendation that emerged from this meeting was that injury be recognized as a major cause of death and disability by the Government of Canada, and that a national strategy of injury prevention was required. While no national strategy emerged to support the achievement of the injury control objectives for Canada, pockets of activity action to support injury prevention began within the federal government.

These activities were bolstered by Canada's response in 1992 to the United Nations Convention on the Rights of Child passed in 1989. The Convention recognizes the importance of improving the living conditions of children in every country and the role of international cooperation in assisting developing countries with this endeavour. At the forefront of Canada's response was the launch of the Brighter Futures program for children that is a multi-departmental initiative to address the well-being of children, particularly young children at risk and their families. Injury prevention activities are a cornerstone of the program. The Family and Child Health Unit at Health Canada was able to use Brighter Futures funding to develop foundational injury prevention resources including a directory of programs and researchers across Canada and a review of legislation pertaining to the prevention of unintentional childhood injury. They also hosted several meetings of key injury prevention leaders across the provinces and nationally to share best practices and methods to develop and implement provincial injury prevention strategies. The Medical Services Branch, now the First Nations and Inuit Health Branch, funded the development of resources and workshops across Canada to address the injury issues in these populations. As motor vehicle collisions were (and in many places continue to be) the leading cause of injury death, in 1996 the collective provincial and territorial Ministries of Transportation and Transport

Canada released a vision document with the goal of making Canada's roads the safest in the world. This document spearheaded initiatives in each province and territory related to the prevention of motor vehicle collisions.

The late 1990s saw the release of the first report on the economic burden of unintentional injury in Canada and again called for the government of Canada to develop a national injury prevention strategy. This call for a national strategy was echoed in an issue paper developed by the Federal/ Provincial/Territorial Advisory Committee on Population Health, Public Health Working Group, Sub-Committee on Injury Prevention and Control Working Group on public health. While this group was disbanded after completing the paper, their efforts resulted in the creation of the Secretariat for Injury Prevention and Control at Health Canada. The mandate of the Secretariat was to provide national leadership and coordination through building infrastructure and capacity to address injury. Even though the Secretariat was short-lived due to shifts in the political landscape, it did provide a backdrop that brought injury prevention organizations together.

The Canadian Collaborating Centres for Injury Prevention

The Canadian Collaborating Centres for Injury Prevention (CCCIP) was established in 1999 following a meeting partially funded by the Family and Child Health Unit at Health Canada. The mandate of the CCCIP was to promote collaboration among injury prevention centres and organizations across Canada and address common issues such as funding and how to move injury prevention forward. The CCCIP has become a facilitator of action and a leader in the field of injury prevention. Its members work collaboratively to improve injury prevention policies, programs and surveillance and to translate research into practice. Furthermore, the CCCIP developed and continues to deliver the Canadian Injury Prevention Curriculum that builds professional capacity across the country in order to further action on reducing preventable injuries. Several other injury prevention curricula for specific issues (e.g. seniors falls) or age groups (e.g. children) have been developed based on this initial curriculum.

Provincial and National Initiatives

Knowledge sharing. The first national conference, the Canadian Conference on Injury Prevention and Control in October of 2000, and the Sixth World Conference on Injury Prevention and Control in May of 2002, Injuries, Suicide and violence: Building Knowledge, Policies and Practices to Promote a Safer World were watershed events for the injury prevention community in Canada. The national conference brought Canadian stakeholders from many sectors together to create an injury prevention community across Canada. The world conference provided the opportunity for this community to showcase its work internationally. The national conferences remain a focal point for the injury prevention community in Canada for knowledge exchange.

Strategies. The beginning of the 21st century saw a great deal of momentum in the field of injury prevention in Canada with most provinces and territories producing a discussion document or a strategy related to injury prevention. Canada's first national strategy on injury prevention was released in 2003, titled Ending Canada's Invisible Epidemic, which again made the call for federal government leadership on the issue. Sustained efforts at the provincial and territorial levels in terms of gaining government support for injury prevention has been variable across Canada.

Research. One of the criticisms of much of the early injury prevention efforts was the lack of evidence related to effective interventions. In response, the Canadian Injury Research Network was formed in 2000. This consortium of researchers, practitioners, clinicians and policy makers continue to work to advance inter-sectorial, inter-disciplinary and cross cutting injury prevention research. Their report, *A Research Agenda for Injury Prevention and Control for Canada, March 2002* laid the early groundwork for Canadian researchers. Also at this time, the Canadian Institutes of Health Research (CIHR) was formed and several Institutes led a strategic initiative entitled, Listening for Direction on Injury Prevention. This initiative was the first attempt by CIHR to address the multi-disciplinary nature of injury control and to identify strategic research and knowledge translation priorities. This process provided the basis for funding opportunities for new research such as the Child and Youth Indicators for Injury Prevention, the Saskatchewan Farm Injury Cohort Study and the Risk of Injury associated with Body Checking among Pediatric Ice Hockey Players. In 2009, CIHR awarded $10,294,425 to seven Strategic Team grants in Applied Injury Research, which has enabled injury researchers to conduct significant research in a number of priority injury areas.

First Nations. Canada has a substantial Indigenous population and continues to be active in addressing the injury issues specific to Indigenous communities. This has been done through the Brighter Futures initiative since 1992 and other activities such as the development of an injury curriculum specific to this population, knowledge-sharing conferences and the creation of a national working group to guide a coordinated injury prevention strategy.

The Way Forward

Injury prevention in Canada has a strong foundation and a vibrant future. In 2012 came the amalgamation of four national organizations – Safe Communities Canada, Safe Kids Canada, SMARTRISK, and ThinkFirst Canada – into Parachute, which is a national voice for injury prevention in Canada. There has been tremendous growth in the number of people and organizations focused on injury prevention in the community, but also in the knowledge-base of Canadian research and evidence-informed practice. Canada has made some progress in decreasing the burden of injury over the past twenty years; decreasing the overall injury mortality rate from 47.3 to 40.5 per 100,000 population from 1990 to 2010. More specifically, Canada has also seen substantial declines in both motor vehicle related death rate from 13.2 to 6.4 per 100,000 and the suicide rate from 12.4 to 10.9 per 100,000 over the same time period. Despite this progress, the injury rate associated with falls and unintentional poisonings continue to rise, increasing from 4.5 to 8.2 per 100,000 and from 2.1 to 4.3 per 100,000 respectively.[3] As a result, injury remains one of the largest public health issues that Canada faces and is a major burden to the healthcare system.

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1.2

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Bridging the Gap Between the Prevention of Intentional and Unintentional Injuries

Introduction

The field of injury prevention related to both unintentional (UI) and intentional injuries (II) has developed over the last 30 years in Canada. Although the networks related to these two injury classifications have developed concurrently, the expertise has been developed almost as two distinct fields and there has been little sharing of knowledge. At first glance, it is difficult to envision what domestic violence and highway injuries have in common. However, there is much expertise to be shared between unintentional and intentional injury prevention networks. The purpose of this chapter is to present an overview describing the benefits of collaboration, and proposes a frame of reference to facilitate greater cooperation between networks.

Preventing Unintentional and Intentional Injuries: Frames of Reference and Historical Perspective

The conceptual basis of the injury prevention approach stems, in large part, from the work conducted by four researchers: Hugh De Haven, John Gordon, James J. Gibson and William Haddon Junior.[1] The most renowned of the four is undoubtedly William Haddon (see Chapter 2.3.2 Identifying Risk and Protective Factors), who is considered by many as the father of modern methods of injury prevention and control. This conceptual basis includes a

definition of the injuries (see frame) and suggests tools to better understand the injuries and determine strategies for control.[2]

Haddon's framework has guided the development of many intervention programs around the world, mainly with regard to UI, firstly in the field of road safety and then in other areas of human activity such as sports and leisure, work or activities of daily living. Canada is no exception to this trend. As such, a network of experts in UI prevention (e.g. the Canadian Collaborating Centres for Injury Prevention) was developed and initiatives in the field of research or interventions were undertaken.

At the same time, in the field of II, the main initiatives were developed as part of violence or suicide prevention programs. These programs were conducted by networks of experts and stakeholders (sociologists, psychologists, social workers, etc.) with relatively few connections with those from the unintentional injury prevention network. The initiatives focused mainly on domestic violence or violence among loved ones including child abuse (youth protection laws) and intimate partner violence (policies, action plans, etc.). Also, other initiatives focusing on crime prevention emerged, including the National Crime Prevention Centre and the National Crime Prevention Strategy (Public Safety Canada). Suicide prevention organizations were also created on a Canadian scale (Canadian Association for Suicide Prevention) as well as in every region of the country. Those initiatives were developed according to the conceptual bases from the various disciplines involved, with no apparent connections to the injury prevention model.

> ## Injuries
>
> **Injuries are defined as *bodily harm resulting from a sudden transfer of energy that exceeds the human body's capacity for resistance*. The energy transferred is most often mechanical (e.g., fracture), but it may also be thermal (e.g., burn), electrical (e.g., electrocution), chemical (e.g., intoxication) or radiant (e.g., sunburn). Note that injuries can also be the result of a *sudden loss of energy or vital element* (e.g., chilblain, drowning, strangulation)[3]**

Under the injury prevention framework, violence (against others and self-inflicted) is considered part of intentional injury, specifically intentional injuries (II). The World Health Organization issued the World Report on Violence and Health[4] that suggested a frame of reference including a definition of violence, a typology and an ecological model to understand and intervene (see Chapter 4.6 Violence). Compared to the definition of an injury, the definition of violence proposed by the WHO goes beyond a simple transfer of energy or the loss of a vital element because it recognizes that violence can also be the result of a threat or an abuse of power. Moreover, that definition includes consequences that exceed simple bodily harm and includes psychological or moral harm, maltreatment or deprivation. Finally, contrary to injuries that are generally recognized as the result of a

sudden event[*], violence may be the result of repeated acts. In fact, some forms of violence, such as abuse, are not the result of an isolated act but rather of a dynamic between aggressor and a victim that takes place over a more or less long period of time. That is also the case with bullying, which is the result of repeated acts towards the same individual because that phenomenon reflects a behavioural pattern, not only an isolated incident.[6]

In summary, the presentation of energy as the cause of injury has certainly helped to better understand injuries as a result of a common etiology, modulated by predictable factors similar to other health problems such as cancer, cardiovascular disease, and infectious disease. However, the Haddon model (see Chapter 2.3.2 Identifying Risk and Protective Factors) is a very medical model that may have suited public health workers, but not necessarily those in the field of social sciences and behavioural sciences involved in the prevention of violence and suicide. Therefore, those in the fields of UI and II are coming from very different conceptual frames of reference.

Violence and Injury Prevention: Bridging the Gap Between the Two Models

Despite the differences in the violence and injury prevention approaches, there are many benefits of bridging the gap between the two fields. Those reasons are particularly related to the many connections that exist between the problem of UI and that of II specifically; similar consequences, an unspecific boundary between UI and II, common associated factors and control and preventive measures impacting both UI and II.

Similar consequences. Both UI and II can result in similar bodily harm for victims, such as lacerations, fractures, burns, oxygen deprivation or death.[7,8] Also, they are likely to result in significant psychological consequences identified as post-traumatic stress.[9]

Unspecific boundaries. The boundary between what is intentional and what is unintentional is often very arbitrary or even uncertain. The classification of an injury based on what is unintentional or intentional poses some difficulties. Firstly, what society considers a violent act may vary from one region to the next and rests on a judgment modulated, among other things, by the social norm[†]. For example, in boxing, the winner is often designated as the one who succeeds in intentionally inflicting injury onto his opponent (often a concussion) or prevents him from getting back up. However, that type of injury is generally classified as unintentional because the rules of the game are respected. The same

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[*] Of course, bodily harm can be produced by repetitive motions. That type of phenomenon is not generally included in the field of injury prevention.

[†] Societal norms are socially shared rules or models of behaviour based on common values and involving pressure to adopt a given behaviour on penalty of reprobation from the society or reference group.[32]

dilemma is encountered when injuries occur in other contact sports such as hockey where body checking is allowed and even encouraged.

Secondly, even when there is consensus and a clear definition of what is intentional or unintentional, it is often very difficult to determine with certainty into which category to place an event. For example, in an Australian study[10], which analyzed motor vehicle collisions involving a single occupant, the authors emphasized the difficulty of clearly distinguishing an "accident" from a suicide. Schaechter et al. (2003) in a review of deaths by firearms among children in Miami-Dade County (USA), concluded that unintentional deaths by firearm are significantly under-reported due to problems associated with classification criteria.[11] Finally, when looking at deaths by intoxication in Canada, the proportion of indeterminate cases with regard to intent is 20%.[12] This illustrates the difficulty of injury classification with regards to intent.[13,14]

Common associated factors. When analyzing the factors associated[‡] with UI and II, many are common to both including, alcohol, firearms and toxic products.

It has long been established that alcohol consumption is associated with many UI[18], from drownings[15] to traffic injuries.[16,17,18] Alcohol consumption is also associated with various forms of violence[18] and more specifically, violence among youth, intimate partner violence, sexual assault and suicide.[4] The presence of firearms in the home increases the risk of homicide by almost 3 times[19] and the risk of suicide by almost 5 times[20] for members of the home and the risk of injury by accidental discharge. [21] The same can be said for the presence of toxic products or medications associated with suicides[22] and UI, particularly among children from 0 to 4 years of age.[23]

Control and preventive measures impacting both UI and II. Many interventions can impact both UI and II. That is particularly true for measures aimed at reducing access to firearms[24] alcohol abuse[18], and interventions with parents aimed at developing safe, stable and healthy relationships with their children. Interventions directed at parents based on home visits by nurses in the pre and post-natal period, have been recognized as being effective in reducing both the risks of various forms of violence[25,26] and the occurrence of UI at home among children.[25]

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‡ A factor is said to be associated when there is a statistical associated between a factor and the occurrence of an event. One cannot necessarily conclude that it is a causal factor.

Taking action to protect oneself from violence (II) or its consequences can sometimes result in an increased risk of UI. For example, some organizations will recommend that citizens obtain a firearm to protect themselves against violence. This can introduce an increased risk of unintentional injuries into the home.[24] Also, some people may choose to relocated from "dangerous" downtown areas to the suburbs because of fear of crime and violence. This can result in increased urban sprawl with negative consequences in terms of road safety related to the increased number of vehicles on the road. Finally, a tax decrease on alcohol may be recommended to counter illegal trafficking[27] and the violence that may be associated with it. Such a decision would likely result in higher consumption and an increase in unintentional injuries associated with impaired driving.[18]

These examples clearly show that some interventions may have effects on both UI and II, which either can be beneficial for both, or detrimental to one or the other. It then becomes important to consider all of the possible effects of an intervention on both UI and II.

Safety, An Integrating Framework

Activities to prevent and control UI and II are conducted by a variety of sectors including transportation, public safety, health, the municipalities, etc. They require diversified expertise from health sciences, humanities, engineering, etc. All of these experts use different intervention models, which, as discussed above, do not facilitate an exchange of expertise and teamwork. However, they all have a common goal; that of ensuring personal safety, which is a fundamental need for human beings. As such, it would be useful to share a framework to promote of synergy between the various sectors and areas of expertise that all can identify with.

Safety

"Safety is a state in which the dangers and conditions that could cause physical, psychological or material harm are controlled in a manner to preserve the health and well-being of individuals and the community. It is an essential resource of daily life that permits an individual and the community to achieve its goals"[28]

In Québec, a frame of reference was developed a few years ago that proposes a definition of safety that encompasses the issues associated with both UI and II.[28] It recognizes the two dimensions of safety that are important to consider, i.e. the subjective dimension (for example, the fear of crime) and the objective dimension (for example, homicides in a community). Moreover, the framework suggests the presence of at least four conditions for ensuring the population is safe. Those conditions are:

❖ A climate of cohesion and social peace and equity protecting the rights and freedoms on the family, local, national and international level;

❖ The prevention and control of injuries and other consequences or harm caused by accidents;

❖ The respect of values and physical, material or psychological integrity of persons;

❖ Access to effective means of prevention, control and rehabilitation to ensure the presence of the first three conditions." [28]

Finally, the framework proposes a definition of the promotion of safety (see box) that echoes the definition of the promotion of health in the Ottawa Charter[29]. Two approaches help promote the safety of a population: the approach via the problem and the setting-oriented approach. The approach via the problem consists of searching for specific solutions to one or more problems taken individually. In the second approach, "motivator [...] is no longer the solution to a specific problem, but rather the improvement of the level of safety of a group".[30] It calls on a structured procedure for planning various activities with the community, involving several phases including the mobilization of key players, the determination of a diagnosis of safety of the environment that integrates the issues associated with UI and II. The development of a resulting action plan is the final step.

> ### Safety promotion
>
> **"The promotion of safety is a process that individuals, communities, governments and other organizations, including private businesses and non-governmental organizations (NGO) apply on a local, national and international level to develop and maintain safety. That process is comprised of all of the efforts made to modify the structures, the environment (physical, social, technological, political, economic and organizational) and the attitudes and behaviours related to safety." [28]**

This frame of reference has been used successfully in Québec on several occasions, particularly to build tools[31] within a safety promotion and crime prevention program and to support the interventions planned within a program to prevent UI and violence in school yards (see case study).

Conclusion

Many gaps can be bridged between the prevention of UI and II. Better synergy between the two networks would help better leverage the expertise and experience acquired. It would

also provide opportunities to form a larger critical mass devoted to injury prevention and more solid bases to justify the investments required. The promotion of safety can, as such, be proposed as a driving force to promote the collaboration among those who work in this field.

Case Study

Promoting physical activity and safety in school yards in Quebec

The schoolyard is an important space for children. They spend many hours a day there, in the morning, at lunch, during recesses or at the end of the day. It is a place where children learn to socialize with their peers, and where they can participate in a variety of free play or organized activity. However, the most recent statistics indicate that half of children are inactive during recesses. Moreover, it has been shown that visits to a doctor or nurse for unintentional injuries among children five to twelve years is related to physical activity in school yards. Finally, schoolyards are places where children feel less safe as a result of different forms of violence (verbal, physical, bullying, intimidation, etc.).

Faced with this evidence, public health officials in the Québec region (National Capital region), in collaboration with academics, deemed it important to intervene to promote safe physical activity and the adoption of healthy behaviours by children in the schoolyard. An offer of service was developed with these goals in mind to implement in schools. This offer was based on a global vision for schoolyards that places an emphasis on safety, and likewise considers the issue of intentional and unintentional injury. It targets primarily the arrangement, organization and supervision of schoolyards, and proposes a process, tools (i.e., the guide to my schoolyard: a nice place; the guide for playgrounds and play structures), training sessions and accompanying information. The process involves stakeholders from academic settings, healthcare and parents, and will involve three successive steps.

The first step presents the vision, proposed implementation plan, tools and supplementary information to schools leaders. At this point, a discussion is initiated to understand concerns and specific needs relating to the schoolyard. The second step consists of creating a "school yard" committee, and determining a diagnosis for the schoolyard. This committee is composed of different kinds of school officials (i.e., special education teachers, physical education teachers, teachers, security services and principals/directors). Depending on specific issues, parents and municipal representatives may be asked to participate. The diagnosis is formulated by committee members through data from reported incidents, complaints made, and direct observation. The third step consists of establishing a certain number of priority actions and proposing an action plan that can be completed during the school year, with the ultimate intention of ensuring physical activity and safety for children.

Many schools in Québec region (National Capital region) have benefitted from this approach. For example, School PM (not actual name of school) welcomes 300 students at the primary level. After offering services in the region, the school management initiated a process to create a schoolyard that was safer and more suitable for physical activity. During the three steps planned for the process, the diagnosis demonstrated a problem with the enclosure and supervision of students during lunch hour, non-optimal usage of the schoolyard, the occurrence of injuries linked to usage of play equipment, hostile behaviours between certain students, as well as unwelcome visitors at lunch hour. In light of this diagnosis, an action plan was developed for the school year. This plan comprised several action items relating to community mobilization (i.e., maintaining a schoolyard committee to ensure the implementation of the action plan), to the organization of the schoolyard (i.e., developing programming for activities midday, developing and promoting a sketch demarcating different play areas by age and activity type), to schoolyard planning (i.e., increasing the absorptive capacity of surfaces under the play structures), to the supervision and boundaries offered to students for their protection (i.e., recruiting and training young leaders, better identification for staff, developing and communicating a code of ethics to respect the schoolyard, surveillance plan to avoid the presence of unwanted visitors).

The schools that have tried this process better understand the importance of having a global vision for their schoolyard. They are equally conscientious of the importance of community mobilization and the importance of the connections that exist between the arrangement, organization and supervision of the schoolyard. The schools that have initiated the process also have a better understanding of the security requirements for playgrounds and play structures. Additionally, these schools more often analyze incident reports, put surveillance strategies in place and adopt clear procedures in case of injuries, conflict or the presence of unwanted visitors. Other positive outcomes observed included: a decrease in the number of interventions to manage incidences of violence between children, and the optimization of management of materials during playtime. Finally, it appears that community mobilization and shared leadership by several parties promotes sustainability.

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The Burden of Injury

Introduction

It may be a surprise to some to learn that the leading cause of death for Canadians during the first three decades of life is not disease, but rather injuries. In 2011, almost 15,000 deaths in Canada were attributed to injuries as a result of motor vehicle collisions, falls, drug overdoses, and drowning, among other causes.[1] Injury is defined as the physical damage that results when the human body is suddenly or briefly subjected to intolerable levels of energy.[2] The injury may be a bodily lesion resulting from acute energy exposure in amounts that exceed the threshold of physiological tolerance, or it may be an impairment of function resulting from a lack of one or more vital elements (i.e. air, water, warmth), as in drowning, suffocation or hypothermia. The time between the exposure to the energy and the appearance of the injury is short. Examples of energy that can cause injury are mechanical or kinetic energy (e.g. falls, motor vehicle crashes, assaults); thermal energy (e.g. burns, scalds); electrical energy (e.g. electrocution, lighting); chemical energy (corrosive agent, poisoning); and, radiation (sunlight, radioactive material). Injuries are often further described as being unintentional or intentional based on the presumed intent. Unintentional injuries include motor vehicle crashes, falls, and burns, whereas injuries considered as intentional include those caused by self-harm, violence, and war. It is important to note, however, that simple categorization is difficult, as the intent of the injury is not always clear. For example, an infant who suffers an inflicted head trauma as a result of being shaken while crying will mostly likely be categorized as an intentional injury. However, in most cases of this nature,

there was typically no intent, on the part of the person who shook the child, to cause injury. Rather, the intent was to calm the crying.

Injury events should not be considered 'accidents' or 'inevitable' as the vast majority of injury events are both predictable and preventable. Based upon this understanding, public health research, policy and programs in recent decades have aimed to shift traditional understanding of injury events towards a view that injuries can be prevented. This effort has led to the development and implementation of numerous prevention strategies, policies and programs, and to significant reductions in injury morbidity and mortality in Canada over the past 20 years. While those in injury prevention and public health can be proud, it is still the case that thousands of Canadians die each year from injury. Thousands more survive and are left with the physical, emotional, social, and financial burdens as a result of injuries.

This chapter will provide an introduction to the epidemiology of injury in Canada and focus on the social and economic burden that injury places on individuals, families, communities, and the nation as a whole.

Injuries in Perspective – The Global Burden of Injuries

According to World Health Organization estimates, over 5.14 million deaths were due to injuries in 2012 - a figure equivalent to almost 1 out of every 10 deaths globally.[3] To put this in perspective, the number of deaths due to injuries in 2012 was greater than those due to tuberculosis, HIV-AIDS, and malaria combined (3.08 million).[3] Although injuries can affect people of all ages, races, and income levels, a disproportionate number of injuries are sustained by those in lower income countries. When categorized by World Bank Income regions, injuries accounted for over 10% of deaths in low-income nations compared to 6% in high-income countries.[4] When based on gender, 2 out of every 3 injuries worldwide are sustained by males.

Unintentional injuries. In 2012, unintentional injuries accounted for the majority of injury-related deaths (72%), with road traffic injuries being the leading cause of injury death (1.25 million) worldwide.[3] In 2012, road-traffic related injuries were the ninth leading cause of death world-wide, increasing from twelfth overall in 2000.[3] With this growth, it is projected that by 2030, road-traffic injuries will be the fifth leading cause of death worldwide.[6] Other leading causes of unintentional injury include, in order, falls, drowning, exposure to fire and hot substance, and poisonings.

Intentional injuries. Injuries from self-harm are the fifteenth leading cause of death worldwide, resulting in over 800,000 deaths in 2012.[3] Notably, 1 out of every 4 injury related deaths in high income nations result from suicide, whereas suicide accounts for less than 1 out of every 10 injury-related deaths in low income countries.[4] However, it should be noted that for a number of reasons (e.g. lack of resources, lack of central record keeping, stigma) it is more difficult to gather accurate mortality data in lower income countries, particularly about suicide. International comparisons, should therefore, be viewed with caution.

Intentional injuries also include those due to interpersonal violence, collective violence, and legal intervention. In 2012, over 26,000 deaths occurred due to war and conflict in low-income nations whereas only 2,300 occurred in high-income nations.[4]

Table 1

Deaths by Specific Injuries Globally, 2012 World Health Organization Estimates[4]

Cause of Death	No. of Deaths (000's)	% of All Deaths	% of All Injury Related Deaths
All Causes	**55,859**	**100**	--
All Injuries	**5,144**	**9.2**	**100**
All Unintentional	**3,716**	**6.7**	**72**
Road Injury	1,255	2.2	24
Falls	693	1.2	13
Drowning	372	0.7	7.2
Fire, Heat, Hot Substances	268	0.5	5.2
Poisonings	193	0.3	3.8
Other Unintentional Injuries	932	1.7	18
All Intentional	**1,428**	**2.6**	**28**
Self-harm	804	1.4	16
Interpersonal Violence	505	0.9	9.8
Collective Violence & Legal Intervention	119	0.2	2.3

Injuries In Canada – Patterns & Prevalence

From the age of 1 to 34, more Canadians die as a result of injuries than from any other cause (Figure 1).[1] In 2011, the leading causes of death for individuals aged 1 to 34 years were, in order, unintentional injuries, suicide, cancer, homicide, heart disease, influenza and pneumonia, cerebrovascular disease (stroke), diabetes, and chronic lower respiratory disease (CLRD).[1] Seventy-four percent of deaths in this age group were due to unintentional and inflicted injuries, compared to 21% due to heart disease and cancer combined.[1] When considering all age groups, 6.2% of all deaths in Canada were the result of injuries, with males accounting for over 63% of all injury-related deaths in 2011.[1,3] However, statistics on injury mortality, though tragic, provide only a small proportion of the true magnitude of the

burden of injury in Canada. In the two-year period, 2009 to 2010, injuries were among the leading causes of hospitalizations across all age groups with over 230,000 Canadians hospitalized as a result of injury related causes.[6]

Figure 1

Ten leading causes of death for Canadians aged 1-34 years in 2011[1]

*Other: influenza and pneumonia, cerebrovascular disease (stroke), diabetes, chronic lower respiratory disease (CLRD).

Unintentional injuries. The vast majority of the injuries that occur in Canada are unintentional. According to recent Canadian data for injury deaths in 2011, the leading causes of unintentional injury mortality were falls (4,198), road traffic collisions (2,351), and poisonings (1,634).[7] In 2011, road-traffic related deaths accounted for 20% of all unintentional injuries, 15% of all injury-related deaths, and were the leading cause of death for young Canadians ages 1 – 19.[7] At the other end of the age spectrum, almost 50% of all injury-related deaths among adults aged 65 years or older resulted from falls.[7]

Intentional injuries. The leading causes of intentional injury death in Canada are suicide and homicide, with 1 out of 4 intentional injury-related deaths being the result of suicide. In 2011, 3,726 Canadians died as a result of suicide[7], while 521 Canadians died as a result of homicide.[7] Almost 80% of all suicide and homicide deaths occurred among Canadian adults aged 20 – 64 years.[7]

Table 2

Leading causes of injury death in Canada, 2008, both sexes, by age group[6]

Age Group (years)	Leading Cause of Injury Death
Infants (< 1)	Suffocation
1 – 19	Road traffic collisions
20 – 64	Suicide
65+	Falls

Figure 2

Injury Deaths by Cause in Canada, all ages and both sexes in 2011[7]

- Falls
- Suicide
- Motor Vehicle Crash
- Poisoning
- Homicide
- Drowning
- Fire, Flames, Burns
- Sequalae, Complications
- Other/Undetermined
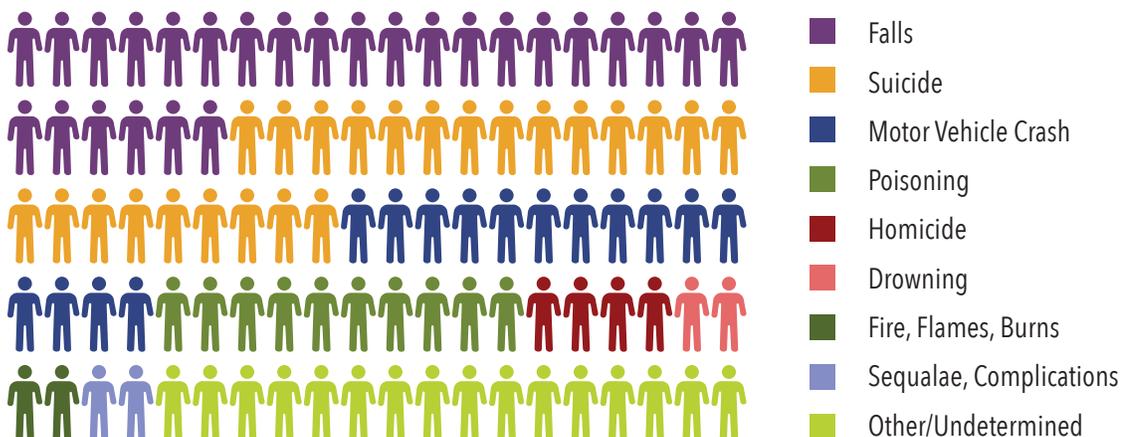
Figure 3

Injury Hospitalizations by Cause in Canada, all ages and both sexes from 2009/10[8]

- Falls
- Self-Inflicted
- Motor Vehicle Crashes
- Assault
- Struck by Object
- Poisoning
- Fire & Flame
- Other/Undetermined
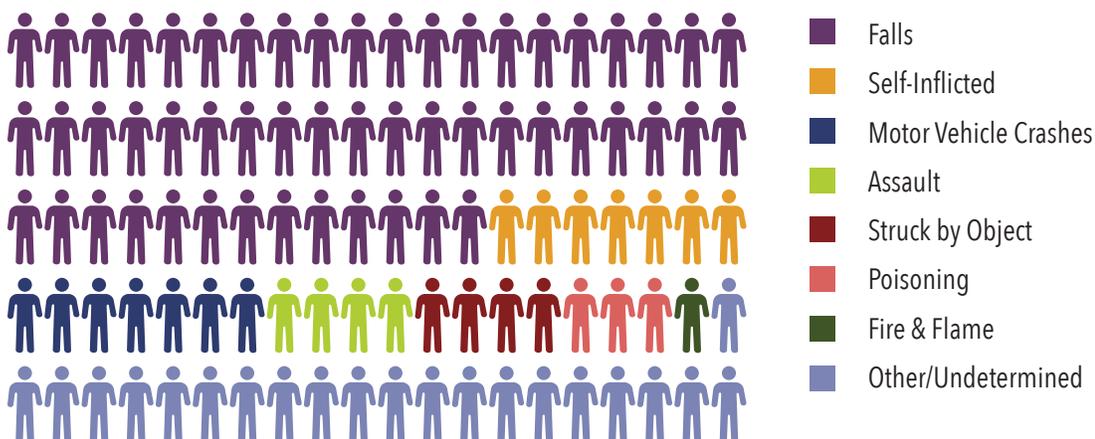
The Burden of Injuries in Canada

According to a 2015 report by Parachute Canada, injuries in Canada in 2010 resulted in over 15,000 deaths, 231,000 hospitalizations, nearly 3,500,000 emergency department visits, and over 60,000 Canadians left with some form of permanent disability.[9] This is equivalent to, 43 Canadians dying each day as a result of injuries and at least 7 Canadians permanently disabled every hour.[9] Of the deaths that occur due to injury, many of them occur among the young, arguably during their most productive years. Potential years of life lost (PYLL) is an estimate of the average years a person or group would have lived had they not died prematurely, calculated using an average life expectancy of 75 years. In 2010, the overall PYLL for Canada due to injuries was 1337 years,[9] far greater than for all other causes of death. The burden of injuries in Canada is a significant public health concern. Each year,

thousands of Canadians lose their lives and many more are left with partial or permanent disabilities due to injuries. Individuals, families, communities, and the nation as a whole are left with the social, emotional and financial, burdens of injuries, the vast majority of which are entirely preventable.

The Economic Burden of Injuries

The National Economic Burden. In 2010, the total cost of injuries in Canada amounted to $26.8 billion.[9] Direct health care costs of injury were $15.9 billion whereas indirect costs such as reduced productivity, disability, and premature death amounted to $10.9 billion.[9] The national per capita costs averaged $788, ranging from $1059 in Saskatchewan to $715 in Quebec. The national per capita cost that injury exerted on the health care system was $467, ranging from $390 in Ontario to $579 in Nova Scotia (see Table 3). The majority of the economic burden of injuries in Canada is a result of unintentional injuries, accounting for 82.5% of total costs in 2010.[9] The costliest causes of injury in 2010 were falls ($8.7 billion), transport incidents ($4.3 billion), and suicide/self-harm ($3 billion).[9]

Table 3

Cost of injury per capita by province in Canada, 2010[9]

Jurisdiction	Economic cost (per capita)	Health care costs (per capita)
Alberta	$1,083	$553
British Columbia	$816	$495
Manitoba	$958	$554
New Brunswick	$924	$531
Newfoundland and Labrador	$749	$477
Nova Scotia	$877	$605
Ontario	$693	$405
Prince Edward Island	$772	$526
Quebec	$746	$470
Saskatchewan	$1,108	$602
Canada	$820	$486

The Financial Burden of Childhood Injuries. For children ages 1 to 14, injuries are the leading cause of death, with close to 300 children killed and 21,000 hospitalized every year.[1] The leading causes of injury death for children are motor vehicle collisions, drowning, poisonings, and falls, most of which are preventable. Though injuries affect those of all ages, children are particularly vulnerable as their bodies undergo rapid developmental changes and are relatively weaker compared to the adult body, further increasing their susceptibility to injuries.

Families of children hospitalized by injury or disease, are often faced with immediate financial strains, and often include travel costs, parking fees, and the cost of meals. In a 2004 Australian study on the financial burden to parents of hospitalized children, the average cost for both meals and parking totaled to almost $200 Canadian dollars a week.[10] In addition, other costly medical procedures not covered by health insurance can have a significant toll on parents and families, especially for those in lower-income categories.

The Economic Burden of Injuries on the Workforce. As the cost of living rises in cities across the nation, Canadians face the ever-increasing need to work in order to sustain themselves or their families, and increasingly, this includes two income families as the norm. With such a large responsibility, injuries among workers or their families can have major financial repercussions. When a spouse, child, or parent is injured or ill, employment Acts in Canada and the US allow workers unpaid leave to care for a family member.[11] While leaves from work to care for injured family members is a positive workplace benefit, the majority of surveyed workers indicated that they could not afford to leave work for an extended time to care for family members and potentially reduce their earnings.[12]

When injuries occur on the job, their effects often have major personal and national economic consequences. According to recent statistics from the Labour Department of Canada, 1 out of every 46 workers covered by a compensation plan was injured severely enough to miss at least one day of work in 2008.[13] A 2001 American study on occupational injuries, found that worker's compensation benefits only replaced between 32 – 42% of a 10-year losses before taxes.[14] With such losses, injuries can lead many workers to borrow money, move or sell their homes, and deplete savings to sustain themselves or their family. As a whole, the direct cost of occupational injuries and fatalities to the Canadian economy totaled to approximately $9.7 billion in 2008.[13]

The Social Burden of Injuries

The Social Burden of Injuries to Children & Families. Although bumps and bruises are an everyday part of growing up as a child, more serious and life-threatening injuries can not only place burden on a child's physical health, but also affect the social and psychological life

of a child and their family. Every day, almost 60 children are hospitalized as a result of injuries that are largely preventable.[8] Whether they are at a hospital or at home, injuries often impact the primary occupation of children in Canada – attending school. In a recent report on injuries among young Canadians by the Canadian Institutes of Health Research[15] some 1 in 4 students missed at least one day of school due to an injury, while 6 – 10% of students missed 5 or more days in 2010. Parents and teachers encourage students to remain at home when sick or injured, but students are often very concerned about missing school even for short periods of time. This added stress, in addition to their time away from school, may affect a child's emotional wellbeing, peer relationships, and future academic performance.[16,17]

When a parent is injured, the psychological effects can often also affect the health of their children. In a recent 2014 American study[18] on the psychological health of parents and children from injuries, injured parents showed decreases in quality of life and higher levels of depression compared to parents not injured. Even more concerning was the finding that when both parent and child are injured, the child is more likely to develop post-traumatic stress disorder (PTSD) symptoms.[18] Siblings of sick and injured children are also often subject to a great deal of stress from changes in family behaviour and structure, which can lead many to feel resentment or jealousy towards the injured child that receives more parental attention.[19,20]

The Psychological Burden of Injuries. Aside from declines in physical health, injuries can often lead to significant changes in the mental and psychological health of an individual, post-injury. One of the most common psychological ailments suffered by many post-injury is post-traumatic stress disorder (PTSD).[21] Post-traumatic stress disorder (PTSD) can be defined as a state of anxiety characterized by the persistent re-experience of traumatic events through dreams, hallucinations, and flashbacks that can lead to feelings of extreme fear, anxiety, and helplessness.[22] Serious injuries involving death or the threat of death to oneself or others can possibly elicit PTSD. PTSD symptoms can be short lived (acute), long term (chronic), or even not appear until months after the traumatic injury, but all forms of PTSD play a large role in an individual's life after their injury. In a 2008 US study of traumatic injury hospitalization with over 2,700 participants, 20% of patients displayed PTSD symptoms a year following their injury.[23] However, research has also shown that strong social support from family and peers is a strong protective factor against PTSD and other common psychological conditions, such as depression.[24,25]

KEY POINTS

❖ Injuries can be classified as unintentional (falls, drowning, etc.) or intentional (suicide, violence, etc.) based on the presumed intent

❖ The vast majority of injuries are unintentional, predictable, and preventable

❖ Globally, approximately 1 out of every 10 deaths are a result of injuries

❖ Globally, 2 out of 3 injuries are sustained by males

❖ For the first 3 decades of life, more Canadians die from injuries than any other cause

❖ Leading causes of unintentional injury in Canada are falls, motor vehicle collisions, and poisonings

❖ Leading causes of intentional injury in Canada are suicide and homicide, with 1 out of every 4 injury-related deaths being a result of suicide

❖ In 2010, injuries result in over 15,000 deaths, 231,000 hospitalizations, and nearly 3,500,000 emergency department visits in Canada.

❖ In 2010, the national cost of injuries in Canada amounted to $26.8 billion

❖ Families of injured children are often under large financial burdens with unexpected costs of hospitalization, therapy and rehabilitation.

❖ The Compassionate Care Act allows workers unpaid leave to care for sick or injured family

❖ Occupational injuries can have major financial burdens as injured workers may resort to borrow money, sell or move homes, and deplete savings.

❖ Every day, over 60 children are hospitalized as a result of injuries

❖ 1 out of every 4 students will miss at least one day of school due to injuries

❖ Parents, children, and siblings may all be under large amounts of stress as a result of injuries and changes in family structure and behaviour

❖ Traumatic injuries can lead some to develop post traumatic stress disorder (PTSD), anxiety disorder, depression, or other psychological ailments

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2

Canadian Evidence-Informed Practice Model

What is evidence-informed practice and how is it different than evidence-based practice?

Evidence-informed public health is "the process of distilling and disseminating the best available evidence from research, context and experience, and using that evidence to inform and improve public health practice and policy."[1] It is the process and practice of making decisions and creating change to promote health and wellbeing. This is different from classically defined evidence-based practice that, in principle, suggests practice decisions are made from clinical research studies. Over the past few decades, it has been recognized that there is much to be gained from the evidence of prevention in 'real world' practice, including evidence from practitioners, stakeholder, knowledge users, and other resources. In the current health care environment of scarce resources and competing issues, it is important that existing efforts and resources are focused on programs that are effective and evidence-based. At the same time, it is essential that the injury prevention community values the evidence generated from and with the people that implement injury prevention practice. To understand the transferability of interventions and why some strategies work in one setting or context and not in others, is important for the practice of injury prevention. Practitioners must "learn to effectively transfer good practice to other settings/contexts."[2]

Why focus on evidence-informed practice?

Evidence-informed injury prevention practice includes a comprehensive approach that includes different types of evidence from both research and practice (see Chapter 2.1 Public Health Approach for more information on the evidence informed public health movement). Following evidence-informed practice includes the actions needed to adopt, implement and evaluate effective interventions to reduce injury, while recognizing the importance of context and the interactions between individuals, communities, policies, and the physical environment. Evidence regarding cost-effectiveness also exists for a number of strategies, and thus provides a significant opportunity to save lives, while saving money at the same time.[2] Without a focus on the use of evidence, clinical practice, individuals, organizations, communities, policy makers, and others "will continue to invest resources in strategies that do not lead to reducing the burden of injury."[2]

There are several reason why implementing an evidence-informed approach can be complex and challenging, including:

❖ Resistance to change

❖ Competing priorities

❖ Failure to plan solutions effectively

❖ Lack of capacity or expertise

❖ Lack of time or resources[2]

❖ The value of an evidence-informed process is realized when the best available research evidence is combined with the practical expertise of professionals in the 'real world'.

❖ With so much to do to address the injury burden in Canada, so little time, and limited resources, there is a need invest in strategies that are most likely to reduce injury.

❖ Numerous ineffective strategies continue to be practiced across Canada despite evidence that they are not the best use of resources.

❖ An evidence-informed process is crucial to effective planning and is useful at more than one point in the planning process.

❖ Evidence from research studies is necessary; however, it is only one part of the process to effect change. The role and impact of the community, and the political and social contexts, drive the successful uptake and implementation of injury prevention practice.

Value is realized when the best available research evidence is combined with the practical expertise of professionals in the 'real world'. This approach requires that professionals are aware of both best evidence and practical aspects of transferring policies and programs from one setting to another.[2]

Strategies to be evidence-informed

Using an evidence-informed approach in prevention planning ensures that the use of different types of evidence occurs at more than one point in the planning process.[3] Knowledge of this process is essential in order to ensure a plan has real impact and uses scarce resources effectively. Section 2 of this resource focuses on the public health approach and suggests ways to use different types of evidence in order to ensure the best programs are selected to address the injury problem at hand.

There are essential components that need to be considered, which include: using the best available research; considering the local health issues and local context; using existing public health resources; and understanding the community and political climate.[1,4-6] It is important to recognize that while evidence from research studies is necessary, it is only one part of the process to effect change. The role and impact of the community and the political and social context (e.g. priorities) drives the successful uptake and implementation of injury prevention practice. This section of this resource will further expand on each of these components in more detail.

Finally, it is important in each component to make "the best use of resources by focusing on those strategies most likely to work in finding a good practice that has been proven to be effective."[2]

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2.1

The Public Health Approach

History of the Public Health Approach

The Canadian Public Health Association has traced the history of public health in Canada over the last 100 years, highlighting a number of important milestones that have been made in the field. Historically, public health concerns in Canada centered on infectious disease outbreaks spreading across the early colonies, including the Montreal smallpox epidemic and the "Spanish influenza".[1] Scientific discoveries altered the understanding of how infectious diseases are transmitted and can be prevented, motivating a number of growing efforts to stop the spread of disease. These prevention efforts, including the implementation of food and water safety regulations and screening measures, increased sanitation, and improved nutrition, education and immunization efforts, resulted in a decrease in the risk of prevalent communicable diseases impacting communities across Canada.[1] An important characteristic of the Public Health Approach was its increased focus on the upstream factors that contribute to the incidence of infectious disease. While infectious diseases were an important priority, fatal and non-fatal injuries were also prevalent with new risk factors emerging. Approaches being used to reduce risks of infectious disease, however, were not applied in the same way to think about the preventability of injury.

The Public Health Approach was first extended outside the realm of classic disease prevention in the 1980's. What signaled public health's entry into the world of preventable injury was seminal work in the application of the Public Health Approach to violence prevention.[2] The public health perspective towards injury was influenced by recognition that injuries are not accidents – they are predictable and preventable events. Applying this

approach to the prevention of injuries brings together multidisciplinary teams including: epidemiologists, health care practitioners, behavioural scientists, biomechanists, rehabilitation specialists, and knowledge translation experts, that create both a systematic and scientific basis to address the significant burden of injury. Despite this movement and recognition that injuries are not accidents, injury continues to be a significantly underfunded and largely understudied area of public health.

The Public Health Approach

The Public Health Approach is first and foremost preventative in nature. It involves understanding the underlying determinants of health problems and developing effective prevention strategies. There are five classic steps in the Public Health Approach including: surveillance; research on risk and protective factors; research on interventions; program and policy implementation; and evaluation and monitoring.[2,3] It has been recognized that to successfully prevent injuries, all five functional elements need to be operationalized, but not necessarily in a linear sequence. Closely tied to the public health approach is a series of concepts that have been introduced as part of the evidence-informed public health movement, which are necessary to consider at each of these stages. The following sections in this chapter will review each step in the Public Health Approach. The final section will briefly review principles of the evidence-informed public health movement and demonstrate how it contributes to the five components of the public health approach.

❖ The Public Health Approach includes five functional steps: surveillance, research on risk and protective factors, research on interventions, program and policy implementation, and evaluation and monitoring.

❖ The functional steps of the Public Health Approach align with principles of the evidence-informed public health movement that emphasizes the use of different types of evidence, evidence synthesis and critical appraisal, and prioritization, based on the strength and consistency of evidence.

❖ All of the steps of the public health approach are necessary in order to successfully prevent injuries over time.

Surveillance

The first stage in the Public Health Approach is surveillance. This is a process that begins with defining the injury problem and continues through to systematic data collection. To

accurately describe the burden and impact of injury on Canadians and the Canadian health care system, surveillance measures used include mortality and morbidity data. This ensures that attention is drawn to both the prevalence and severity of injury problems. Injury indicators can also be used to describe the burden of injury problems in Canada. The Child Injury Prevention Injury Outcome Indicators project[4] identified three main indicators that can be used across all injury types and that were found to be most important amongst decision makers: mortality rate; potential years of life lost; and hospital separation rate.

These measures are used as indicators of both the burden and severity injury. For example, an increase in mortality due to a specific injury would indicate the need for more effective injury prevention strategies in that specific area. A decrease in mortality may indicate injury prevention strategies are working. A measure such as hospital separations rate gives a value to the burden of injury to the health care system. Tracking the specific trends in injury diagnosis can in turn be used to inform prevention programs. When prevention strategies are implemented with no plans to continue to invest in surveillance, there are no means to evaluate the effectiveness of these strategies or detect inadequacies with respect to implementation.

Risk and Protective Factors

Unlike mortality and morbidity measures that serve to describe burden across different types of injuries, establishing the risk and protective factors surrounding a particular injury type provides an indication of the underlying behavioral and environmental determinants of an injury problem.[5] For example, important risk factors for drowning that have been established include age, alcohol use, and lack of training.[6,7] Important protective factors for injuries and fatalities resulting from motor vehicle collisions include restraint use.[8] The second stage of the Public Health Approach is to synthesize the evidence of the risk and protective factors for injury.

There are two important types of information on risk and protective factors: 1) the availability of sound evidence of an association between a risk or protective factor and an injury outcome, and 2) information on the prevalence of these factors in the target population. Evidence on risk and protective factors is fundamental to the development of prevention strategies. Limited access to information on the prevalence of specific risk and protective factors within a defined population can challenge efforts to select high-impact prevention strategies. For example, a promotional campaign to encourage the use of seatbelts will not be likely to result in any measureable impact on motor vehicle injuries if the population targeted already has a high compliance rate.

Selecting/Designing an Intervention

The third stage of the Public Health Approach is to develop and/or select effective prevention strategies. Information that is gathered at this stage informs the development or selection of an effective, targeted intervention aimed to reduce the injury risk established at the surveillance stage. Gielen and Sleet (2003) categorized injury prevention strategies into 'active or behavioral strategies' and 'passive or environmental strategies'.[9] This can help practitioners to think about the type of intervention to be designed or selected, and to align efforts to create an inclusive, impactful program to effectively reduce injury. Active behavioural strategies are designed to encourage people to take measures to protect themselves and others from injury. For example, this may include programs designed to prevent fatalities from motor vehicle collisions among infants through educational interventions to promote the use and proper installation of child safety seats.[10] Passive or environmental strategies are designed to change products or environments to prevent injury. For example, this may include the installation of ignition interlocks in vehicles to reduce alcohol-impaired driving and alcohol-related crashes.[11,12]

The development and/or selection of prevention strategies should coincide with efforts to evaluate impact on behavioural objectives and injury outcomes. At this time, there is a growing body of synthesized literature on the effectiveness of prevention strategies. Prior to developing a new prevention strategy, there is significant value in first reviewing the available evidence on the effectiveness of prevention strategies for a defined injury problem focusing on synthesized literature.[13] Evidence from the behavioural sciences can also support the development of new strategies by identifying the underlying constructs that link behavioural objectives to intervention components.

Research on interventions is an important component of the Public Health Approach; however, a number of prevention strategies are delivered on an on-going basis without any supporting evidence of effectiveness. The delivery of injury prevention strategies with no supporting evidence of effectiveness or efforts to evaluate levels of effectiveness poses the risk of on-going investment in strategies that will not contribute to a measureable reduction in injury risk.

Program and Policy Implementation

A well-thought-out implementation strategy increases the chances of success when an organization or community adopts an evidence-based prevention strategy. The collection and use of this information is critical when applying an evidence-informed approach to prevention practice. There are four core components that can help support the successful implementation of prevention strategies: 1) maintaining the fidelity of existing evidence-based prevention strategies; 2) the careful adaptation of existing strategies for new populations and settings; 3) the development of a well planned implementation strategy; and 4) support to ensure the sustainability of the strategy over time.

Implementation fidelity has been defined as "the degree to which...programs are implemented...as intended by the program developers".[14] This can be extended to think about how to successfully scale-up existing evidence-based strategies. To ensure that the intended outcomes are met, there is a need to retain the core components and implementation supports that are important for the effectiveness of the program or policy[15,16] Carroll et al. (2007) have developed a conceptual framework to understand and measure implementation fidelity based on a review of existing literature.[17] To measure implementation fidelity, one must consider levels of adherence to the details of content including coverage, frequency and duration. This is supported by potential moderators, including the comprehensiveness of policy description, strategies to facilitate implementation, quality of delivery, and participant responsiveness.[17]

The second component worth considering for program or policy implementation is adaptation. Existing evidence-based prevention strategies may be used to target new populations and settings. There is a need to ensure that the components and delivery of the intervention to be applied fits the target population. Considering the adaptation of an existing prevention strategy for a new population, Castro et al., (2004, 2010) outline a range of potential sources of mismatch including different languages, underlying risk profile, urban or rural setting, type of staff, and community readiness that may result in impact of a misalignment between the intervention and the new population.[17] For example, without sufficient levels of community readiness in a new population, there may not be sufficient infrastructure to deliver the program.[18] Various tools are now available to help guide the adaptation of evidence-based prevention strategies.[18-20]

The third component outlined above is a well-planned implementation strategy. Prevention strategies found to be effective in a controlled setting or specific population may not be effective when scaled-up or targeted towards a new population.[21-23] There is a need to identify the processes and supports used to successfully implement prevention strategies. Previous evaluations of successful prevention strategies may provide information on specific conditions, resources, and supports used to support delivery. If there is a gap in the availability of this information, generalized implementation science theory and concepts can

guide the development of an implementation strategy.[24] Implementation strategies should be described with the same level of detail as core program components to facilitate replication and measurement of implementation fidelity.

The final component that has been outlined for program and policy implementation is sustainability. Sustainability has been defined as the "degree to which an innovation continues to be used after initial efforts to secure adoption are completed".[25] Following successful implementation, a prevention strategy may fail to be maintained within an organization or community setting. Initial implementation and sustainability are distinct factors, and require careful consideration at the design stage.[26] A number of internal and external factors can influence a prevention strategies' sustainability following integration into standard practice,[24] including changing priorities and resource availability.[27] To support the long-term success of prevention strategies, there is a need to identify factors that are required to maintain the strategy over time, such as the nature of the strategy, the context in which the strategy will be implemented, and the population that is being targeted.

Evaluation and Monitoring

The final stage of the Public Health Approach is evaluation and monitoring. To promote successful evidence-based prevention strategies to reduce injuries across Canada, there is a need to focus on collecting information that can help improve the design, delivery, dissemination, and sustained use of evidence-based interventions. This information can also help monitor the fidelity of evidence-based strategies. Evaluation is a critical component within the process of mobilizing an intervention, as it demonstrates its success to funders, the community, and/or individuals committed to reducing injury in Canada. If the intervention does not meet its intended outcomes, evaluation provides the means to identify barriers and make appropriate changes to increase the success of the intervention moving forward.

There are three types of evaluation involved in successful program planning: formative, process and outcome evaluation. Formative evaluation includes activities at the pre-project planning stage and during initial implementation.[28] At this stage, one would first consider the need, fit, resources, evidence, readiness, and capacity related to the intervention under consideration.[29] Program logic models have been recommended as a strategy to support ongoing monitoring and

evaluation and are part of the formative evaluation stage.[30,31] Traditional logic models define the inputs, processes, and outputs of the prevention strategy connected to the initial, intermediate, and long-term outcomes. Evaluations will typically examine both process and outcome indicators. Outcome indicators focus on measuring how well the prevention strategy met its intended results. Initial, intermediate, and long-term outcomes of a prevention strategy can be examined to inform whether the overall goals of the program have been met.

Process indicators focus on tracking the intensity of what is being delivered (e.g., number of people participating in training sessions) and how participants are responding to the intervention components (e.g., levels of satisfaction with training sessions).[30] This information can be used to improve the delivery of prevention strategies and explain why the desired outcomes were not met. Information from both process and outcome indicators should play a critical role in the evaluation of an injury prevention strategy. Outcome evaluation asks the important question of whether or not a program was effective.

Evidence-Informed Public Health

This final section discusses the evidence-informed public health movement,[32] which was introduced in the first chapter in this section, and outlines how it relates to the five components from the general Public Health Approach.[2,3] Both the evidence-informed public health movement and the general Public Health Approach focus on the upstream factors that influence health problems and integrate different types of evidence to inform prevention practice. The evidence-informed public health movement incorporates the five components reviewed above; however, it makes further contributions through advocating for: 1) greater use of this information in public health decision making; 2) a focus on the best available scientific evidence; 3) increased role of the community in decision making; 4) increased focus on evidence-synthesis to mobilize prevention strategies that work as opposed to a sole focus on the development of new strategies; and 5) a more rigorous and critical approach to the use of evidence in practice.[33] Brownson et al. (2009) provide a comprehensive review of concepts and tools associated with 'evidence-based public health'.[33] Other authors have referred to the 'evidence-informed public health' movement, using the phrase 'evidence-informed' rather than 'evidence-based' to acknowledge that decision-making in public health practice should be influenced by available evidence from research but also integrate considerations around the local context, community or political readiness, and available resources.[32,33]

The evidence-informed public health movement advocates for an increased focus on evidence synthesis, critical appraisal, and evaluation of the strength and consistency of evidence.[33] Consistent with the Public Health Approach, the process of evidence-informed

public health gathers evidence that draws on injury indicators, risk and protective factors, and research on interventions and their implementation.

By using the evidence-informed public health approach, activities in public health practice are explicitly linked with the underlying scientific evidence that demonstrates effectiveness. It has been argued that components of the Public Health Approach will only be successful if accompanied by strategies and principles of the evidence-informed public health movement.[32,33]

Case Study: The Public Health Approach to Traumatic Brain Injury

The CDC has adopted the public health approach to influence their research and programs targeting traumatic brain injury. In 2005, the CDC published an article that provides an overview of how the public health approach has been used to identify important efforts needed to reduce the impact of this injury type.[34] They provide an overview of their work across 4 areas including surveillance, identifying risk and protective factors, developing and evaluating intervention, and dissemination information to improve TBI outcomes.[34]

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The Injury Prevention Spectrum and the 3 E's

The Three E's of Injury Prevention

In the era following World War II, a number of industrial safety programs began. Many of these were organized around a model believed to have been developed by the U.S. military during the war years, called the Three E's of Safety: Education, Enforcement, and Engineering. As injury prevention began to emerge as a distinct discipline, the model of the Three E's was often incorporated into the design of prevention programs in the community, in addition to those in the workplace.

Figure 4
The Three E's of Injury Prevention

E Education Enforcement Engineering

Education

The basic concept behind education is that the public, given information or skill training, will retain what has been taught and use it to reduce the risk of injury. Examples of educational interventions include an initiative that trains and counsels parents to reduce the risk of household pediatric injuries by reducing exposure to prescription medications and household cleaning agents[1] or strategies aimed at promoting the use of booster seats to reduce the risk of injury from a motor vehicle collision.[2]

Enforcement

Enforcement strategies include the creation and enforcement of laws, regulations, and policies aimed at reducing injuries. These strategies are generally effective when enforced; however, they are often a contentious public issue as opponents often characterize them as limiting personal freedoms. Examples of enforcement interventions include graduated driver licensing;[3] the banning of a consumer product that has been determined to be too risky for general use (such as baby walkers or three-wheeled all terrain vehicles) or the mandated use of a product designed to reduce injury, such as bicycle helmets.[4]

Engineering

Engineering strategies involve the development or modification of products and environments to make them safer. It involves modifying some aspect of a product or the environment.   Generally, engineering efforts are very effective. Examples of engineering approaches include a change in residential hot water heaters that are installed at a medium water temperature rather than high, in order to reduce the risk of scald injuries from overly hot tap water;[4] the installation of ignition interlocks in vehicles to reduce recidivism among convicted drunk drivers;[5] or traffic calming features incorporated into residential neighbourhoods.[6]

The major contribution of the 3 E's model of injury prevention has been the shift in focus from injuries being seen as the sole responsibility of the person injured, to the recognition that others (e.g., employers, supervisors, equipment manufacturers, policy makers, designers of the built environment, whole community) have a collective responsibility to prevent injuries. Multi-faceted initiatives that use more than one strategy have the greatest chance for success.[4] For example, community-based, multi-faceted interventions to prevent falls have been cited in the literature as effective programs for seniors.[7] In recent years, there have been efforts to expand this model to embrace a more multi-faceted, health promotion orientation by adding more E's such as: Economics, Evaluation, Enablement, and Empowerment; however none of these alternative models have been commonly adopted.

The Spectrum of Prevention

In 1983, Dr. Larry Cohen introduced a multi-factorial model called the Spectrum of Prevention. The model is comprised of six interrelated levels and was designed to shift focus beyond individual educational interventions to a multi-factorial approach. Briefly, the spectrum consists of: strengthening individual knowledge and skills; promoting community education; educating providers; fostering coalitions and networks; changing organizational practices; and influencing policy and legislation. These are arranged in a rough hierarchy, with interventions at the higher-level of the spectrum being more efficient in terms of effort per person impacted, and are generally more effective than those lower down in the hierarchy. However, the levels are interrelated, and those interventions most likely to succeed will be those that address multiple levels in the spectrum.[8]

Figure 5
The Spectrum of Prevention*

THE SPECTRUM OF PREVENTION

Influencing Policy and Legislation

Changing Organizational Practices

Fostering Coalitions and Networks

Educating Providers

Promoting Community Education

Strengthening Individual Knowledge and Skills

Cohen and Swift define the first level of the spectrum, building individual knowledge and skills, as "enhancing an individual's capability of preventing injury or illness and promoting safety."[8] This is analogous to education, the first E of the 3 E's. An example of action or a program at this level of the spectrum would be a program offered to teach individuals in the safe operation of a new piece of technology, or the instruction sheet provided with most consumer goods. The second level of the spectrum, promoting community education, is an extension of the above individual approach to include situations where information is provided to a larger audience. Examples include public awareness campaigns and social marketing efforts directed through mass or social medial channels. Educating providers is

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* The Prevention Institute http://preventioninstitute.org/component/jlibrary/article/id-105/127.html

the next level, defined by Cohen and Swift as, "informing providers who will transmit skills and knowledge to others."[8] Examples of this strategy include providing training to professionals, such as delivering the Canadian Injury Prevention Curriculum to Health Promotion staff in public health units, as well as various 'train-the-trainer' peer leadership and mentorship programs. Fostering coalitions and networks is the fourth level of the spectrum, which acknowledges that to successfully and effectively reduce injuries requires effort from multiple individuals and groups. Building effective teams, coalitions, alliances, and networks that consist of people from a variety of disciplines and interest in the program to reduce injury can be seen to be a prevention intervention in its own right, and has been previously discussed in this section (See Chapter 2.1 Public Health Approach) as an important component of any successful multi-factorial injury prevention effort. Examples of fostering coalitions and networks include the Canadian Collaborating Centres for Injury Prevention. Finally, the sixth level, changing organizational practices, is described by Cohen as the most often forgotten level of the spectrum. It involves working for change in policy and procedure at an organizational level, ranging from educational institutions or law enforcement, through to changing practices and norms in the corporate sector. This level is also analogous to the enforcement E in the 3E's of injury prevention. Examples range from changes in enforcement strategies by running sobriety checkpoints to reduce drunk driving, and to improving the occupational health and safety culture to reduce the risk of occupational injury within a large company. Changes in municipal, provincial/territorial, or federal laws, as well as formal policies and standards is also a focus of the sixth level of the spectrum. Examples range from the creation of municipal alcohol policies for public events, to adopting consumer product safety legislation and empowering government agencies to issue recalls of hazardous products.

As with the three E's of injury prevention, the Spectrum is a tool that encourages prevention practitioners to think beyond individual education. Both models encourage the use of multiple strategies focused at more than one level, in order to achieve the highest degree of effectiveness.

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2.3.1

The Public Health Approach is widely used by prevention researchers and practitioners as a systematic way to estimate the burden of a problem, evaluate risk and protective factors, and to develop and evaluate interventions. As introduced in Section 2.1, the five steps involved in the Public Health Approach include: 1) surveillance; research on 2) risk and protective factors; 3) designing/selecting interventions; 4) program and policy implementation; and 5) evaluation and monitoring. Also mentioned in Section 2.1, is the evidence-informed public health movement, and its close tie to the Public Health Approach. This chapter will discuss the process to operationalize the first step in the Public Health Approach, defining an injury problem, and will suggest a process to gather this information that aligns with the evidence-informed public health movement.

Ways to Define an Injury Problem in Canada

There are traditional ways to define incidents in public health related to injury prevention and they include: incidence, prevalence, and the burden of injury. Alternatively, there is also the use of 'injury indicators,' which are operationalized to define the burden of specific injury problems in Canada, as developed by the Canadian Injury Indicators Development Team. There are different types of indicators classified as outcome, risk, and policy indicators.[1] Outcome indicators draw on incidence, prevalence, and burden of injury data that can help describe an injury problem in Canada. Risk indicators capture data regarding risk and protective factors that include data on, for example, child restraint use, seatbelt use, bicycle helmet use, and measurable aspects of playground safety, such as surface performance. These are the underlying behavioral and environmental factors that injury prevention

programs are designed to address. Finally, there are policy indicators that include data that pertain to legislation and policies currently in place.

The following sections outline the most common data types used for outcome indicators to define an injury problem: incidence, prevalence, and the burden of injury; as well as the systematic approaches to attain this information. Outcome indicators can help support a strategic planning process by identifying where the top injury problems are. This data can also be used to monitor trends in the top injury problems in Canada. Outcome indicators can also be used routinely in the development of communications to the public about injury prevention.

Incidence. Incidence is defined as the number of new cases of a given condition occurring within a defined population.[2] It is usually represented as a rate, calculated by the number of injuries divided by a population over a given period of time. For example, the rate of Emergency Department visits for young children (0-4) injured in Ontario from 2002-2003 was 12,410 per 100,000.[3] Other common ways to measure incidence is the number or rate of hospitalizations or deaths. These can also be called morbidity rates (which commonly use health care utilization measures), and mortality rates (which calculate the number of deaths).

Prevalence. Prevalence is defined as the number of cases of a given condition at a specific point in time. It is similar to incidence, but also considers the duration of a specific condition. Prevalence is generally used to define infectious or chronic diseases and rarely used as a measure in injury. This is in part because of the difficulty in defining how long an injury lasts and when and if an injury moves from an acute to chronic phase.

Burden of Injury. Increasingly, the burden of injury is being chosen as the optimal way to define an injury problem. Calculating burden takes into account how much it costs the health care system to care for people who are injured at the time of their injury.[4] The strength of this approach is that it also calculates costs in terms of time lost from work, damages to person and property, and the ongoing cost of disability that results from the injury.

One measure of the burden of injury is Disability Adjusted Life Years, or DALYs. This combines two concepts – the years of life lost due to premature death, as well as the adjusted quality of life due to years living with a disability as a result of injury. The Global Burden of Disease study presents data on DALYs for many health conditions around the world, including those resulting from injury and violence.[4]

Locating the Best Available Research Evidence

The first step to locate the best available surveillance data is to clearly define the problem at hand by setting an operational, measureable, and answerable research question.[2] Injury is a

problem across the lifespan, so it is important to define the problem for the specific population under study to determine who is at increased risk. Previous Canadian research suggests there is substantial variation in who sustains an injury by age, sex, geographic location, and socio-economic status.[5] Clearly defining the problem by taking all of these factors into account will help focus the search strategy at the stage of evidence gathering. The evidence-informed process recommends framing a research question/problem using the following four elements: population, intervention, comparison, and outcome (PICO).[2]

PICO has been used traditionally in the process of gathering evidence to examine if/how an intervention works within a particular population, e.g. does enhanced enforcement intervention or program increase seat belt use in licensed Canadian drivers? However, PICO can be used as a tool to assist practitioners in a process to gather surveillance data required to establish the burden of injury at hand. There are variations of PICO, applicable to causation and qualitative studies that can help in the second stage of the Public Health Approach to understand the strength of association between and risk or protective factors. For example, PICO is used in cases to examine causation (e.g., does cellular phone use increase motor vehicle collisions in licensed Canadian drivers), where "I", intervention is replaced by "E", examination of an exposure as a causal factor for an outcome. Finally, there is PS, specific to creating literature search questions for qualitative research where the problem being examined may not include an intervention or comparison group. Population remains the same as in PICO, where the population of investigation is identified, but the intervention and comparison elements are replaced with "S", situation, e.g. what is the experience of obese children ages 11 – 15 years when they participate in a neuromuscular training program designed to decrease sport related injury?

> ## PICO
>
> **Patient/Population/Problem:** Who are the people of interest? What is the age group, sex? What is the injury problem?
>
> **Intervention/Exposure:** What is the intervention or exposure?
>
> **Comparison:** What is the alternative to the intervention or exposure?
>
> **Outcome:** What is being measured?

Conclusion

Defining the problem is one important step in the Public Health Approach to preventing injury. When considering how to define the problem, it is important to understand what type of data will be used: Is it incidence, prevalence, or burden that is being considered? It is also important to understand mortality and morbidity, as well as ongoing disability resulting from injury. Finally, defining a specific, answerable, searchable question is part of a focused strategy to find the highest quality research evidence available on injury burden.

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Steps in the Public Health Approach to Injury Prevention
Identifying Risk and Protective Factors

As outlined in Chapter 2.3.1 (Surveillance: Defining the Injury Problem), first stage of the Public Health Approach is to define the injury problem at hand. This includes a process to gather information from injury surveillance data and other sources. After the injury problem has been defined and a specific question has been formed to help gather evidence to support efforts to reduce the injury problem, the next step in the process is to identify the underlying risk and protective factors. This section discusses the importance of determining both risk and protective factors specific to an injury problem. Understanding the factors that contribute to the issue is a necessary part of prevention that helps practitioners plan prevention programs. The objectives set out in intervention planning will focus on changing or enhancing the established risk or protective factors. The intervention designed or selected will then be based on proven practices to address that risk or protective factor.

Risk and Protective Factors

Earlier sections in this resource described the various determinants of health and their relationship to injury. A determinant is a word used to describe factors that control or influence an outcome. A determinant can place an individual or community at greater, or lesser, risk. The key determinants described in Section 3.0 of this resource are examples of risk and protective factors for injury. A risk factor is defined as any attribute, characteristic or exposure of an individual that increases the likelihood of developing a disease or injury.[*] For example, across most injury types, low socioeconomic status is associated with increased

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[*] Retrieved from http://www.who.int/topics/risk_factors/en/

risk of injury. Studies report that children and youth are more likely to suffer fatal and non-fatal injury as the result of a motor vehicle collision.[2] Studies carried out in Europe demonstrate a strong link between socioeconomic status and injuries/deaths from falls, burns, drowning and poisoning in children and youth.[2] In addition, males and younger age groups are more at risk for suicide if they have poorer socioeconomic status.[3]

Most often in the literature, risk and protective factors for injury are broken down by injury type. For instance, speed is a significant risk factor for a motor vehicle related injury.[3] Falling from a significant height on hard playground surfaces increases the risk of injury and fracture, compared to standing height.[4] (See Chapter 4.4.2 on Children's Falls). Older men are more at risk of dying from a fall than older women, whereas older women are much more likely to be hospitalized because of a fall, compared to older men.[5]

Compared to risk factors, protective factors are those variables that act to protect an individual from the risk of injury.[6] Higher socioeconomic status is the most cited factor to reduce the risk of injury, except for injuries related to sports and recreation.[7] As stated in the Chapter 3.0 Key Determinants of Injury, this may be due to greater exposure to both sport participation and access to organized sport. The use of seat belts and child restraint systems are established protective factors against motor vehicle crash related injuries, bicycle helmets are protective against brain injury in bike crashes,[22] and exercise to establish strong muscles in seniors is protective against falls and fall related injury.[5]

Often, determinants of injury work together, potentially adding to the risk for injury. For instance, families with lower education levels, lower income and poor housing are more at risk for injury.[8] Just as these variables at one end of the spectrum increase a person's chances of being injured, at the other end of the spectrum they act as a protective factor against injury (i.e., a variable associated with a decreased risk for injury). The higher the education level and income status, along with secure and safe housing, the less risk of suffering an injury. This is true across all injury types except sport and recreation injury, as noted above.

How an Injury Happens

Although injuries happen in a quick moment, there are determinants that were in place before the event occurred. Dr. William Haddon, a physician in the United States and a pioneer in injury prevention was the first to view injury as an epidemic that can be studied and thus eliminated, once all the factors affecting the situation were identified. Dr. Haddon clustered factors that contribute to an injury under the headings 'host', 'agent', and 'environment' (both social and physical). In addition, Dr. Haddon inferred that a timeline was involved in the injury process: factors are at play before the event, during the event, and after the event. The result of Dr. Haddon's thinking was the creation of a grid that captures pre-event, event, and post-event factors under the headings of host, agent, and social and physical environment.[9]

Injury prevention planners can use this tool, called Haddon's Matrix, to think about risk and protective factors that can influence a particular injury event. Community partners who have used this tool to assess how to prevent youth suicide found that it helped them to see beyond individual factors to the role that the community could play in halting these events.[10] It also helps avoid the tendency to jump to a solution or an intervention before critically assessing all the factors that contribute to an injury event. (See Figure 7 for an example of a completed Haddon's Matrix).

According to Haddon's Matrix, three factors need to be in place for an injury to occur:

1. **Host – the person injured**

2. **Agent – what injured them (i.e., what caused the transfer of energy)**

3. **Environment – the social, physical and policy context of the event**

Figure 6
The Injury Triangle
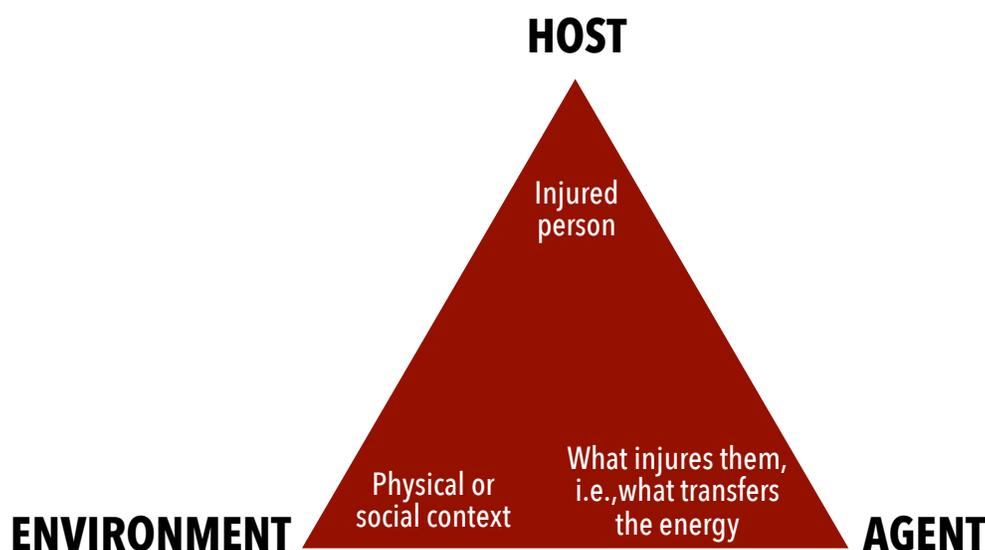
In order for an injury to occur, there needs to be a connection drawn between all three factors in Haddon's Matrix. Using child poisonings as an example, the goal of prevention is to break that connection between the host and the agent (e.g., child resistant packaging of medication); or between the host and the environment (e.g., medications are kept in locked cupboards); or between the agent and the environment (e.g., container has only non-lethal quantity of medication).

The Timeline. By identifying pre, during, and post factors in an injury timeline, one can begin to identify primary, secondary, and tertiary prevention opportunities. For some injuries,

tertiary prevention (i.e., prevention that occurs after an injury has occurred, which prevents re-injury and increases quality of life in persons who have suffered an injury) is critical.

The Host. In any particular injury event, factors at the level of the host including age, sex, and physical, cognitive, and emotional development, is important information used to estimate the risk of injury. Understanding the factors that are associated with increased risk for injury allows practitioners to develop or select prevention strategies to increase safety from both a passive and active behaviour change level (See Chapter 2.3.3 Selecting or Designing an Intervention). In addition, there are many factors that play a role in an individual's decision to participate in behaviour that may increase their risk for injury. Chapter 3.2.1, Risk Perception and Risk Mitigation, explores the various theories and factors that influence a person's behaviour. No two individuals are the same, nor will they necessarily act in the same way in any given, potentially injurious situation. Some will heed rules and prevention strategies and always obey them, while others will not. Some are more curious and some feel the need to seek risk. For instance, some children will never try to access the dishwasher detergent under the sink while others, if left unattended, will figure out how to access and ingest it.

Risk occurs in a situation where a person can recognize and evaluate the situation and decide on a course of action. Risk taking involves participation in an activity with uncertainty of the outcome and requires a person's choice to participate in the activity or not. Injury prevention efforts have the goal to eliminate hazards and mitigate risks. Adults should try to eliminate risks that children cannot see or manage without removing all risks, so that children are able to meet challenges and choose to take risks in relatively safe play settings. This means finding a balance between those risks that foster learning and the risks that can result in serious injury.[11,12]

The resiliency of the individual is also an important factor to consider when thinking about risk and protective factors for individuals. This topic was well described in the Resiliency chapter of this resource (See Chapter 3.6.2). Some families and communities seem to demonstrate a resiliency to injury, regardless of the existence of factors that increase their risk for injury. For example, an individual or community that reports low socioeconomic status may not be at higher risk for injury. Strong social supports despite low incomes, or few jobs in this case, may be protective factors. A child who has good self-esteem and receives consistent parenting does well in school even though his caregivers have little education and income.[13]

In order to develop self-esteem and confidence (both of which are contributors to resiliency), children need to be exposed to risk. There is emerging evidence to suggest that imposing too many restrictions on children's outdoor play hinders their development.[14] There is a paradigm shift in some parts of the world from implementing strategies that keep children "as safe as possible" to "as safe as necessary", encouraging risky active play.[14] The United

Kingdom has developed a resource that shows play providers "how to replace current risk assessment practice that fully takes into account the benefits to children and young people of challenging play experiences".[15]

There is evidence to suggest a link between the development of anxiety disorders and the lack of exposure to risk as children.[16] Rather than limiting a child's exposure to risk, creating opportunities for children to learn to manage risk increases their sense of competency to mitigate fear.[16] Children who engage in risky active play (i.e., play in which there is a risk for injury from falling, speed, interacting with dangerous tools or elements, rough and tumble play, and play where children could be out of sight from adults) are hypothesized to develop better resilience, a known protective factor for a number of life's risks (See Chapter 3.6.2 on Resiliency for more information).[16]

The Agent. The terms "risk" and "hazard" are often used interchangeably to refer to the "agent" in the injury triangle. A hazard is a source of harm that a person may not be able to recognize and as a result, may increase their risk of injury. For example, the lead in paint or toys that children put in their mouths, presents a poisoning hazard. The sources of hazards can be chemical, mechanical, thermal, electrical, and radiation. Some have added the absence of vital energy (e.g. heat, air) to this list.[17] Examples of environmental hazards include: uneven stairs (mechanical hazard) that increase the potential for a fall; hot coffee near a toddler (thermal hazard) leading to a scald; a live wire (electrical hazard) that increases the chances of being electrocuted; prolonged unprotected sun exposure could cause as sunburn (radiation hazard); and drowning is an example of the absence of vital energy (the result of the absence of oxygen to the brain).

The Environment. The environment – both physical and social – is the context within which the injury event occurs. The physical environment may be easier to identify (e.g., road conditions, weather, and the time of day associated with motor vehicle collisions). The social environment could include other factors involved or present at the time of injury, whether there were distractions that influenced the behavior of the host, such as loud music or too many people causing distraction of the driver in a vehicle. In addition, the attitudes and/or beliefs of the host and community, about injury prevention are also important factors to consider. The balance between risk reduction and healthy risk taking is a critical factor in all aspects of the environment.

Haddon's Matrix Example

Below is an example of a completed Haddon's Matrix. Practitioners should not worry about getting the various factors in the "correct" boxes, as factors in this matrix may fit in more than one. It is more important to think of as many factors as possible.

Figure 7

Example of a Completed Haddon's Matrix for Child Poisoning[18]

	Person *Preschool child*	**Cause** *Chemical energy Medication*	**Environment: Physical**	**Environment: Social**
Pre-Event *Will the poisoning occur?*	Age Gender Skill level of child (i.e. dexterity to open a 'child resistant' package) Perception of child (i.e., do they understand the difference between candy and medications?) Tendency toward risk-taking behaviours?	Type of medication Amount of medication available and accessible to child	Was the medication within reach? Where is medication stored (in a purse or briefcase?) Type of container (blister pack versus bottle, or medicine put into another container) Type of closure	What are the caregiver's attitudes toward safety and supervision? What is the caregiver knowledge regarding the effectiveness of 'child resistant' packaging? What is the caregiver's knowledge regarding poisoning hazards in the home? Marketing practices – e.g. many tablets look like 'candy' to a young child, taste good (e.g. children's vitamins) Manufacturer packaging and standards (i.e. - child resistant packaging and fewer pills per package) Pharmacist warnings to clients regarding toxicity and storage of medications Pharmacy disposal programs
Event *Will injury occur as a result of the poisoning?*	Age Health of child (taking any medications) Physical size	Type and amount of medication consumed (adult vs. pediatric dose, liquid versus solid) Tablets coated (coated tablets delay absorption) Size of pill Taste of medication	Opportunity for caregiver to intervene? i.e., Did he/she witness ingestion? Visual supervision? How long was the child unattended?	Does caregiver recognize that poisoning has occurred? Proximity and type of supervision What is caregiver's perception of appropriate supervision
Post-Event *What will the outcome be?*	Age Health of child Physical size (i.e., weight)	Can the medication's effects be reversed or treated? Did level of medication in bloodstream remain at toxic levels after initial assessment and treatment with activated charcoal? Some medications very harmful with just 1 pill in small children (e.g. cardiac medication, antidepressants)	Poison center in local area and caregiver knowledge of Poison Center number to call and to go directly to emergency department Proximity of medical care EMS response time Access to telephone Access to acute care Medical staff knowledge of how to treat poisoning in children	Knowledge caregiver has on what to do in an emergency situation. Support for Poison Center, toll free help line and public awareness Access to Poison Center by calling 911.

There are many examples of Haddon's Matrix on Parachute's website, found here: http://www.parachutecanada.org/child-injury-prevention.

Determining Which Risk and Protective Factors to Address

Determining the underlying risk factors for an injury problem is important as they help practitioners and researchers establish the necessary components to develop or select interventions to prevent injury. For example, speed is a significant risk factor for motor vehicle collisions that causes significant injury to drivers, passengers, and vulnerable road users, such as pedestrian and cyclists.[3] Understanding that speed is a risk factor is important as it is used later in the Public Health Approach to select or design interventions to reduce collisions. There are many strategies to reduce speed such as the implementation and enforcement of speed limits.[3]

To determine the risk and protective factors for an injury outcome, it is important to use a process to gather, critically appraise, and synthesize evidence. Often, this process is available in the form of high level syntheses or systematic reviews that establish associations between risk factors and injury outcomes. For example, a recent systematic review and meta-analysis on the association of joint injury, sport activity, physical activity, obesity, or occupational activities as predictors for osteoarthritis demonstrated that those with a previous joint injury were at an over 3-fold increased risk of developing knee osteoarthritis, and were at over 5 times the risk of developing hip osteoarthritis later in life.[21] These studies provide practitioners with the required information to build successful intervention options.
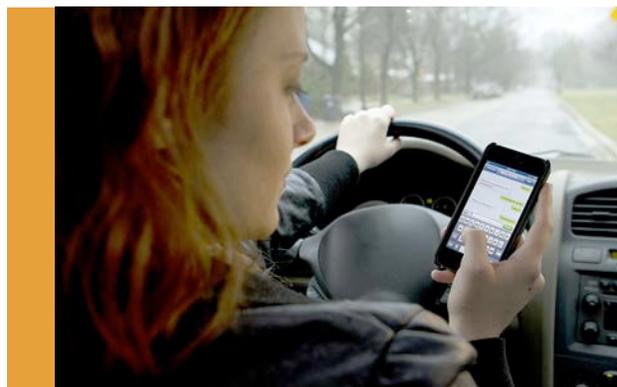
It is not only important to understand the relationship between a risk factor and an outcome, but the strength of the relationship as well. Statistical methods are used to provide evidence of an association with a risk factor and an outcome, and then to assess the strength of that association. As demonstrated with the example above, the association with injury and osteoarthritis is stronger with hip osteoarthritis over knee osteoarthritis. This information is also helpful to practitioners and researchers to understand how to select appropriate interventions to reduce the injury burden. For example, there is a high level systematic review that established a 74% increased risk for fatal motor vehicle injuries with a 0.02% increase in blood alcohol concentration.[19] Understanding that drunk driving increases

a person's risk of fatal injury may place a precedence to implement an intervention to address drunk driving over another risk factor for motor vehicle collisions.

Finally some risk and protective factors are more modifiable than others. For example, a person's age or sex is a non-modifiable risk factor for many injuries. However, there are modifiable factors such as a person's self-esteem, physical and mental competency, physical fitness, and understanding and perception of risk, to name a few. An example to help place modifiable versus non-modifiable risk factors into perspective is to look at younger males as a particular risk for motor vehicle collisions. The non-modifiable risk factor in this scenario is age and sex; however, what can be modified is the people they drive with, when they get their driver's license, the time of day they can drive, zero tolerance for alcohol, etc. This example is a program called graduated driver's licencing and it has been demonstrated as an effective strategy to reduce the incidence of youth injuries and deaths from motor vehicle collisions.[20]

Conclusion

Identifying risk and protective factors is the second step in the Public Health Approach. It is important for both practitioners and researchers to understand the relationship of the determinants of health as risk or protective factors to manage and mitigate the risk of injury. Haddon's Matrix is an excellent tool to help practitioners capture and visually represent the potential risk and protective factors involved in the injury timeline, resulting in prevention of the incident or the mitigation of the effects of the injury. Once practitioners have identified which risk and protective factors are modifiable, they can work within the context of an ecological approach to develop or select an intervention to reduce the injury burden.

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Steps in the Public Health Approach to Injury Prevention
Selecting or Designing an Intervention

The next step of the Public Health Approach is selecting/designing an intervention. This step exists after identification of the injury problem, the at-risk population, and the risk and protective factors that influence the level of risk.[1] The information drawn from these previous stages is important as the selection or design of an intervention is dependent on knowing the burden of injury and the risk and protective factors. For example, understanding that motor vehicle collisions represent a significant burden of injury in the Canadian population, and that risk factors such as driver inattention, speed, and substance abuse while driving are all risk factors that increase the risk of collision, are important to consider when selecting or designing a specific injury prevention intervention to reduce the injury problem.

To select or design an intervention in response to an injury problem, practitioners and researchers should understand the different forms that injury interventions can take and to understand that there is a recommended process to select or design effective interventions from research and non-research literature. This chapter outlines the stage of intervention selection in the Public Health Approach, and recommends a process to accomplish this that aligns with the evidence-informed public health movement (please see Chapter 2.1 for more information on the Public Health Approach).

Types of Interventions

Injury prevention strategies are broadly classified into a number of approaches. The concept of the Three "E's" of injury prevention was discussed earlier in this section

(see Figure 4). Briefly, interventions can be classified as having an education, enforcement or engineering focus. The traditional three "E's" of injury prevention have been broadened in recent years to include "Economics" and "Environment" as additional approaches for intervention strategies. As each approach has strengths and weaknesses, developing intervention strategies that incorporate two or more "E's" will ensure a more effective intervention. Another useful resource in understanding the different types of interventions is to use Haddon's Countermeasures.

Haddon's Countermeasures

As discussed in the previous chapter, risk and protective factors were established in association with an injury outcome. It was recommended that practitioners search the literature for high-level syntheses and systematic reviews to establish these associations and to understand the strength of the association between a risk factor and an outcome. In addition, Haddon's Matrix was a tool suggested to think about the risk and protective factors that may be amenable to change to reduce the risk of injury.

Haddon also created what was called the "Ten Countermeasures" that align with the matrix (i.e., pre-event, event, post-event), designed to understand how prevention could interfere with the transfer of energy causing injury. The countermeasures align with primary, secondary, and tertiary prevention (see Figure 8) and can be used to further inform the selection of an intervention.

The countermeasures provide an opportunity to expand our list of potential interventions to generate interesting and innovative interventions beyond those we might normally consider. Application of Haddon's Matrix and Countermeasures moves the focus of injury prevention interventions beyond the individual and encourages consideration of other intrapersonal and environmental risk factors that could be changed to reduce injury.

Another aspect of an injury prevention intervention is to consider how much effort is required by an individual to minimize the risk of injury. It is important to understand the kind of intervention planned for implementation. An intervention can be an active or passive strategy. Active or behavioural strategies provide the structure to prevent injury on an individual level.[22] In other words, the intervention encourages individuals to use strategies to protect themselves from injury. Buckling a seat belt, placing medication in a locked cabinet or anchoring a bookcase to the wall are active interventions to prevent injury. The second, called passive or environmental strategies, do not rely on an individual making a choice or acting to prevent an injury. Examples of passive interventions include the implementation of speed bumps and the installation of air bags in motor vehicles. Passive interventions are present regardless of the behaviour of an individual and therefore, provide a high degree of protection from injury. Implementation of passive strategies is often challenging as they may

Figure 8

Haddon's Ten Countermeasures and Examples[13,14,15]

Pre-event (Primary Prevention)

1. **Prevent the creation of the hazard**
   e.g., ban on the manufacture of wheeled baby walkers, ban on three-wheeled all terrain vehicles

2. **Prevent the release of the hazard**
   e.g., prevent the sale of wheeled baby walkers, introduce graduated driver's licensing

3. **Separate the person and hazard in time or space**
   e.g., implement segregated cycle lanes, locating high volume roadways away from residential neighbourhoods

4. **Place a barrier between the person and hazard**
   e.g., implement mandatory 4 sided pool fencing, create safety guards on work-related machinery

Event (Secondary Prevention)

5. **Reduce the amount of the hazard**
   e.g., reduce speed limits, decrease water temperatures on hot water tanks

6. **Modify the rate or spatial distribution of the hazard**
   e.g., bicycle helmets, blister packaging for medication, seat belts, air bags

7. **Modify the basic qualities of the hazard**
   e.g., implement energy absorbing surfacing in playgrounds, replace roadway lighting infrastructure with breakaway light poles

8. **Strengthen the resistance to the hazard**
   e.g., implementing a warm-up program for sport and recreational participation, implementing standards with building and fire codes

Post-Event (Tertiary Prevention)

9. **Begin to counter the damage already done by the hazard**
   e.g., installing smoke detectors, providing rapid treatment in the form of first aid

10. **Stabilize, repair and rehabilitate the object of the damage**
    e.g., providing/having access to emergency medical facilities, acute care and rehabilitation facilities

take years of design or engineering to develop and may require enactment of/changes to legislation to become adopted. Most injury prevention interventions lie on a continuum between passive and active and designing or selecting an intervention should focus on multiple levels of influence, potentially incorporating a number of strategies with differing levels of required effort. Both active and passive strategies can be applied if using an ecological model for injury prevention. Ecological modelling for injury prevention can provide the greatest uptake of interventions as they address both the environmental

changes to reduce injury and the strategies needed to convince policy makers and/or individuals to enforce or uptake the intervention.

Levels of Intervention

Intervention strategies are designed to target a population on an individual level, organizational level, community, or public policy level. Often, successful interventions occur on multiple levels of influence including those that target the individual, changing the environment, implement policy and apply enforcement (i.e., interventions that utilize an ecological model).[2] There are many strategies that exist in the intervention literature, what is important is to consider are only those that have demonstrated significant levels of effectiveness. Without a program demonstrating that it actually works, efforts to implement them are futile (see section below on the process to select or design interventions).

Ecological Models for Injury Prevention

The process of selecting interventions to tackle an injury problem should be considered from many angles through an ecological model approach. The idea behind ecological modeling is that there are many factors that influence individual behaviour. In addition, there may be interaction of these influences across all levels. Ecological models focus on a specific behaviour where a collection of activities are implemented on multiple levels and where the most relevant influencers are utilized.[2] Levels of influence are intrapersonal, interpersonal, organizational, community and public policy.[2]

Figure 9
Ecological model for health promotion[4]

Intrapersonal level interventions focus on the target population's knowledge, perceptions, attitudes, intentions and skills around a defined behaviour;[4] for example, providing information to a child on the importance of wearing a bicycle helmet to prevent head injury when cycling. Interventions designed to target prevention at the interpersonal level consider the influence of the target population's social groups and their contacts such as family, healthcare providers, work colleagues, etc., that have considerable influence on individual behaviour choices.[4] Interventions designed on an organizational level focus on programs, systems and policies in specific settings.[4] An example of an organizational intervention would be a hospital program that ensures new parents have the proper car seat installed upon hospital discharge with their new born, or a ski hill reducing prices for patrons wearing helmets. Community level interventions encourage collaborative action for change between multiple sectors. Community interventions can use coalition and advocacy groups, common messaging and practice, media events, etc. to encourage the adoption of an injury prevention strategy. An example of a community intervention is where a multi-sectoral group made up of representatives from public health, enforcement, local business, schools and the local municipality, plan, advertise and host a bicycle rodeo focusing on proper use of helmets and safe cycling. Finally, the public policy level includes the development and enforcement of laws and regulations that fall under federal, provincial and municipal jurisdictions. It also includes the development and enforcement of policies within various businesses and organizations.[4] An example of this level of influence is the development, revision and enforcement of the Canada Consumer Product Safety Act. This act prevents unsafe products to be imported or sold in Canada.

The Ottawa Charter for Health Promotion supports an ecological approach to prevention noting that, "health promotion demands coordinated action by all concerned: by governments, by health and other social and economic sectors, by non-governmental and voluntary organizations, by local authorities, by industry and by the media."[5] The Charter indicates that health promotion action includes building healthy public policy, creating supportive environments (physical and social), strengthening community action through information and funding support, developing personal skills and reorienting health services to focus more on prevention than clinical and curative services.[5]

Behaviour Change Theory

The final consideration when selecting or designing an intervention to reduce injury is to understand and integrate behaviour change theory into program planning. Leaders in injury prevention have spoken to the lack of integration of behavioural science theory to injury prevention practice.[22] Applying evidence specific to behavioural sciences when applying an intervention can increase the effectiveness of the program.

An important goal for injury prevention interventions is to change behaviour that increases a person's risk for injury. Behaviour change happens on different levels. A researcher may target specific at-risk populations and identify the associated risk and protective factors and disseminate their work to encourage individuals to adopt injury-preventing behaviours. A prevention organization may use the media to promote injury prevention awareness and encourage safe behaviours (e.g. use social media to encourage the use of helmets in cycling and snow sports) or collaborate with industry to ensure that a particular product is safely designed and easy to use. Behaviour change theories provide insight into how and when behavioural changes can be achieved in a population or setting.[9] There are theories and models that explain processes and necessary components to facilitate change in individuals, communities and organizations.[9] There are also theories and models that guide the development and implementation of healthy public policy and communication strategies that support and motivate change.[9] Using theories

and models to guide the content and process of an injury prevention intervention increases the likelihood of positive outcomes.[9] It is ideal to have a general understanding of a broad range of different theories and how they can be applied to various contexts and situations.[6,9] The National Cancer Institute's (2005) document, Theory at a glance: A guide for health promotion practice 2nd edition[20] and Nutbeam et al.'s (2010) book, Theory in a nutshell: A practical guide to health promotion theories 3rd edition[9] provide succinct descriptions of various behaviour change theories.

Applying behaviour change principles to injury prevention interventions can be done in a variety of ways. Two tools for achieving behaviour change are discussed briefly below: social marketing and developing health public policy.

Social Marketing

Social marketing has been utilized for more than three decades in the fields of public health and injury prevention (most notably road safety), achieving overall significant success. Social marketing is not a science, but rather a professional practice which relies on multiple scientific disciplines to create programs designed to influence human behavior on a large scale.[23] Social marketing most often targets complex social behaviors, with delayed and distant benefits to audiences who usually do not recognize a problem, and are not seeking a solution. Like other professional practices, social marketing uses science extensively, but also relies heavily on experience. The most successful social marketing campaigns are

developed within a framework of enquiry where scientists, practitioners, and artists work collaboratively to develop creative ways to change behaviour for social good.

Formal definitions of social marketing vary as different authors emphasize different aspects of its concepts and principals.[6] French et al. define social marketing as "the systematic application of marketing, alongside other concepts and techniques [e.g. behavioural change and communication theories], to achieve specific behavioural goals, for a social good."[6] French et al. present eight benchmark criteria to describe the key concepts and principles of social marketing: behavioural focus; customer orientation; theory informed; developing insight; segmentation; understanding the exchange; the competition; and methods mix.[6] A more classic description of social marketing is the "Four P's:" product, price, placement and promotion which describe its broad, strategic elements.[7]

French et al.'s benchmark criteria of behavioural focus requires one to articulate a desired behaviour that is realistic and measurable.[6] The desired behaviour would be referred to as the product in the traditional description of social marketing.[7]

In order to acquire a customer orientation, details must be gathered about the target audience's social context, the challenges they face and their coping mechanisms.[6] This information can be collected through questionnaires, interviews and direct observation of the target audience and through existing research or contacts who work with the audience.[6] To increase the possibility that the intervention will influence the target audience, concepts from one or more behavioural change theories must be learned and applied.[7] The possibility of affecting change is also enhanced by developing insight which is gaining an understanding of the target audience's beliefs, attitudes as well as barriers and enablers to change.[7] Insight can also be achieved by understanding people who already do the behaviour that is being promoted.[7] Segmentation is grouping people according to characteristics, attitudes and behaviours.[6] By identifying a specific target group, well-tailored, effective interventions can be developed.[6]

Understanding the exchange is knowing if the target audience will derive sufficient value from maintaining or changing the desired behaviour.[6] Value and costs can include time, effort, money and social consequences.[6] Value and costs are referred to as "price" in the classic social marketing terminology.[7] Exchanges can be positive in that persons who perform the defined behaviour get physical, social or psychological benefits. On the other hand, exchanges can be negative in that individuals are penalized, or have social disapproval for not performing the desired behaviour.[6] An example of a positive exchange is parents receiving a gift certificate for a stationary walker (e.g., exersaucer) or jumper, in exchange of a baby walker (note that baby walkers are prohibited and are not allowed to be imported, sold, or advertised in Canada[8]). Parents may receive social approval from health professionals and/or peers as well as comfort knowing that a risk for injury has been eliminated. A negative exchange example is a levy put on baby walkers making them more

expensive compared to stationary walkers or jumpers. Exchanges can also vary in the degree to which the target audience has to consciously weigh the consequences of behavioural options.[6] For example, speed bumps are a passive exchange to control speeding. A more conscious decision or "active exchange" is a fine for speeding, as persons may evaluate the chances of getting caught in their behaviour decision making process.[6]

"The competition" refers to factors that work against the desired behaviour. Forces that promote counter-behaviour can be internal or external. For example, people's beliefs, attitudes and habits are internal factors that may counter desired behaviour change, and social norms, advertising and environments are examples of external factors.[6] Practitioners must think about the competition against behaviour change from social marketing perspective for initiatives to be effective.[6]

Information collected for French et al.'s "benchmark criteria" provides direction for the remaining classic social marketing concepts, "place" and "promotion".[6] "Place" refers to where the target audience is reached with "product" information and to where the voluntary exchange takes place.[7] By having a full understanding of the audience as well as their influencers and environment, information and/or any equipment may be "placed" strategically to enhance the behaviour's desirability and convenience.[7] For example, placing information on the prevention of ski and snowboarding injuries to children in popular parenting or ski/snowboarding magazines may have more influence than having it presented on an injury prevention organization's website.

"Promotion" refers to the communication and messaging aspects of a social marketing intervention.[7] Promotional strategies usually communicate important information about the "product", the costs and benefits of the "product" and/or how barriers to the "product" can be overcome.[7] Again, information collected for "benchmark criteria" would direct what kind of messages would be used and how they would be delivered.[6,7]

French et al.'s remaining benchmark criteria is "methods mix" and this principle of social marketing states that behavioural goals are more likely achieved by implementing a number of multi-component interventions that are tailored, evidence and insight-led.[6] This concept reinforces, yet again, that when selecting an intervention, activities should be implemented on multiple levels of influence that reflect sound, scientific research, contextual and experiential evidence.The development of a social marketing strategy provides for focus on a social problem as well as affording a framework for taking action. The strategy below is an

PROBLEM:

Q. What is the social problem I want to address?

A. To reduce the number and severity of ladder-use injuries in the workplace.

BEHAVIOUR:

*Objective***:**

Q. What action do I believe will best address that problem?

A. To increase compliance to ladder use safety rules in 100% of ladder use work in the   workplace.

Audience:

Q. Who is being asked to take that action?

A. All workers in the workplace.

OVERALL STRATEGY:

1. Better understand the current ladder use behaviour of workers

- ❖ Look for any differences related to those that do and do not currently comply with safe ladder use rules
- ❖ Identify perceived barriers and benefits to current ladder use safety compliance
- ❖ Identify who influences workers' decision making about safe ladder use
- ❖ Identify perceived barriers and benefits to adopting safe ladder use behaviour
- ❖ Identify what workers say would work to have them adopt safe ladder use behaviour

2. Re-frame the problem

- ❖ Make employer aware of data on the number of unsafe ladder use behaviours, injuries and near misses
- ❖ Change the "framing" of the problem from acceptable ladder use to unsafe/contrary to policy ladder use
- ❖ Pose the question: what are these workers thinking?

3. Identify specific behaviours that will help workers change

- ❖ Identify specific worker behaviours that could be brought under co-worker influence
- ❖ Identify specific worker behaviours that could be brought under supervisory control

4. Energize workplace management and supervisory staff

- ❖ Use management and supervisory staff to lead, model and promote use of ladder safety rules
- ❖ Use management and supervisory staff to enforce use of ladder safety rules
- ❖ Look for ways to make the new enforcement compatible with existing workplace safety operations

5. Create behavioural social marketing campaign directed at workers,management and supervisors

- ❖ Ensure the involvement of workers, management and supervisors in the creative process of developing and deciding on campaign messages, channels and materials
- ❖ Develop leading and lagging indicators to monitor and evaluate the campaign

6. Implement, publicize and monitor/evaluate the campaign

- ❖ Be flexible and ready to respond to new information and unanticipated developments
- ❖ Stay or change course as appropriate

example of a social marketing intervention to reduce ladder use injury within a workplace.

Policy

Legislation and enforcement have been identified as a type of intervention that can have significant impact on changing behaviour. This section provides a brief overview of how implementing policy can be used to advocate change. Please see chapter 2.3.4 Program and Policy Implementation for more information about how policies are implemented.

Policy is the intentions, decisions or actions that an authority has or will express through laws, regulation, procedures, guidelines or rules.[16] Policy stimulates social change through rules that support voluntary adoption of a behaviour.[17] Christoffel and Gallagher[1] (2006) indicate that because "it's the law" many people comply with the legal requirements simply out of citizenship obligations and because the law communicates social expectations that establish social norms which direct behaviour.[14] Seat belt legislation is an example of a policy which has been effective to change behaviour. Transport Canada indicates that "seat belt use has increased over the past 25 years so that now 95% of Canadian vehicle occupants in all seating positions wear belts, and this includes those people in urban and rural areas based on surveys conducted in 2009 and 2010."[19] To further facilitate adopting new behaviour, efforts must be made to ensure that the behaviour is encouraged and easily adopted by the target audience as described previously by social marketing principles.

When considering policy, we often think of legislation and public policies set by a level of government; however guidelines, procedures, rules and policies can also be developed by organizations, institutions, and even within families and individuals. These make up the other domains of policy. We are all familiar with the family rules we had as children – many around injury prevention issues such as wearing bicycle helmets, riding in a car seat, and looking both ways before crossing the street. At the organizational/institutional level, policies could include workplace guidelines around safe equipment use, or school polices concerning management pick up and drop off areas to ensure safe pedestrians crossing. The domains of policy that we may be seeking to influence will be dependent on our interventions. For the remainder of this discussion, the focus will be on influencing public policy but the same principles would apply to any domain of policy.

There are a large number of factors that affect the creation of public policy. While evidence can influence policy, it is not the only influence. Other influences include positive or negative media coverage, party politics, lobbyists and pressure groups, values and traditions, and resources.[1,16] Many of these factors align with those discussed in the social and political context chapter (See Chapter 2.4 Political and Social Context of Injury Prevention). The interaction of various factors sometimes results in compromises that results in the implementation of only partial best evidence. For example, in Alberta, the injury prevention

community advocated for all-ages bicycle helmet legislation. Legislation was passed; however, it requires only those under 18 years of age to wear a helmet.

Selecting/Designing an Intervention to Reduce Injury

With limited resources, prevention practitioners want to ensure the intervention selected is going to reduce the injury problem and/or facilitate uptake of injury prevention behaviours. This chapter has outlined some important concepts in selecting or designing an intervention. This section provides guidance on the process of selecting or developing an intervention to increase the likelihood of positive outcomes.[9] It is important to align this stage of the public health approach with the process of evidence-informed public health.[10]

The National Collaborating Centre for Methods and Tools defines evidence-informed public health as "the process of distilling and disseminating the best available evidence from research, context and experience, and using that evidence to inform and improve public health practice and policy."[10] The premise of this definition is that an evidence-informed decision cannot be made with evidence found in research alone. Evidence for the suitability and potential success of an injury prevention intervention should also include observations and understandings of the target audience, their social, political and physical environments as well as the resources available.[10]

The National Collaborating Centre for Methods and Tools offers a model to search for a suitable, evidence-based injury prevention intervention.[11] The most important step in the process to select an intervention is to ensure that the intervention chosen reflects sound, scientific research, contextual and experiential evidence.[3] This process is completed by reviewing the highest level of scientific evidence to identify an existing intervention, specific to the population targeted. Practitioners can find this information from library databases and catalogues or through organizations that collect, evaluate and/or synthesize published injury prevention research. Examples of such organizations include SafetyLit®, Health Evidence™, the Cochrane Collaboration and the Canadian Best Practices Portal. If there are only primary studies that have not been evaluated or synthesized, and/or if there is limited knowledge about research design and evaluation, there are tools available to use to evaluate the quality and relevancy of the research collected. The Critical Appraisal Tools Program as well as McMaster University's Health Evidence Tools, provide checklists to determine the

quality of studies including systematic reviews, and qualitative or quantitative primary studies.[12]

Where an effective intervention specific to a target population is not available, a practitioner can select an intervention that demonstrates effectiveness for a different population, and use a process of adapting the intervention to the target population at hand. Important in this process are evaluation components, used to determine if the adaptation was successful to both implementation planning outcomes (i.e., process outcomes) and injury outcomes (i.e., intermediate and long-term outcomes) (see Chapter 2.3.5, Evaluation and Monitoring). A researcher may also note that an intervention for the specific risk factor under study is not available, or published interventions may not have demonstrated a sufficient level of effectiveness. Researchers in this case would use the public health approach, aligned with the evidence-based public health movement to design an intervention for the target population.[11]

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2.3.4

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Steps in the Public Health Approach to Injury Prevention
Program and Policy Implementation

Introduction

Developing or selecting effective programs to implement is a key component in the injury prevention pathway and is a key stage in the public health approach. Transferring programs into real world settings, ensuring their fidelity, and maintaining their sustainability, however; is a complex, yet necessary component of this process that is often not considered. Therefore, implementation planning and the evaluation of a program's implementation are intertwined and should be included in intervention development. This chapter focuses on the approach to both program and policy implementation and suggests a process for implementation planning.

Program and policy implementation planning should be intentional, systematic, and evaluative because designing an effective intervention to obtain significant outcomes requires more than simply learning, applying, and reporting information.[1,2] Successful implementation planning involves an evidence-informed approach, working within a team of researchers, stakeholders and knowledge users who will review scientific evidence and consult best practice, those who work in the field, and members of the target population.

Implementation planning is involved early in the public health approach. Clearly identifying the problem to be addressed, understanding the population at risk, and outlining the risk and protective factors within the population of interest are important elements where implementation planning is integrated. Implementation strategies such as creating an implementation team, developing an action plan, and developing and maintaining partnerships and collaboration, can be planned at this stage. By considering an

organization's current strategies, interventions, and activities, complimentary program goals and objectives will lead to greater chances of the program's success. Most importantly, identifying the processes and supports needed and intermediate and long-term outcomes will lead to greater implementation success.

Core Components of Implementation

Program success depends on effective methods for implementing and evaluating a prevention program.[1,3] Implementation planning is a process that is not necessarily linear; however, there are some preliminary steps that are recommended. There are four core components that can help support the successful implementation of prevention strategies: 1) a well planned **implementation** strategy using an action plan; 2) maintaining the **fidelity** of existing evidence-based prevention strategies; 3) **adaptation** of intervention for new populations and settings; and 4) efforts to measure and increase **sustainability** over time.

Core components of implementation

These components can help the successful implementation of prevention strategies:

❖ Implementation strategy

❖ Fidelity

❖ Adaptation

❖ Sustainability

Implementation Strategy

The first step is to ensure that there is a well-planned **implementation strategy**. Outlining a specific strategy to ensure necessary factors for successful implementation is important. The strategy should include efforts to ensure the fidelity of the program being implemented, ease and documentation of the adaptation of the program to the target population, and sustainability of the program over time. This can be done by on-going information gathering, and is suggested in this section of this chapter as a stage-by-stage approach; however, implementation can be thought of as a non-linear process. For instance, some stages may be skipped and re-visited at a later date. Other times, unanticipated events may occur which have implications on the success of a program (e.g., personal reasons causing a team member to take time away from the program). Realizing such issues and being attentive to details is supportive of a well thought out implementation strategy. To map the processes and supports needed, practitioners or researchers can create an implementation action plan. An action plan assists implementers to think about the necessary inputs to support the intervention, the core activities that are markers of success of the program, and the resulting outputs.

Developing an Action Plan

Action plans are often used in implementation planning and follow similar guidelines for logic model development, as outlined in the Evaluation and Monitoring chapter (Chapter 2.3.5). Action plans can be used to visually highlight the implementation strategies by outlining the necessary internal and external processes involved. There are many sources of information to help practitioners develop action plans; one in particular, from the National Implementation Research Network has many resources and tools for practitioners specific to implementation action planning.*

It is important to outline all of the formative, process and outcome indicators involved in program implementation. These measures are used to evaluate the implementation and effectiveness of the program. Formative indicators include the pre-project planning activities that should be thought about at the initial implementation stage.[4] Formative indicators should include the need, fit, resources, evidence, readiness and capacity related to the intervention under consideration.[5] Implementers should think about conducting a needs assessment at the pre-planning stage to increase uptake and adaptation of the program when implemented. (See Chapter 2.3.5 Evaluation and Monitoring for more information on conducting a needs assessment). Process evaluation measures the success implementing the core components of a program as they were intended. Process indicators answer the following types of questions throughout the implementation process: Which components of the program have been implemented? What existing resources are there to support the implementation of this program? What decisions were made to commit to adopting the program? Outlining the process indicators in an action plan is one way of mapping out program plans and setting up implementation evaluation measures. It is important to consider that implementation planning should be created with the implementation team and reviewed by a working group. This is also an effective method for communicating the stages of the program to partners and stakeholders.[6]

Establishing an Implementation Team

Coordinating an **implementation team** and working group should be one of the first activities when thinking about implementing a program or policy. The implementation team should be made up of at least three partners who have expertise in:

❖   the field of the injury the program relates to,

❖   undertaking innovative program implementation,

❖   knowledge of implementation science/theory, and/or

❖   use of implementation in practice, and/or organization and system changes.[1]

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* National Implementation Research Network - http://nirn.fpg.unc.edu

It is also a good idea to invite organizational supports on the team, such as:

❖ a practitioner or individual with expertise in the area of the injury of interest,

❖ management to lend leadership and knowledge on policy information (e.g., liability),

❖ administration to assist with human resource and structural issues,

❖ representatives from a healthcare sector or other sectors (e.g., community services, transportation) to play a lead role and discuss mandates related to your program, and

❖ regional authority, provincial, community, federal, and national supports as they can advise on from a variety of perspectives (e.g., a community versus national) .

Establishing Working Groups and other Partnerships

A **working group** can complement the implementation team. Working group members are those that participate in the program, and also potentially benefit from participating. Working group members could include specialists, members of the community, and participants from the program. Representatives of the target population and those who work with the target population must also be included into the working group. Working groups members provide valuable information, including constructive criticism (perceived and actual barriers to the minimizing the injury prevention issue, best approaches, etc.) to better inform and tailor the program to increase readiness for change among the target population. Once the working group members have been identified, the implementation team could distinguish standing and non-standing contributing members to clarify members' roles.

Working groups can consists of:

❖ **implementation team members**

❖ **experts in the area of injury prevention**

❖ **stakeholders**

❖ **knowledge users**

❖ **community members**

Developing action plans helps implementers think about implementation stages for a new or adapted program, as well as the factors that must be considered in this plan. There are different stages in the action plan that align with the stages of implementation: exploration (or needs assessment), installation (or adaptation), initial implementation, and full implementation.[7] As mentioned earlier in this chapter, there are three forms of evaluation specific to implementing a program or policy change. Specifying the evaluation measures within the action plan can help in the process of implementing and later evaluating the program. There is **formative evaluation**, **process evaluation** and **outcome evaluation**.

Formative indicators describe the pre-programming or initial implementation outcomes that often focus on efforts to increase capacity and available resources where the program is being implemented. Process indicators describe outcomes that are specific to program activity and implementation. Outcome evaluation measures the effectiveness of the program. Implementers should think about the short-term, intermediate, and long-term outcomes of a program.

When thinking about the implementation outcomes, the following are just some of the questions to consider:

❖ **Formative: When is the best time to implement such a program?** Is there interest and readiness from the public, health region, or government to address this issue immediately? Consider seasons, workload, fiscal year, funding cycles, program fit, etc.

❖ **Process: Who is the target population?** Who benefits from the program? How is this population different from the population where the intervention has been shown to be effective?

❖ **Outcome: What is the targeted change from implementing such a program?** Increased knowledge? Behaviour change? Skill development? Environmental modification?

Considering the Organization's Philosophy, Values, and Principles

❖ Is the program part of the organization's mandate?

❖ Are the goals and objectives of the program consistent with the values of the overseeing organization?

❖ Re-visit the target population: are there any sub-populations that should be considered in light of the program's philosophies, values, and core principles?

❖ Consider broader issues, such as population and organizational readiness, as well as other current events which may affect the implementation process.

Fidelity

Implementers must be aware about the necessary components of a program to ensure effectiveness. Often, practitioners will select an effective intervention from their literature review that was implemented in a population different from their target population. It is important at the stage of program implementation to measure how the program is being initially implemented and then to what degree the components are maintained. **Fidelity** is defined as "the degree to which...programs are implemented...as intended by the program developers".[8] A programs success relies on the core components that support the interventions effectiveness[9,10] therefore, ensuring fidelity is a core component of an

implantation plan. There are many frameworks in the literature that support ways to measure implementation fidelity.[11]

Adaptation

Adaptation is another important component to think about and evaluate when implementing a program. As mentioned in the previous section, practitioners are best suited to choose an existing evidence-based prevention strategy that was shown to be effective. Often, these strategies were implemented in a population other than the target population. In this case, implementers must consider adapting the program to fit their target population. Implementers should also document and evaluate the adaptation of the existing prevention strategy. This helps future implementation of the program to save time and valuable resources. There are a number of things to consider when adapting an existing program to a new target population. These include differing environments, staff, resources, and setting where the program is being implemented, and the underlying risk profile of the population.[12] There are a number of tools and resources for practitioners to use to guide the adaptation of evidence-based prevention strategies.[12-14]

Regardless of the type of intervention being implemented, implementation strategies should address the specific conditions, resources, and supports in place that can be used to promote implementation. The success of a program involves the implementation team strategizing about the existing conditions and resources available. Resources include the staff, their capacity and demands that may interfere or compliment the implementation of an intervention. In addition, resources and supports such as the costs associated with program implementation also need to be projected. There are costs due to resource packages (e.g., training materials, schedules, etc.), equipment, staff time, materials, and administrative processes that must be thought of when implementing a program. Practitioners and researchers can use generalized implementation science theory and concepts to guide the development of an implementation strategy.[15] Implementation strategies must be detailed documents that contain the strategies required that align with the core program components. This will ensure the implementation efforts can be replicated and set up to measure fidelity.

Below are some tips to keep in mind when thinking about the implementation strategy:[3]

a)   Determining specific dates for program implementation

b) Communication protocols in cases of gaps, challenges, and barriers during implementation

c) Leadership engagement to sustain the new program

d) Regularly scheduled meetings, phone calls, or emails to maintain communication for ongoing feedback and opportunities for any changes to the implementation plan

e) Monitoring of the implementation process to assess if the program should be continued or modified and any implications for uptake. To do so, consider the program's:

- perceived usefulness by all involved individuals,

- time allocation, and

- sustainability, both internally and externally, and what resources would be necessary.

Sustainability

The final core component important in program or policy implementation is **sustainability**. Factors that support and impede sustainability are important to think about and measure during the implementation stage (and in the implementation action plan) as it provides practitioners with the necessary information to understand the context in which a program continues, or does not continue, after implementation efforts are complete. Some factors that contribute to sustainability include changing priorities and resource availability.[16] To support the long-term success of prevention strategies, practitioners should identify the factors that maintain the strategy over time considering the nature of the strategy, the context in which the strategy will be implemented and the population that is being targeted. In addition, it is useful to identify the factors in place where a program is not sustained, as these factors may not necessarily be the opposite of those that are identified to sustain it. Often, programs are implemented into a local community or specific population and the adherence or commitment to continue the program dwindles over time.

The successful implementation of a program and its subsequent sustainability are distinct issues, which should be considered at the intervention design or selection phase. In doing so, the indicators of success for the initial implementation and the sustainability of the program can be considered and strategically evaluated, thus lending to a holistic approach in

ensuring the success and fidelity of the program.[17] A number of factors influence sustainability following initial implementation into program maintenance.[15] The factors that ensure the success of a program over time need to be identified and collected by program or policy implementers.

Conclusion

Practitioners charged with implementing effective injury prevention programs into real world settings must consider the context within which the program is being implemented to adapt the program to increase uptake and sustainability, at the same time, maintaining the program's fidelity. Implementation planning and the evaluation are key components to this process and should be considered early on in an evidence-informed approach to injury reduction.

Recommended Resources and Readings

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National Collaborating Centre for Methods and Tools
http://www.nccmt.ca/

National Implementation Research Network
http://nirn.fpg.unc.edu/

Implementation Research: A Synthesis of the Literature http://nirn.fpg.unc.edu/resources/implementation-research-synthesis-literature

Knowledge Transfer & Implementation of Evidence-Based Practice in Children's Mental Health
http://nirn.fpg.unc.edu/resources/knowledge-transfer-implementation-evidence-based-practice-childrens-mental-health.

Public Health Ontario – Online Health Program Planner
http://www.publichealthontario.ca/en/ServicesAndTools/ohpp/Pages/default.aspx

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The previous steps in the Public Health Approach described a process to gather and synthesize different types of evidence to understand the injury problem, assess the risk and protective factors, select or design an intervention to address the injury problem, and a way in which to set up that intervention for success. The last, and equally important, stage of the Public Health Approach is evaluation. Evaluation is the measurement of the effectiveness of interventions[1] and their implementation efforts. Evaluation is a critical component of the Public Health Approach as it provides information on intervention delivery, effectiveness, and utility in the population targeted. The results of an evaluation are often needed to justify resources dedicated to it, or to reflect on the selected intervention to determine if a greater impact could be made in the community.

There are three types of evaluation that align with the evidence-informed public health movement and the Public Health Approach: formative evaluation, process evaluation and outcome evaluation.

Formative Evaluation

The first type of evaluation is called formative evaluation. This includes activities at the pre-project planning stage and during initial implementation.[2] It is important for researchers and practitioners to understand that evaluation planning begins this early, as this ensures that all indictors to be used in both implementation and intervention evaluation are set in place. At this stage, one would first consider the need, fit, resources, evidence, readiness and capacity

related to the intervention under consideration.[3] A needs assessment is an important part of implementing an intervention into a target population and should be conducted to determine what the real programming needs are in the community. Taking the time to conduct such an assessment can save wasted time and effort by ensuring that the selected program activities are focused on important outcomes, and that resources will be matched appropriately. (Please see Chapter 2.3.3 Selecting or Designing an Intervention for more information on how to conduct a needs assessment).

There is also a need to understand the infrastructure that is required to successfully implement the intervention of interest. Developing a logic model is an important step within the formative evaluation stage. A logic model assists evaluators to think about the necessary inputs or resources that are needed to support the intervention, the core activities that are part of the intervention and implementation strategy, the resulting outputs or products of those activities, and the short-term, intermediate and long-term outcomes. As described earlier in this resource, practitioners charged with implementing an injury prevention program should start thinking about evaluation before there is a program to evaluate. A logic model highlights evaluation activities for an organization and can help with visualizing the necessary internal and external processes. It can also help those who are involved in designing and implementing the intervention come to a common understanding of what the intervention is and what impacts it can have on the community. There are a number of resources available to support logic model development.*

Another core activity of the formative evaluation stage is to collect information about the intervention during the initial implementation stage. Plan-Do-Study-Act cycle provides an opportunity to collect information that can lead to ongoing improvements in the delivery of interventions.[4] It allows adjustments to be made in the early stages of program delivery or to test out different approaches. At the end of the formative evaluation stage, clear documentation and operationalization of the core components of the intervention would be completed and a documented implementation strategy would be in place. Essentially, this provides a road map for others to be able to replicate the intervention and the implementation supports. For example, if the intervention is designed for registered nurses within hospitals to provide educational sessions to new

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* The Centers for Disease Control and Prevention provide a number of resources that can help shape the logic model development process: http://www.cdc.gov/eval/resources/#logicmodels

parents on how to properly install car seats, the information and practical skills intended for uptake in new parents should be clearly described, and more generally, what the educational sessions would look like when done successfully should be described as well. During the formative evaluation phase, work would be completed to operationalize the implementation strategy: planning the selection of the registered nurses to deliver the training, how to train the nurses to be effective teachers, and how support systems would be set in place for the nurses to complete the work.

When several Plan-Do-Study-Act cycles are completed, there is confidence in the intervention design, and when clear documentation of the intervention and implementation strategy is complete, process evaluation can then be initiated.

Process Evaluation

Process evaluations examine whether or not the core components of the intervention were delivered as planned. Evaluations of intervention effectiveness may report that the intervention failed to produce desired outcomes. Process evaluations are important because they can help understand the results of outcome or summative evaluations. For example, it is informative to look at adherence to the 'active ingredients' of the intervention or the core components to understand what parts of the intervention are essential (i.e., required for fidelity).[5] There may also be interest in coverage; for example, asking questions about the target population and feedback specific to the benefits from intervention participation. Process evaluation could also include looking at whether the frequency and duration of program delivery was aligned with the original plans. If a program has low adherence, looking at the strategies in place to facilitate implementation, the quality of delivery, and whether participants are engaged in the program, can be used.[5]

Outcome Evaluation

Outcome evaluation asks the question of whether or not a program was effective. There are numerous indicators one might use to measure the short-term, intermediate, and long-term outcomes of a program. Measuring or observing the impacts of a program on the intermediate or long-term outcomes may be more limiting. The sooner that the outcomes of investments can be measured, the better. Initial or short-term outcomes tend to focus on reach and efforts to increase capacity, knowledge, awareness, or the availability of supports. Intermediate outcomes tend to focus on some aspect of behaviour change (e.g., increase use or installation of car seats, use of personal protective equipment). Long-term outcomes or distal outcomes in this field tend to focus on injury outcomes. There may be opportunities to use local, provincial/territorial, and/or national data. Important in this evaluation phase,

and in all process involved with evaluation, is the inclusion of stakeholders, which includes feedback on both the process and outcome evaluation measures.

Resources Required

It has been recommended that practitioners and/or organizations set aside a budget that is specific to the costs associated with evaluation. Hiring and managing external consultants to perform evaluations of injury prevention programs is often an expensive and time-consuming process. In addition, external evaluators sometimes fail to appreciate important aspects of a program, and as a result, produce evaluations that are not as useful as they could be. Organizations can develop internal capacity for evaluation. The organizations with this capacity will not have to remain dependent on external resources for this critical function.

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2.4

The Political and Social Context of Injury Prevention Practice

Introduction

The previous chapters in this section have outlined a process to use different types of evidence to tackle an injury problem. An equally important part of the process is to understand and assess the context within which injury prevention initiatives move from theory to practice. For example, if a specific community and their politicians do not see playground injuries as an important safety issue, strategies to prevent these injuries may not be implemented. In this case, practitioners could advocate and raise public awareness regarding the burden of playground injuries. Using techniques such as advocacy and public awareness creates buy-in, and are examples of how both the social and political context can play a significant role in pushing an injury prevention agenda forward.

Assessing the social and political context is not a one-time exercise.

Practitioners must continuously assess and monitor the context as they move through the steps of the Public Health Approach and over the life of a prevention initiative.

The political and social context will continuously shift and change over time. Ensuring an on-going understanding of this context will allow practitioners to be more effective and ultimately more successful in their injury prevention efforts.

This chapter will highlight the importance of context in injury prevention practice and how establishing community and political support, understanding other community health issues

and existing public health resources, all create the necessary pre-conditions to advance injury prevention practice.

Important questions surrounding how the social and political context serves as the underpinning of injury prevention practice, is highlighted in Figure 10. Gathering evidence to answer each of the five questions posed in this model provides the important information about the context in which injury prevention works to select, implement, and monitor evidence-informed practice. As highlighted in previous chapters in this resource, an ecological approach to injury prevention may be the most effective; however, one of the strongest predictors of change is through the generation and enforcement of legislation, standards and policies.

Figure 10
Policy and Social Context
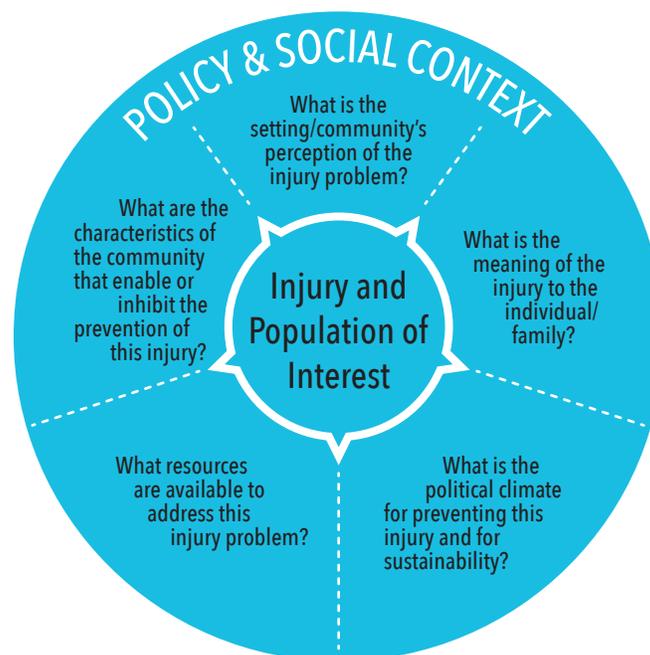
Social Context

It is important to consider a community's perception of an injury problem. As highlighted in Chapter 2.3.5 Evaluation and Monitoring, a needs assessment answers important questions specific to the local context such as: What does the community know about injury prevention? What injury issues are of most concern? For example, if a community has recently experienced the loss of a child due to drowning, this would create the public awareness and concern regarding drowning, in addition to actively supporting changes to prevent this type of injury in the future (e.g., 4-sided pool fencing). Assessing readiness for

change and/or 'teachable moments' can open doors, and provide opportunities to introduce new or existing strategies that will benefit the community.

To understand the social context, characteristics within the community that may enable or inhibit the prevention of injury must be considered. Are there 'known' truths about injury that the community accepts? For example, do community members have a perception that injuries are "accidents" that tend to happen as a result of bad luck or fate? Are certain injuries viewed as a badge of honour or right of passage, passed down through families? Perceptions or beliefs about injury and injury prevention will affect how messages are received, how much attention is paid, and/or if efforts to reduce the burden of injury are actively disregarded.

One strategy to promote uptake in a community-driven initiative is to find what is called a 'champion'. A champion is a person from the community, prevention organization, or research team that is engaged in addressing the injury burden and motivated to seek a solution. A champion can be used to promote injury prevention practice by providing perspective on a community's perception of injury, and on ways to influence injury reduction. A champion is also a person that can play a major role in the uptake, implementation, and evaluation of an injury prevention program. This person contributes significantly to understanding how the injury affects an individual, family, and/or their community, and can help identify other people who can influence uptake and evaluation processes.

Another strategy used to advance injury prevention practice includes an assessment of the available public health resources. This includes human as well as financial resources; both of which are important factors in addressing any social issue. It has been shown that when an issue is identified as a priority and has available or attainable resources dedicated to it, changes will result. There are both benefits and challenges specific to injury prevention in assessing the available resources. One challenge includes the diverse sectors that an injury prevention issue crosses. These include sectors such as health, transportation, education, and justice. Benefits include the opportunity for many champions; people in decision-making positions and volunteers who can influence injury prevention in the community. Challenges include getting everyone on the same page, working towards the same goal, and sharing information. Differing agendas, priorities and levels of control can side track efforts; however, when aligned, efforts result in a successful solution.

Understanding the social context within injury prevention practice that includes the needs of the community, other public health issues of concern, and the available resources, impacts the success of injury prevention efforts. Awareness of these issues plays a significant role in aligning strategies for prevention.

Political Context

The other, arguably most influential context to consider when thinking about injury prevention practice is the political context. Injury prevention literature shows the implementation and enforcement of laws and regulations can provide far-reaching and long-term benefits in reducing injuries. Standards, policies, by-laws and legislation are considered enforcement strategies, one of the 'E's' of the 3E approach to injury prevention (See chapter 2.2 for more information on the 3E's of Injury Prevention).

An enforcement strategy can be implemented at a variety of levels, such as municipal, provincial/territorial, and federal, depending on where the control or jurisdiction is located. Adoption of formal policies by boards and commissions also fall under the umbrella of policy and legislation. The regulation and enforcement of policies and legislation are powerful tools in the prevention of injury; however, policy and legislative solutions must be addressed across the spectrum, or with an ecological approach to injury prevention. Legislation is most effective when used in combination with environmental modification, educational activities, and increasing public awareness.[1]

Injury prevention practitioners must consider several factors to determine their impact on the policy decision-making process. These factors include whether injury is seen as an issue, whether there are champions to move the policy change forward (or naysayers that will need to be convinced), the election cycle, and if there is political will to address the injury issue. By examining these factors opportunities, or "policy windows", can be identified.

There are four general steps that advocates must take in order to successfully influence the policy-making process.

❖ **Understand government:** Understanding how government works is the first important step in navigating and working within the political context. Each level of government (i.e., municipal, provincial/territorial, federal) has its own processes and procedures to form and pass legislation. There are prescribed processes by which bills become law or funding requests become part of the budget. When seeking to understand government, it is crucial for injury prevention practitioners to be aware of the level of responsibility (jurisdiction), the decision-making process, current legislation, regulations and policy, and cycles of government. Likewise, each piece of policy, legislation or regulation will need to go through a process of agenda setting, policy formulation, decision-making, policy implementation, and ultimately, policy evaluation.

❖ **Determine strategy and tactics:** Choosing the best strategy and/or tactics to influence policy is not an ad hoc process, but rather one that involves an in-depth understanding of context and options. Strategy and tactics are generally interrelated; however, they refer to slightly different aspects of a public policy campaign. A strategy is a generalized plan to achieve one's goals and tactics refer to the methods and actions taken to execute the strategy.

In determining strategy and tactics, an injury prevention practitioner will have to determine certain contextual factors that will influence their approach. These include determining: the prevention goal and clarifying the specific request to government; the available resources and limitations; allies and opponents; and whether the campaign is short or long-term.

❖ **Build relationships:** Relationships play a critical role in navigating both the political and social context. In order to move the policy making process forward, relationships are often the key to accessing and leveraging resources and relevant information. Building relationships can take different forms. First, coalition building brings together groups of people around a specific issue or for a defined purpose, can expand the resources of a given movement, and also increase the likelihood of success by ensuring a broad base of support. A broad and diverse coalition of support can further demonstrate the relevance of an issue and the impact policy action will have on multiple sectors and interests. For the most part, coalitions are external to government. Second, there is building relationships with decision-makers themselves. Decision-makers are the elected officials or those with influence within government bodies that can facilitate the identification of a champion that has access to the inner workings of government. Building relationships is an important component in navigating the government system and attempting to identify and capitalize on policy windows when they arise.

❖ **Appeal to government:** Appealing to government means not only understanding which issues will interest a decision-maker at any one time, but also knowing how to frame and communicate the injury problem to make it resonate and align with a decision-makers priorities and philosophy. Sources for this information are: official party platforms; involvement of a decision-maker in previous causes and events; a keen understanding of a decision-maker's own personal biases and personal history; and the issues and concerns within a decision-maker's constituency.   At the core of appealing to government is also highlighting the return on investment that their involvement and promotion of a policy can garner. Appealing to government also means constructing a narrative or telling a story around the prevention issue that goes beyond the evidence to provide a persuasive, compelling message that necessitates action. For example, tragic incidents can often trigger public concern, demonstrate the human side to the injury issue, and provide a face to the cause. If this concern is effectively channeled, it can

produce a rapid and sustained momentum in a political commitment to injury prevention.

The policy making process is described using two different approaches; the linear and the contextual views of policy making.

A linear view of policy making sees the evolution from evidence to policy as following a sequential path. In this case, four steps are undertaken to reach a policy solution: 1) problem identification is where an injury issue or gap in knowledge surrounding an injury issue is identified; 2) evidence gathering is where the evidence to support the presence of the problem and its accompanying evidence-based solution is compiled; 3) knowledge brokering and transfer is where those who possess the evidence distribute it into the hands of those with the power to influence policy change (i.e., decision makers); and 4) action marks the introduction and implementation of a policy or legislative reform that directly addresses the problem and solutions identified in steps one and two. In this model, decision makers are always receptive to the evidence received.

Figure 11
Policy-making: A linear view

Problem

⬇

Evidence

⬇

Knowledge Brokering & Transfer

⬇

ACTION
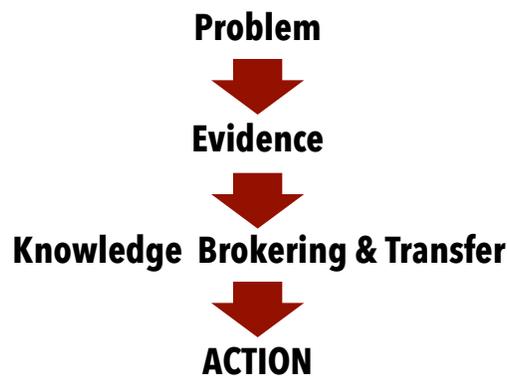
The linear view of policy making is often considered too simplistic as it fails to take into account the social and political context that impacts the process. In contrast, the contextual view of policy-making provides a realistic and adaptable method for achieving public policy solutions for injury prevention. The contextual view of policy-making accounts for the realities of a decision maker's subjective view that impacts their ability to take a particular policy approach. These include: 1) the importance and magnitude of public opinion; 2) competing priorities; 3) their own personal biases and preferences; 4) the periodic need for crises management; and 5) the election cycle. All of these factors constitute a real world, ever-changing political environment within which those who wish to influence policy must operate.

Within the contextual view of policy-making it recommends an assessment of the social and political context as a continual search for opportunities or "policy windows", verses a one-time exercise to promote policy change. In this method, evidence still plays a critical part; any proposed activity should be based on data demonstrating the issue is important, the target population is appropriate, the intervention is effective and demonstrates a return on investment. The contextual view of policy-making uses evidence as one part of a comprehensive approach to sway decision-makers into taking a particular course of action.

Figure 12

Policy-making: A contextual view

Final Thoughts on the Policy and Social Context for Injury Prevention

To develop effective solutions to injury prevention problems, it is essential for practitioners to consider the social and political context. Doing so improves the effectiveness of tools, strategies, and techniques that are required to navigate the policy making process and to implement laws and regulations that can result in sustained reductions in injury rates. There are various situations, people, timing, processes and resources that will impact action and the likelihood of success. To be successful in developing and implementing injury prevention solutions, practitioners require the knowledge and skills for raising public awareness, building relationships with elected officials, and shaping laws and policies. Injury prevention practitioners including health professionals, researchers, knowledge translation

experts, and other vested people and organizations, have valuable information to contribute to their communities and policy that will make a real difference in the lives of individuals.

Case Study in Social Context and Policy – The Consumer Product Safety Act

Canada's Consumer Product Safety Act illustrates effective advocacy for injury prevention public policy. This movement took into account the social and political context throughout the legislative approval process.

The process of passing the Canadian Consumer Product Safety Act originated with identification of the injury burden, specific to consumer products. Between 1990 and 2007, more than 1.6 million injuries were treated in the emergency departments of the 16 hospitals participating in the Canadian Hospitals Injury Reporting and Prevention Program [CHIRPP] (ages 19 years and younger).[2] From 1997 onward, 46% of emergency visits involved consumer products, including toys, magnets, furniture, and window coverings.[2] Furthermore, for nearly two-thirds of all cases in children under the age of 5, the product was a direct cause of the injury and a contributing factor in one-third of all cases.[2]

Removal of unsafe products from the marketplace was identified as an effective way to reduce the likelihood of these injuries; however at the time, the Consumer Safety Product Act was notably out-dated. The Hazardous Products Act that regulates the import of consumer products into Canada, was more than 40 years old and ill-equipped to be responsive to the realities of a modern, global marketplace; therefore, the legislative renewal process to update the act, based on the burden of injury attributed to imported consumer products was initiated by the Canadian government in 1998.

However, it would not be until 2010, that Canada passed renewed consumer product safety legislation. There are a number of reasons for the length of the process and both social and political factors intervened between the initiation of Legislative Renewal in 1998 and the passage of the Canadian Consumer Product Safety Act in 2010. In 2003, extensive public consultations were conducted and between 2003-2008 other activities such as a survey of Canadian parents that identified the misperception that if a produce was for sale in Canada, it had been tested and was safe. Products continued to be found with safety concerns. In 2008, the 39th Parliament was suspended before being able to pass the first iteration of the consumer product safety legislation, Bill C-52. Following the legislative process, Bill C-52 was reintroduced during the next Parliamentary session. The prorogation of the Government in 2009, again mandated that this second iteration of the legislation, now Bill C-6, was halted mid-way through the legislative process. The legislation was reintroduced under a third iteration, Bill C-36, when Parliament resumed and this time, was passed and received Royal Assent in December 2010. The Canadian Consumer Product Safety Act came into effect in

June 2011.* In the aftermath, numerous public consultations on the regulations within the Act and subsequent evaluation of its effectiveness have been undertaken.

Ultimately, the successful effort to pass the Canadian Consumer Product Safety Act was the result of understanding the social and political context, while utilizing resources at strategic time points in order to capitalize on "policy windows", such as after a product recall that drew attention to the issue. Understanding government was critical to navigating the many factors that contributed to the delay and several iterations of the policy, while remaining persistent throughout the process. It was also important in ensuring that interested stakeholders were able to contribute to the legislative debate by appearing before committees at the House of Commons and Senate, providing written submissions and meeting with elected members of Parliament. Following procedures to appear before committees or provide submissions was paramount.

Building and sustaining relationships were also important to the process. A coalition of like-minded, but diverse organizations, collaborating and leveraging resources and connections, encouraged the passage of the legislation. These included: Option Consommateurs, a non-profit association whose mission was to promote and protect the basic rights of consumers; Environmental Defence, an environmental action organization, and Safe Kids Canada, a national injury prevention organization focused on unintentional injury in children. These organizations shared resources and information, and communicated coordinated messaging regarding the legislation. Together, they employed strategies and tactics that addressed the social and political context. Meetings were held with elected officials and policy officials, press releases were issued at critical points, opinion editorial/op eds (an article published by an author not usually affiliated with the publication) were written in newspapers familiar to decision-makers, and organizations took part in media events along with the Minister of Health.

An important part of this successful policy change was the social support created to pass the bill. A narrative was developed describing the importance of the legislation that garnered a significant amount of social support. The narrative underscored the need to keep children and families safe, while providing both the government and parents with a specific way to do so. For example, a coalition of stakeholders issued a joint press release addressed directly to the members of the Senate committee during their consideration of the legislation's second iteration. The release was entitled *Health, Environmental*, and Consumer groups urge the Senate to pass Bill C-6 before the holiday gift-giving season. Released in early December,

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* The Canadian Consumer Product Safety Act contained three key features to modernize Canada's consumer product safety regime: Prohibiting the manufacture, importation, advertisement or sale of consumer products that pose an unreasonable danger to children and human health; mandatory recall powers for the government to remove unsafe consumer products from the market, the requirement of suppliers to provide test results and safety reports to Health Canada regarding any serious injuries or illnesses resulting from the use of their products; offence related to false packaging or deceptive labeling of unsafe products.

the press release highlighted the importance of the consumer product legislation during a time particularly focused on family – the winter holidays.

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Engagement

To understand the importance of engagement in injury prevention, it is essential to look at the overall context within which this work happens. As mentioned in the previous chapter, there is a political and social (local and community specific contexts) context within which injury prevention occurs. In addition, there are a number of other important influences when charged with selecting impactful interventions within a context of scarce resources. The model below outlines how engagement with the targeted community, the relevant municipal, provincial and/or federal decision makers, and partnerships with key stakeholders and knowledge users is the foundation of an engagement model.

This model places engagement as the outermost layer of the injury prevention process. This is important as it demonstrates how engagement is involved at every stage of applying an evidence-informed approach to prevention. Important to consider in this process, are all of the factors that can create success in program implementation. This includes consideration of the local social and political climate of the community and the available public health resources. Where these considerations are specifically made is in the implementation planning stage of the Public Health Approach (See Chapter 2.1 for more information). This stage provides the information on the important components' to include and to adapt information to a local context.

Figure 13

Using good practice to plan effective actions to prevent injury and promote safety[1]
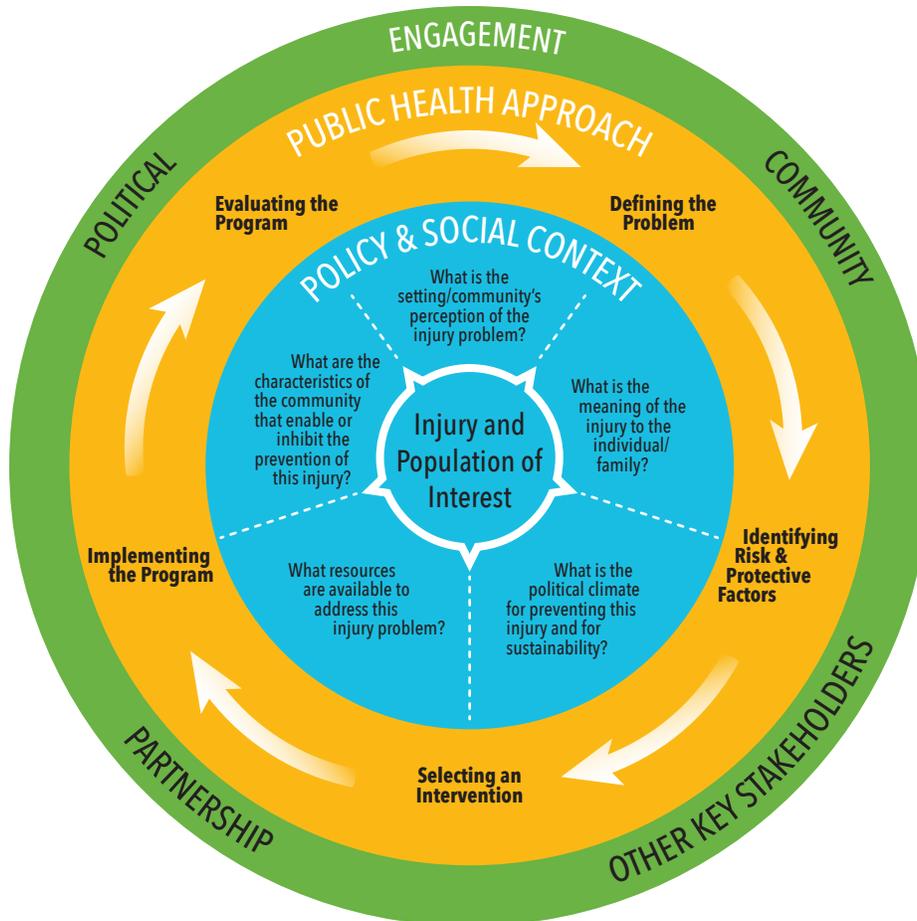
Evidence-informed practice draws attention to the different types of evidence and how it is used in this process, and how evidence can come from more than one source. Specific to engagement, practitioners would use evidence from the information gathered from community members, stakeholders, politicians, decision-makers and partners throughout the Public Health Approach to injury prevention.

Engagement of the community, stakeholders, politicians, decision-makers and partners will help assess the local social and political context (i.e., establishing required conditions for success), and it also ensures a more collaborative approach to building capacity by tapping into the knowledge and expertise of others, identifying champions, and bringing new and existing resources to the table. Depending on the specific injury prevention or safety promotion area of focus, other key stakeholders may be identified and engaged in these activities.[1] Although the health sector is important, it is only one partner in the search for injury reduction. Multi-sectoral action is essential and work needs to be coordinated across

sectors and government ministries. Consideration of each component of the model is important, in addition to an integrated approach to plan actions that effectively prevent injuries and promote safety.[1]

Professional Frameworks

There are many frameworks that speak to the process of achieving engagement with different groups. The type of engagement framework will depend on the goal(s) of the group, duration of the work, and the type of people who will be participating. Regardless of the type of framework, the over arching objective is to bring together a group of individuals and/or organizations to work as a collective towards a shared outcome. This could take the form of a defined project, a mechanism to share information, or make connections to others working in similar areas. In addition, the structures of these engagement frameworks can take different forms. They could be set up to have a leader with members connecting to the leader, (traditional top down approach), a hub and spoke format where there is a central coordinator (think of an airport), or a co-creative model where there is no defined leader but rather connections between and amongst the participants.

Communities of Practice. A community of practice is a collection of people who engage on an ongoing basis towards a common endeavor. Communities of practice emerge in response to common interest or position, and play an important role in forming their members' participation in, and orientation to, the world around them. The Canadian Knowledge Transfer and Exchange (KTE) Community of Practice (KTECOP) is an example of a network of KTE practitioners and researchers who share KTE practices and experience, build peer relationships for information exchange and support, build KTE capacity, advance knowledge of KTE effectiveness, and share KTE events, job opportunities and other related KTE activities (http://www.ktecop.ca).[2]

Networks. Networks can be very formal or relatively informal in structure. There are innumerable ways of defining and understanding networks; simply, they can be understood as interconnected systems. More specifically, "networks are systems of relatively autonomous actors that are working in concert to achieve shared goals or pursuing individual goals within a shared system."[3] In Canada there are communities that have achieved the designation of a Safe Community. Each community operates activities in their local area but is part of a larger

network across Canada. This network has shared communication vehicles that allow each community to connect with each other, and Parachute, a national not-for-profit organization designated as an authority of knowledge translation in the injury prevention community. Safe Communities have both individual and shared goals within the network. Individual goals vary; for example, one Safe Community may focus attention on drowning prevention while another may focus on poison prevention; however, the overall shared goals of both Safe Communities is to reduce preventable injuries to local communities. Ultimately, the work of this network addresses a common goal of reducing preventable injuries.

Collaboratives. Collaboratives represent the action of working with someone or a group of people, to produce something.[4] Collaboratives typically have a smaller number of people compared to networks and can have structures such as Term of Reference, membership definitions, meeting timetables, etc.

There are a few examples of collaboratives in injury prevention:

❖ **Canadian Collaborating Centres on Injury Prevention (CCCIP):** Established in 1999, The Canadian Collaborating Centres on Injury Prevention (CCCIP) is a community of practice representing injury prevention centres throughout Canada. Its membership represents all of the provincial injury prevention centres and the leading national injury prevention organizations in Canada. The CCCIP provides a unique opportunity for leading injury prevention professionals to share knowledge and experiences, support individual and collective initiatives, policies, and research, and further the work of injury prevention throughout Canada.

❖ **Atlantic Collaborative for Injury Prevention (ACIP):** ACIP is a partnership of injury prevention practitioners from both government and non-government organizations. The goal of ACIP is to reduce the burden of injury in Atlantic Canada.

Committees. Committees can be defined as "a group of people appointed for a specific function by a larger group and typically consisting of members of that group."[4] Ideally, a committee is struck for a very specific objective with a defined time limit to achieve the objective. In 2005, the momentum for Federal/Provincial/Territorial action on injury prevention was renewed to facilitate collaboration aimed at enhanced injury prevention. This momentum formed a national injury prevention committee with representatives and injury experts from across Canada called the Injury Prevention and Control Task Group (IPCTG). The purpose of IPCTG was to identify key national injury prevention priorities that could be incorporated into a vision paper for Canada. The vision paper and action plan was completed in 2010 and the committee was subsequently folded.

Public Engagement. The previous section in this chapter discussed the different forms that engagement with professionals can take. Just as important are mechanisms to engage the public in injury prevention.

The Community Against Preventable Injuries is a community outreach group to understand the perceptions, knowledge, and behaviours related to injury in Canada. Using the social marketing tool ***Preventable*** as a platform, the Community Against Preventable Injuries identified opportunities to engage the public in discussions about preventable injuries. This included scenarios that did not provide direct messages, but encouraged audiences to think about their own attitudes and beliefs about injury. In Alberta, public engagement has been also done at the community level. There are community driven awareness programs that are designed to promote discussion and reflection at that moment of risk, for example, an overturned ATV at a trailhead with the messaging "Before you think you won't need a helmet today, have a word with yourself."[5]

Conclusion

Engagement of both professionals and the public is essential in the process of injury prevention. Injury prevention is too significant an issue to rely solely on the engagement of only one sector. To be effective in injury prevention, efforts and resources brought from different groups enhance the promotion of preventable injuries.

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3

Key Determinants of Injury

What are the key determinants of injury?

Injuries are often attributed to the behaviours of individuals. A senior fell because he or she did not install grab bars in the home. A child is hurt when a parent is not providing supervision. A young man is in a car crash while speeding. While individuals do play a role in injuries, the occurrence of severe and fatal injuries is far more complex than individual choice. Injuries are the result of the interplay with individual, community, structural and societal factors.[1] This includes everything from social connectedness in the community to income support and childcare policies. This range of factors combine to create the conditions in which people live, work, and play, ultimately impacting the options they have and exerting significant influence over day to day life. Looking back to the earlier examples, perhaps the senior who fell did not have the financial means to install grab bars or the social connectedness to have support for home improvements. The child may have been unsupervised because the parent had to work two jobs to make ends meet but could not afford daycare. The car crash may have occurred due to a combination of developmental stage and stressful conditions in the home.

The evidence is clear that injuries do not affect all Canadians equally. Similar to other health issues, severe and fatal injuries are disproportionately experienced by individuals and populations who live in less affluent neighbourhoods, have low socioeconomic status, have low educational attainment.[3] The likelihood of experiencing this type of injury declines for every incremental increase in income and neighbourhood affluence. This effect has been

demonstrated across numerous injury issues including, but not limited to, motor vehicle collisions, falls, suicide, and violence.[4] The one exception to this trend is sport and recreation related injuries which tend to increase with income.[1] This is likely due to enhanced economic and social opportunity to participate in organized activities.

Injury risk is also influenced by gender, the physical (subsequently referred to as built) and social environment, employment status and work environment, and whether the individual lives in an urban or rural setting. There are 12 key determinants of health that have been defined by the Public Health Agency of Canada (see textbox on Key determinants of Health). These social, economic, and built environment conditions produce higher risk for certain age groups and populations.[1] While risk for certain types of injuries varies by age group, children, adolescents, and seniors have the highest rates of injuries throughout the lifespan. This can be exacerbated by other risk conditions such as low socioeconomic status. Both Indigenous populations and new Canadians may experience stressors such as discrimination, racism, language barriers, and lack of access to appropriate services which can impact injury risk and overall wellbeing.[5] The rate of intentional and unintentional injuries among indigenous populations in Canada is significantly higher than the non-indigenous population.[6] This is the result of a complex interaction of social, economic, and built environment determinants that includes the historical experiences of colonization and the detrimental impact of this practice that continues to present day.

> ## Key Determinants of Health[2]
>
> 1. **Income and Social Status**
> 2. **Social Support Networks**
> 3. **Education and Literacy**
> 4. **Employment/Working Conditions**
> 5. **Social Environments**
> 6. **Physical Environments**
> 7. **Personal Health Practices and Coping Skills**
> 8. **Healthy Child Development**
> 9. **Biology and Genetic Endowment**
> 10. **Health Services**
> 11. **Gender**
> 12. **Culture**

How do the determinants impact risk for severe and fatal injuries?

There are a variety of means by which determinants affect injury risk. A lack of resources can mean increased exposure to hazards such as inadequate or unsafe housing and dangerous

conditions in the community. It can also mean that individuals or families are unable to purchase products that can prevent injuries from occurring such as baby gates, bicycle helmets, or winter tires.[3] Experiences of social and material deprivation result in a great deal of stress and can contribute to feelings of anxiety, sadness, and hopelessness.[5] In addition to the negative impact that chronic stress has on physical and mental health, it may also lead to unhealthy coping mechanisms such as drug use, excessive alcohol use or other risk-taking behaviours, all of which are known to increase risk for both intentional and unintentional injury.

What are the implications for injury prevention?

The evidence regarding the determinants of injury has significant implications for how we understand and address severe and fatal injuries in Canada. Injury surveillance systems need to be capable of capturing a range of social, economic, and built environment determinants that may relate to the injury itself. It is also important that those working in injury prevention are able to identify inequities in injury rates so that those populations at highest risk for injury are prioritized for prevention strategies. This involves analyzing injury data in detail by factors such as age, sex, employment status, income, Aboriginal status, educational attainment, and the built environment.

Injury prevention strategies have typically focused at the level of primary prevention, with emphasis on education, engineering, and enforcement. While these strategies are important, they need to be considered within the reality of people's daily lives. Injury prevention strategies can serve to increase disparities if they do not take into consideration many of the determinants. For example, a law requiring the mandatory use booster seats would benefit those who can afford booster seats; however, the same safety benefit would not exist to those who are less able to afford them.

Current knowledge of injury-related inequities requires that injury prevention move towards primordial prevention. Primordial prevention is a term used to describe initiatives that attempt to improve daily living conditions by increasing opportunities and social connectedness and reducing the stress caused by low income, unsafe environments, and insecure or unsafe employment. Not only will this approach reduce injuries due to improved social and economic conditions, it will also serve to increase the effectiveness of primary prevention strategies. Individuals will be increasingly receptive to a strategy such as education when their basic needs are met.

Conclusion

This chapter provided an overview of the evidence regarding numerous social and economic conditions and their impact on injury rates in a Canadian context. The key determinants to

be examined are socioeconomic status, education; work, social, physical and build environments, healthy child development, biology and genetic endowment, gender, health services, and culture. While these are likely not the only social determinants of injury and do not include all of the determinants identified by PHAC (see textbox on Key determinants of Health) they feature prominently in the research literature as key contributors. Although these issues are presented separately in the sections to follow, it is important to remember that they typically do not exist in isolation but instead interact to produce risk or protective conditions. In some cases there may be a cumulative effect. The purpose of identifying those at high risk of injury is not to lay blame. Instead, the intent is to enhance understanding of inequities and identify where efforts and resources are most needed.

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3.1

Socioeconomic Status

Introduction

Income and social status (or socioeconomic status - SES) is a person's positioning within social or economic hierarchies in society that has been shown to influence mortality, morbidity, psychosomatic health, somatic health, and self-perceived overall health.[1,2,3] Past studies have established an association between SES and injury, but this association is not straightforward in that low SES is not always associated with increased risk for injury.[4,5,6] This chapter begins with an overall look at the association between SES and injury experience. The chapter then continues to look at this relationship in child and adolescent populations specifically, and to describe potential avenues for preventive intervention. Data from the Canadian Health Behaviour in School-aged Children study are used to illustrate SES and injury relationships.

The Links Between Injury and Socioeconomic Status

A persons socioeconomic status (SES) refers to their social and economic position in society and is established by using measures of income, wealth, occupation, or education level.[7] SES is a health determinant of particular interest because it underlies or is directly linked to many other social determinants that influence health outcomes. There is a large body of literature that establishes the profound relationship between SES and physical health, whether it is self-perceptions of health or objective outcomes such as mortality or medically diagnosed or treated injury.[8,9] Educational level is one component of SES; a higher level of

education can indicate higher levels of literacy and greater potential knowledge of the benefits and risks of certain health behaviours. At an individual level, lack of education regarding risk-taking behaviours (such as drinking, smoking, drug use, violent behaviours, risky sexual practices, and risky driving) can increase an individual's likelihood of injury.[10,11] Low SES can restrict an individual's access to health resources and care, leading to a greater likelihood of more serious morbidity or mortality if injuries are sustained.[12] At an individual or family level, the stresses of low SES and time required to search for employment or secure the essentials for daily living may lead to lack of parental support or supervision of children which may increase a child or youth's risk for injury.[13,14] At a neighborhood level, it is believed that low income or disadvantaged neighborhoods can have increased exposures to hazards due to poor housing, higher density traffic, and more criminal activity which can increase risk of injury.[15] These less advantaged areas typically also have less access to resources such as fire and police protection, road maintenance, and recreational facilities which have been shown to reduce risk of injury.[16]

There have been many studies conducted in Canada and worldwide that assess the impact of wealth and social position on injury risk and experiences. Lower SES is generally associated with an increase in injury risk. For example, an Australian study by Jolly, Moller and Volkmer (1993) demonstrated a three fold greater risk of injury for the lowest socioeconomic quintile compared to the highest.[17] Brownell and colleagues (year) confirmed that people with lower SES were at greater risk of injury hospitalizations.[18] Faelker et al (2000) conducted a study in Kingston, Ontario examining the socioeconomic gradients of injuries treated in emergency departments and found that there was a significant linear trend with people of lower SES presenting more often with injuries than those of higher SES.[19]

Low SES tends to be associated with negative health and injury outcomes; however, there is relatively limited epidemiological information that assesses the relationship between SES and particular types or causes of injury.[20] In one Canadian example, Simpson and colleagues found an inverse relationship between SES and injuries related to fighting, with twice the odds of a fighting injury in lower SES groups.[21] Potter and colleagues (2005) assessed SES and its association with recreational and non-recreational injuries.[22] Participation in organized forms of sport and recreation, where sport injuries are sustained, were associated with being from a higher SES group.

Child Injury as It Relates to Income and Social Status

Injury in childhood is a significant concern. The Health Behaviour in School-aged Children (HBSC) study is a nationally representative general health survey completed every four years by a representative sample of school children in grades 6-10 in 46 different countries, including Canada. In 2010, 26,078 Canadian students in 436 Canadian schools completed the

survey. Data from this cycle of the HBSC survey indicated that 40% of Canadian children had sustained an injury that required some form of medical treatment in the year before the survey. These statistics are broken down by age and sex in Figure 14.

Figure 14

Proportion (%) of Canadian children who report having had a medically treated injury in the 12 months preceding 2009-2010 survey completion (Source: HBSC 2009-2010)
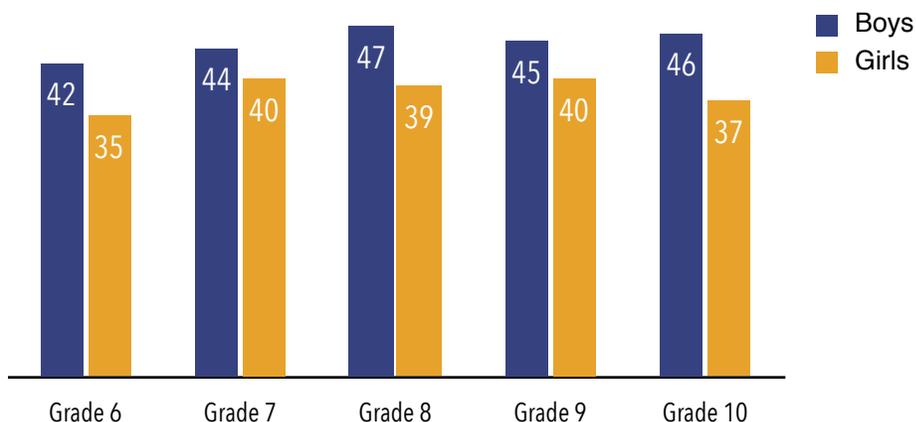
In the HBSC study, students are asked to indicate if their family was: not at all well off; not well off; average; well off; or very well off. This is one form of self-reported measure for SES10. When injury prevalence was examined by self-reported SES, a socioeconomic gradient was evident for any injury occurrence. This was also true for those injuries that were defined as severe by the medical intervention required (i.e., cast, stitches, operation or overnight in the hospital) or because the young person missed five or more days of usual activities (Figure 15).

For girls, a greater proportion of any and severe injuries were reported among those with lower SES. Boys demonstrated a "U" shaped pattern with increased injury reports in both the low and high SES groups. Previous research has shown that this is likely due to the different kinds of activities that boys participate in and the kinds of injuries they sustain[5]. Sports injuries, for example, have different mechanisms and potential risk factors than a burn or scald. When examining HBSC data for sports injury only (Figure 16) this "U" shaped pattern is again obvious for boys. In fact, for those who sustained any injury or any severe injury that was due to playing or training for a sport or team, there was a higher proportion of more affluent youth.

Figure 15

Proportion (%) of Canadian children who report having had any medically treated injury and any severe injury in the 12 months preceding 2009-2010 survey completion, by self-reported SES level (Source: HBSC 2009-2010)

Any injury — *Severe injury*
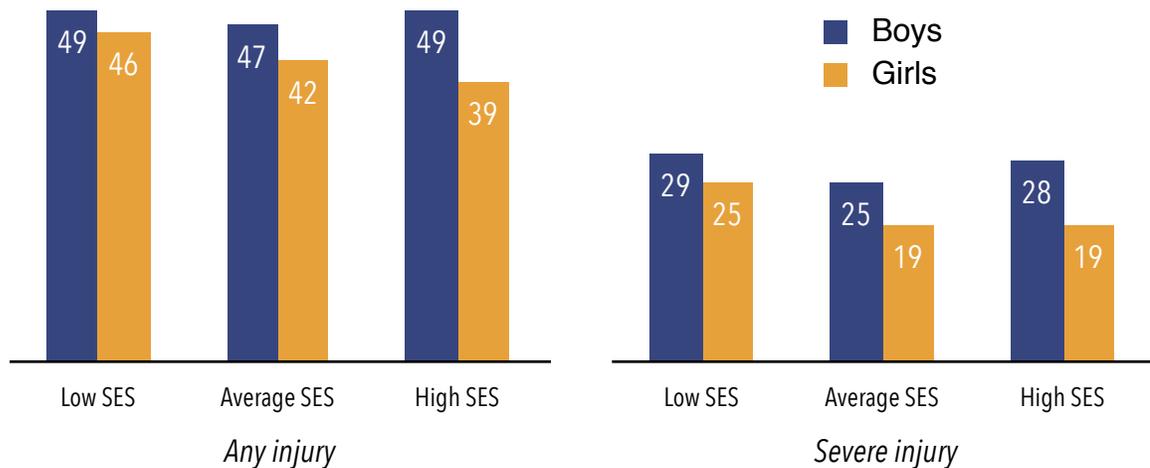
Figure 16

Proportion (%) of Canadian children who report having had any medically treated sports injury and any severe sports injury in the 12 months preceding 2009-2010 survey completion, by self-reported SES level (Source: HBSC 2009-2010)

Any sports injury — *Severe sports injury*
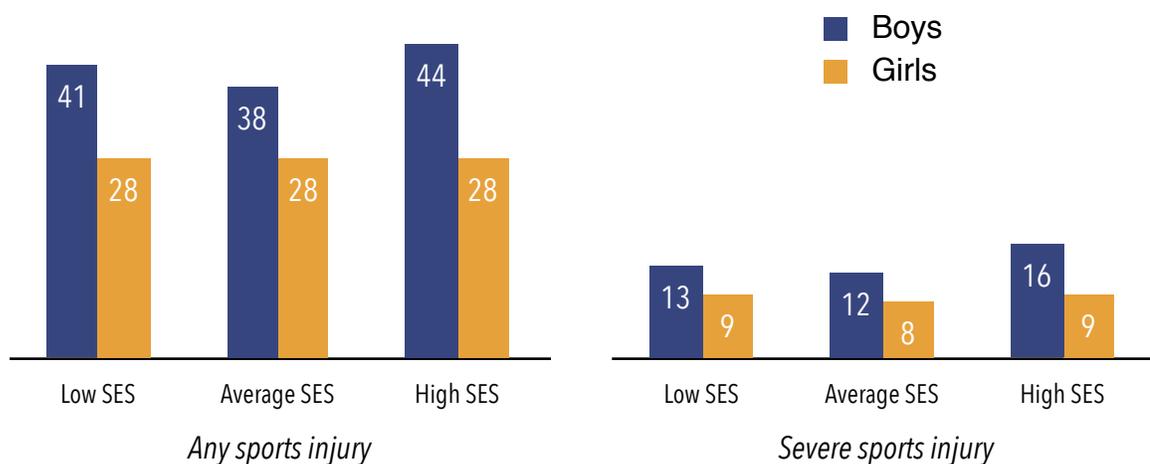
Over the past decade, there has been increased attention towards other types of injuries and their relationships to SES. Bicycling-related injury, for example, and the non-use of protective equipment such as helmets, has been a focal area.[23] Bicycling can have important health benefits, but can also put a person at risk for cycling-related injuries. Previous research has indicated that bicycling-related injuries do not follow the same patterns in their

association with SES as do injuries related to the participation in a team or sport.[24] Rather than having a dual peak at low and high SES, in bicycling, data from the Health Behaviour in School-Aged Children (HBSC) study indicates a linear gradient, with lower SES being associated with a 30% greater risk of injuries from bicycling as compared to average or higher SES groups, when helmet use is controlled for.[5]

Three quarters of Canadian children ages 11-15 years are bicycle riders. Independent factors associated with bicycle ridership among students included being male, a younger student, higher SES, and a resident of a small town. Among bicycle riders, 43% reported never wearing and 32% inconsistently wearing a helmet. Only 26% of students reported always wearing a bicycle helmet. Helmets were less frequently used among students of lower SES (40.5% do not wear them in the highest SES group while 49.1% do not wear them in the lowest SES group with a distinct and continual gradient). There has been some research demonstrating the association among non-use of helmets, bicycling-related injury, and SES.[25] The cost of a helmet is a barrier for some in lower SES groups.[26]

Results from the HBSC examples highlight three things. First, it is essential to consider level of SES when examining injury risks because there are associations across the socioeconomic gradient. Second, it is essential to consider the type of injury that is of interest to determine how SES plays a role in its determination and whether higher or lower SES may put a child at greater risk. And finally, there appear to be differences between SES and injury patterns by sex.

Links to Product Safety

Being of a lower income or social status (also known as socioeconomic status - SES) can result in inequitable access to safety promotion products such as bicycle helmets, helmets for use with off-road vehicles and approved car seats. In addition, levels of parental supervision can differ for children from different SES groups, and injury among children has been associated with unsafe, unsupervised use of heat sources, small appliances, playground and sports equipment, bicycles, ATVs etc. There may also be product safety related associations between SES and injury at the neighbourhood level as communities of lower overall SES may not be able to afford, or may not monitor development and upkeep of, the most up-to-date and modern safety equipment in parks, playgrounds and other public spaces.

Recommendations

Previously, interventions to encourage the use of safety equipment such as bicycle helmets have tended towards whole population-level approaches including legislation.[27] There have also been non-legislative interventions aimed at the general public or broad groups of young people[28] and interventions to increase helmet uptake among people in low SES groups.[25,29] These have each had distinct merit for contributing to a reduction in injury and increasing the accessibility of safety equipment for the most at-need.

A recent Manitoba-based study by Brownell and colleagues (2010) found that child injury hospitalizations (ages 0-19 years) have decreased over time from 1986 to 2006 for all SES groups.[18] However, the strength of the association between SES and injury has increased over time. In practical terms, this means that SES level has a stronger association with injury today than it did two decades ago. This pattern may be due to the association of injury prevention activities having a less pronounced impact in lower SES groups.[18] While it may appear this would call for targeted injury prevention in those with lower SES, targeted programs may miss other people, such as those of average SES who are also at an overall increased risk of injury. Instead, injury prevention advocates have encouraged addressing the broader determinants of injury, including the inequitable distribution of social and economic resources, in order to reduce the injury socioeconomic gradient.[30] In essence, this implicates poverty reduction strategies and a continuing emphasis on underlying social and economic conditions that promote health and safety.

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3.2

Education and Literacy

Introduction

The level of education a person completes is an important determinant of health and injury. It is commonly included as an indicator of income and social status (or socioeconomic status – SES) along with family or individual income, wealth, and occupation. These income and social status indicators are interrelated and interact to produce risk or protective conditions.[1,2,3] (See Chapter 3.1 Socioeconomic Status) This chapter focuses on describing the specific relationship between education and injury with reference wherever possible to Canadian contexts, while recognizing the influence of other components of SES.

The World Health Organization has identified lower education levels to be linked to poorer health, greater stress, and lower self-confidence.[4] Higher levels of education and literacy are, in turn, associated with improved working conditions/employment, and higher incomes, which lead to improved health outcomes.5 Education levels can also impact the employment market, facilitate citizens' civic activities and engagement levels, and influence citizens' understandings of their world and collective actions that can improve societal conditions.[2] Education increases overall literacy and understanding of how one can promote one's own health through individual actions.[2]

Education and Injury Outcomes

Lower levels of education have been linked to significantly higher death rates resulting from a host of different health issues, particularly for people who did not complete high school

level education.[6] Completion of post-secondary education has been associated with a lower risk of injury,[5] whereas those with lower levels of education demonstrate greater serious or severe injury rates.[3] A review by Cubbin and Smith (2002) found significant associations with low education and higher risk of homicide, motor vehicle fatalities, and other external causes.[3] Education level is also associated with certain outcomes of automobile collisions. Less-educated men were more likely to experience a fatal automobile crash than more highly educated men.[5,7] Other associations have been found between low education and specific types of injuries including: pedestrian, bicycling, driver injuries, and fires,[7] in addition to homicides[3, 8] and suicides.[3]

The influence of education on injury outcomes is not only evident at the individual level, but is also related to the level of education completed by parents and caregivers. Higher maternal education levels have been associated with a reduced risk of pedestrian or bicyclist injuries[3] and also found to have a protective effect on hospitalization for burns among their children, as compared to children of less well educated mothers.[7] In a Kingston, Ontario study, increased risks of childhood injury were found in populations with higher proportions of families headed by an adult with less than high school level education.[9]

Education and Risk-Taking Behaviours

Increased injury risks associated with lower education are influenced by the relationship between level of completed education and risk taking. The likelihood of injury can be impacted by an individual's lack of education regarding risk-taking behaviours, which can result in injury. (See Chapter 3.1 Socioeconomic Status) Educated populations are better positioned to access information and understand the impact of health from lifestyle options.[6] Risk-taking behaviours can include drinking, smoking, drug use, violent behaviours, risky sexual practices, and risky driving.[10] For example, alcohol impairment is a known risk factor for motor vehicle collisions across socioeconomic groups; however, the proportion of impaired drivers is higher among injured drivers with low individual education attainment.[7] Use of safety equipment has been cited with education level as well: seat belt use in the United States increases with educational level in both men and women.[7] Finally, level of education is likely to influence a parent's perception of risk as well as parenting behaviours.[11]

Recommendations

In general, interventions that are designed to increase and improve overall education levels will not be focused on reducing injury; a reduction in injury rates in the vulnerable populations described above would be a by-product of these high-level interventions, such as policy or programs targeted at increasing general education levels. However, given that there is a connection between low education and increased injury rates, there are inter-

measures that can be executed in order to influence change and deliver injury prevention and risk education to high priority populations.

An example of this type of intervention would be an injury educational program targeting families with low education levels with the goal to increase injury awareness and prevention. An example of one such program is the Canadian Child Injury Prevention Resource program. This online resource provides resources designed for practitioners (as well as other Public Health workers including, Childhood Educators, Day Care staff, or others working with caregivers) working in the Community Action Program for Children and Canada's Prenatal Nutrition Program (CAPC/CPNP). These practitioners identified the need for simple messages and images to use with the families they serve, to teach them about preventing injuries in children. They also identified the need for training in the area of child injury prevention, particularly addressing the key determinants of health and how to influence behaviour change. (See footnote[*])

In addition to the types of interventions that can be designed for families of low education attainment about injury, it is also important to think about other key determinants when working to improve education levels and access to education. Education must not be considered as an individual issue impacting health and injury, but one that interacts with other determinants to affect health outcomes. There is a need; therefore, to build protective and supportive environments that influence all determinants of health including access to quality education.[5] A multi-faceted approach is necessary, beginning with early child experiences and continuing throughout the lifespan. In order to foster healthy development and facilitate learning, support must be developed at the individual, familial, community, and national levels.[5]

Low and Low (2006) make recommendations specifically related to education for focusing on evidence-based policies to optimize early childhood development and education as a means to improve the health of a population[12]. With healthy policies integrated across the spectrum oriented around optimal human development, the foundation for successful educational and health outcomes is built[12]. An educated population is better positioned to access information, understand the implication of lifestyle and behaviour choices (such as risky behaviours), navigate the health care system, and make choices that optimize individual health as well as that of their families.[6]

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[*] Parachute's Child Injury Prevention Resource - http://parachutecanada.org/child-injury-prevention

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Education and Literacy
Risk Perception and Risk Mitigation

The Perception of Risk

The field of risk perception is one that has made a tremendous amount of growth, particularly in the field of injury prevention. This field of research was initially predicated upon an assumption that there is a divide between objective and subjective risks. Objective risks were those risks calculated as data driven probabilities of hazardous occurrence. Subjective risks were the risks associated with a person's perception of the likelihood of an event. In general, the field of injury prevention no longer embraces the notion of objective risk and instead, a distinction is drawn between the assessment of risks by experts and novices while recognizing the role of subjective processes in both types of assessment.[1]

The field of risk perception is divided into a number of research traditions from the quite empirically grounded tradition modeled on psychometric studies of sensory perception, to the more sociologically and anthropologically oriented traditions of culture theory and social amplification of risk. Psychometric studies of risk focus on attributes of hazards that may increase or decrease perceived individual risk level. For example, one study of the perceived risk in the nuclear power industry in the Netherlands found the following list of attributes that influence risk perception.

Table 4

Negative Attributes that Influence Risk Perception[2]

1. Involuntary exposure to a risk.

2. Lack of personal control over outcomes.

3. Uncertainty about probabilities or consequences of exposure.

4. Lack of personal experience with risk (fear of the unknown).

5. Difficulty in imagining risk exposure.

6. Effects of exposure delayed in time.

7. Genetic effects of exposure (threat is to future generations).

8. Infrequent but catastrophic accidents.

9. Benefits not highly visible.

10. Benefits go to others (inequity).

11. Accidents caused by human failure rather than natural causes.

People are more likely to rate a hazard as of higher risk for a number of reasons. Table 4 describes the negative attributes that influence risk perception. The entries in the table; however, do seem to cluster around a number of issues, namely the uncertainty felt by the public about the hazard, the potential for extreme outcomes, and lack of perceived control over exposure to or mitigation of the risk. This helps to explain why, for example, many people are more nervous about flying then driving. Flying, an objectively quite safe form of transport, is one that they have less frequent exposure to than driving, over which they feel they have little control, and which, in the rare cases of a crash, is quite catastrophic and heavily covered in the media. Among the challenges facing injury prevention practitioners then is the frequent need to call attention to risk of injury in mundane settings and everyday activities over which people feel confident in their control.

Decision Making Under Uncertainty

The basic framework of normative Decision Theory states that decisions under risk are made by laying out one's alternative courses of action in a matrix against the potential states of the world, each with it's associated estimate of probable occurrence or risk. One then fills the

matrix with estimates of expected outcomes, usually the product of the value or utility of that alternative given that state of the world, and the probability of that particular state occurring. The probabilities used are based upon one's perception of risk, or receipt of suitable risk communication, or from personal experience.

Once one has set up the decision problem in such a matrix (either explicitly or more often implicitly) the question remains how to decide from among the range of possible courses of action. Within the field of Decision Theory, dealing with decisions under uncertainty and risk, a number of formal decision rules have been proposed (e.g., Maximin, Maximax, Hurwicz' Alpha) and there have been many debates in the literature over the relative strengths and weaknesses of each of these rules.[3] Each is dependent upon the ability to generate a mathematical model of the problem to be solved and raises the question of where the alternatives come from to begin with, and how one specifies the range of possible states of the world. There is disagreement about the specifics of how one makes such judgements, but some points of agreement upon what requirements a completely rational agent might meet in doing so.

According to Janis and Mann, the average decision-maker, whether an individual or an organizational body, is faced with a sequence of four questions. Answering affirmatively to all four in order, results in vigilant information processing, while answering negatively at each stage leaves the individual in a less vigilant state, when weighing alternatives. The sequence of questions, and the state arrived at by answering no to each are presented in Table 5.

Table 5
Questions to be Answered Affirmatively to Reach Vigilance[3]

	Sequence of Questions to Be Answered	Consequences of Answering "No" at Each Stage
1	Are the risks serious enough if protective action is not taken?	**Unconflicted Inertia**
2	Are the risks serious if the most readily available protective action is taken?	**Unconflicted Change**
3	Is it realistic to try and find a better means of escape?	**Defensive Avoidance** – Tendency to satisfice rather than solve the problem.
4	Is there sufficient time to search and deliberate?	**Hypervigilance** – Tendency to keep searching for alternative courses of action, in a non-systematic or thorough way. Often results in panic.

Injury prevention practitioners attempting to change the public's behaviour are up against the problem of leading their audience to answer yes to each of the above questions. Failing to do so will leave people choosing to do nothing, or to take the easy way out in the first three cases, or to just be numbed by fear, and left in a state of denial in the fourth case.

Of course, reaching a decision is not the end of the process either. Once decisions are made they must be implemented, and then the decisions must be lived with. There has been a great deal of psychological research on the techniques employed by individuals to live with their decisions. For example, the literature on Conflict Decision Theory has generated a list of strategies that are employed to bolster one's chosen course of action (Table 6).

Table 6
Bolstering Strategies[3]

1. ***Exaggerating favourable consequences*** of the favoured course of action focuses attention on gains to be made.

2. ***Minimizing the unfavourable consequence*** is frequently associated with the (often self-induced) belief that if worst comes to worst, it will not be so bad.

3. ***Bolstering the belief that the decision is reversible*** is exemplified by the rationalization, "I can always stop if it's hurting me."

4. ***Denying aversive feelings*** anticipated in connection with unfavourable consequences. (For example believing that being under qualified for a job will be challenging, not frustrating).

5. ***Exaggerating the remoteness of the reckoning*** is the principle feature of rationalizations of recklessness.

6. ***Minimizing personal responsibility***.

It is worth noting that individuals and organizations do not employ the above strategies only after making a decision, but frequently in advance as well. Doing so results in short cutting many of the more elaborate decision procedures outlined above, in order to arrive at a preferred course of action.

Choices Are Made in Contexts

In addition to the psychometric approaches to risk perception discussed above, there are growing traditions of scholarship focussing on the social and cultural dimensions of risk, and

in particular of risk perception.[4] There has been strong challenge to the psychological approach to risk management from the perspective of cultural theory. Anthropologist Mary Douglas, among others, has argued that one cannot divorce issues of risk perception and hazard identification from cultural bias, [5] the shared attitudes and beliefs that help define a particular social environment. From this perspective, it is meaningless to discuss what constitutes a hazard, until one understands what a particular group values and does not value.[5] Such cultural bias is characterized in two ways, first the extent to which an individual feels part of a larger social context, called ***group***, and second the extent to which social interactions in this context follow rules of conduct, called ***grid***. Thus Douglas's theory is most often (at least initially) referred to as ***Grid-Group Cultural Theory***. Cultural biases can then be classified into one of four quadrants based upon whether they are high or low group, and high or low grid (see Table 7).

Table 7

Four Grid-Group Culture Biases[1]

	High Group	**Low Group**
High Grid	Hierarchists	Fatalists
Low Grid	Sectarians/Egalitarians	Individualists

Each of the above orientations can also be linked to one of four beliefs about the nature of nature itself.[6] The individualist tends to see nature as ***benign***, subject to perturbation but able to reassert homeostasis. The egalitarian on the other hand sees nature as ***ephemeral*** in a state of precarious balance, susceptible to catastrophic perturbation. Hierarchists tend to see nature as ***perverse/tolerant*** as blending of the above two positions. Finally, fatalists see nature as ***capricious***. These views of nature in turn impact upon the types of interventions one is likely to see as beneficial in dealing with probabilistic outcomes, or indeed whether one believes one should intervene at all in the case of fatalists.

There have certainly been critics of the contributions of culture-theory to the study of risk perception, and especially to its more strongly written indictments of post-modern society. There can no longer be any doubt; however, that it is valuable to consider issues of risk perception at a scale larger than the individual.[5]

There is a research tradition that has found that subjects in groups are willing to make riskier decisions than subjects evaluated on their own.[7] This phenomenon has been dubbed the *risky shift*. While there is little disagreement about the existence of the phenomenon,

there are competing research traditions offering quite different explanations for it, such as: *diffusion of responsibility, persuasion, familiarization,* and *cultural value*.[3]

Diffusion of responsibility in this context means that the potential regret for harm caused by an individual decision, is mitigated by the presence of others during the decision making process. Thus one is freed from the idea that one, as an individual, has harmed another (or oneself) by taking a risk, in much the same way that inhibitions are released in incidents of mob violence.

The persuasion hypothesis is that individuals or groups in dominant positions are able to sway other group members. Given that such dominant individuals or groups are likely to be more aggressive in nature, their persuasion will often be in the direction of increased risk taking. For example, it has shown on occasion that individuals in a group that have behaved more in a riskier way, often show less variability in their individual risk proneness, presumable due to the influence of persuasion.

The familiarization hypothesis assumes that individuals are often more risk averse due to lack of familiarity with a given hazard. Under this hypothesis, group discussion serves to familiarize new members, and thus reduce fear of the unknown.

Finally, the cultural value hypothesis assumes that some groups are more risk prone as part of their cultural boundary maintaining mechanisms. Individuals valuing membership in such groups are therefore encouraged, out of a sense of group loyalty, to adopt a more risk tolerant orientation. This is a likely explanation for much of the increased risk taking seen in college-age social groups for example.[8] Recent research in eastern Europe has also found that young people's perception of the quality of their environment inversely impacts on the prevalence of high risk behaviours in which they engage.[9]

Regardless of the cause, or more likely causes, of this effect, it is a significant finding that groups will often behave in a more risk prone fashion than individuals. The implications for social marketing and policy making are likely to be great. However, one must note that this research tradition has come under harsh criticism by social scientists who have found that often groups make better assessments of risk, and safer choices than individuals.[10]

Risk Mitigation: **Can good decision making be taught**? Numerous theories have been proposed over the years to explain the link between people's behavioural choices and their health outcomes. Most theories were developed as intervention models within individual health practices, thus the implications drawn for injury prevention programming require generation of more elaborate models. Finally, it must be noted that most of these models were designed to be general-purpose, one-size-fits-all frameworks. The potential utility of any of these models in explaining the risk taking behaviour and potential for interventions in those processes must always be viewed with a healthy scepticism.

The following models have all developed from social, personality, and cognitive psychology attempting to address the primary limitation of earlier economic models, namely the belief that people will always act rationally. That being said, it must be understood that each of these models are in turn products of their own time with the attendant limitations of the then current psychological paradigms.

The Health Belief Model (HBM) was originally developed in the 1950's by social psychologists in the U.S. Public Health Service and is arguably the most widely used conceptual framework in the health behaviour field.[11] The HBM is a value-expectancy theory that states that individuals will take action to prevent a negative health outcome if they believe that: 1) they are susceptible to this health threat, 2) it has serious clinical and/or social consequences, 3) a course of action available to them would reduce their susceptibility or the severity of the condition, and 4) the benefits to taking action outweigh the barriers to action (including consideration of physical, psychological and fiscal benefits and barriers).[11] The likelihood of an individual taking action to prevent a negative health outcome can be influenced by personal factors (such as age, sex, ethnicity, personality, socioeconomic status, and knowledge) as well as cues to action (such as media information, trust in message source and physical symptoms).[11]

The Protection Motivation Theory (PMT) was originally introduced by Rogers[12] in order to explain the effects of fear appeals on persuasion (e.g. attempts to "scare straight" a target audience with graphic depictions of the consequences of bad choices). The PMT is quite similar to the Health Belief Model (HBM) in that it is also an expectancy-value theory and the two models share several of the same dimensions. PMT proposes that an individual's likelihood of adopting a suggested health behaviour is based upon four factors: 1) the perceived severity of the threat, 2) the perceived vulnerability of the threat if no protective behaviour is adopted, 3) the efficacy of the recommended preventive behaviour, and 4) the perceived ability to perform the recommended behaviour.[12] In PMT, behaviour is a function of two appraisal processes: threat appraisal and coping appraisal. The threat appraisal factors that increase the probability of maladaptive responses include intrinsic rewards (e.g. physical and psychological pleasure), and extrinsic rewards (e.g. peer approval). The threat appraisal factors that decrease the likelihood of the maladaptive response are the severity of the threat (in terms of physical, psychological, social, and economic harm) and the perceived susceptibility to the threat. Fear also can indirectly affect the appraisal of the severity of the danger. The coping appraisal process evaluates one's ability to cope with and avert the threatened danger. The coping appraisal factors that

increase the probability of the adaptive response (adoption of recommended behaviour) are the individual's belief that the suggested coping response is effective and that he or she is capable of performing the suggested behaviour. Coping appraisal is the combination of these appraisals of response efficacy and self-efficacy, minus any physical and psychological costs of adopting the recommended preventive behaviour.[12]

Fishbein and Ajzen (1975) developed the Theory of Reasoned Action (TRA)[13] that incorporates the components of decision theory while allowing for social influences. TRA assumes that a behavioural intention measure will predict the performance of any voluntary act.[13] This theory; however, has some limitations in that it focuses on the determinacy and performance of a single behaviour rather than the choice amongst alternative behaviours. Another limitation of TRA is that it can only predict behaviour that is completely under volitional control, which clearly limits the applicability of this theory. In order to address this shortcoming, Ajzen (1991) modified the Theory of Reasoned Action and created the Theory of Planned Behaviour (TBH) by including the concept of perceived behavioural control (PCB).[14]

In many senses, the various Social Cognitive models have been theoretical competitors to one another, and indeed something of a mini-industry has built up trying to compare them to one another. Most of the identified differences between these models have been relatively minor, such as how the various components mathematically enter the model (e.g. multiplicative versus additive). Each of these models has something of value to contribute, and in the main, they actually agree on some of the key issues. The chain linking awareness of risk to changes in behaviour is forged of links such as self-efficacy, perceived costs and benefits of changing behaviour, social context, and multiple competing sources of information. Further, each of these models raises the spectre of the potential for ill-conceived approaches to drive people to maladaptive responses such as denial, fatalism and hopelessness.

Does it make a difference if it can? Research suggests that stable personality traits are determinants of risk taking behaviour and thus that better risk taking may not be easily teachable. For example, people can be dichotomized into those who are risk tolerant and risk averse. Those who are risk-tolerant or risk-seeking, perceive benefits to risk-taking that influences exploration of opportunities associated with risky behaviours. Risk-averse are those motivated toward maintaining security and safety and will abstain from risky behaviour.[15] Risk tolerant people are associated with sensation seeking, defined as the seeking of varied, novel, complex, and intense experiences and the willingness to take risks to engage in those experiences.[15] According to this perspective, some individuals have a greater need for stimulation than others, and this translates into riskier behaviour.

One of the key principles of normative decision theory as described above is the assumption that individuals will select one of the decision rules listed such that they gain as much as possible, or at the very least, lose as little as possible. There has been considerable work in

descriptive decision theory showing that often real decision makers, whether individual or corporate, do not behave this way. Traditionally, researchers have considered such departures from the maximization of utility to be lapses in rationality, and have offered numerous logical and psychological explanations for why such behaviour might occur.

More recently, there have been researchers that have demonstrated that in many cases, subjects are not only acting to make the most favourable decision, at present, but also to minimize potential future regrets from lost opportunities.[16] This newer principle in decision theory is known as regret. Initially little more than another psychological explanation for lapses of rationality, it has grown as a concept into the idea of another set of utilities that decision makers must consider if they are to be considered rational at all. Thus not only has descriptive decision theory been modified by the concept of regret, but also normative decision theory.[17]

The concept of risk homeostasis, pioneered by Wilde (1994), may also help to explain risk taking behaviour. Wilde (1994) suggests that individuals may continually monitor the degree of risk that they perceive in his/her life and compare this with the amount of risk they are willing to accept. If individuals perceived risks are lower than what they perceive to be acceptable, they may choose to engage in actions to increase their exposure to risk. Each individual will have an ideal "set point" for risk, this forms part of their personality and is; therefore, difficult to change. An individual's ideal "set point" for risk; however, may be modifiable through intervention. For example, there have been significant improvements in the rate of motor vehicle deaths in the past decades when the denominator of the rate is the number of km driven. When the denominator is the population, and thus a crude per capita rate is calculated, improvements are much more modest—and in some jurisdictions vanish altogether.[10] So in one sense our roads and vehicles are safer because we can drive more before having a crash; however, taken as a purely public health issue, road safety has not shown as much improvement since we have consumed a lot of those benefits, by choosing to drive more.[10]

Nature and Nurture

While it was noted above that the term risk carries no particularly negative connotation in the context of formal decision theory, nonetheless it does in common discourse. In fact, much of this paper has slipped into common usage seeing risk as something to be avoided

or at least minimized. There is some reason to believe that a certain amount of exposure to risk may be necessary and even beneficial. Social scientists, while recognizing the importance of security to healthy development also emphasize the importance of interaction with an enriched environment as equally important.[18]

Actively interacting with an enriched environment carries with it increased risks of negative events such as injuries; however, it has been demonstrated that the lessons of self reliance and resiliency under stress learned from this increased level of risk can have enormous impact in how individual will deal with stressful situations later in life.[19] The key to such experiences being enriching and not devastating seems to be the quality of the interaction between the developing child and their social context, as is being revealed through the recent research into the potential benefits of risky play.[20,21]

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3.3

Employment and Working Conditions

Introduction

Employment is an important determinant of health. It is directly linked to other determinants such as income, housing, and food security.[1] For the majority of people, employment determines personal income, and many experts consider income to be the most important determinant of health.[2] A large body of evidence supports links between income, health, and injury,[3] as discussed in the previous chapter related to income and social status. Factors such as housing conditions and food security are directly related to income, thus, closely linked to employment. Aside from the relationships to other determinants of health, employment directly relates to health and injury through job characteristics, type of work, and working conditions. This chapter will summarize the literature linking employment and working conditions to health, and will discuss the social aspects of employment and injury risk.

Employment, Working Conditions and Health

Research suggests that employment is linked to health through various mechanisms. This section will focus on important health implications related to income, job security, work pace, work hours, and the perception of a work-life balance.

Workers at the low end of the income spectrum are more likely to experience financial stress compared to those at the middle or higher end.[4] Stress is related to poor physical and mental health outcomes, as well as interpersonal problems.[5] Furthermore, financial strain

can explain a significant portion of the relationship between employment status and depression.[5] Finally, lower paying jobs tend to be characterized by poorer working conditions, more dangerous tasks and environments, and are more physically intensive compared to jobs that are typically higher-paying.[4]

An additional aspect of work with important links to health is a lack of job security.[6] In Canada, the main health challenge as related to job security is not chronic-unemployment, but intermittent or precarious work.[4,6] Employees in these unstable positions have increased levels of stress and overall poorer health than those in permanent positions. Furthermore, temporary and part-time workers are less likely to have benefits such as prescription drug coverage or dental care, which are not covered under provincial health care plans and are very important to maintaining good health.

Other important determinants of health as related to work include work pace, time and work-life balance.[4] Since the 1990s, Canadians have experienced an increase in hours worked and the amount of overtime worked. This is particularly common among those working in white-collar, management level positions or highly skilled blue-collar jobs.[8] Long working hours have been linked to health problems such as high blood pressure and heart disease.[8] Further, this trend has contributed to increased stress and anxiety for families, and limits the ability to maintain a work-life balance.

Employment, Working Conditions and Injury

In addition to the impact work has on overall health, research has demonstrated links between work and injury. A study by Mustard et al. (2013) examined the association between unemployment and cause-specific mortality between 1991 and 2001.[9] Results suggested that Canadians exposed to unemployment may experience an increased risk of mortality including those related to accidents and violence.[9] In this study, the term 'accident' refers to the International Classification of Diseases (ICD-10)[*] cause of death codes for traffic accidents, falls and other accidents (codes V, W, X, Y), and served as an indicator for death due to injury.[9] In another study, a survey of Canadians determined that 30% felt that their employment was a risk to their health and safety.[2]

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[*] For more information on the International Classification of Disease visit http://www.who.int/classifications/icd/en/

The following section focuses on the specific links between employment, working conditions and the risk of injury.

Type of work. Studies have examined the relationship between type of work and injury risk. Differences exist between positions traditionally classified as 'blue-collar' and 'white-collar,' with the most dangerous industries in Canada being blue-collar jobs such as mining, forestry, fishing, agriculture, and construction.[4,10,12] The increased risk is due to a combination of factors such as more dangerous environments, the use of heavy equipment, the physical demands of work, and the use of protective equipment.

Gender and race. There are important associations between work-related injury, gender and race. As previously mentioned, blue-collar jobs have a higher risk of injury compared to white-collar jobs, and these positions are typically male-dominated.[12] This partly explains a heightened risk of injury for males, especially young males.[10, 12]

Women experience higher risk of injury in certain situations; for example, women tend to occupy lower wage jobs compared to males overall, placing them at higher risk for health-related issues. An example of this is a continuing care assistant role, which tends to be a job held by females, where they earn lower wages and work in an environment placing them at higher risk of injury.[12] In addition, women are more likely to experience violence in the workplace.[12]

Racial minorities also experience a heightened risk of injury. People belonging to racial minorities tend to be employed in under-regulated occupations, work long hours, experience high stress levels and paid low wages. Furthermore, the work conditions associated with these types of jobs increase the risk of injury.[10,12] Examples of these types of work conditions include non-membership in a union or collective bargaining agreement, employment in physically demanding occupations, employment in a workplace with less than 20 employees, regular shift work, and having non-permanent employment.[13]

Intensification of work. In the context of the workplace, intensification refers to increased effort, tighter timelines, and increased demand.[8] This is an increasing trend noted in the literature since the 1980s, demonstrated across many workplaces.[8] Studies have shown that intensification is associated with increased stress, back problems, neck and shoulder pain, and other injuries.[8] Looking at the Canadian meat packing industry as an example, one Canadian study found intensification factors such as consolidation into a smaller number of large, highly specialized, and mechanized plants; deteriorating labour relations in the face of falling profits; and an intensified labour process, stressing line speedups and a growing risk of repetitive strain injuries, to have contributed to high and rising injury rates in the meat industry during the 1980s.[14]

Recommendations

Experts have suggested a number of recommendations related to improving the health of workers and reducing the risk of injury. A common component relates to policy development. Policies could be developed at all levels of government as well as the organization level to target high-risk jobs that are low paying and under-regulated.[11] (See Chapter 4.12[12] Workplace injuries for more information.)

A provincial example of commitment to health and safety laws for worker safety comes from the Manitoba Five Year Plan for Workplace Injury and Illness Prevention, which lists important components of legislation, including immediate fines for activities that present imminent risk to life or health, and strong protections when a worker refuses unsafe work. (See footnote[†])

Furthermore, health promotion and injury prevention communities can work to improve their communications with policy makers. Public health professionals can focus on recognizing the contextual factors that motivate policy action. Working toward an interactive policy development process with active engagement of decision makers is more effective than a passive 'knowledge dissemination' approach.[11]

Within the Canadian context, Ontario has the lowest rate of work-related injury compared to other provinces, and also has the strongest occupational health and safety legislation, even when controlling for type of employment. Thus, it has been suggested that differences in enforcement, education, and workplace hazard exposure are significant in reducing workplace injuries.[12]

Evaluation of knowledge transfer efforts with decision makers is often overlooked, but should be prioritized in order to improve the understanding of effective strategies.[15] In the workplace, educating both employers and employees about the health impact of cost-cutting and performance improvement strategies is an important next step.[8,11] Overall, future research, education, and policy development efforts need to focus on ensuring that the relationship between work and health is well understood and improved. Evidence has shown that healthy workplaces improve recruitment and retention, workers' health and well-being, quality of care and patient safety, organizational performance, and societal outcomes.[16]

[†] For the full plan, please visit: http://www.gov.mb.ca/labour/safety/pdf/workplace_injury_illness_prevention_web.pdf

Many Canadians will spend the majority of their life at work, and it should be a place where people can thrive and achieve optimal health, without being injured and disabled.

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3.4

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Social Environment

Introduction

Injury is a complex health outcome with multiple individual, social, and physical environmental risk factors.[1] Social environments are characterized by the relationships that exist between individuals, interactions in communities, and global societal context (culture) that shapes norms, ideas, options in life, and behaviours.[2] Public health has long recognized that improving the social environment can improve health.[3] It has been well documented that social relations are among the most influential social factors leading to (and preventing) injuries in various settings and populations. For example, in a representative sample of male and female Canadian workers, high levels of social support at the workplace were associated with fewer repetitive strain injuries,[4] and Canadian youth living in areas with higher levels of social cohesion reported fewer injuries.[5]

The purpose of this chapter is: 1) to introduce and discuss a conceptual model for exploring relationships between the social environment and injuries; 2) to provide an overview of existing evidence for potential links between the social environment and injuries with a focus on Canadian studies; and 3) to suggest potential avenues for future research and intervention.

Theoretical Connections Between Social Environments and Injury

The theoretical mechanism by which social environments may affect injury rates can be conceptualized using eco-social models such as those proposed by Krieger (2001)[6] or earlier by Bronfenbrenner (1994).[7] The authors of this chapter have recently developed a similar eco-social model of injury (Figure 17). This approach suggests that the etiology of a health outcome, such as injury involves complex interactions between individual, family factors, and the contextual nature of built and social environments in which people live, interact, and work. These models depict health outcomes as arising from interactive processes between individuals and their surrounding environment in which interpersonal relationships are embedded. Use of the eco-social model allows one to describe and examine interactions between hierarchical levels of ecological systems, from societal to community and interpersonal levels, and finally to individual outcomes.

Figure 17

An Eco-Social Model describing the relationship between social environment and injuries (created by Vafaei. A. based on the eco-social model) [6,7]
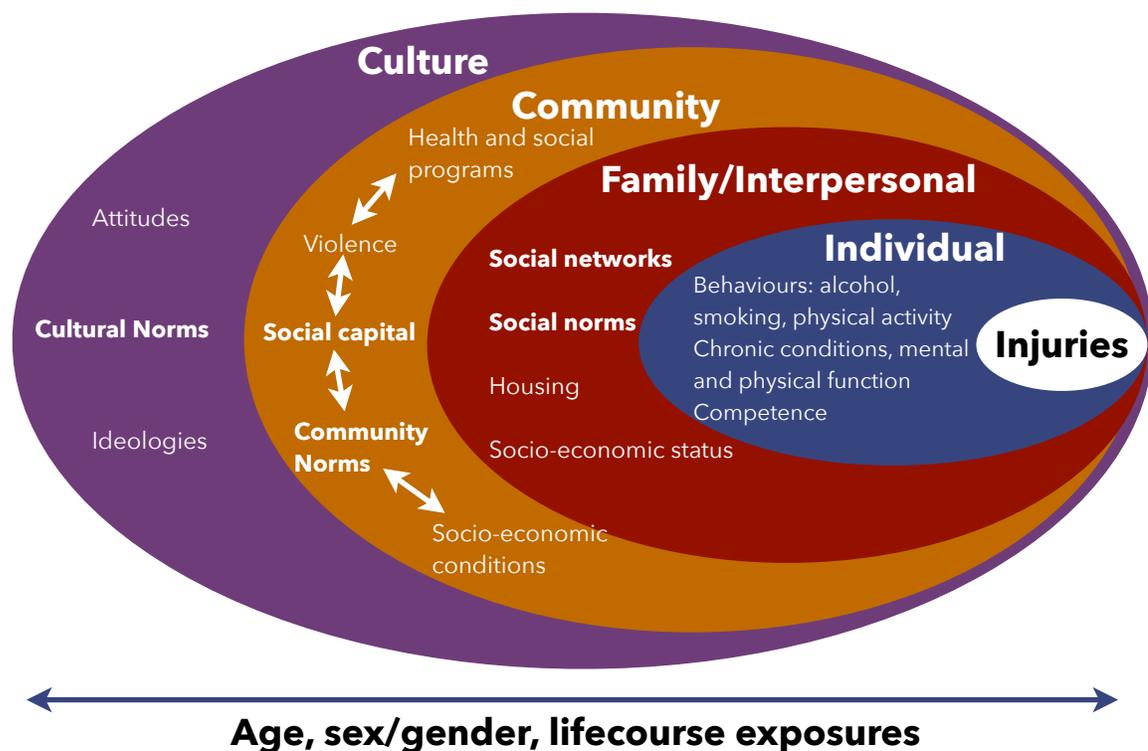
Specific Pathways of Social Influence

Simultaneous consideration of multiple individual, physical, contextual, and social factors has been suggested for exploring the etiology of injuries.[1] According to eco-social models (Figure 17), social factors can potentially impact injuries through social networks which operate at interpersonal levels, and through social capital, which is a factor at the community level.

Social Networks and Injury. As depicted in Figure 17, social networks are characterized by relationships and interactions within a community or an organization. Most people integrate into society via their social networks and this social integration is beneficial for their health.[8] This is true for both the quantity of a person's networks (e.g., number of people one knows) and the quality of that network (e.g., the level of support they provide).

Social networks may influence health via several pathways,[9] including social influence and social engagement. With respect to social influence, behaviours associated with injuries can be reinforced when they are confirmed by peers and are discredited when disapproved of by other members of one's social network. Instances of social engagement include getting together with friends, religious group attendance, and participation in professional and community groups. These instances are important factors for socializing, providing a sense of identity and shaping behaviours, including those that put individuals at greater risk for injuries. The impact of social networks extends to all age groups. It has been shown that various social ties influence health behaviours at different life stages and these processes accumulate throughout the life course and shape health behaviours over time.[10]

Pooled and synthesis studies have provided direct evidence about the impact of social networks on injuries in different populations. In a meta-analysis of 11 prospective studies, Deandrea et al. (2010) found that living alone and not having close friends or family will independently increase the risk of fall injuries in older adults (Pooled OR=1.33, 95% confidence interval: 1.21-1.45).[11] A systematic review conducted by Kristman & Vafaei (2011) demonstrated that in most work settings, a supportive workplace and good relations between workers and peers or supervisors were protective against work-related injuries.[12] A recent study in Boston's Cape Verdean community showed that a negative social network increases the risk for violence-related injuries. In fact, 85% of gunshot injuries in the sample of 763 individuals occurred within a single social network.[13] Finally, it has been shown that having delinquent friends is strongly associated with violent behaviours among youth.[14]

Social Capital and Injury. Social capital is a complex social construct and there is controversy over its definition and nature. Social capital is related to social networks, but is a contextual phenomenon that operates at a higher level than social networks.[15] Generally, social capital can be conceptualized as the presence of strong social bonds and it is agreed that trust, informal social networks, and civic participation are its main components.[15] In

other words, social capital is the meshing of individual networks that create a whole social network including the complete set of relationships among all participants in the network.[16] It is through this network that opportunities for trust and reciprocity develop, such that resources, knowledge, and behaviours can flow to the entire collective and to individuals in the network, with potential positive and negative influence on their health. Social capital is measured by levels of social cohesion, interpersonal relationships, trust, and civic participation at a community level and is an important determinant of health.[17]

The eco-social model can also be used to explain how social capital influences various health outcomes including injuries.[6,7] Specifically, social capital is a contextual factor which operates between higher contextual levels of cultural, economic, and political situations, and the interpersonal level, with possible mediating effects between upstream social factors and individual health. As shown by Kawachi (1997), social capital is a mediator in the relationship between income inequality and health.[18] Social capital can also off-set associations between low SES and poor nutrition by increasing availability of food provided by religious institutions in high social capital regions.[19] The main pathway between social capital and injuries is through health behaviors. Resources mobilized by high levels of social capital in a community can provide opportunities for better health literacy, shape norms and attitudes, and enhance political support for social and public health reforms, all of which have preventive impacts on injury-related health behaviours such as drinking and drug use. Another injury-related pathway is through the link between social capital and social problems. In areas with low levels of social cohesion, there would be insufficient capacity to establish effective social controls, and therefore crime rates and the risk for violence-related injuries would be high.[20] Similar impacts have been reported for unintentional injuries in youth populations but with less clear pathways.[5,23]

The relationship between social capital and injury is somewhat unclear,[14] and the evidence is very scarce. One study, which included 30 European countries, provides ecological evidence that low social capital is related to self-inflicted injuries in general populations.[21] A systematic review of literature from Latin American countries suggested that social capital could play a protective role in certain health outcomes including injuries.[22] Another study in Australia specifically investigated the vulnerable population of adolescents and showed that building social capital among friends will reduce risk-taking behaviours.[23] A very important finding with potential implications for prevention indicated that students who do not feel

connected to other people and their schools are more likely to drink alcohol or engage in delinquent behaviours[24] and are less likely to wear seat belts and bicycle helmets.[25]

 Social Norms and Injury. Social norms generally define social organizations.[26] Criminologists have argued that the level of social organization in a neighbourhood, or the degree to which residents are able to realize common goals and exercise social control, links the social composition of a neighbourhood to rates of deviant behaviour.[27] Deviant behaviours such as drug and alcohol use directly increase the risk of injuries. Furthermore, in societies with low levels of social organizations, violent crimes and related injuries are more prevalent. Specific social norms may encourage or prevent behaviours such as drug use, alcohol intake, and other high-risk activities that are all related to injuries. Social norms may also contribute to the creation of community perceptions such as feelings that a specific neighbourhood may or may not be safe.

Case Studies

 A summary of findings from two Canadian studies of the relationship between the social environment and injuries is presented.

Neighbourhood Social Capital and Youth Injury

The objective of the study conducted by Elgar et al. (2010)[5] on Canadian youth grades 6 to 10 was to examine whether adolescents' exposure to neighbourhood social capital, which was defined as levels of trust, cohesion, and cooperation, reduces socio-economic differences in physical and psychological health outcomes. Injury was among examined outcomes and it appeared that social capital modifies effects of socio-economic status on rates of injuries in this population. The study included 9,717 Canadian youths participating in the 2006 Health Behaviour of School-aged Children study. It was found that in areas of low social capital, higher levels of SES were associated with a decrease in the risks for injuries whereas in areas with high social capital, having a better SES was associated with more injury. The increased risks for injury in areas with higher social capital among affluent youth may be due to increased participation in sports.

The Quality of Social Networks and Occupational Injuries

A cross-sectional analysis of a representative sample of Canadian workers was conducted with the objective of determining the association between the amount of support social networks at work and work-related injuries. The authors used two definitions of work-related injuries: repetitive strain injury (RSI) as an injury that occurred by the on-going repetition of the same movement, and serious injury as an injury serious enough to limit normal activities. The study found both males and females reporting high social support at work were less likely to report work-related RSI. These findings were independent of other

extraneous factors such as age, income, and work status. Level of social support was not associated with the most serious injury at work.

Recommendations

Understanding the social factors that contribute to the occurrence of injuries may support prevention strategies recommended by health and social policy makers and program implementation teams.[28] As compared with medical interventions,[28, 29] social interventions have been shown to be effective for reaching larger proportions of the population,[30] and can lead to overall improvement in health of populations.[28] Social and behavioural factors can be modified by education, community capacity-building strategies, and urban planning initiatives. Examples of injury prevention activities associated with social environmental factors might include peer education programs for high risk behaviours, occupational health and safety campaigns that focus on building and leveraging stronger social environments at work, improvements in lighting and green space features to encourage more use and feelings of safety in public places, or neighbourhood watch initiatives.

Conclusion

Social environments impact injuries via several pathways. The quality and quantity of social interactions in the community and social norms influence individuals' health behaviours and possibly their vulnerability to injuries.

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3.5

Linda Rothman, Ph.D.

Physical and Built Environments - Introduction

Introduction

In this chapter, the built environment within the physical environment as one of the key determinants of injury will be described. The built environment is a common risk factor that affects many health-related outcomes including the risk of injury, levels of activity, cardiovascular health, and many aspects of quality of life.[1] The built environment refers to the man-made portion of the physical environment that provides the setting for human activities. It includes urban form, physical road infrastructure, land use patterns, and transportation systems.[2] The built environment is also frequently referred to as the "physical environment" or "urban form."

Howard (2010) describes what is called the 'common risk factor approach'[1] which is more frequently being used in public health for complex health-related issues such as injury, as opposed to the more traditional focus on risk factors for specific populations and disease. There is only one built environment for all ages and all health outcomes; therefore, more than one health outcome should be evaluated when making modifications to the built environment, as there may be differing effects on health. Howard gives the example of increasing the walkability of the built environment, which may increase walking and improve cardiovascular health, but may have negative effects in terms of pedestrian injury risk. Analysis of the potential effects of built environment changes should therefore take into account all important health outcomes together and include all demographic groups.

Modifying the built environment can help to prevent many types of injuries, including falls, drowning, and motor vehicle collisions. It can encourage physical activity and safe play,

reduce pollution, and improve quality of life. Built environment modification can also interact to modify the influence of other determinants of injury, such as income and social status. For example, a study in Toronto found that socioeconomic disparities disappeared in school playground injury rates after school playgrounds throughout the city were replaced to conform with Canadian standards.[3]

This chapter is organized into several subsections, which describe the influence of the built environment on injuries related to several specific topics and settings in Canada: housing, care settings, street design, rural environments and outdoor play environments. In each of these subsections, the burden and mechanisms of injury are described for the specific setting or topic, as well as injury prevention strategies and policy implications. These examples will illustrate the importance of the built environment as a key determinant of injury in Canada.

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Physical and Built Environments
Housing

Introduction

The Ottawa Charter on Health Promotion identifies housing as a prerequisite for health.[1] Housing is a broad contextual issue that is strongly shaped by public policies. The housing environment directly influences health, including the incidence of injuries. Considerable research has identified a social gradient in housing and injury risk. That is, populations with low income and low educational attainment are at a higher risk of injury in the home. Public policy directly affects the availability and accessibility of affordable, safe housing. This chapter examines housing as a key determinant of health, its relation to injury risk, and the implications for public policy.

The United Nations recognizes access to affordable and safe housing as a fundamental human right – a right that left unfulfilled acts as a significant determinant of health.[2] Research shows that housing conditions such as exposures to damp, mould, and overcrowding are related to serious chronic health conditions.[3-5] In addition, housing interacts with other determinants such as income and food security, and relates significantly to injury and fatality risk.[6] A substantial body of research identifies a social gradient in access to and impact of housing on health and injury risk. Low-income populations tend to have a higher risk of illness and injury related to the home environment compared to higher income populations.[4,5]

Key housing issues in Canada include shortages of affordable and safe housing. Housing insecurity exists where there is a disproportionate amount of income allocated toward

maintaining the household (i.e., greater than or equal to 30% or more of gross household income going toward housing alone). Unsafe housing refers to housing with structural or other defects and requiring significant repairs. Renter households are particularly at risk, as renters often live in housing that requires significant repairs such as plumbing issues or structural problems in the home.[7] The conditions found in substandard housing (e.g., risk of fire, and falls in the home) can increase injury risk for children and adults. This chapter will examine housing as a determinant of health and injury risk in Canada. It will also identify public policies that can reduce housing insecurity and the risk of injury in the home environment.

Housing as a Determinant of Health

Determinants of health are the living and working conditions that influence the health of individuals.[8] They are key factors that shape whether people are healthy or prone to illnesses, particularly chronic illnesses such as cardiovascular disease and type 2 diabetes, among others.[9] Housing as a determinant refers to lack of access to affordable, quality, and safe housing.[3] A substantial body of research shows that housing as a determinant of health can lead to chronic respiratory conditions, cardiovascular disease, permanent disability, and premature mortality.[11-13] Housing insecurity also leads to increased risk for injury.[3,4]

The Canada Mortgage and Housing Corporation devised the term core housing need to identify the number of Canadian households with housing problems.[14] Core housing need consists of three criteria:

❖ Affordability: Tenants pay 30% or more of their gross income on housing.

❖ Suitability: The housing is inappropriate for housing size and composition.

❖ Adequacy: The housing lacks full bathroom facilities, or requires major repairs.

Of the three criteria, the majority of core-need cases concern affordability.[15] Over 3 million (25.2%) Canadian households paid 30% or more of their incomes on housing in 2011.[16] The costs associated with providing shelter alone erode income available to cover other necessities such as food, clothing, and recreation associated with the health and wellbeing of both children and adults.[17]

Several factors have contributed to this problem. First, household incomes have failed to keep pace with housing costs in most Canadian municipalities.[7] For example, neighbourhoods in the City of Toronto have become increasingly segregated into concentrations of wealth and poverty. In addition, the restructuring of the Canadian labour market from manufacturing to service jobs has led to the growth of low-paying, insecure jobs.[18] Recent immigrants, women, youth, and visible minorities are particularly likely to be employed in these types of jobs. As a result, these populations are also more likely to live in substandard housing, which is harmful to the health of household members and can increase their risk of injury. The following sections explore conditions of substandard housing and how these relate to increased injury risk in the home.[4,5]

Injury Risk in the Home

Preventable injury has been identified as a leading cause of premature mortality for Canadians of all ages.[19] Causes of housing-related injuries include structural conditions from substandard housing, lack of safety equipment, low income, and chronic material deprivation conditions.[19-22, 6]

Structural conditions in the home are associated with increased injury risk.[4] These conditions include exposed heating areas, unsecured upper-story windows, low window sill heights, slippery surfaces, breakable window glass, and poorly designed stairs with poor lighting. Residents of high-rise buildings, especially children, are particularly susceptible to falls from windows, balconies, faulty or steep stairs, and other structural.[4]

The lack of safety equipment such as gates or handrails can increase the risk of injury for seniors and children.[5] Falls by seniors represent a significant proportion of morbidity and death; 20 to 30% of seniors suffer injuries each year, and not surprisingly, falls are a leading cause of injury-related hospitalizations.[23] Low-income households may lack sufficient income to purchase extra handrails, safety gates, and other devices that can protect seniors and children from serious and potentially fatal injury. Installing safety measures such as safety gates in the home can help reduce potential injuries requiring medical attention by up to 70%.[6]

The home environment is identified as a primary factor leading to unintentional injuries in children in low-income households.[24] Secure and safe housing is important for the wellbeing of children, as it is a significant determinant.[5] Risk factors associated with increased risk for injury in children include their natural inquisitiveness, and the amount of time spent in the home.[25] This is particularly true for children in low income households which have fewer resources available for child care or recreational activities outside of the home. It is widely recognized that thermal injuries in the home result in a high proportion of morbidity and death.[26] In Canada, low socioeconomic status is highly related to most causes of injury,

particularly fire/burn injuries.[19] The risk of fire is associated with materials used in housing construction; general building maintenance (e.g., heating equipment); and availability of smoke detectors, fire alarms, and other prevention devices. Research shows that prevention devices such as smoke detectors can significantly reduce fires in the home.[26]

Public Policy Change Towards Housing Security

The relationship between the lack of affordable and safe housing and the disproportionate burden of injuries and injury risk in the poorest households has been consistently reported. These issues can be addressed through public health initiatives and housing policies. Local, provincial/territorial, and federal governments can address these issues, but it requires political will and considerable advocacy effort by communities and housing activists to place these issues on the public policy agenda. For example, the provincial and federal governments can develop public policies to expand and protect an affordable rental housing market. Provincial governments can reinstate rent control in provinces to help create affordable housing and also strengthen safety provisions for housing construction and maintenance to further ensure access to safe housing.

Governments can enact public policies and programs to make it easier for low- and modest-income households to buy and own their homes. This can be achieved by financing new affordable housing through cost-sharing among the federal, provincial/territorial and municipal governments, and the affordable housing sector.[27] All levels of government can help ensure access to affordable and safe housing for all citizens regardless of income.

Provincial building codes establish minimum safety standards for all buildings and housing in a province. The Ontario Building Code prohibits the use of building materials known to be hazardous to human health, among other measures, for all housing units. They can also provide safety mechanisms such as smoke detectors for all households. A recent study found that a community-based smoke alarm distribution program was particularly effective in reducing fire fatalities and injuries within the first five years following installation of the devices.[28] The lack of efficacy in the sixth year was likely attributable to lack of battery replacement for the devices. This suggests the need to provide back-up supports for low- and modest-income households in addition to prohibiting the use of flammable housing construction materials.

The Federation of Canadian Municipalities and other housing advocacy organizations in Canada have called for a national housing strategy.[29] A national housing strategy will not only ensure the availability of affordable housing units, it can also ensure safe housing by strengthening provisions for repairing existing units, and establishing national safety standards on building materials, safe housing structures, safe window sills and surfaces, and other measures. A key component of this strategy would be to establish penalties to ensure compliance with these safety measures.

Conclusion

A substantial body of research demonstrates a strong relationship between housing insecurity and the risk and incidence of preventable injuries and fatalities that occur in the home environment. This research highlights a social gradient in the incidence and risk of injury associated with housing insecurity. Emotional wellbeing and injury risk should be recognized as key housing policy issues and regulations must be established to ensure safe and affordable housing for all citizens.

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3.5.2

Physical and Built Environments
Care Settings

Introduction

Long Term Care (LTC) facilities provide 24-hour professional supervision and care for individuals who have complex care needs and can no longer be cared for in their own homes or in an assisted living residence. The majority of LTC residents are older adults (age 65+) and typically have severe behavioural problems on a continuous basis, are cognitively impaired (ranging from moderate to severe), or have complex medical conditions with multiple disabilities that require professional nursing care. Hospitals have a more diverse patient population; however, in 2012/2013, older adults accounted for 40% of all hospitalizations in Canada and 57% of all hospital bed/days.[*]

Falls are the most frequently reported cause of injury in hospital and LTC settings;[1] therefore, will be the focus of this section. A description of falls in older adults in other settings are included in Chapter 4.4.1. Other reported injuries in hospital and LTC settings include pressure ulcers,[2] burns and scalds,[3] and unintentional poisoning.[4]

The LTC environment is of particular concern to health care providers as the rate of falls among LTC residents is two to three times that found among community-dwelling older adults.[5] Approximately 30% of falls in LTC residents result in injury.[6] In comparison, only 10-15% of falls among older adults in the community result in injury.[6-8] Hip fractures occur almost four times more often in LTC settings than in private homes,[9] with less than 15% of

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[*] Canadian Institute of Health Information. (2013). Discharge Abstract Database 2012/13.

residents who sustain a hip fracture able to regain pre-fracture ambulation status.[10] Furthermore, one quarter of fall-related traumatic brain injuries in older adults occur in LTC facilities.[11]

Similar to LTC, hospitals are also a particularly high risk environment for fall-related injuries. Falls account for 38% of all in-hospital patient incidents[12] and 44-60% of these events result in injury.[13,14] As a result, nearly 1 in every 1,000 elderly patients end up suffering a hip fracture after admission to an acute care hospital,[15] with approximately 50% of patients dying within one year after the fracture.[16]

In this section, key features of the built environment and protective equipment that are commonly incorporated into injury prevention strategies in hospitals and LTC facilities will be described.

Built Environment in Care Settings

The built environment can impact both physical and mental health. Within care settings, many aspects of the built environment are associated with an individual's risk of falling and/ or subsequent likelihood of injury in the event of a fall. Although certain modifications to the built environment have offered reductions in the incidence of falls among community-dwelling older adults, there is little evidence from randomized control trials to suggest environmental modifications on their own, are effective in reducing fall rates or fall injuries amongst seniors in hospital and LTC.[17] When tailored to suit the needs of individual facilities and residents; however, multifactorial environmental interventions have been observed to reduce rates of falls in both care settings. For example, in a prospective cohort study conducted in nine Australian LTC facilities, environmental modifications were associated with reductions in both the proportions of fallers (7% reduction; p = 0.044) and single fallers (4% reduction; p = 0.040), but not the total number of falls.[18] Here, interventions included environmental modifications such as low beds, height-adjustable chairs, and hazard removal, as well as protective equipment such as movement alarms and wearable hip protectors. In order to effectively reduce the rate of falls in acute and LTC; therefore, a multifactorial approach should be considered (based on the current falls literature), which comprehensively targets environmental, situational, and intrinsic risk factors.

Flooring and transitions. When designing hospitals and LTC facilities, a common approach to minimize risk for falls is to use non-slip, non-glare, and even surface (e.g., no inclines, steps, or loose carpets) floors and floor coverings.[19,20] Obviously, the intention here is to prevent those falls arising from slips, trips, and stumbles, which according to real life video footage of falls (227 falls experienced by 130 residents in two LTC facilities), account for approximately 24% of falls in LTC common areas.[21]

Floors and floor coverings might also help to ameliorate the risk of injury in the event of fall. As is discussed in Chapter 3.7.1: The Physics of Injuries, the stiffness of flooring can greatly affect the risk of injury in the event of a fall. For example, a fall onto concrete flooring is more likely to generate the energy required to break a hip than a fall onto freshly turned dirt. Softer floor coverings have been investigated as a means to reduce fall-related injury rates; however, softer floor coverings also have the potential to increase risk of falling if there are impairments in balance and mobility. Therefore, floors must be stiff enough to allow for safe movement, but soft enough to cushion the landing of falls.[22]

Carpet is becoming more prevalent in care settings as a means to create environments that mimic home and community life, but also as a potential intervention to prevent fall-related injuries. Unfortunately, there is conflicting evidence on the clinical value of carpet as an environmental intervention. For example, according to the recent Cochrane review,[17] the use of carpet compared to vinyl in sub-acute elderly care rehabilitation wards is associated with an statistically significant increase in the rate of falling (e.g. falls per person year; RR=14.73, 95% confidence interval: 1.88-115.35) and a non-significant increase in the risk of falling (e.g. number of fallers; RR=8.33, 95% confidence interval: 0.95-73.37).[23]

Compliant or "safety" flooring is a rather new approach to injury prevention. Compliant flooring is a padded layer that is typically installed beneath vinyl or carpet. An example compliant flooring system is SmartCells[†]. SmartCells promotes their flooring system as a dual-stiffness rubber surface layer that is supported by an array of cylindrical rubber columns that are designed to buckle and absorb energy during impact. When walking on SmartCells, the system is stiff enough not to impair balance, but during high impact activities such as falling, the force of the body site(s) contacting the flooring is sufficient to cause the rubber cylinders to buckle, decreasing its effective stiffness.[24] Little is known about the feasibility of compliant flooring as an injury prevention approach – the first randomized control trial to investigate its effectiveness in LTC is currently underway, the details of which are described more extensively in the case study, "Compliant Flooring May Reduce Fall-Related Injuries" (ClinicalTrials.gov #: NCT01618786).[51]

Although promising from an injury prevention perspective, for patients/residents, the use of softer floors (e.g., carpet, compliant dual stiffness flooring) in care settings might impact the safety of caregivers through increased exposure to pushing and pulling forces. To illustrate this, consider pushing a shopping cart on hard vinyl flooring versus on carpet. The latter task would prove much more difficult, and over time, could increase risk for repetitive strain injuries of the lower back, shoulder, and neck. Therefore, when selecting floor coverings for care settings, designers must consider whether floors will negatively impact the mobility and balance of older adults, but also the health and safety of care providers. If softer floors are

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† Link to more information on Smartcell - http://www.smartcellsusa.com/fall-protection/

to be used, proper engineering controls (e.g., ceiling lifts, motorized equipment) need to be in place to mitigate any increased physical demands.

Fall Mats. Another way to soften the landing of falls is to provide padding between the impact site (e.g., hip, head) and the landing surface, through the use of fall mats or bedside mats. Fall mats represent another type of safety floor commonly used in care settings. According to materials testing, fall mats absorb up to 5.4 times the amount of impact energy than carpet, subsequently transmitting less force to the body; [25] however, fall mats may undergo excessive deflection during standing and walking (compared to carpet), which could lead to impaired balance control. Furthermore, fall mats may be tripping hazards for staff and patients/residents.

Lighting. Older adults may experience changes in their vision as a part of the normal aging processes and/or a function of disease, including: decreased visual acuity, increased sensitivity to glare, decreased field of vision, distorted depth perception, decreased vision in low light, decreased ability to differentiate between contrasting surfaces, glaucoma, cataracts, macular degeneration, and diabetic retinopathy.[20] Proper lighting in care settings is therefore important to reduce the risk of falling for older adults with low vision, but also for the ease of all individuals navigating through the infrastructure. Whenever possible, natural light is recommended. Glare can be minimized by ensuring light is even, soft, and well-diffused, and by using full spectrum lights or soft lights.[19,20] Window coverings should also be used to prevent large patches of distracting light.[19]

Due to the sudden postural changes often related to toilet use (e.g., quickly leaving the bed) and low visual input, toileting during the night has been identified as a particularly high-risk activity.[26] This is especially concerning given that falls in bathrooms are more likely to result in injury compared to those in bedrooms;[27] however, clear visual input can decrease fall risk associated with overnight toileting amongst hospitalized older adults.[28] For ambulatory patients, sufficient light must be available to allow safe navigation from the bed to the washroom at night. Care settings are encouraged to install night-lights close to the floor near washroom entrances to help create distinct visual pathways.

Clutter. Clutter is perhaps the most established environmental risk factor for falls, indicated mostly in trips and stumbles, which according to real life video of falls in LTC, account for about 21% of falls.[21] Examples of common tripping obstacles include equipment and mobility aides, level ground, and one's own feet. To reduce clutter leading to falls, care settings should offer adequate space for storage of mobility aides and equipment.[19,20] If storage is limited and equipment/carts have to be left in hallways, all equipment carts should be located on the same side of the hallway in order to provide a clear space for older adults to mobilize.

Hand rails and grab bars. Care settings are also encouraged to incorporate handrails and grab bars[19,20] to facilitate safe navigation and weight transfers (especially on and off toilets). These devices assist patients/residents to offset age-related deficits in strength, coordination, and balance. For example, when descending stairs, light handrail use has been observed to improve control of balance among older adults,[29] presumably though added proprioceptive feedback. Handrails and grab bars can also aid patients to regain stability after a balance perturbation (e.g., slip, trip, or stumble) through execution of "reach to grasp responses." Indeed, it seems that older adults rely more on upper limb movements to recover balance (than younger adults) in general[31] but unfortunately are less able to execute rapid "reach to grasp responses."[30]

When designing handrails and grab bars, designers must again consider user preferences. For example, in a laboratory based study, older adults have been observed to favour use of vertically aligned grab bars (vs. L-shaped or horizontal bars) to regain balance after slips were artificially induced during bathtub entry and exit.[31] Although investigators did not explore the relationship between specific impairments and preference of grab bar style, 36% of participants reported complaints of pain in lower limb joints and 53% reported visual deficits requiring the use of "regular glasses".[31]

Toileting aids. Toileting aids can help the user to function independently when using the toilet. Raised toilets seats, grab rails, toilet frames, and self-lift seats are all aids to assist with transferring on and off a toilet.[32] The aforementioned toileting aids are common for individuals with physical disabilities, such as severe arthritis in the knees and/or hips, or sarcopenia (normal age-related muscle loss) that makes rising from a seated position difficult.[32] Raised toilets seats, in particular, help reduce the degree of flexion required in the hips and knees when sitting, which makes it easier for the user to sit down and stand up.[32] Raised toilet seats usually provide a rise of 5, 10, or 15 centimeters and, therefore, the proper rise will depend on the specific needs of each individual resident. When taking into account resident preference and aesthetics, the Ontario Long-Term Care Facility Design Manual suggests that raised toilet seats should be installed as needed, rather than providing raised toilet seats for all resident washrooms.[19]

Furniture. Interactions with furniture can lead to falls arising from a "loss of external support" or "incorrect weight shifting," which accounts for approximately 11% and 41% of falls in common areas of LTC facilities, respectively.[21] An illustration of "loss of external support" is a resident trying to transfer from reclining on a lazy-boy recliner to a standing position. To prepare for the transfer, the resident slowly shifted his/her weight (by scooting) towards the edge of the chair and the elevated foot rest gave way beneath their weight, and the resident falls to the ground. Other examples of loss of support involve "sliding out of a chair or wheelchair" when transferring from standing to sitting, or even when sitting quietly. When designing furniture to prevent imbalance arising from "loss of external support," there

seems to be an obvious need for automatic-locking mechanisms, which cause mobile devices to become relatively immobile as soon as there is a transfer of weight.

Aside from helping to prevent falls, furniture can also be designed to minimize the risk of injury in the event of fall. For example, low-low beds are commonly used in hospital and LTC settings. Lowering the height of a bed reduces the potential kinetic energy that patients/residents have if they fall from the bed. As low-low beds can be lowered to almost floor level (about 7-8 inches above ground), the chances of sustaining an injury from falling off the bed are very small. Although theoretically sound, there is surprisingly little evidence to support the benefits of low-low beds to prevent falls and injuries.[33]

Protective Equipment

Protective equipment refers to protective clothing, or other garments or equipment/aids designed to protect the body from injury. Examples given in this section include assistive devices, hip protectors, footwear, and bed and chair exit alarms.

Assistive devices. It is quite common for a resident of LTC to use an assistive device (e.g., cane or walker). Assistive devices help maintain balance while performing activities of daily living, and reduce lower-limb loading to compensate for weakness or injury.[34] Research suggests that the use of some types of assistive devices may actually increase an individual's risk of a fall and injury.[34] This may be a result of the increased attentional, neuromotor, musculoskeletal, physiologic, and metabolic demands that are placed on the user. A recent study investigating gait patterns with patients diagnosed with Parkinson's Disease suggests 4-wheeled walkers may provide the most consistent advantages for improving mobility and safety versus canes or standard, two-wheeled or U-step walkers.[35]

Hip protectors. Hip protectors consist of soft foam padding or hard shield domes inserted into the hip region of specialized garments or undergarments worm by older adults with mobility issues. Hip protectors are designed to decrease the force transmitted to the femoral neck by absorbing energy in the pad material, and by spreading the force over a larger contact area.[36,37] When in place (and correctly positioned) at the time of falling, specific types of hip protectors reduce fracture risk between 69-80% [38-40]. The clinical value of protectors; however, has been compromised by lack of regulations assuring the quality of available models[22] and limited user adherence in wearing the devices (often less than 50%[41,42]) resulting in a large number of falls occurring without hip protection.[43]

When designing hip protectors, engineers must consider both the biomechanical capacity of models (force attenuation properties) and factors affecting user adherence. There is a trade-off to consider between pad thickness, protective capacity, and user compliance. Obviously, the thicker the pad, the more energy the pad is able to absorb and/or shunt away from the

femoral neck which in turn may decrease use in older adults due to the products bulk, obtrusiveness, and decreased comfort.

Results from a systematic review to identify factors that influence acceptance and adherence of hip protectors among older adults living in LTC facilities[50] identified 7 key strategies to improve compliance:

❖ Organizational commitment

❖ Dedicated champion to motivate, mentor, and monitor

❖ Involvement of everyone responsible for resident safety

❖ Staff education of the benefits and correct use

❖ Engagement and education of residents and families

❖ Choice of hip protector models with proven efficacy

❖ Protocols to ensure adequate supply, variety of models, correct fit, and laundering

Footwear. The type of footwear a resident wears will increase the risk of slips, trips, and falls by altering somatosensory feedback to the foot and ankle and modifying the frictional condition at the shoe/floor interface.[44] Residents/patients of care homes and hospitals should be encouraged to always wear shoes or socks with a non-skid sole. It is especially important to discourage walking barefoot as fall risks will markedly increase.[45]

Bed and chair exit alarms. Care staff may prescribe a bed or chair exit alarm for a resident who has been identified as high risk for sustaining a fall. If the resident attempts to leave the bed or chair without assistance, an alarm will sound to notify care staff that can then go to the resident's room and assist with the transfer, if time allows. Bed and chair exit alarms are often used for residents/patients that have mobility impairment and are confused or not able to follow instructions. A single-site, clustered randomized controlled trial with nearly 28,000 hospital inpatients, aimed to discern whether increasing bed alarm use would decrease hospital falls and related events.[46] Although the study may be underpowered, the results suggest that bed exit alarms had no clinical significance in the reduction of falls or fall-related injuries. As this study was performed in acute care settings, conclusions cannot be drawn regarding the effectiveness of bed and chair exit alarms on the reduction of falls and fall-related injuries in LTC. A multisite, randomized controlled trial is needed to truly determine their clinical effectiveness.

Conclusion

This chapter highlights how the built environment and protective equipment may play an important role in the prevention of injuries related to falls in LTC and hospital settings. Falls result from a complex interaction of physiologic, environmental and situational factors. Interventions that go beyond the design of the built environment and protective equipment should also be considered, including educating staff about fall risk factors and prevention strategies, reviewing prescribed medicines to assess their potential risk for falls, Vitamin D supplementation, and exercise to improve balance and strength.

Case Study: Compliant Flooring May Reduce Fall-Related Injuries

One promising intervention is to install compliant or "safety" flooring, similar to the rubber tile found on some children's playgrounds, in care settings that are at a high risk for falls, such as assisted living, long-term care (LTC), hospitals, and palliative care centres.

The logic behind compliant flooring is simple: decreasing the ground stiffness of the floor will decrease subsequent forces applied to the body at impact. Biomechanical studies performed in a laboratory setting have shown that purpose-designed compliant flooring can reduce the force applied to the hip during a fall by up to 35%[47] and to the head during a fall by up to 70%,[48] without substantially impairing balance.[24,47]

Researchers at Simon Fraser University, in partnership with the Fraser Health Authority, have translated over a decade of compliant flooring research experience to design and conduct a 4-year clinical trial entitled 'The Flooring for Injury Prevention (FLIP)' Study. The FLIP Study is a comparative effectiveness randomized controlled trial that will determine whether compliant flooring reduces fall-related injuries in LTC relative to standard (control) flooring. Researchers will also examine if compliant flooring reduces health care resource utilization and costs due to fall-related injuries in LTC relative to control flooring. The results of the FLIP Study will be used to guide programs and policies for fall and injury prevention in older adults, and to improve the design and renovation of various types of healthcare infrastructures.

Note: The outcome monitoring for the Flooring for Injury Prevention (FLIP) study extends from September 2013 to August 2017 (ClinicalTrials.gov #: NCT01618786).

Links to product design: http://www.smartcellsusa.com/fall-protection/

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Physical and Built Environments
Street Design

Introduction

The built environment comprises transportation systems, land use patterns, and street design. Built environment variables related to transportation are often categorized into three principal dimensions - the "3 D's": Density, Diversity, and Design.[1] Density relates to the compactness of a neighbourhood, frequently operationalized as population density. Diversity refers to range of land uses, and may be measured as the proportion of a specific land use in a particular mix (e.g., commercial) or with various land use mix indices. Design addresses the more detailed street characteristics which may relate to: streets (e.g., street pattern, street type, intersection treatment); pedestrian and cyclist provisions (e.g., sidewalks and bike lanes); or site design (e.g., parking).[1]

This section focuses on how street design influences road traffic safety. Of the 3 D's, the focus on design features is warranted, as these are built environment features that can most feasibly be modified in existing neighbourhoods, at least in shorter time horizons and lower costs than density and diversity. In Canada, the Transportation Association of Canada Geometric Design Guide provides direction for street design, but there are many details and subtleties in implementation. Below, road traffic injury burden and risk in Canada is reviewed, and then an overview of evidence on how street design influences road safety is presented.

Road Traffic Injury

Road traffic injury is an international health policy imperative, with over 1.2 million people killed, and another 20-50 million non-fatal injuries worldwide in traffic crashes in 2010.[2] Road traffic injury was ranked the eighth leading cause of mortality globally,[3] and is predicted to be in the top 5 by 2030.[4-6]

Road safety comparisons between regions is challenging due to differences in reporting and a lack of data. Fatalities, although far more rare than injuries, are generally more accurately documented, and rates can be compared across settings and times. Canada has made great strides in reducing road traffic fatality rates, however the declines have slowed in recent years, with reductions of 37% from 1970-1990 to only 17% from 1995-2009.[7] Internationally, Canada's road safety ranking has slipped, relative to other countries.[7] Renewed efforts have been directed to achieve Canada's vision to have the safest roads in the world through Canada's Road Safety Strategy 2015.[8]

In Canada in 2011, there were 2,006 fatalities, almost 167,000 total injuries and 10,443 serious injuries as a result of road traffic collisions.[9] Of the fatalities, 1,420 were motor vehicle drivers and passengers, 315 were pedestrians, 168 were motorcyclists, and 52 were bicyclists. This shows that the majority of road traffic fatalities and injuries are car occupants, due largely to the fact that the majority of travel is by car. However, the risk of each of these travel modes varies. Risk is an incidence rate, with the numerator the number of fatalities or injuries and the denominator a measure of exposure: typically the number of trips or kilometers travelled. Comparisons between modes are hampered by a lack of data, since exposure data is not often available, especially for modes other than cars. While the total number of pedestrians and cyclists killed or injured is lower than motor vehicle occupants in Canada, these road users are at a much higher risk when considering their exposure. A recent study using British Columbia data found that pedestrians and bicyclists have fatality or injury rates 2-8 times higher than car occupants, per km travelled.[10] A study in the US found similar trends, but also included bus and motorcycle risk, reporting a much lower fatality rate for bus travel (over 20 times) than any other mode, and that motorcycle travel had much higher fatality and injury rates than any other mode (over 25 times higher than other modes).[11] Cyclists and pedestrians are often referred to as vulnerable road users, and are at a much higher risk of severe injury or fatality than car occupants as they don't have a protective "shell" around them.[12]

Street Design

The preceding section outlines the devastating burden of road traffic injury and the differences in road traffic injury risk between countries and by mode. In many countries, the primary consideration for street design has been motor vehicles, with less attention to

pedestrian or cyclist safety. High speeds roads have been built in residential areas, at the same time that play and walking areas have been overlooked in community planning.[13] Traditional road safety interventions have targeted individual road use behaviour change, but these have not realized impressive results.[14-20] It has been proposed that scarce resources be redirected instead to built environment approaches focused on street design which have evidence supporting their efficacy.[18] Almost half of the strategies promoted through Canada's Road Safety Strategy 2015 are directed at street design.[8] Modification of the built environment, such as street design, shifts some of the responsibility from the individual, and benefits the community as a whole.

The section below provides evidence on how street design impacts road safety, with particular attention to vulnerable road users. Evidence related to interventions across 3 mitigation strategies will be presented: speed control, separation, and measures to increase visibility.[21]

Speed control. Motor vehicle speed is the major risk factor for all crashes, and directly influences injury severity. [22,15] For car occupants involved in a crash with an impact speed of 80 km/h, the likelihood of death is 20 times what it would have been at an impact speed of 32 km/h.[23] Pedestrians have a 90% chance of surviving collisions with motor vehicles travelling at 30 km/h or below, but less than a 50% chance of surviving a collision at speeds of over 45 km/hr.[23,15] Much of the focus on speed reduction is through adaptations to street design. Traffic calming measures to reduce speed include: vertical and horizontal shifts in traffic (e.g., road humps, raised crosswalks), optical measures (road surface treatment), redistribution of traffic (one-way streets) changes to the road environment (vegetation,[25] and road narrowing.[26]

Many of these speed reduction measures have shown documented improvements in road safety. One systematic review and meta-analysis on the effect of area-wide traffic calming (suites of engineering measures aimed to reduce speeds and volumes, especially on residential roads) found an 11% reduction in injuries (fatal and non-fatal), based on 16 studies from high income countries:[25] another found an 15% reduction in injuries, with greater reductions on residential roads than major streets. [27] There is evidence that narrower roads have fewer pedestrian collisions, primarily due to reduced vehicular speed.[26] There are also reviews indicating the effectiveness of red light cameras,[19] speed enforcement detection devices,[28] and street lighting in reducing motor vehicle crashes.[29]

It is important to note that measures may have different safety impacts on different road users. For example, while the evidence presented above for area-wide traffic calming reported reductions in overall injuries, few studies focused specifically on pedestrian-motor vehicle injuries reported significant reductions.[21] Another example is roundabouts, which are widely promoted for their safety benefits for motorists and pedestrians,[21] however a review found that multi-lane roundabouts are more hazardous to cyclists than other types of intersections, unless separated cycle tracks are,[30] and a recent study in Vancouver and Toronto traffic circles (single lane roundabouts on residential roads) were the most dangerous intersection type for cyclists.[31] These examples illustrate the necessity that the effects of road design features be properly evaluated for all road users.

Separation. Physical separation of vehicles from vulnerable road users is an effective method to increase safety, especially along major roads. A review of cycling safety research,[32] found most route types with reduced risk of injury (cycle tracks [physically separated bike lanes alongside major streets], painted bike lanes, signed bike routes, minor streets, and bike paths) were separated from motor vehicles or along low volume routes. Routes associated with increased injury risk were major streets, sidewalks, and multiuse paths. Empirically, cyclist safety increases with the degree of separation from traffic: bicycle lanes carry half the cyclist injury risk of major streets with no cycling facilities; cycle tracks (physically separated bike lanes alongside major streets) carry one-ninth of the risk.[33] Recent research supports a safety benefit for cycle tracks.[34,35]

For pedestrians, there is strong evidence supporting safety benefits of pedestrian refuges (islands that allow rest points mid-crossing), and for overpasses and underpasses.[36,21] Some evidence supports safety benefits of sidewalks, especially in residential areas.[37] However, this association may not hold true for child pedestrians. Several studies have reported a relationship between the presence of sidewalks and more collisions involving child pedestrians, which has been explained as being perhaps due to children treating sidewalks as extension of play areas, or exercising more caution where there are no sidewalks present.[38-42] There is a similar lack of consensus related to the injury risk for children cycling on sidewalks, with one study reporting decreased risk,[43] and others increased risk,[44,45] which was suggested to be due to more experienced child cyclists riding on the road, and newer cyclists riding on the sidewalk. These mixed findings suggest a need for further study on children's road safety.

Temporal separation of vehicles from vulnerable road users, such as pedestrian scrambles, has been used to improve safety at intersections. Pedestrian scrambles provide pedestrians with an exclusive signal phase to cross when all motorized vehicles are stopped. These types of signals have been associated with reduced collisions and conflicts between motor vehicles and pedestrians when both are compliant with the signals.[46,36,21,47]

Visibility. Improved visibility of both pedestrians and cyclists is important to consider in road traffic safety. There is increased risk of injury for both cyclists[32] and pedestrians[48] at night, especially in unlit conditions. Increasing the intensity of light at pedestrian crossings has been associated with a decrease in nighttime pedestrian collisions.[49,21] Clear lighting of crosswalks through automatically activated in-pavement flashing lights have reduced vehicle speeds and conflicts.[50] Crosswalk pavement markings, on the other hand, have been found to be ineffective in reducing pedestrian collisions and sometimes more dangerous for pedestrians, depending on where the crosswalk is placed.[51,21, 52] There is new research on cycling safety suggesting promising effects of 'blue crossings' at intersections for cyclists,[53] painted bike boxes,[54] and painted bicycle lanes.[55] Parked cars can also obscure the vision of both pedestrians and drivers; the presence of parked cars has been associated with child pedestrian collisions,[56] and cyclists' injury risk on major streets is higher when there are parked cars, compared to when there are not.[33]

Conclusion

Although there is promising evidence supporting the effectiveness of built environment street design interventions, there is a need for more well-controlled studies. Street design changes can be costly, and the evaluation of effectiveness requires the well-coordinated efforts and foresight of many different disciplines, including city planners, transportation engineers, public health practitioners, and researchers. It is particularly important to evaluate the effectiveness of specific interventions for different road users, as there is evidence that interventions which are beneficial for some users may be detrimental for others. Creative methods are required to design our roadways so that all road users can share the roadways safely and effectively. There has been some recent movement to adopt "Complete Streets" planning policies in some parts of Canada, which ensures that transportation infrastructure is planned for all abilities, ages, and modes of travel across the transportation network. Some communities have also built Dutch-style Woonerf streets where the boundaries between different types of road users have been removed. Canada's vision is to work towards having the safest roads in the world. Continued efforts to raise public awareness, improve collaboration among stakeholders, enhance enforcement, and support road safety research and evaluation as described in Canada's Road Safety Strategy 2015 are essential in order to achieve this goal.[8]

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3.5.4

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Physical and Built Environments

Rural Environment

Introduction

Canada is a vast country with 95% of its land mass considered rural, northern, or remote.[1] Over 6 million Canadians live in rural areas, representing 19% of the Canadian population.[2] Living in a rural environment poses unique challenges related to injury prevention due to different social, economic and built environment conditions compared to urban areas. Seventy percent of traumatic deaths in Canada occur in rural areas; however, only 30% of Canadians live in these areas.[3] Injury rates are over 1.5 times higher in rural compared to urban environments in Ontario.[4] A recent systematic review of studies examining rural injury in children in Canada and the US reported the risk of overall and severe injury was higher in rural areas compared to urban, and the injuries tended to be more severe. In addition, healthcare costs are higher for injuries in rural children.[15] In this chapter, the major mechanisms of injury in rural environments and some of the factors attributed to the disparities in rural compared to urban injury rates in Canada are described. Finally, implications for injury prevention efforts specific to rural areas are discussed.

Motor Vehicle Collisions

Motor vehicle collisions are the leading cause of injury-related mortality in Canada.[6] Fatalities due to motor vehicle collisions are overrepresented in rural populations. Of all reported fatal collisions, 56% occur in rural areas where only 19% of Canadians live.[2,7-8] It has been estimated that rural populations in Canada experience 2–3 times the risk of death following

a collision compared to those in urban areas.[9,10] In children, the crash fatality risk in rural areas is even greater; estimated at over 5 times that of urban areas in Alberta.[11]

There are several factors that contribute to the increased risk of injury in rural populations. People in rural areas have a higher exposure to vehicle travel, spending more time in cars and travelling greater distances, which increases their collision risk. Built environment factors that are characteristic of rural areas may also contribute to the increase in risk of collision and injury. Most rural driving occurs on roads with higher speed limits, and it is well recognized that higher driving speeds are related to higher collision rates and fatalities[7] (See Chapter 3.5.3 – Street Design and Chapter 4.2 – Transport Injuries for more information). Head-on collisions that result in the most severe injuries occur most frequently on roadways that do not have separated traffic streams, which are most commonly in rural locations.[12] Road safety features are less common in rural areas, such as traffic control devices, lighting, and sidewalks for the separation of pedestrians from vehicular traffic. There are also pronounced disparities between rural and urban access to trauma centres in Canada.[13] Further distances to advanced trauma centres and to emergency care is associated with worse outcomes, and may contribute to higher fatality rates.[11,14,15]

There are also behavioural factors that contribute to higher collision rates in rural areas. In general, rural residents are less likely to use seatbelts and child safety seats when operating a motor vehicle, in addition to being less likely to use helmets when riding a bicycle.[12] Although the gaps between urban and rural seatbelt use rates in Canada have been narrowing, differences continue to exist with significant variability across provinces and the territories. A recent study by Transport Canada examined seat belt use in Canadian provinces and territories. This study reported that 96% of occupants of light-duty vehicles in urban areas were observed to use seat belts, versus 92% in rural areas.[16] However, in the Northwest Territories, there was 56% gap between urban and rural seat belt usage (95% versus 38% respectively). In Prince Edward Island, there was a 10% gap (92% urban versus 82% rural) and in Saskatchewan, an 8% gap (98% urban versus 90% rural) in urban versus rural usage was present. Many of the provinces have an approximate 4-5% difference in rates. Although there is little current Canadian data available regarding urban versus rural use of child safety seats, a US study found that restraint use among children 0-4 years was less common in rural versus urban areas (72% versus 96%).[11,17] Finally, an older study done in Winnipeg found that urban bicycling helmet use was 2.5 times higher than rural use.[18]

Driving impaired by alcohol continues to be a significant problem in Canada. Despite declines in rates of fatal injury in drivers reported above the legal limit (i.e., 80 milligrams of alcohol per 100 milliliters of blood) prior to 1999, rates have subsequently leveled off over the past 10 years. In 2010, 34% of fatally injured drivers had a blood alcohol concentration over 80mg%.[19] There is evidence that impaired driving is more frequent in rural areas. In Alberta, annual impaired driving rates were 3 times greater in rural areas compared to urban areas in 2001.[20] In the 2011 Ontario Student Drug Use and Health Survey of 7th-12th graders in Ontario, high school students living in rural areas were twice as likely to report drinking and driving a vehicle.[21] (See Chapter 4.2 Transport Injuries).

All terrain vehicles, or ATVs, represent an increasing mechanism for injury and fatality in Canadians, particularly in paediatric populations in remote areas of Canada including First Nations, Inuit, and Métis communities.[22] ATVs are used primarily for recreational purposes; however, children and youth in rural and remote areas of Canada use ATVs for transportation purposes. ATVs take the lives of an average of 141 Canadians every year.[22] In addition, the number of ATV fatalities has been increasing, averaging 179 per year in 2003/2007; of these deaths, 40% were under the age of 19.[22]

The most significant mechanism associated with ATV injuries and deaths is collisions; rollovers, colliding with a fixed object, or falling off an ATV are cited as the most significant contributors. There are several factors that increase both the risk and severity of ATV-related injuries among children and youth. These include carrying or being a passenger on an ATV, driver error, poor judgment, and loss of control.[22] For children, inexperienced drivers and lack of supervision from adults are contributing factors to the high rates of injury in this age group.[23,24]

The Canadian Paediatric Society recommends that children under the age of 16 should not be involved in the operation of an ATV. In addition, the following are recommended to reduce the burden of injury specific to ATV use by and with children and youth:[22]

1. Youth over the age of 16 who operate an ATV should wear approved personal protective equipment, specific to ATV use. This includes helmets, eye protection, and clothing and footwear that would protect the user from colder temperatures

2. Single rider ATVs should not take passengers at any time.

3. ATVs should never be used after the consumption of alcohol, or any other substance that could cause impairment of the driver

4. Government approved ATV training courses should be undertaken by ATV users including completion, testing, and passing, prior to use. ATV drivers should complete an approved training course. Training should have both theoretical and practical components and include mandatory testing to pass the course

The Canadian Pediatric Society also makes specific engineering recommendations for the ATV industry including:

1. To reduce the margin of error associated with ATV use, ATV design and standards of operation should be improved.

2. Specific marketing to youth under the age of 16 should not be endorsed by ATV manufacturers.[22]

Finally, local, provincial/territorial, and federal levels of government in Canada must enforce current legislation that reflects these recommendations, in addition to working at the community level to mandate local training, licensing, and registration.[22] A unified, ecological approach to ATV injury prevention should include education, engineering, and enforcement programs; in addition, community-based programs should include prohibiting ATV use as a form of recreation by children and youth.

Agriculture Injuries

Occupations most often found in rural environments such as agriculture, mining, forestry, and fishing are among the most dangerous. Heavy equipment used in mining, forestry or farming can lead to increased injury risk. The agricultural industry ranks as the fourth most hazardous in Canada with respect to rates of fatal injury.[25]

The average annual number of fatalities on farms between the years 1990 and 2008 was 104 per year, with an overall fatality rate of 13 deaths per 100,000 farmers. Although the age group associated with the highest absolute number of deaths was 50 – 69 years (approximately 16 per year), the highest rates were reported in farmers over the age of 80, with a rate of almost 80 deaths per 100,000.[26] Older farmers routinely work beyond retirement age and conditions associated with aging (e.g., arthritis, vision and hearing impairments) can make daily activities involved in farming extremely dangerous.[27]

Children living on farms also face unique injury risks as they live and play in environments often characterized by heavy equipment, large vehicles and animals, and unpredictable work demands placed on their parents. Between 1990 and 2008, almost 250 children under 15 years of age were killed in agricultural incidents. Between 2000 and 2008, the number of

child fatalities per year fell to an average of 10, down from an average of 16 deaths per year in the previous 10 years. While this decrease is encouraging, the adjusted per-population fatality rate in children has only decreased an average of 0.4% annually.[26] See Chapter 4.1 Agricultural Injuries.

Burns

The risks of fatality from residential house fires in rural areas are more than twice those reported in urban areas.[28] This increased risk may be due to: lower use of smoke detectors, wood stove and kerosene to heat homes, and increased prevalence of mobile and substandard housing; all factors associated with higher risks of death from fire.[28] (See Chapter 4.10 Burns.)

Drowning

Canada is known for its vast bodies of water. Individuals living in rural communities have a much greater exposure to open bodies of water, putting them at increased risk of drowning. In rural areas, travel by boat and snowmobile is common; fewer people wear floatation devices and there is little access to swimming lessons.[29] Aboriginal peoples in rural areas are particularly over-represented in drowning incidents.[29] Drowning rates are up to 10 times higher in Aboriginal populations versus non-Aboriginal, and 15 times the national average for Aboriginal children.[30] There are also ethnic differences in drowning rates of those living in rural versus non-rural locations. Individuals of Asian, Greater African, and Hispanic ethnicity living in rural Ontario had significantly higher drowning rates than Greater Europeans living in rural Ontario.[31] (See Chapter 4.9 Drowning.)

Conclusion

There are unique challenges to injury prevention in rural environments in Canada, due to geographic diversity, greater distances to trauma and emergency care, different lifestyles, and sparse populations. As a result of these challenges, safety programs may be more difficult to implement in rural environments. In addition, many of the effective prevention strategies conducted in urban environments are not readily transferable to rural environments. For example, a designated driver program is more challenging due to the increased distance between homes, and 4-sided pool fencing to prevent drowning is less relevant when there are sloughs, dugouts, rivers, and lakes. It is evident, however, that the injury burden is higher in people residing in more rural and remote areas, requiring focus from the injury prevention community. Current rural injury surveillance data is sparse, and this must be addressed in order to accurately define the burden of injury in rural areas, and the factors contributing to this burden. In addition, there is a need for improved rural road

conditions and road safety awareness, more occupational health and safety issues directed towards rural workers, and increased awareness and uptake of safety devices related to fire hazards and drownings in rural settings.

Summary Key Points

Injury morbidity and mortality is considerably higher in rural compared to urban areas.

People living in rural communities generally need to travel longer distances and on more dangerous roads; therefore, injuries and death due to motor vehicle collisions are much more common.

Improved rural road conditions and raising road safety awareness need to be explored.

Certain rural-based industries such as farming have high levels of occupational hazards, and attention to occupational health and safety issues specific to rural settings is important.

There is a need for increased awareness and uptake of safety devices related to fire hazards and drownings in rural areas.

Future research should explore whether conventional strategies, mostly developed by urban program planners for urban residents, are equally effective in rural settings.

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3.5.5

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Physical and Built Environments
Outdoor Play Environments

Introduction

Over twenty years of cross-disciplinary research has demonstrated that quality outdoor play environments can contribute positively to children's physical competence, social interactions, and cognitive skills.[1] Several studies have looked at how spatial arrangement, natural elements, and available loose materials in outdoor play spaces promote play and contribute to healthy child development.[2-4] Other studies have shown that interventions in children's play spaces such as adding green areas, natural elements, and loose play parts can have a positive influence on children's play.[3-5]

Opportunities of Outdoor Play Environments

The physical environment can also have a significant impact on children's behaviour. Detrimental effects occur when schoolyards and play spaces restrict challenging play and offer few natural spaces.[6-8] A higher incidence of aggressive behaviours has been linked to play spaces with little challenge and few natural environments. [9,10] For example, a comparative study of Australian school grounds found that schools most likely to experience bullying and fighting had very limited access to natural spaces.[10] Similarly, findings from a study that compared the play environments of 12 Vancouver preschools suggested that a lack of physical and cognitive challenge was a major reason for increased bullying.[9]

Extensive research supports the importance of outdoor challenging play and nature play for the promotion of healthy child development; however, recently, trends have been shifting towards greater monitoring and restrictions on children's play.[6,8,11] This trend has limited children's access to the outdoors and nearly eliminated challenging play from today's playgrounds.[7,12,13]

Research suggests that the impulse to make children's outdoor environments structured and 'safe' by eliminating risky play has harmful long-term impacts.[6,14,15] The challenges presented to children through thrilling and exciting play that could potentially pose a risk of physical injury lets children test their physical limits, develop their motor skills and confidence, and helps them to learn how to manage risk in their environment.[6,16] Offering children risky play opportunities within their play environments provides them with the physical and cognitive challenge necessary for healthy development.[6,8,15]

Despite increasing evidence in support of challenging play, the balance of safety versus risk is an ongoing issue. In recent years, many playgrounds have been altered to improve 'safety,' often resulting in the **KFC** playground comprised of a **kit** of play equipment, **fence**, and a **carpet** (rubber surfacing).[17] The KFC playground has been criticized for offering little challenge and few natural elements.[7, 18]

The Seven C's Design Guidelines for Optimal Play Environments

A five year multi-disciplinary study in Vancouver identified the precise outdoor physical characteristics that contribute to early childhood development.[19] These findings, coupled with findings from a review of the literature concerning landscapes designed for children, were compiled into what is called the *Seven Cs Informational Guide for Young Children's Play Spaces*.[19] The Seven Cs design guidelines can be used to increase the amount of challenging play on a playground.[19] *The Seven Cs Informational Guide* can help educators, designers, administrators, and parents to design outdoor play spaces that consider children's developmental and play needs. The guidelines are based on a qualitative assessment of the **character** and **context** of a play space, and discuss how the overall design promotes **connectivity** and **clarity**, while offering opportunities for **change**, **chance**, and **challenge** within the space. Together, these design guidelines can be used to build outdoor environments that contribute to quality play and support early childhood development.

The Three C's of Challenging Play

To design playgrounds that offer children more challenging play, three of the design guidelines - **change, chance** and **challenge** - should be considered. Introducing these three

elements to the outdoor play space means thinking beyond the KFC playground. Not only does it require recognition that risk-taking is a healthy and necessary activity in the play environment, but it also promotes an obligation to expand and diversify the materials that are integrated into the play space. These materials, including plants, boulders, bricks, sand, logs, and other items not normally associated with playgrounds, can help increase the amount of challenging play opportunities offered to children while developing a more organic character in the play space.

By integrating risky play into the playground, children are given the opportunity to learn to manage risks in their environment during childhood. Considering recent trends in risk-averse play space design, risky play is an innovative approach that engages children, promoting their wellbeing *within* the environment rather than protecting them *from it*. The *three Cs*, **change, chance,** and **challenge** will help to create natural environments that offer children healthy risk-taking opportunities that are enjoyable, socially acceptable, and present them with the physical and cognitive challenges necessary for development.

Implementing the Three C's: Two Case Studies

The following case studies present how the *Seven Cs Design Guidelines* were used to introduce the elements **change, chance** and **challenge** in playground interventions at two early childhood education centers in Vancouver. The case studies present how natural materials were used and arranged to increase physical, cognitive and social challenge suitable for primary age children.

The playground interventions are part of a larger study scientifically investigating the effects of natural play spaces and challenging play on children's development. The interventions were installed at two preschools that were part of the original study that helped generate the Seven Cs. They were selected for intervention because they were rated the lowest on the Seven Cs scale for optimal play environments of the 16 centres studied.[19] The interventions employed the Seven Cs in order to increase the playground's rating and expand the amount of risk-taking and nature play opportunities in the space. The objective of the study was to measure if children's behaviour changes or if their developmental trajectory is impacted when play environments offer more nature and challenging play opportunities.

The interventions were designed to be temporary, so no construction was undertaken. The changes in the space were created from the addition and arrangement of the following materials:

Clumping Bamboo in pots *Sand* *River Rocks*
Woody Shrubs in pots *Gravel* *Granite Rocks*
Grasses *Pea Gravel* *Boulders*
Flowering Perennials *Washed Glass* *Logs*
Sedums *Pebbles*
Annual vegetables *Paving stones*
Sod *Bamboo poles*

Change

Designing for change involves providing a range of **spaces and sub spaces** that accommodate different size groups and can be appropriated for a variety of different types of play. It also includes creating a **play space that is constantly changing**. This can be accomplished by adding materials that change, like vegetation, or by including materials that can be moved throughout the play space, allowing children to directly participate in changing their own playground.

Differently sized spaces and sub-spaces. Both of the play yards before the intervention could be considered one whole space, one large room, with very few (if any) sub spaces. The intervention created several spaces with the use of plants, primarily clumping bamboo, woody shrubs, and tall grasses. Sod was used to define and highlight spaces that already existed within the play space. This provided children with a range of spaces to explore, making the play space seem larger and more expansive. This gave children the opportunity to play with the sensation of 'getting lost.' The sensation of 'getting lost' has been described as a risky play category that offers children the cognitive challenges of navigation and exploration, and the thrill of being 'unseen.' [20]

Center A
Before and After the Seven C's Intervention

Center A Pre-Intervention

Center A Post-Intervention
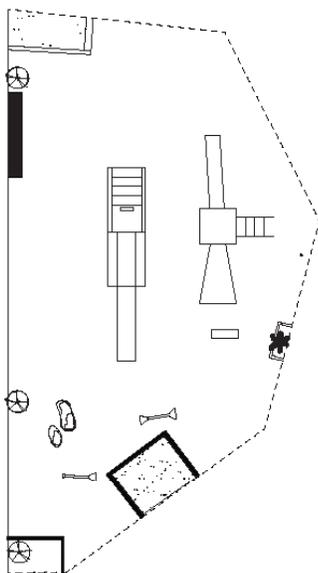
Plan 1: Center A Pre-Intervention
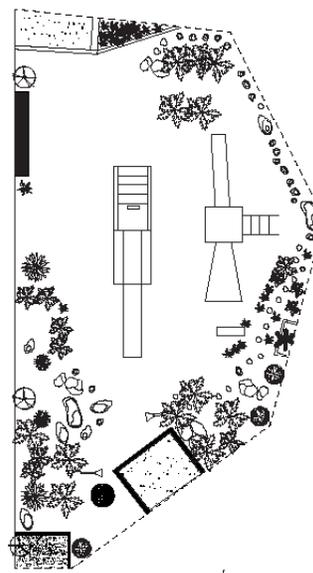
Plan 2: Center A Post-Intervention

Center B
Before and After the Seven C's Intervention
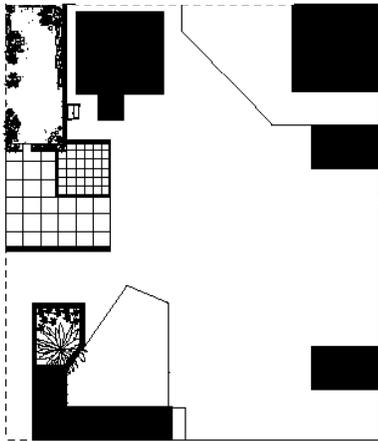
Plan 3: Center B Pre-Intervention
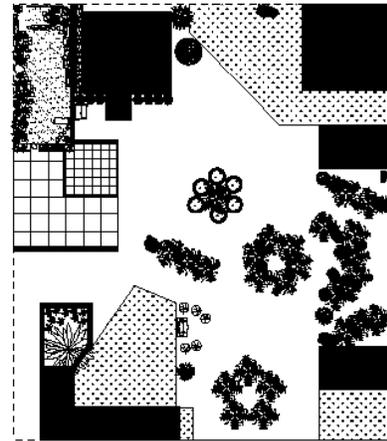
Plan 4: Center B Post-Intervention

Plants were used to create small, medium, and larger size "rooms" throughout the space. Smaller rooms can hide one or two children, medium rooms accommodate three to four, and larger rooms can squeeze in five or six.

Small 'Room' at Center B

Medium 'Room' at Center B

Spaces that allow children to be alone are important in centers where children are grouped together for long periods of time. [21]

'Forest' at Center A
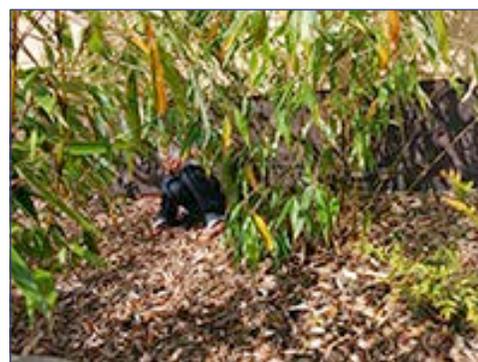
Hiding space in 'Forest' at Center A

Grass under play structure at Center A

Defining existing space with sod at Center B

Larger rooms in both spaces, referred to as the 'forest' by the children, were designed to include smaller sub spaces created with plants and boulders. These spaces-within-spaces invite children to explore, hide, and seek.

Defining spaces that already existed in the playground by laying sod created softer, more inviting places for children to enjoy. It also helped to invigorate underutilized spaces like a shaded back corner and the space below play equipment, which previously were unused.

Changing Materials

Adding vegetation to both play spaces gave the children a wealth of things to observe and investigate. These changing objects entice children to stop and interact with the environment. They also prompt them to describe what they see to each other. Verbalization for primary age children is a cognitive challenge that can be encouraged by changing spaces.[18]

Observing alone at Center B

Observing together at Center B

Designing for Chance

Designing for chance is achieved by offering children elements in the play space to **create and build with, manipulate, and change**. These elements offer children the chance for something to happen.

'Jewel Box' at Center A
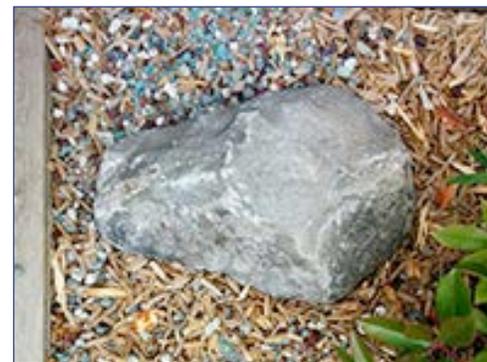
'Jewels' hidden behind a rock at Center A

The pre-intervention playgrounds offered children few materials to move around, mix, and create with. Both playgrounds had sandboxes before the intervention. Each place space received a 'jewel box,' also referred to at Center B as a 'treasure chest': a large terracotta planter filled with multi-colored pebbles, pea gravel and colourful washed glass. They also received bamboo poles, gravel, sharp rocks, and loose paving stones. The materials were placed in zones, but the children were allowed to mix and move the materials around the playground.

Some of these elements, particularly because of their shape and weight, could be considered 'dangerous tools.' The use of dangerous tools is also considered a risky play category as they challenge children's bodily and motor control.[20] Early on in the intervention, educators were concerned that the children would misuse the heavy paving stones, use them aggressively, or hurt themselves because they were too heavy to lift. However, by the end of the data collection period, several educators expressed that they had found them to be among the best additions to the play space.

Paving stones in a 'gravel pit' at Centre A

Building with paving stones at at Center A

Vegetation was also a popular play prop. Nervous educators were reassured that the plants, especially the clumping bamboo, could withstand children's tugging and constant attention. Plants need water, and this became a popular activity at both centers. The look and feel of the centres changed during the watering period, adding a variety of creative and imaginative play opportunities.

Playing with plants at Centre A

Plants as a play prop at Centre A

Playing with water at Center B

Watering the rock at Center B

Challenge

Challenging elements were placed throughout the playground for children to **explore, master, and test their limits**.

Boulders were provided for climbing and jumping at Centre B

A boulder placed near a fence gives smaller children the opportunity to master climbing with a bit of assistance at Center A

Various sized rocks for balancing at Center A

Tires for balancing at Centre B

Conclusion

Providing children with play environments that *change*, give children the *chance* to create and imagine, and offer them not only physical but social and cognitive *challenge* is essential to healthy child development. Thinking beyond the KFC requires us to approach play design with the objective of expanding play opportunities rather than restricting them. Arranging natural materials to create spaces within the playground, and placing materials in a way that encourages diverse interaction will inspire children to engage with their environment and learn from it. Flexible play spaces with a variety of diverse play opportunities allow children to determine the level and types of challenge they need to explore for their own developmental benefit. Creating versatile play environments that are inclusive of risks rather than averse to them will ultimately benefit children by teaching them to manage risk in their own environment.

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Healthy Child Development
Rights of the Child

Introduction

Injuries are a leading cause of disability and death of children in Canada.[1] To complement a public health approach to this problem, practitioners and researchers in the fields of health promotion and injury prevention have begun to consider how a human rights framework might be used to support their work on child injuries. They have done this by specifically exploring how the United Nations Convention on the Rights of the Child (UNCRC) might guide their ongoing studies of the problem as well as interventions in the field. For example, the 2008 World Report on Child Injury Prevention specifically references the UNCRC in defining the responsibilities that countries across the world have toward children with respect to unintentional injuries.[2] The UNCRC is similarly cited in the 2006 World Report on Violence against Children, an international study that addresses the scale and impact of intentional injuries against young people.[3] Within Canada, the UNCRC has been used as a tool for framing health policy decisions, developing programs, conceptualizing research initiatives, and advocating for better strategies to improve the health and well-being of children and youth. [4,5,6]

The goal of this chapter is to describe how the UNCRC has been and could be relevant and useful for those working in the field of injury prevention. This chapter begins with an overview of the UNCRC and its principles. The major themes of the Convention's articles - protection, provision and participation are then discussed. In each of these areas, some examples are offered of how the UNCRC is pertinent to injury prevention policy and practice and further possibilities for its application are presented. This chapter concludes with some

reflections on the importance of the UNCRC as a tool and potential framework for conceptualizing injury prevention efforts related to children and youth.

United Nations Convention on the Rights of the Child: An Overview

The United Nations Convention on the Rights of the Child is an international human rights treaty that grants children a comprehensive collection of rights. Adopted by the United Nations general assembly in 1989, it is the most widely ratified international convention in the world. Canada's ratification of the UNCRC in 1991 indicated its agreement to be legally bound by the Convention's articles and commitment to upholding the rights of children across all realms of their lives.

The UNCRC definition of childhood (article 1) includes all people under the age of 18 years, and recognizes childhood as a distinct period in the life cycle with unique characteristics and developmental stages. The UNCRC recognizes children as individuals with specific rights – as subjects rather than objects. Governments are responsible for respecting children's rights not just because children are vulnerable people in need of protection, or because they are future adults with unlocked potential. Rather, the UNCRC acknowledges children as independent bearers of human rights in the present moment, capable of participating in decisions that affect them.

The UNCRC is comprised of fifty-four articles that depict a full range of children's rights and corresponding obligations of governments to ensure these rights. Countries that have ratified the UNCRC must take legislative, administrative, social, educational and other measures to implement the Convention and report periodically to UN Committee on the Rights of the Child. In response, the Committee provides feedback to countries in the form of Concluding Observations that are intended to help them work progressively toward full implementation of the UNCRC.

 Four guiding principles (each with its own corresponding article) assist with the ongoing interpretation and application of the UNCRC: the best interests of the child; non-discrimination; survival and development; and respect for the views of the child. These principles help countries to implement the Convention and resolve conflicts between particular rights. For example, the "best interests" principle may be employed in determining how authorities respond to situations of online peer bullying or harassment. In this case, the right of a child to freely express her/himself (article 13) conflicts with the rights of other children to be protected from all forms of violence (article 19).

A closer examination of the UNCRC reveals language and measures that are pertinent to childhood injuries. The clearest examples of this can be illustrated using three themes,

known as the "3Ps", [7] that are routinely used to group articles of the Convention: protection, provision and participation. In the next section we offer a more in-depth discussion of the 3Ps, focusing especially on their relevance to childhood injuries and approaches to dealing with these injuries in Canada.

Protection

UNCRC articles grouped under "protection" involve the right to be shielded from harmful acts and practices. Of the several articles that pertain to children and injury, Article 19 makes one of the more explicit references to the connection, asserting that children have the right to safe environments, free from "all forms of physical or mental violence, injury or abuse, neglect or negligent treatment, maltreatment or exploitation." [8] See Table 8 for a list of the other UNCRC articles related to protection and other aspects of child injury. It is worth highlighting here that the articles are meant to be interrelated and indivisible, so do not fit precisely into subject areas or categories. For example, a child's right to fully participate in society (article 12) is related to having an adequate standard of living (article 27) and not experiencing violence (article 19) or discrimination (article 2).

The concept of protection in this instance aligns well with approaches to injury prevention and safety promotion. For example, protection is integrally related to legislation, regulation and enforcement across a number of areas, including: speed limits, drink-driving laws, child restraints, four-sided pool fencing, hot water tap temperature legislation, and smoke alarms. It is a primary motivation behind child-related product safety standards and is central within the Canadian Consumer Product Safety Act, which aims "to protect the public by addressing or preventing dangers to human health or safety that are posed by consumer products in Canada."

Similarly, notions of protection also underlie many injury prevention education efforts that are specifically designed for young people (e.g., Think First for Kids) as well as those that target parents, caregivers, community members and professionals have regular involvement with children (e.g., Safe Kids Week).

TABLE 8

Summary of some key UNCRC articles related to child injuries

Summary Key Points

Article 2 – Right to protection from discrimination

Article 3 – Right to have best interests considered

Article 6 - Right to life, survival and development

Article 9 – Right not to be separated from parents (unless this harms child)

Article 12 – Right to express views and be heard

Article 13 – Right to freedom of expression

Article 14 – Right to freedom of thought, conscience and religion

Article 16 – Right to privacy

Article 17 – Right to access information

Article 19 – Right to protection from all forms of violence, injury and abuse

Article 23 – Right for children with disabilities to have special care, enjoy life and participate in society

Article 24 – Right to highest standard of health and healthcare

Article 27 – Right to an adequate standard of living

Article 30 – Right of minority and indigenous children to enjoy own culture, practice own religion, and speak own language

Article 31 – Right to rest, leisure, play and recreation

Article 32 – Right to protection from economic exploitation and performing harmful or hazardous work

Article 42 – Right for children to know their rights

Finally, existing efforts to prevent and mitigate the consequences of "intentional injuries" (injuries resulting from self-directed and interpersonal violence intended to cause harm) are grounded in concerns about child protection. Injuries from child maltreatment, suicide, self-harm and assault are viewed as important public health issues due to the large burden they place on the health care system and devastating short and long term effects they can have on children, families and communities.[9] They are also important human rights issues under the UNCRC, and have been flagged by the UN Committee on the Rights of the Child as issues that should be further addressed within Canada. For example, in their 2012 Concluding Observations for Canada (regarding Canada's third and fourth reports on UNCRC implementation) the Committee expressed concern about: high levels of violence and maltreatment against children; rates of youth suicide; widespread incidence of school bullying; and the condoning of corporal punishment under section 43 of the Criminal Code of Canada.[10] In addition to a number of specific recommendations, the Committee suggested that Canada "prioritize the elimination of all forms of violence against children"(p. 11) and develop a comprehensive violence prevention strategy.

Provision

UNCRC rights under the theme of "provision" involve possessing, receiving or having access to certain resources or services. Article 6 holds that "States Parties shall ensure to the maximum extent possible the survival and development of the child". This and other articles related to provision address the wellbeing of children across a number of domains (e.g., health, education, justice) while taking a holistic and developmental view of childhood.

Within the field of injury prevention, upholding the provision rights of children involves investing in children in ways that account for their evolving capacities over time. It necessitates the creation of policies, practices and programs that are developmentally appropriate, rather than simply replicating approaches that were created for adults. It acknowledges that children are more susceptible than adults to certain types of injuries, with variance across age and development. It also implies planning for children in proactive rather than reactive ways. For example, designing and modifying traffic patterns to divert vehicles away from residential neighborhoods where children play and walk/bike to school can both prevent injuries and increase a neighborhood's "child friendliness".[11] Such environments might also promote children's access to leisure, recreation and play (article 31) and have positive effects on children's physical, social and emotional development.[12,13]

Under article 24 of the UNCRC, children have a right to enjoy the highest possible standard of health, including access to medical assistance, health care, prevention efforts and health education. Access to health care services can influence whether a child survives an injury and how well a child recovers from an injury. The availability of child-sized equipment, appropriate pediatric acute care, burn centres and poison control centres can make a

difference for children in the immediate and long term. Such measures are also in keeping with the World Report on Child Injury Prevention recommendation to "strengthen health systems to address child injuries" and engage allied sectors in providing injured children with high quality care, rehabilitation and support services.[2]

The right to equality in accessing health-related resources and services is also explicitly outlined in article 24 of the UNCRC and reinforced by the guiding principle of "non-discrimination". The need for explicit efforts to ensure equality in providing support to children (within health and other areas) is reflected in the UN Committee on the Rights of the Child's concern about the "continued prevalence of discrimination on the basis of ethnicity, gender, socio-economic background, national origin and other grounds" within Canada and recommendation to "address disparities in access to services by all children facing situations of vulnerability, including ethnic minorities, children with disabilities, immigrants and others."[10] With this in mind, efforts to address the complex and often interrelated factors that contribute to the unequal burden of injury across various groups of children are especially relevant and critical.

Participation

The UNCRC is the first international document that specifically outlines children's participation rights.[14] The theme of "participation" involves the right of children to actively engage in society and have their voices heard. The UNCRC asserts that children have the right to express their views and be involved in making decisions that affect their lives (article 12). They also have the right to freedom of expression (article 13), freedom of thought, conscience and religion (article 14), freedom of association and peaceful assembly (article 15), and access to information (article 17).

With age and maturity, children must have increasing opportunities to make decisions and take part in the activities of society. While the term "child" is used in the UNCRC (and throughout this chapter) to refer to people under the age of 18, there is recognition of the different capacities of infants, toddlers, school-aged children and youth to make decisions about their lives. The UNCRC takes into account the range of children's developmental trajectories and also the unique circumstances of some children. For example, Article 23 of the Convention holds that, "a mentally or physically disabled child

should enjoy a full and decent life, in conditions which ensure dignity, promote self-reliance and facilitate the child's active participation in the community." [8]

Further, the UNCRC states that children have the right to be heard in assessments and determinations about their individual situations, and to participate in decision-making on issues pertaining to children more generally. This means that young people in Canada have the right to be involved in developing child-related laws, policies and practices. Within the field of injury prevention, honoring the participation rights of children necessitates not only asking, "how will this affect children?" but also "how can we involve children?" These questions are important when deliberating about issues that clearly relate to children (e.g., playground design, bullying prevention policies) as well as those in which young people might not be top of mind, but are directly or indirectly affected (e.g., traffic patterns, workplace policies). Injury prevention practitioners who have influence at the municipal level are especially well-positioned to promote participatory decision-making with children. For example, those working to foster "safe communities" and "child-friendly" neighborhoods have opportunities to engage young people in the design of public spaces and places.

Upholding the participation rights of children also entails developing research agendas that genuinely and effectively include the voices and concerns of children. This means involving children and youth in defining research priorities, designing studies, carrying out research projects, and developing knowledge translation strategies. Participatory research methods (e.g., Action Research and Community-Based Participatory Research) are particularly well suited to actively engaging young people in knowledge creation. Such efforts may require building the capacity of injury prevention researchers and practitioners to work with children in ways that foster meaningful participation.

Conclusion

The UNCRC – as a legally binding international agreement – is a powerful tool for upholding the rights of children. It provides a framework for decision-making, advocacy and monitoring while setting standards against which to assess and improve the treatment and well-being of young people. The UNCRC is also a document that needs to be applied with contextual factors in mind, such as the national and cultural context it is being used within. It also needs to be actively utilized if it is to be an effective tool for addressing a wide range of issues related to young people. With this in mind, we hope that this chapter inspires thinking about the application of the UNCRC within the field of injury prevention in Canada, and the kinds of engagement that would be most productive and in the best interests of children moving forward.

Case Study

Article 32 of the UN Convention on the Rights of the Child (UNCRC) states that a child has the right "to be protected from economic exploitation and from performing work that is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral or social development." [8] The article further specifies that countries must take legislative, administrative, social and educational measures to ensure this right, including: providing for a minimum age for admission to employment; ensuring appropriate regulation of the hours and conditions of employment: and providing for penalties and other sanctions to ensure enforcement of the article.

Within Canada, some groups have called for increased commitment to upholding article 32 of the UNCRC, with a focus on both children's rights and injury prevention. The First Call: BC Child and Youth Advocacy Coalition is an example of a group that has taken this approach. In 2009, First Call released a report on research examining WorkSafeBC's young worker injury claims called "What's Happening to Our Children?: A Look at Child Work-Related Injury Claims in BC Over the Past 10 Years". A key finding of this research was that WorkSafeBC injury claims among children under between 12 and 14 years of age increased tenfold over a four-year period following changes to BC's child labour laws related to this age group. The report also highlighted that B.C. was the only province that did not place legislative or regulatory restrictions on the occupations, tasks, or time of day a child over 12 years could work.

First Call also published a subsequent report in 2013 entitled "Child Labour is No Accident: The Experience of B.C.'s Working Children." This document examined the consequences of B.C. child labour laws using existing studies along with interview and focus group research with young people. It also contrasted BC's law with employment standards in other jurisdictions. At the time the report was released, WorksafeBC provided data related to the risks faced by working children, including: a dramatic increase in annual payments for accepted disability claims related to children ages 12 to 14 injured on the job and the payment of over 1.1 million dollars in disability claims for 179 children injured on the job from 2003-2013. This included two males under the age of fifteen, now permanently disabled, who received payments for "high cost" injury claims while working at workplaces prohibited to children in other provinces. It also included nine young people designated as "long-term disabled" as a result of work-related injuries sustained when they were under the age of 15 years.

First Call's report highlighted the UN Committee on the Rights of the Child's 2012 concerns that Canada: does not systematically collect data on child labour; has inconsistencies in legislation across the provinces and territories, and allows 16 year old children to perform dangerous and hazardous work in some jurisdictions.[10] It also included the Committee's recommendations to Canada to: establish a national minimum age of 16 for employment;

harmonize provincial and territorial legislation to ensure adequate protection for all children under the age of 18 from hazardous and unsafe working environments; and take steps to establish a unified mechanism for systematic data collection on incidences of hazardous child labour and working conditions. The First Call report ended with specific recommendations for improvements to the Employment Standards Act and regulations to bring BC's law into compliance with the commitments made by Canada in ratifying the UN Convention on the Rights of the Child.

First Call's ongoing work in this area demonstrates the application of both an injury prevention and human rights perspective in protecting children from exploitation and injury in the workplace.

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3.6.2

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Healthy Child Development
Resiliency

Background

Injury resilience is a complex social, medical, and community process of great interest to the injury management and injury prevention community. For this discussion, injury resiliency is the ability to recover from injury to a level at or above original capacity. Individuals demonstrate resilience when they can face difficult experiences or injury and rise above them.[1]

An injury can be defined as any harm or damage that is done or sustained. Injury can be external, such as strain, sprain, contusion, laceration or fracture to a body structure, intentionally or accidentally. Injury can also be internal such as rumination on life's problems, thinking about underachieved goals, blaming oneself for mishaps or reactions to abuse or insult.[1] Injury is a common predictable life event. It is expected and frequent in youth sports.[2] Injury is a common household and activity of daily living reality. Injury is costly to our medical and vocational systems. In the elderly, unexpected falls are the leading trauma reporting to emergency medical facilities in Canada.[3]

The scope of injury is wide. The recreational participant, the elderly person who falls, the worker injured doing their job, and those injured during activities of daily living all have disruption to varying degrees. Some are injured by what others say or do. It is probable that the number of psychological casualties will be greater than physical casualties after trauma or disaster.[4] The reactions to injury are diverse and may not be predictable. The need and

benefit from injury resilience is a science in infancy with most of the knowledge yet to be determined.[5]

Resilience is used in child psychology to describe success against odds.[6] In Cognitive Behavioural Therapy, resilience is a process not a trait and is described as the ability to cope and adapt in the face of adversity and/or bounce back and restore positive function when stressors become overwhelming.[7] Resilience is the ability to transform adversity into a growth experience and move forward. Resilience can be thought of as a measure of the ability of an organism to adapt, and to withstand challenges to its stability. Resilience is a positive trait, process, characteristic, or observation. Resilience can minimize injury impact for the injured person(s) and their communities.

Key Steps for Maximizing Injury Resilience

1. Facilitate healthy and connected early life experiences to maximize brain elasticity and adaptability. This includes assisting community efforts to reduce negative child experiences such as child abuse and neglect. Positive early childhood experiences pay large dividends to individuals and society.

2. Acknowledge that injury will and does occur in all parts of the lifecycle.

3. Recognize the injured person brings their personal life experience, knowledge, and fears to this point in their life. Their resilience capacity is impacted by past experiences and the context of their current injury.

4. Empower individuals and communities with knowledge and skills to deal with the immediate physical and psychological needs of injury.

5. Engage the care team needed to surround the injured person with positive effort.

6. Seek opportunity and innovative options to recover and grow from this injury experience.

7. Encourage self-control, self-management, and self-esteem elevation through community partnerships and support. Avoid individual and cultures of learned helplessness.

8. Encourage a positive mental health and support and treat mental stress and illness.

9. Encourage early recognition of co-morbid conditions that would benefit from acknowledgement and treatment.

10. Engage in further research on injury resilience principles, education, and application in all parts of the lifecycle and all communities.

Platform for Injury Resilience

There is evidence that some of the characteristics of resilience are genetic, familial, and inherent within individuals.[8] Resilience can be impacted by life events and social organization. Evidence and case studies report individuals can prepare themselves to be more resilient in the face of injury. Evidence informs recommendations to individuals and communities to enhance the probability of a resilient response to injury. These include reassurance, first aid, positive re-direction, persuasion, advice, support to establish safety, calm, and a sense of being able to solve problems for oneself, group, or community with support and hope.[4]

Communities may be geographic, such as a town/city, or organizational clusters, such as the youth sport community, a team, a school or the elderly cohort. There are things that can be done to make communities safer and to increase injury resilience within communities. These strategies include community preparations (i.e., first aid available), positive attitude building, knowledge, skills, and actions (i.e., workshops/community committees/organizations to mobilize infrastructure and resources to reduce, best manage, and support injured persons). Individuals and communities can be taught, positioned, and facilitated to improve injury resilience.[9] There is much more to be determined about the added value of options for injury resilience enhancement.

Injury Resilience and Collateral Risks/Damage

Injury resiliency is an important issue that impacts the outcome, the rates and quality of recovery, and the collateral damage from injury. There are key features that can impact injury resilience that can be provided to individuals, communities, and care providers to increase the speed and level of recovery. These include responsible use of alcohol and drugs, reduced inequity and inequality, safety infrastructures, risk behavior reduction, mental health support, and information management. The costs of limited or absent injury resilience are very high to individuals and communities. If individuals and communities could enhance injury resilience, this would reduce injury rates and increase recovery, productivity, health, and happiness.[10]

The application of injury resilience enhancement knowledge and skills improves injury outcomes. Research on this issue comes from areas of injury such as burns, spinal cord

injury, and from communities who have experienced natural disasters, trauma, or tragedy. There is experience and exploration of this concept throughout the lifecycle - newborn, children, adults, and elderly. The general principles are transferable across life cycles, individuals, communities, and organizations. Those general principles include adaption, neurobehavioral development, plasticity, anxiety, and fear management.[8]

The body has incredible self-righting capacity.[11] The characteristics that make individuals more likely to have injury resilience including flexible thinking and being calm and innovative.   Decisive action and self-control improve resilience. Interpersonal connectedness, optimism, and positive perceptions of self, community, and life are helpful. Tenacity is a positive attribute that contributes to injury resilience. Adaptive calibration can serve a useful purpose. A belief in a creator or higher power can be a positive factor for some injured persons and communities. A more resilient approach to injury improves neuro-immunological response and repair.[12]

Early life exposure to stressful and maladaptive experiences or role models may inhibit injury resilience. Positive developmental cascade increases resilience across levels or domains of function.[13] Learned helplessness is a feature associated with low resilience.[14] Less adaptive and marginalized persons who see themselves and their community without choices or options may have more challenges to being resilient. A lack of preparation and forward planning may inhibit preferred responses to injury. Low self-worth and low self-esteem are associated with low resilience.

Resilience is a function of both internal personality and external environmental factors. The external context can include poverty, lack of safety, violence, abuse, and illness. These challenges can undermine a person's resilience. Having skills and role models with healthy problem-solving abilities, empathy, and optimism strengthen resilience. Resilience is reduced in people with mental illness and mental health challenges.[5]

An Individual's Injury Resilience

At the heart of a person's resilience is a belief in oneself – yet also a belief in something larger than oneself.[15] Those who master resilience tend to be skilled in preparation and adaption for change. Those who accept what happens with flexibility rather than rigidity have improved injury resilience.

There are identified traits of emotionally resilient people. They know their boundaries. They keep good company. They cultivate self-awareness. They have positive developmental cascade. They practice acceptance. They are willing to sit in silence. They do not have all the answers. They have a menu of self-care habits. They enlist their team. They consider the possibilities.[16]

The word "crisis" in Chinese is formed with the characters of danger and opportunity. (咊㦳) An injury crisis can create fear and unrest, and paralyses action. Resultant toxic environments may erode organizational, community, and personal health effort. For some, the toxicity of uncertainty is personal, and community health-reducing.[7]

Key Determinants of Resilience

The key determinants impact injury risk and resilience. Profound differences in health outcomes exist between high income and low income communities/ nations. A significant contributor to poor health outcomes in lower socioeconomic communities is the lack of basic necessities of life (safety, food, water, housing, sanitation, primary health care, etc.). In high income communities/nations such as communities in Canada, there remain significant differences in key health indicators such as infant mortality, life expectancy, and child injury and mortality rates. The evidence is clear that social supports for security (safety, housing, income, employment), education, equity, and health and social services improve health outcome measures.[17]

Some nations such as Sweden have most effectively translated social determinants of health into government policy that empowers effective social action. This provides broad based, inclusive social support for the most vulnerable. This improves health, wellness, and resilience for all.[17]

Communities Empower Resilience

The extensive volunteer contribution of first aid responders, coaches, care providers, etc. are part of a community system that improves and empowers individuals and communities to reduce injury and improve injury resilience. The education, social and health systems that support and connect these essential elements of a healthy society build capacity and reduce distress. This contributes to injury resilience in a manner that is difficult to measure. Working together to be prepared for injury and to assist with the management of injury in a manner that enhances resilience creates positive outcomes for injured persons and communities.

An injured person may or may not acknowledge their reality. There is a role for the support community to assist an injured person to acknowledge their injury if they are unable or unwilling.[17] Acknowledgement of the injury is a key early step. Appropriate early diagnosis

with confident mutual understanding is helpful. When there is diagnostic uncertainty, recovery and injury resilience may be delayed or undermined. A supportive and compassionate approach to reduce acute physical and psychological distress is helpful. Facilitation of ongoing support and a care plan encourages confidence, hope, recovery, and resilience. Clarifying reassurance to address fears and concerns is recommended. Engaging the care team and building trust around the injury recovery process usually has a positive impact.[4]

Establishing a sense of safety and calm and instilling a sense of mastery to overcome problems for oneself or as part of a connected group (family, school, team, spiritual, cultural or community group) fosters hope. Solution-focused processes leading to the implementation of recovery decisions will help ensure success. Making a care plan and acting on it in a timely manner may not always be enough to foster resilience. Tenacity is helpful.

Success does not happen by chance alone; it exists because it is made to be. The principles of strength-based Cognitive Behavioural Therapy have taught us that resilience can emerge from many different combinations of strengths. Creative exploration of strength and positive aspirations should be encouraged.

Positive moods are linked to an increase in emotional resources as well as to health promotion, wellbeing, and resilience. Be prepared for injury with acknowledgement, injury management, a support team, and a belief in recovery, opportunity and positive growth from the experience. Maximizing injury resilience is a community project that is worthy of great effort and ongoing research.

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Healthy Child Development
Childhood and Adolescence

Introduction

Injuries are the leading cause of mortality and a significant cause of morbidity for Canadian children and adolescents.[1] The prevention of unintentional injuries to children and adolescents differs substantially from that of adults for two main reasons: first, patterns and susceptibilities to injuries change as children and adolescents grow, due to physical, cognitive, psychomotor, and behavioural development. Second, children and adolescents' physical and psychological characteristics make them more vulnerable to injuries. Consequently, strategies to prevent unintentional injuries in adults cannot be directly translated to children and adolescents, and must consider differences in injury vulnerabilities across developmental stages.

Child Development and Injury Patterns

Causes of unintentional injuries among children and adolescents vary by age due multiple factors, such as child development and exposure to hazards.[2] In Canada, the leading causes of injury hospitalizations reflect these age-related differences.[2] Although falls are the leading cause of injury for all age groups (see Table 9), they are most prevalent during the first year of life and between the ages of 5 and 9. Burns and threats to breathing (e.g., foreign objects in respiratory track, suffocations, and strangulations) are tied as the second cause of injury hospitalization among infants, but are less prevalent among older children. Unintentional poisonings are prevalent among children 1 to 4 years of age, and to a lesser extent, infants;

however, they are infrequent among older children and adolescents. Finally, while motor vehicle collision (MVC) injuries and injuries resulting from being struck (by or against an obstacle) are infrequent among children 0 to 4 years of age, these two types of injuries become more prevalent among older age groups.

Table 9

Leading Causes of Unintentional Injury Hospitalization for Canadian children 0 to 19 years old

<1 Years	1-4 years	5-9 years	10-14 years	15-19 years
Falls (46%)	Falls (39%)	Falls (56%)	Falls (39%)	Falls (24%)
Threat to breathing, Fire/Hot object/ substance (6% each)	Poisoning (15%)	Struck by/against an obstacle, Pedal cyclist non-traffic (7% each)	Struck by/against an obstacle (15%)	Motor vehicle traffic collision (21%)
Poisoning (5%)	Fire/Hot object/ substance (7%)	Motor vehicle traffic collision (7%)	Motor vehicle traffic crash, Pedal cyclist non-traffic (8% each)	Struck by/against an obstacle (14%)

MVC= Motor Vehicle Collision. Source: Canadian Pediatric Society[2]

Infants and toddlers. Falls represent the highest proportion of unintentional injury resulting in hospitalizations among infants and toddlers. Falls from one level to another, particularly drops from furniture, are more frequent in the first year of life when children have limited mobility.[3] Falls on the same level become more prevalent around the first year, when children gain mobility and begin to explore their surroundings.[4] Infants and toddlers are more likely to sustain injuries to the head as a result of falls or a MVC, because their heads are proportionately large and their necks are weak.[5] Poisonings and foreign body injuries are more prevalent among children 0 to 36 months of age.[3,4,6] who tend to explore the world orally.[7,8] Furthermore, children's lower body mass relative to that of adults' renders poisonous substances more toxic for children.[9] Burns and scalds are more frequent among infants and toddlers, because their skin burns at lower temperatures, more quickly, and deeper, compared with adults.[9] Additionally, their physical capabilities often surpass their ability to judge hazards; that is, while they can reach to grab and tip mugs or pots, they lack the experience to identify the hot liquid as dangerous.[10,11]

Children and adolescents. Falls represent the main cause of unintentional injury among children and adolescents;[2] however, the circumstances of injury incidents differ across age

groups.[6] For example, falls from playground equipment are quite common among children 5 to 8 years old, but are infrequent among younger and older age groups.[6,12] In contrast, the prevalence of falls on the same level (e.g., from skateboards or non-motorized scooters, or due to tripping, slipping or stumbling) increases steadily with age and becomes most frequent among 12- to 16-year olds. Injuries resulting from being struck (by or against an obstacle) are mostly sports related among teenagers between 13 and 18 years of age.[6] However, unintentional sport injuries are rare among younger groups.[6]

Rates of MVC and pedestrian injuries increase steadily as children develop. Pedestrian injuries occur more often between 5 and 8 years of age,[6] when children gain independent mobility but have not fully developed the perceptual and cognitive skills required for safe street-crossing; specifically, (a) determining if a crossing spot is safe, (b) identifying hazardous traffic, and (c) forming a comprehensive picture of the situation by integrating information from different stimuli in the traffic environment.[13,14] Likewise, their short stature makes them less visible to drivers, as well as making it more difficult for them to see over vehicles while crossing streets.[15] Injuries while cycling are more common between the ages of 5 and 16 years;[6] which is typically when children are spending more time on bicycles and before they start driving. Injuries to motor vehicle occupants (driver and passengers) are most frequent among adolescents 15 to 19 years,[6] the time period when many become young drivers or passengers of young drivers.

Place of occurrence. The geographical location where injuries take place also changes with age. The majority of injuries in the first years of life tend to occur at home.[4] By the time children reach 5 years and spend increasingly more time outside their homes; however, more than half of injuries take place elsewhere.[4] Injuries on footpaths or playgrounds (outside schools) increase by at least three times among children 5 to 7 years old compared with toddlers.[4] With age, roads become a more prevalent injury location as children spend more time cycling,[6] and then driving.[16]

Parenting. Parents' attitudes and behaviour are important determinants of unintentional childhood injuries, particularly for infants, toddlers and preschoolers, who rely on adults for their safety,[17] and are frequently under parental supervision.[18] The impact of parental supervision on injury risk is not uniform across all age groups, because it decreases as children gain more independence.[19] Parental influence on injury risk in later years of life is indirect, as it is derived from teaching and from modeling risk behaviour and safety practices.[20] Consistent parenting regarding rules and consequences for undesirable behaviours is associated with a lower risk of injury among children 4 to 11 years old.[21] Further, social norms, including those instilled by parents, are associated with use of safety equipment among adolescents.[22]

Parents can find it challenging to determine the optimal balance between supervising and protecting their children, and providing sufficient opportunities for independence and

healthy risk taking (which children need to promote their development).[23] For many years, the message to parents has been that children should not be allowed to engage in tasks for which they do not have the cognitive or physical capabilities.[24] Research has raised concerns; however, regarding the potential deleterious effects that limiting risk taking (particularly during play) could have on child development.[23,25] Recent injury prevention efforts encourage an approach to keeping children as safe as necessary rather than as safe as possible - limiting children's exposures to dangers, such as strangulation hazards, but maintaining opportunities for challenge and risk taking.[26–28] Parents are encouraged to make decisions regarding acceptable risks based on the competence and needs of their child, rather than anxiety -regarding their safety.[29]

A similar tension arises around unintentional injuries in adolescents, whose risk taking behaviour is often considered a normal part of their development.[12] Since adolescents are increasingly influenced by and spending time with peers, the search for equilibrium between risk and safety centers more on young people's ability to independently manage risk and distinguish between safe an unsafe risks.[12]

Injury Prevention and Child Development: A Canadian Example

The promotion of child passenger safety in Canada illustrates how injury prevention strategies consider child development-related factors in each of the three Es (Engineering, Enforcement, Education))Refer to Chapter 2.2 Injury Prevention Spectrum and the 3E's) of prevention. Engineering interventions have included the development of different types of child safety seats, each of which is designed to address specific injury vulnerabilities of different developmental stages.[5] Rear facing seats are recommended for infants, toddlers and children who still fit in them, because the backward position provides additional protection for their weak necks and relatively large heads,[30] Forward-facing seats use five-point harnesses that redistribute the energy of the crash more evenly and protect children's bones and internal organs.[30] When children outgrow forward-facing seats (i.e., when they exceed the maximum height and weight limit specified by the seat manufacturer), it is recommended that they be restrained using a combination of seatbelts and booster seats.[30] At this stage, the main concern is correct seatbelt fit, ensuring that the shoulder belt does

not cut across the child's neck, and that the lap belt rests on the hips, not the belly. Otherwise, the energy of the crash is directed to the child's neck or abdomen, increasing the risk of injury to the neck and internal organs.[31] Once they surpass the height and weight limits of their booster seats, as specified by the manufacturer, and provided they fit correctly, children can wear an adult seatbelt.[30]

Educational interventions to improve child passenger safety in Canada typically focus on informing parents about the best choice of seat for their children, correct installation, and optimal timing for transitioning children from one type of seat to the next. A number of educational programs have been developed and implemented in Canada. Websites from many public and private organizations, such as Transport Canada and Parachute Canada, offer information about child safety seat use. Because child safety seats come in many different types and makes, many organizations, like St. John Ambulance also offer child safety seat installation workshops and clinics. These clinics are typically staffed by certified child seat technicians, who provide parents with hands-on education on the correct installation and use of child safety seats.

Enforcement interventions to improve child passenger safety in Canada also consider different developmental stages. Federally, the Motor Vehicle Restraint Systems and Booster Seats Safety Regulations (SOR/2010-90) establishes the definitions of different stages of child passenger safety, and sets forth the standards for manufacture and importation of each type of child safety seat. Additionally, each province has enacted laws that make drivers responsible for the safety of their passengers. Use of rear-facing and forward-facing seats is mandatory across Canada. However, booster seats are not mandatory in all provinces or territories.

Conclusion

The prevention of unintentional paediatric injuries requires considerations that are unique to children and adolescence. Children and adolescents are more susceptible to injuries than adults because of their stature or because their bodies, bones, muscles, skin, and brains are developing. Moreover, children and adolescents' vulnerability to certain types of injuries changes as they grow and engage in different activities, in different places, and within different social contexts. For this reason, strategies to prevent injuries vary by developmental stage. Finally, many strategies are targeted at caregivers to encourage changes in their behaviour or the environment around children.

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3.6.4

Alexandra Kelly, M.P.H

Healthy Child Development
Youth

Introduction

Youth is an important development stage, marked by rapid physical and social change. The Public Health Agency of Canada defines youth as individuals ages 12 to 19,[1] which is an important distinction when considering statistical data. Defining this age group by chronological age alone; however, does not necessarily reflect the impact of environmental, physiological and psychosocial factors that affect development and maturation throughout adolescence, and which contribute to youth behavior, in particular, risk taking behaviors. To account for these different factors, the most appropriate definition of youth would be a time period starting with the onset of puberty, concluding in one's early twenties; a time when responsibilities gradually shift to that of adulthood.[2]

During youth, there is typically an increase in risk taking paired with the "maturation of the cognitive-control system."[3] Physiological development and maturation, combined with engagement in thrill seeking activities, can result in increased participation in risky behaviours, and increased risk of injury.[4] Unintentional injury is the leading cause of death for Canadian youth, while intentional injury is the second leading cause of death.[5] Unintentional injury remains one of the leading causes of hospitalizations among youth.[6] Injury prevention is therefore, critical for this tumultuous period in the lifespan.

Development and Perception of Risk

There are two classifications of risky behaviour: adaptive and maladaptive. Adaptive risk behaviour is normal and important to the development of a healthy individual, helping to define their sense of self.[7] Adaptive risk taking behaviours are positive, satisfying adolescent needs such as autonomy, mastery and intimacy.[8] Adaptive risk behavior can be a part of healthy social development, for example, public speaking where one can exercise autonomy.[9]

Conversely, maladaptive risk behaviours can carry negative consequences, both for the individual and society as a whole.[8] These consequences can have direct impact on an individual, in the form of physical or emotional injury, or an indirect impact with economic or social repercussions to both the individual and society. Examples of maladaptive risk taking behaviours are distracted and impaired driving; two behaviours that have enormous resonating negative impact on youth, their families and communities.

Risk can be encountered in social, health and ethical arenas, each with their own associated difficulties and opportunities.[9] Youth risk taking that has the potential to result in injury can be viewed as a complex interplay between both cognitive and social contexts. In the greater context of youth development, this encompasses "increasing independence, autonomy from the family, greater peer affiliation and importance, sexual awareness, identity formation, and physiological and cognitive maturation."[10]

Cognitive Influence

There are major developmental changes in the physical and cognitive attributes that occur during youth. Changes in cognition contribute to the development of risk taking behaviour. Developmental neuroscience points to the interface between two networks in the brain; the socio-emotional and cognitive-control.[3] Socio-emotional development occurs rapidly around puberty.[3] This results in heightened sensitivity to social and emotional stimuli, as well as reward responses in the brain.[3] The socio-emotional response is represented as a powerful motivation to seek rewards, such as popularity, status or thrill and is often more powerful than the inherent risk an activity may pose, leading to heightened risk and possible injury.

Meanwhile, cognitive control development happens at a slower pace, extending into young adulthood.[3] The cognitive control centers of the brain are responsible for the executive functions of the brain: forward thought, planning and self-regulation.[3] The relatively slower development of cognitive control functions poses issues for risk-seeking youth: they are more likely to participate in potentially harmful activities, without a comprehensive understanding of the potential hazards.[3] This slower development of cognitive control often exhibits among youth as risky behaviours such as impaired driving, cycling with disregard to the rules or increased propensity towards excessive partying.

The contrasting rate of maturation between these two networks manifests as opposing forces - youth have an inclination towards risky and rewarding behaviours, without the benefit of fully developed self-regulation or forward thought.[3,4]

Key Determinants

The social context is an important contributor to risk taking behavior among youth. Where and how youth spend time- whether at home/family, at school or with peers[11] can influence their choices and activities and serve as determinants of behavior. Parents and the larger family have an important role in the socialization of young people, where behavior is modeled, and values and norms are developed through adolescent maturation. Parenting styles can impact youth resiliency and performance in other areas, with positive impact demonstrated in parenting that "combines warmth, control and affection."[11] Parental support can counteract negative peer influence and involvement in risky behaviours, especially during adolescent growth and development of personal autonomy.[11]

The educational environment can influence risk behavior among youth, given the social support networks fostered by teachers and peers. Positive experiences in an academic setting can help develop emotional and social strength, minimize maladaptive risk behaviours among youth. Youth that fail to establish these connections; however, may be more likely to engage in high risk behaviours which can lead to injurious outcomes.[11]

Peer influence can expose a vulnerability to maladaptive risk taking, related to youth socio-emotional development and related inclination towards reward-seeking behaviours.[3] Peer influence can have marked impact on decision-making,[12] with the potential for the social normalization of risky behavior leading to increased risk taking.[13] The impact of peers on risk taking can be countered by other factors, including family values, or parenting styles.[11]

Interventions

It is important to recognize the cognitive changes occurring amongst youth, and support this through structures at home, at school and in the community. Bolstering otherwise weaker areas during this period of development, such as cognitive development, is important. Youth can be supported through families, communities and education. The consideration of other

injury determinants is important, such as young driver inexperience on the road, or physical fitness in athletes to prevent injury. This is where relevant, well-rounded and engaging educational strategies are important for the development of well-informed youth.

Steinberg (2007) recommends reducing the opportunities that youth have to exercise their immature judgment that result in potentially risky or unsafe behaviours through the creation of mechanisms that support development.[3] This can assist in the appropriate development of judgment and can provide a safe environment to discuss, or simulate personal reflection on risk taking. Healthy public policies help to support and protect youth as mature judgment develops.[3]

The home can play a positive role in injury prevention. Parents' engagement in their child's life and the fostering of open communication is crucial. Additionally, parents serve as one of the important role models in their child's life, modeling risk mitigation behaviours. When driving, for example, it is critical for parents to demonstrate safety behaviours by always buckling in, driving defensively by obeying traffic signals and not speeding and exhibiting distraction-free behaviour, signifying the importance of focus while driving. The negative impact of peers on risk taking can be countered by positive family values, or parenting styles.[11]

Schools can provide a healthy environment in which to thrive and develop self-esteem. Positive connections with teachers as well as peers are crucial for healthy behaviours and emotional well-being. It is important for parents and school personnel to ensure that youth are not alienated in academic settings.[11] Healthy friendships that support a young person's development are necessary to combat alienation. Ensuring these positive relationships highlights the important need for teachers and parents to be engaged and as communicative as possible.

Case Study: Youth Driving

Youth road safety is an example of how a varied approach can influence the reduction of injury and fatality rates amongst youth. An effective injury prevention approach is one that is multi-faceted, and includes the 3 E's of injury prevention: education, enforcement and engineering.

Driving is a new learned behaviour among most youth and can be a dangerous activity. An effective intervention is the implementation of graduated driver licensing (GDL), a "multi-staged [program that] typically include[s] an extended learner's stage and an intermediate or novice stage before graduation to a full license."[14] In all Canadian provinces and territories, the GDL legislation allows for supervised and measured progression as skills are developed that are necessary for driving. Reviews of provincial data have found that "collision

reductions attributed to GDL were in the order of 15-30%, depending on the specific age group and the measure used."[15]

The importance of parental influence on driving cannot be overlooked, as their driving behaviours and patterns set an example for youth. Expectations set and enforced by parents are equally important, as genuine and clear expectations impact their child's behaviour behind the wheel.[16] Research points to a potential linkage between "parents who are involved in their young people's lives, who monitor, who nurture, who have high expectations, and who are not overly permissive, tend to have youngsters who drive with fewer crashes and offenses."[16]

Safe youth driving is also supported by youth education programs, such as the Youth and Road Safety Action Kit, produced by the Youth for Road Safety and the International Union for Health Promotion and Education.[17] This resource introduces youth, as well as organizations, to youth-related road safety issues. Through education and empowerment, the toolkit guides users through key information as well as potential road safety projects that can be implemented. With youth acting as leaders, as well as a target demographic, this campaign serves to educate and empower youth to be better road users.

Summary

Youth is a tumultuous period in human development. It marks the passage from childhood to adulthood, and is characterized by considerable physiological development and maturation of the cognitive-control system. During this important period, injury prevention depends on a supportive, environment that aligns with best practice strategies, designed to accommodate the developmental processes of adolescence. Through a multi-pronged approach to injury prevention that includes the direct involvement of youth, young people can mature and safely develop into healthy adults.

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Biological and Genetic Endowment
Physics of Injuries

Introduction: Injuries are Caused by Energy Exchanges

Injuries to biological tissues are caused by energy exchanges. During events such as automobile collisions and falls, injuries may occur when kinetic energy is converted into strain energy, which deforms the tissues and organs of the body, generating force. If the force and deformation exceed a given tissue's failure limit, injury occurs to that tissue. Burns occur due to transfers of thermal energy that exceed tissue tolerance limits. Drowning, suffocation, and ischemia arise from deprivation of oxygen and metabolic energy beyond physiological thresholds. In each case, the transfer of energy is the agent that causes injury.

Injury prevention strategies are designed to affect the chain of causation of injuries by either reducing the magnitude of the energy or managing how the energy is absorbed. Automobile speed limits (which tend to reduce the kinetic energy before impact) are an example of the former, while deformable car bumpers (which absorb energy during impact) exemplify the latter. An understanding of the physics that govern risk for common or serious injuries allows for a systematic approach to the design and selection of prevention strategies. This general field of study is often referred to as "injury biomechanics."[1-4] In this chapter, we will consider the physics of injuries due to mechanical forces, focusing on general concepts that are applicable to the analysis of other injuries.

The Need: A Scientific Approach to Design in Injury Prevention

Even if we may have trouble describing the underlying physics, most of us have a strong intuitive understanding of the mechanisms of injuries, and the rationale for injury prevention strategies. These impressions are based on our daily experiences, which give rise to internal models that we use in evaluating the risk for injury associated with a given scenario, and in avoiding injury-causing situations.

For example, consider the problem of falls, which are the number-one cause of unintentional injuries over the lifespan, and especially common in children and seniors.[5] We understand that, in general, the higher the height of a fall, the greater the risk for injury. We also recognize that, the softer the landing surface, the lower the risk for injury. With regard to automobile crashes -- the second highest cause of hospitalized injuries across the lifespan5 -- we understand that the risk for injury increases with the impact speed of the vehicle, and with the stiffness of the impact surface.

The challenging but important role for the injury prevention researcher and practitioner is to identify quantitative values of design parameters. For example, what should be the maximum allowable height of playground climbing equipment? What is the required stiffness of the ground surface below these structures? What are safe automobile speed limits? What is the desired stiffness of deformable car bumpers?

Rather than relying on intuition or trial-and-error, a scientific approach is required to quantify these design parameters in the development of improved approaches to injury prevention. As described below, this involves careful consideration of both empirical data and theoretical (or physics-based) models of injury.

The Role of Models in Injury Prevention

Injury prevention experts rely on two general and complementary types of scientific models to examine the mechanisms of injuries, and evaluate the effect on injury risk of specific modifications (interventions):

❖ *Statistical models* that describe trends in epidemiological data (for example, comparing the estimated speed of automobile crashes to related injuries); and

❖ *Physics-based models* (simulations) of injury, which may be either physical (e.g., a crash-test dummy) or mathematical in nature.

This chapter focuses on the general steps involved in the development of physics-based models of injuries due to mechanical forces. We will utilize the simplest possible models that

are capable of describing the phenomena of interest, and predicting (through model simulations) how specific design variables affect injury risk. When combined with epidemiological data and scientific (laboratory-based) observations, these model predictions can be used as a basis for designing and evaluating interventions.

Step 1: Probability for injury can be expressed by the "factor of risk." We start to develop our model by considering a simple ratio called the "factor of risk" [6,7] which is borrowed from engineering theory (where its reciprocal, the "safety factor," is used in the design of load-bearing structures). The factor of risk is defined by the ratio of the mechanical force applied to a given biological structure, divided by the force that causes failure or loss in function of that structure, under similar loading conditions:

Equation 1

$$factor\ of\ risk = \frac{applied\ force}{failure\ force}$$

This model predicts that failure will occur if the factor of risk is equal to or exceeds 1, while failure should not occur if the factor of risk is less than 1.

The factor of risk concept allows us to predict whether injury will occur for a given activity, if we know the applied force, and the force that causes failure under similar conditions. Unfortunately, it is a challenging task to determine each of these values. Researchers cannot ethically conduct experiments with living people to measure the forces generated under the conditions that are likely to cause injury (automobile crashes, falls from standing). Nor can they ethically measure the failure forces of tissues in living people. Instead, they must rely on data from cadaver studies and animal models to estimate these values. When combined with forensic and epidemiological evidence, these data guide the development and validation of physics-based models of injury, and corresponding approaches for biomechanical testing of interventions.[8,9] In the next section, we consider the factors that influence the applied force, for a simple (but well-accepted) physics-based model of a human fall.[7,10-13]

Step 2: Applied forces depend on impact energy and effective stiffness. Reducing the stiffness of impact surfaces is among the most common approaches to injury prevention, as discussed in our playground and automobile collision examples. But why is stiffness important to risk for injury? As explained in Section A, injuries occur when applied forces exceed the failure threshold of biological tissues. Force is generated during an impact event when kinetic energy is converted to deformation in human tissues, and in environmental structures. The magnitude of force produced depends on the mass, and on the force-deflection (stiffness) and force-velocity (damping) characteristics of the colliding objects.

Let us consider the simplest mathematical model that is able to explain these relations, based on the principles of conservation of energy, and applied to the example of impact to the body during a fall (Figure 18). We will assume that the body's centre-of-mass undergoes

free fall over a vertical descent distance h, in units of m, and impacts the ground with a velocity v (in m/s). By "free fall," we mean that there is no mechanism acting to reduce downward velocity during descent (e.g., muscle action, initial impact to other body parts, or air resistance). We will also assume that, during impact, the body has an effective mass m (in kg), which "bounces" on a spring having an effective stiffness k (in N/m). As discussed below, the magnitude of k will depend on both the stiffness of the impacting body part (kb) and the stiffness of the impact surface (ks). We will make two further assumptions, which we discuss further in Section H. First, we assume that both k and m stay constant throughout the impact. Second, we simplify the problem considerably by ignoring damping, which generally has a less important role than stiffness in influencing peak force during impact to the body.[14]

Figure 18

Energy exchanges giving rise to force production during impact to the body from a fall (See text for explanation of parameters)

conservation of energy:

$$mgh \; = \; \frac{1}{2}mv^2 \; = \; \frac{1}{2}\frac{F^2}{k} \qquad\qquad F = \sqrt{2kmgh} \; = \; v\,\sqrt{mk}$$

$$k \; = \; \frac{k_b \; k_s}{k_b + k_s}$$

fall initiation | initial contact | peak force
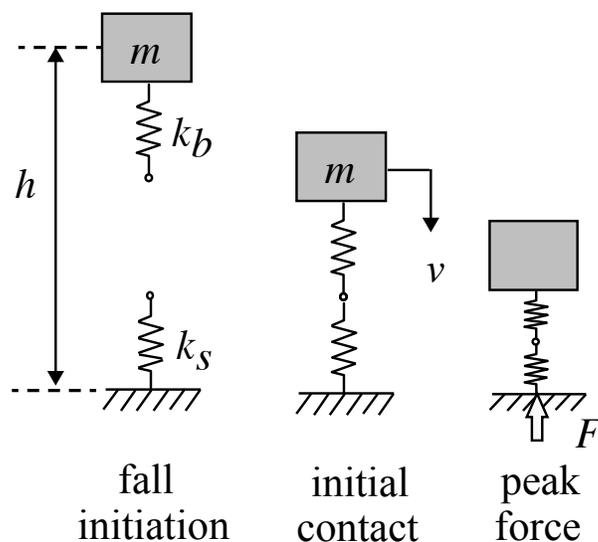
Must have $k_s \le k_b$ for substantial force attenuation. If $k_s = k_b$, there is a 30% reduction in peak force. If $k_s = (0.5)k_b$, there is a 42% reduction in peak force.

We start by equating the body's gravitational potential energy before the fall (when we assume the vertical velocity of the centre-of-mass is zero) to the kinetic energy at the instant of landing from the fall (just before impact force starts to be generated):

Equation 2

$$E = mgh = \tfrac{1}{2}(mv^2)$$

where *g* is the gravitational constant (9.81 m/s²).

This provides us with an estimate of the impact velocity, which theoretically scales with the square root of the fall height:

Equation 3

$$v = \sqrt{2gh}$$

We then consider that, at the instant of peak downward motion (and force generation) during impact from the fall, the downward velocity v is zero. At this moment, the kinetic energy has been entirely converted into elastic strain energy in deforming the spring (of effective stiffness *k*) to its maximum deflection *x* (in m):

Equation 4

$$E = mgh = \tfrac{1}{2}(mv^2) = \tfrac{1}{2}(kx^2)$$

At this same instant, the body spring has developed a peak force *F* (in N) according to the relation:

Equation 5

$$F = kx$$

We can then expand our statement of conservation of energy as follows:

Equation 6

$$E = mgh = \tfrac{1}{2}(mv^2) = \tfrac{1}{2}(kx^2) = \tfrac{1}{2}\left(\frac{F^2}{k}\right)$$

finally arriving at two expressions for the estimated peak force F during the impact:

Equation 7

$$F = \sqrt{2kmgh} = v\sqrt{mk}$$

These two simple expressions for F, based on a linear mass-spring model and the principles of conservation of energy, are highly useful for the design of interventions to prevent injuries due to impact. They show that impact force scales with the square root of stiffness, mass and fall height, and linearly with impact velocity.

Returning to the notion of the effective stiffness *k*, it is important to recognize that different body sites have different baseline (unpadded) stiffnesses, and will experience different magnitudes of applied force, for a given impact energy. Our model accounts for this by incorporating an effective stiffness *k*, that depends on the stiffness of both the body (k_b) and the impact surface or padding (k_s). Typically, these elements have a "springs-in-series" arrangement (Figure 1), where the total effective stiffness *k* is governed by the "lowest stiffness" component:

Equation 8

$$k = \frac{(k_b k_s)}{(k_b + k_s)}$$

In practical terms, this explains why a highly stiff foam lining in helmets is effective in reducing impact force to the head (which has a high stiffness), but may have little effect on forces applied to a softer body part, such as the hip or outstretched hand during a fall.[22,25-27] In order to cause a sizeable reduction in impact force, the stiffness of the padding must be lower than the stiffness of the impacting body part. It also indicates the need to measure the stiffness of the relevant body site, and to accurately simulate this baseline stiffness in biomechanical testing systems.

Step 3: Failure forces and stresses for biological tissues. Attention must now be directed to the denominator in the factor of risk - the failure strength of biological tissues.

Note the factor of risk has been defined in terms of the force required to cause failure of a *structure* (e.g., whole-bone fracture). During structural testing, measures are acquired of force in Newtons (N) and displacement in metres (m) to the point of failure (Figure 19a). The primary outcome of the experiment is the force required to cause failure of the structure. Other parameters of interest include the stiffness, calculated as the slope (in the linear elastic region) of the force-displacement curve, and the energy absorbed to failure, calculated based on the area under the force-displacement curve.

The failure force of an anatomical structure will depend on the material properties of the tissue, the geometry of the structure, and the mode of loading. For example, structural testing of whole bones from elderly human cadavers has shown that, when tested in a fall loading configuration, the mean fracture force is 2260 (SD = 1010) N for the distal radius[15] and 3980 (SD = 1600) N for the proximal femur.[16,17] Furthermore, the failure force of the proximal femur is higher when tested under impact loading than slowly applied loading.[18,19] Similar effects are observed for brain tissue, where experiments with humans and primates have shown that the brain can tolerate higher accelerations if the duration of the pulse is shorter.[20,21] Based on these observations, researchers have developed an empirical "head injury criterion" that is widely used in automobile and helmet design, and predicts risk for specific levels of traumatic brain injury based on both the magnitude and duration of the applied force.[1,22]

Sometimes, it is more appropriate to define the factor of risk based on the stress required to cause failure or loss of function at an internal or material level (e.g., cortical bone micro-cracks, or tearing of nerve axons), instead of the force required to cause structural failure. Material properties depend on physical characteristics inherent to a given material, and are independent of geometry (although they tend to depend on the direction and mode of loading e.g., shear versus axial loading in compression versus tension). During material testing (Figure 19b), measures are obtained of stress σ in Pascals (Pa = N/m^2) and strain ε (which is dimensionless). The peak magnitude of stress up to failure is often referred to as the material "strength." For axial loading, the failure stress σ is calculated as the failure force divided by the initial cross-sectional area of the tissue sample. Strain is calculated as the

change in length of the tissue sample divided by the original length. The modulus of elasticity (or Young's modulus) of a material is the slope (in the linear elastic region) of the stress–strain curve.

The failure force and failure stress of tissues generally depend on the direction of force (e.g. tension or compression), the point of application of the force, the rate of loading, and the "boundary conditions" (how the tissue is constrained). For this reason, in describing the factor of risk, the applied force and the failure force must be measured under "similar loading conditions." For example, the failure stress of bone is about 50% greater under compression than tension (120-209 MPa versus 120-140 MPa),[23] similar to concrete. It is also important to recognize that tissues may be injured due to repetitive loading (fatigue) at force and stress levels well below those required to cause failure under a single application of load. Furthermore, there can be dramatic changes in the strength of tissues during development and aging,[24] which must be considered in designing age-specific interventions.

Figure 19

Typical (a) force-deflection (structural) behaviour and (b) stress-strain (material) behaviour of human bone.
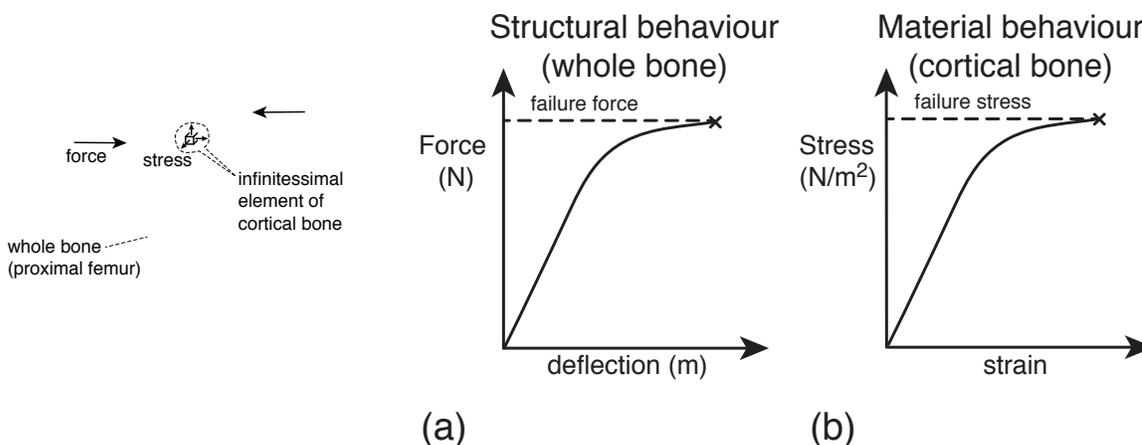
Practical Issues in Selecting Model Parameters

Two practical issues associated with selecting our model parameters should be considered. First, in order to provide reasonable predictions, the values of the input parameters to the model (i.e., impact velocity, effective mass and stiffness, and tissue failure force) must accurately describe the injury-causing scenario and population sample of interest. Published data may be limited for the injury mechanism and population of interest, necessitating experimental measures.

Second, there may be important usability constraints on design parameters, which compete with biomechanical effectiveness. For example, in designing protective clothing, designers must consider the maximum padding thickness (and weight) that individuals are willing to wear. This will limit the maximum attainable deflection x of the padding (before the padding undergoes excessive compression and "bottoms out" developing very high stiffness). Similarly, limitations may exist on how much the stiffness of a playing surface may be reduced, before there is impairment in mobility.[28] Designers must integrate these constraints into their model to identify feasible solutions that provide the best possible protection.

Limitations of the Model

The model incorporates several important assumptions in simulating the dynamics of impact, and predicting risk for injury. First, a linear spring has been used (with a constant value of k) to describe the force-deflection characteristics of the impact. However, the stiffness of both the body and the impact surface are typically nonlinear. In particular, as shown in Figure 18, the stiffness of biological tissues typically increases at low force levels to a constant value that is maintained over a linear (elastic) region, followed by nonlinear behaviour associated with yielding and ultimately failure. Furthermore, as previously mentioned, biological tissues have rate-dependant (viscoelastic) behaviour - meaning that they dissipate energy through heat generation (damping-like behaviour), in addition to absorbing energy through elasticity (spring-like behaviour). Accordingly, their force-deflection behaviour will be rate-dependent. Similarly, impact surfaces often have nonlinear and rate-dependent behaviour. In order to understand if a linear spring model is reasonable, we need to measure the stiffness of the body, and the impact surface, throughout the range of force associated with the impact, and at representative rates of loading. If necessary, nonlinear models of stiffness and damping may be needed to be incorporated into the model.

Second, the outcome parameter from the model is the peak force applied to a given body part. The model provides no insight into how that force is distributed (as pressure) over the impact surface. Accordingly, it cannot be used to describe the protective value of approaches to injury prevention that focus on spreading the impact force (and the local stress) over a large area. Examples include the rigid shell of a helmet, which spreads the contact force over a large region of the skull, and contoured automobile interiors, which prevent localized stress concentrations during an impact. By coupling the rigid shell or contoured geometry with padding, helmets and car interiors rely on both "energy shunting" and "energy absorption" to protect against injury.

Third, the model assumes that the movement of a single effective mass governs force generation during impact. Based on experimental measures, this appears to be a reasonable

assumption for impact to the hip or head,[1,10] but not for a fall on the outstretched hand, which requires a two-mass model to describe the essential impact dynamics.[29]

Finally, the model assumes a single value of tissue failure force (or stress), whereas typically there is considerable variability in failure force across the population. By incorporating known epidemiological data on injury incidence and estimated failure force variability, more sophisticated models can offer predictions on the probability of injury (across the population) for a given activity.[30-33]

Summary

Injuries are produced by energy transfers. The applied force generated during an impact event depends on the impact velocity and effective mass and stiffness of the body and impact surface. Tissues fail when the applied force exceeds the value that causes failure (or loss in function). A low stiffness and large "crush distance", as provided by car bumpers and soft playing surfaces, reduces the peak force generated in absorbing a specific amount of mechanical energy. Helmets (and contoured car interiors) reduce injury risk by absorbing and spreading the impact force over a large contact area (reducing local pressure).

Case Study: Foot Fractures from Unexpectedly Stepping off a Curb

Stiffness has an important role in considering protective responses for injury avoidance, which are remarkably complex in humans. During daily activities such as walking and running, we precisely modulate leg stiffness, through appropriate muscle activations, to maintain impact forces well below injury thresholds.[34] We also modulate leg stiffness in landing from a jump,[35] and arm stiffness in arresting a sudden fall,[36] to maintain contact forces below injurious limits. One way we achieve this is through energy absorption in stretching tendons, which are very good springs.

As an example of the importance of these protective responses, consider that a surprisingly common scenario underlying mid-foot (Lisfranc) fractures - which typically require 6 weeks in a cast - is accidentally stepping down off a curb or into a pothole.[37,38] Even though the descent height may be only about 10 cm, the forces generated at the instant of contact during the unexpected step down are many times larger than those involved in voluntarily stepping down the same height.

What's going on here? During a controlled step down, we modulate the state of muscle activity in the muscles spanning the ankle, knee, and hip, and the configuration of the leg at the instant of contact, so the total (effective) stiffness of the leg is relatively low. This allows

us to absorb the energy of the descent in the muscles and tendons of the leg, without the production of large contact forces. The leg stiffness we select, through muscle activations that commence before landing, is typically calibrated very precisely to the estimated descent distance and the presence of any obstacles.

In the unexpected step down, the motor program for selecting leg stiffness was absent or erroneous, and the short descent distance allowed for little time for corrective actions. Consequently, the contact stiffness of the leg is excessive, generating forces and a "factor of risk" for foot fracture many times greater than in the controlled step down.

Case Study: Survival from Falls from Great Heights

In 1942, Hugh De Haven published a seminal paper in the journal *War Medicine*, entitled "Mechanical analysis of survival in falls from heights of fifty to one hundred and fifty feet." [39] His intent in studying these cases of "extraordinary survival" was to establish an improved understanding of the strength of human anatomic structures and their ability to tolerate pressure increases, in order to suggest improvements to aircraft and automotive design. Recognizing that "evidence of the extreme limits at which the body can tolerate force cannot be obtained in laboratory tests", "a study of cases of free fall was undertaken", where "speed of fall, striking position, deceleration and relation of resultant injuries to structure could be determined." De Haven recognized that risk for injury was not governed by the impact velocity per se, but rather by the resulting rate of change of velocity during impact, which depends on the stiffness of the impacting surfaces. This is what allowed a 10 storey fall onto freshly turned soil to result in no injury, while a fall from the same height onto concrete tends to cause serious injury or death. De Haven also realized that the force applied to the body at impact is distributed as pressure over the areas of contact with the impact surface. The paper was pioneering in combining observational (forensic) evidence with physics-based models to understand mechanisms that allowed for prevention of injuries, despite overwhelming impact energy.

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Biological and Genetic Endowment
Older Adults

Introduction

The risk for intentional and unintentional injury in older adults is determined by a complex interaction of biological, social, and economic factors. The purpose of this chapter is to discuss the key determinants of injury among older adults. Although this brief description is not able to address all known factors, its intention is to emphasize the importance of addressing key determinants of injury when working to prevent injuries in older adults.

Older Adults' Risk for Injury

Canadians over the age of 65 are a growing percentage of the population. By the year 2051 it is estimated that older adults will make up almost 25% of the country's population.[1] This changing demographic has numerous implications for healthcare and other systems in Canada. Older adults in Canada are at higher risk of experiencing several different types of intentional and unintentional injury and account for 41% of all injury-related hospitalizations.[2] As described later in this resource, falls are the leading cause of injury among older adults resulting in a significant number of hospitalizations and death each year. The rate of fall-related injury hospitalization among Canadian older adults in 2009/2010 was 57.5 per 1000, translating to just over 250,000 individuals. Between 2003 and 2008 both the number and age standardized mortality rate due to falls increased among Canadian older adults with over 2600 deaths in 2008 alone.[3] Motor vehicle collisions are also an issue, particularly among those ages 65-74.[2] Older adults are over-represented in motor vehicle

fatalities. In 2011 more than 400 Canadians aged 65+ died in a motor vehicle collision and over 1100 were seriously injured.[4]

In addition to risk for unintentional injuries, older adults in Canada are also at risk for intentional injuries including those resulting from physical or sexual abuse. Nearly 3000 cases of family violence against those over the age of 65 were reported to police in 2010.[5] Abuse of older adults is likely under-reported, due in part to the fact that the perpetrator is most likely to be known to the victim. Suicide in Canadians 60 years of age and older is also an issue in this age group and accounts for 19% of reported suicides.[6] Each of these injury issues is explored more in depth in later chapters across age groups.

Key Determinants of Injury for Older Adults

Injury risk among seniors is the result of a complex interaction of factors including changing physical health, and social and economic conditions.[7] The natural process of aging can increase risk for injury by affecting vision, balance and gait, strength, cognition, and increased risk for acute and chronic illnesses.[3] These changes can be exacerbated by income and social status (See Chapter 3.1 Socioeconomic Status for more details). As described earlier in this resource, income is closely tied to health and wellbeing, including risk and protection from injury. In addition to being a determinant of health in itself, income is also linked to other determinants that affect seniors such as quality and safety of housing, access to nutritious foods, education level and employment and working conditions. These conditions are influenced by and interact with factors such as gender, race, disability, and Aboriginal status.[8] These determinants not only impact risk of injury but also injury outcomes and recovery.

Poverty among Canadian older adults is a growing concern. Following a decline for several years, the percentage of older adults living in poverty has been increasing since the mid 1990s.[9] In 2013, 7.2% or 350,000 of Canadian older adults lived in poverty.[10] Poverty is higher among older adults who are single compared to those living with families and is more common among women than men. In addition to those living below the poverty line, 19% of older adults live just above it.[11] This population experiences some of the challenges of having a relatively low income and is vulnerable to moving below the poverty line. Poverty impacts injury risk in older adults in numerous ways. As noted earlier in this resource and in the research literature, the stress of poverty has substantial impact on overall health and well-being and ultimately increases the risk for a range of health issues including chronic disease, mental illness, substance use and abuse, and intentional and unintentional injury.[8] Furthermore, older adults with lower incomes may not have the resources to access products, goods, or services that can assist in injury prevention such as appropriate footwear and clothing, assistive devices, exercise, good nutrition, and visual aids.[3] As an

example, the ability to afford visual aids such as eyeglasses can assist an individual in avoiding obstacles in their environment, perceiving depth, and using stairs.

Safe, adequate and affordable housing is a significant issue for older adults in Canada and is heavily linked to issues of income. Housing is considered to be acceptable when it meets standards of adequacy, suitability and affordability. Adequate housing is that which does not require major repairs. Suitable housing has enough bedrooms for the number and type of residents. Affordable housing is that which does not cost the owner or renter more than 30% of their gross household income. In 2006, 14.4% of Canadian older adults were in core housing need, meaning that their housing did not meet standards of one or more of adequacy, suitability, or affordability.[12] As described in the housing section of this resource (Chapter 3.5.1 Housing), housing is foundational for health. Research has demonstrated that the safety and adequacy of housing can contribute to a variety of health issues including injury.[8] One of the most obvious links between housing and injury risk in older adults is that of falls. Fifty percent of falls in older adults that require hospitalization take place in the home; therefore, the design and layout of homes, the extent to which they are in disrepair, and the ability to make the home age friendly all impact the risk for falling.[3] As described in the falls chapter of this resource (Chapter 4.4.1 Falls – Older adults), injury prevention measures in this case can include retrofitting homes to make them more accessible (e.g., ramps instead of stairs) and installing supportive devices such as grab bars in the bathroom. These types of renovations may come at significant cost and are not accessible by all Canadian older adults, creating a disparity in injury risk among this population. Older adults are also at increased risk for injury as a result of fire in the home. Homes with old or faulty wiring along with homes not equipped with devices such as smoke detectors and fire extinguishers all increase the risk for burn and smoke inhalation injuries. Similar to renovations related to falls, fire prevention measures may not be affordable and accessible for all older adults.

Where older adults live in Canada can also impact injury risk, with different risks related to urban versus rural living. Seniors living in rural areas may experience higher levels of isolation with limited options for transportation. As an example, older adults may have to give up or reduce driving for safety reasons. Without options for public transportation in rural areas, this may mean that they may no longer be able to participate in social engagements. Isolation can have impacts on mental wellbeing, exercise, social support and nutrition. All of these impact risk for injury. Lower income older adults are also more likely to live in neighbourhoods that are low income and ultimately less age-

friendly through their design, infrastructure, and services.[7] In both urban and rural living situations, social networks are of significant importance to the well-being of older adults and can be highly protective of a range of injury issues including falls.[3] Social networks can reduce stress, promote positive coping strategies, and enhance overall wellbeing all of which contributes to reduced injury risk.[3]

The link between social and economic factors and risk for injury among older adults has significant implications for injury prevention. In order to prevent injuries among older adults, injury prevention researchers and practitioners must seek to understand the impact of these factors on health and wellbeing in older adults and incorporate this knowledge into injury prevention strategies.

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3.8

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Gender & Injury

Introduction

Gender plays an important role in understanding both the causes and consequences of injury. Before discussing the influence of gender on injury across the life course, it is important to clearly define gender. According to the Canadian Institutes of Health Research, gender refers to "the socially constructed roles, behaviours, expressions and identities of girls, women, boys, men, and gender diverse people. It influences how people perceive themselves and each other, how they act and interact, and the distribution of power and resources in society. Gender is usually conceptualized as binary (girl/woman and boy/man), yet there is considerable diversity in how individuals and groups understand, experience, and express it."[1] There are significant differences in unintentional and inflicted injury rates across the life course, with men and boys typically at greater risk for both. In this section, gender differences in the burden of injury will be reviewed, along with the risk factors that predict these differences, with a special emphasis on the socially constructed roles, behaviours and perceptions that differ across men and women and boys and girls. While a number of risk factors are shared, some are gender specific; these will be discussed within a life course perspective that is sensitive to developmental changes in the type, frequency, and severity of injury from infancy to the later years.

Gender & Injury in the Canadian Context

For virtually every kind of injury beyond two years of age, Canadian boys and men are two to four times more likely to sustain an injury than girls and women, and their injuries are more severe.[2] These differences have important implications for morbidity and mortality, as outlined below. The myriad of risk factors that contribute to increased injury liability for boys and men are not yet well understood. Lifestyle and personality characteristics/traits, such as impulsivity, sensation seeking and risk-taking behaviour, differences in socialization during childhood, attributions for how and why injuries happen, along with a variety of other factors have all been investigated with a view to better understanding why a strong gender discrepancy begins early in life and persists across the life course.

Gender Differences in Injury in Childhood

In Canada, mortality risk due to unintentional injury is slightly higher for males than females in both infancy and early childhood. For infants under one year of age, mortality risk was estimated to be 8.2/100,000 for males and 7.6/100,000 for females in 2009, while for children one to four years of age, mortality risk was estimated to be 4.0 for males and 3.2 for females.[2] The same difference can be seen for hospitalizations in the same year; the crude rate per 100,000 was 398 for males and 325 for females under one year of age, and 403 for males and 319 for females between the ages of one and four years of age.[3] The leading cause of death (suffocation) and leading cause of hospitalization (falls) are similar for both male and female infants; however, poisoning occurred more often with male infants and injury due to fire or hot object/substance are more common for female infants.[3] In contrast, drowning is a leading cause of death for preschoolers aged 1-4 years, followed by traffic collisions for both males and females.[3] Children under four are most often seen or admitted to emergency departments for closed head injuries.[3]

It should be noted that overall unintentional injury deaths for children and youth 0 to 19 years of age declined in Canada between 2000 and 2009, with a 34% decline for males and 36% decline for females.[2] However, the mortality rate due to unintentional injury continues to be higher for boys than girls in middle childhood (5-9 years of age), with rates of 2.7 and 1.6 per 100,000 for males and females respectively.[2] In middle childhood, motor vehicle traffic crashes are a leading cause of mortality, followed by drowning for boys and fire/flame for girls. Boys are also hospitalized more often for injury than girls in this age group, with falls and being struck by or against an object the most common causes of injury. In addition, boys are significantly more likely than girls to experience sport-related injuries in middle childhood, with fractures and sprains experienced during soccer being the most common type of injury brought to emergency departments in Canada.[4] For younger children, injuries occur more often at home, while for older children, injuries occur more often at school and at sporting events.[5]

Primary Risk Factors. Two main risk factors that contribute to gender differences in injury from infancy to middle childhood include parental socialization and children's perceptions and attributions. Parents socialize boys and girls differently regarding a variety of behaviours, and these difference are also apparent when it comes to injury. For example, in an observational study of playground play, mothers of 6-8 year olds were more likely to express caution to daughters but provide encouragement to sons about risk-taking.[6] In a study of hypothetical scenarios, mothers attributed their sons' risky misbehaviour predominantly to nonmodifiable characteristics, but attributed their daughters' risky misbehaviour to factors that a parent could expect to influence.[7] Other work examining children's perceptions found that preschool-aged children viewed fathers as more likely to permit boys to engage in higher levels of risk than girls.[8]

Gender differences in children's attributions for injuries, their appraisals of risk, and their perceptions of injury severity and social norms have all been shown to influence risk taking behaviours and injury outcomes. For example, by the age of six, children rate girls as having a higher risk for injury than boys,[9] although boys are injured more often than girls and also experience more severe injuries. School-age boys were more likely to attribute injuries to bad luck and rate their risk of injury as lower than girls.[10] In another study using daily telephone interviews with school-aged children, boys were more likely to report having experienced injuries and close calls, were more likely to repeat behaviors that had resulted in prior injuries, were more likely to attribute injuries to bad luck and to rate their injuries as lower in severity than girls.[11]

Contributing Factors. A variety of factors contribute to gender differences in injury in childhood.[12] One recent study focused on the influence of gender stereotypes, and found that both younger boys' and girls' conformity with masculine stereotypes predicted their injury-risk behaviors.[13] Child temperament has also been shown to play a role, with difficult and/or hyperactive children at greater risk for injury, although this risk can be mitigated by positive parenting behaviours.[14] Vigilant parent supervision of young children at home has been linked to decreased injury risk[12], while sibling supervision is related to increased injury risk for preschoolers due to a combination of poor quality of supervision by older siblings, coupled with noncompliance by younger siblings.[15] Outside of the home, child pedestrians take more traffic safety risks in the company of peers, and fewer risks in the company of adults and parents.[16] Type of activity is also an important contributing factor for gender differences in injury. School-aged males presented at emergency departments with a greater overall number of sport-related

injuries than females; these injuries were typically, fractures, strains or sprains.[17] Early adolescent boys aged 10-14 years experienced the highest proportion of injuries in 11 out of 13 sports identified (the two exceptions were ringette and volleyball).[17]

Prevention and Intervention Programs. Numerous prevention and intervention programs target child injury, but for the most part they do not distinguish between boys and girls. For younger children, programs focus on parents, while for school-aged and older children, the focus shifts to the children themselves. Education and training programs for parents of infants and preschoolers have been shown to be effective in reducing child injury and improving home safety.[18] These programs are typically administered on a one-to-one basis in the home as part of a multi-faceted intervention during the first two years of a child's life, and tend to focus on possession and use of home safety equipment and home safety practices (e.g., storage of hazardous substances). One Canadian-based home visiting program for families with children under the age of 8 years showed moderate reduction in children's injury rates over three years, although effects appeared to diminish over time.[19] Parenting programs designed to reduce physical maltreatment of young children have been shown to have limited effectiveness, in that outcomes associated with physically abusive parenting improve, but reduction of physical abuse or neglect has not been demonstrated.[20] Programs that promote home-based environmental modifications for children under the age of five have not yet been rigorously evaluated[21]; however, policy-based prevention measures have been very successful in reducing injury-related morbidity and mortality for young children, such as pool fencing to prevent drowning,[22] bans on unsafe equipment (e.g., infant walkers),[23] and required use of protective equipment such as car and booster seats for infants and preschoolers. In fact, car seats can reduce the risk of death by 71% for infants under age 1 and 54% for children ages 1 to 4,[24] although gender differences have been found between mothers and fathers in their reported usage of booster seats.[25]

For parents of school-aged children, education programs include the encouragement of protective equipment in sport and recreational activities such as bicycle helmets. Community-based education programs that include the distribution of free helmets have been shown to be most effective.[26] It should be noted that due to mounting evidence, policy requiring the use of bicycle helmets for children under the age of 18 years is mandatory in many provinces across Canada.[27] For higher risk sports such as snowboarding, helmets may have a stronger protective effect among males than among females.[28] Effective education programs targeting school-aged children include pedestrian safety programs that improve children's knowledge and road crossing behaviour,[16,29] self-care when home alone[30] and more recently, specific training for supervising siblings.[31] School-based anti-bullying and dating violence prevention programs been also been shown to be effective.[32]

Gender Differences in Injury in Adolescence

Adolescents aged 12 to 19 have the highest likelihood of injury of any age group,[33] with almost one-third (32%) suffering either an unintentional or inflicted injury, including self-

inflicted injuries. While hospitalization and mortality rates increase for both genders in the pre-teen and teen years, rates increase dramatically for males compared to females.[34] In fact, males aged 12 to 19 represent the age group at greatest risk for injury across the life course. In addition to age, teenaged males who self-identify as Aboriginal and who live in low-income neighborhoods in the most remote communities have the highest risk of unintentional injury.[35]

Primary Risk Factors. Motor vehicle-related injury is the leading cause of hospitalization and mortality for youth aged 10 to 19, accounting for more than 50% of all deaths and hospitalizations in this age group.[34] Male teens are more likely to be involved in fatal crashes than female teens, are more likely to engage in risky driving, and are more likely to report drinking and driving.[36] It is noteworthy to highlight that male teens and young adults involved in collisions are significantly more likely than motorcyclists or drivers of other ages to drive at unsafe speeds and to have been drinking alcohol or consuming drugs prior to the incident.[37] Other risky behaviours that put male teens at greater risk for motor vehicle injury include not wearing a seatbelt, driving with other teens present in the car, driving late at night and the potent combination of drinking and driving at night with friends present in the car.[36]

Suicide is a serious cause of teen morbidity and mortality that increases markedly after the age of 14. In 2009, it ranked as the ninth overall leading cause of death in Canada but among those aged 15 to 34, suicide was the second leading cause of death, preceded only by unintentional injuries.[38] Over the past decade, the most common method of suicide in Canada has been strangulation and suffocation (44%), followed by poisoning (25%) and firearm use (16%) with males more likely to use suffocation and females more likely to use poisoning.[38] It is important to note that attempted suicide and non-suicidal self-inflicted injury represent the leading causes of hospitalization for female, but not male, teens.[39] However, suicide mortality is consistently higher for males than females throughout adolescence, accounting for almost 80% of these deaths.[38] Non-suicidal self-injury (NSSI) involves deliberate self-injury or harm, such as cutting or burning one's skin, in the absence of suicidal intent. Female teens are twice as likely to engage in NSSI than male teens.[40] Recent work has also shown that lesbian, gay, bisexual, transgendered, and genderqueer young adults are at greater risk for NSSI than heterosexual young adults, with the highest rates of self-injury reported by the transgendered and genderqueer sub-sample, which had a NSSI rate of 67% and also the highest severity of self-injury.[41]

Male teens have higher mortality, hospitalization, and emergency department visit rates for most leading causes of injury than females.[39] Sport-related injury is the leading cause of emergency department visits for 10-19 year olds, followed by motor vehicle-related injury

and self-inflicted injury.39 Sport-related falls typically involve cycling, skiing, s nowboarding, hockey, skateboarding, and football/rugby. Teens are also less likely to use helmets and sport-specific protective equipment prior to sports and recreation activities.33 The use of all-terrain vehicles are more likely to result in hospitalization mainly due to concussions and non-concussion head injuries.34 Teenagers who live in rural areas tend to have higher rates of injury-related mortality and hospitalization than those who live in urban areas with respect to all typologies of injury.42

Contributing Factors. The high frequency of motor vehicle and sport-related injury among teens can be attributed to several factors, including personality factors such as risk-taking and thrill-seeking behaviours, driving ability, such as lack of knowledge and experience, perceived environment, such as parental expectations and controls and community norms, and developmental factors such as hormonal changes, and psychosocial and emotional factors including propensity to peer pressure.[36] In contrast to more expert and mature drivers, male teen drivers tend to overestimate their driving abilities, exceed the speed limit, and consume alcohol and/or drugs prior to driving, placing themselves and others at greater risk of injury. Furthermore, male teens often adopt an aggressive driving style while not paying enough attention when driving.[43]

As noted, risky behaviors during adolescence are associated with, if not casually influenced by, various age-related biological, cognitive, emotional, and socio-developmental factors.[44] To some extent, risk-taking behavior is regarded as developmentally normative for male adolescents, and often it appears as a syndrome of deviant behaviour associated with developmental and behavioral problems that can result in adverse outcomes. Suicide and deliberate self-harm in adolescence can also understood as a combination of risk factors that precipitate and maintain these problems, although there are distinct gender differences.[45] For example, a recent study indicated that adolescents with elevated depressive symptoms experienced a 40% increase in the total number of injury events in the past six months, including violence-related, transport-related or unintentional injuries.[46] While elevated depressive symptoms were positively associated with being involved in a violence-related injury for both male and female teens, they were associated with transport-related injuries for males only and unintentional injuries for females only.[46]

Prevention and Intervention Programs. Given the high direct and indirect costs of injury,[47] it is of primary importance to implement strategic and collaborative integrated approaches to reduce the incidence and severity of injuries among youth. An integrated approach

includes a focus on education, social marketing initiatives, policy, research and practice by government and other partners. [48]

Although there are few, if any, gender-based injury prevention programs for teens, youth risk-taking behaviors are best managed by a range of initiatives that simultaneously focus on decision making processes, emotional regulation, the type and quality of relationships adolescents have with peers and adults, and the organization of environmental contexts that limit or promote opportunities for the expression of risk-taking behaviours. [44]

One of the more effective practices in preventing motor vehicle crashes among adolescents is the Graduated Driver Licensing systems (GDLS). [49] These systems are designed to provide new drivers with experience and skills gradually over time in low-risk environments. Generally nighttime, expressway, and unsupervised driving is restricted during initial stages, but these are lifted over time and with further testing of the individual, eventually concluding with the individual attaining a full driver's license. A promising strategy in some provinces is the engagement of pediatricians and general practitioners to encourage parents to enforce GDLS. Other best practices target impaired driving and alcohol and/or drug use prior to driving. [48] Specifically, these include designated driver programs, safe ride home programs, and alcohol ignition interlock programs. Other relevant measures include night-time passenger restrictions, driver education, parental interventions, improvement of safety belt use, and involvement of alcoholic beverage and entertainment industries in encouraging responsible behaviour.

Best practice regarding the prevention of sports and recreation injury currently target the use of appropriate sport-specific protective equipment (e.g., helmets), correct instruction given by coaches and teachers, stretch and strengthen programs to prevent injury, increased supervision, and concussion awareness. [48] For cycling in particular, effective injury prevention programs specifically include the use of helmets while riding and bicycle helmet legislation, the peer and adult companion helmet use program, improvement of the road safety environment, and non-legislative strategies such as provincial wide media campaigns and community-based prevention programs. [26,27] A recent Australian study found that risk of injury for both sexes during 11 of the 20 most common leisure and recreational activities for teens was low, with approximately 25% of those surveyed reporting at least one minor injury; gender differences in type of chosen activities were noted, with girls more likely to walk and dance, and boys more likely to ride bicycles and engage in roller blading and roller skating. [50]

During sports and recreational activities, injuries frequently occur as a result of being struck by an object or another person.[48] Surprisingly, wearing safety gear can lead to increased risk-taking behaviors as teenagers feeling protected may have increased levels of sensation seeking and parents may reinforce this phenomenon. Some effective strategies to prevent sports and recreation injuries for youth include optimizing the physical environment, establishing norms surrounding peer-group behavior, establishing strategies for adult supervision, prohibiting body checking in ice hockey, and educating especially high-risk populations, such as males 10-19 years of age.[48]

Regarding depression, suicide and self-harm, combined psychosocial and pharmacological treatments have been shown to be effective.[51] Evaluation of evidence-based practice for suicide prevention rarely includes gender differences. In one notable exception, a school-based teen suicide prevention program was shown to be more effective for girls than boys, with girls demonstrating significantly greater knowledge and more constructive attitudes about depression and suicide, a greater likelihood to seek help when depressed and to intervene on behalf of friends, and a greater likelihood to report their suicidal ideation and suicide attempts 3 months post-intervention than boys.[52] Other recommended suicide prevention strategies include teacher and primary care physician training to better recognize adolescent depression and mental health disorders, and passive community-based strategies such as bridge safety barriers, detoxification of cooking gas and car exhaust, and changes to packaging of analgesics. In addition, media education regarding responsible reporting of suicide, the provision of crisis hotlines, and close supervision of youth who have survived a suicidal attempt are also recommended.

Gender Differences in Injury in Adulthood & Later Life

A recent review concluded that adult men were more likely than women to die of injury, with rare exception, across all manner of death, cause of death, and across all ethnic and age groups.[53] The gender disparity in unintentional and violence-related injury mortality was greater, with rare exception, than ethnic and age group disparities in fatal injury.[53] In Canada, the third leading cause of death for adult males in 2011 was unintentional injuries, while this cause ranked fifth for adult females.[54]

As Canadians grow older, their risk for injury increases. The projected number of injury-related mortalities and hospitalizations among seniors will increase significantly over the next decade, and the number of people aged 65 and older is projected to increase dramatically in Canada.[55] Rates of mortality and hospitalization due to injury are highest amongst the very elderly—those aged 85 years and older.[34] Significant gender differences have been found in the injury-related mortality and hospitalization rates of seniors.[56] Males over the age of 65 have consistently higher rates of mortality than females of same age accounting for almost 60% of all injury deaths, with males aged 75 and older presenting the highest rate of mortality due to injury. Conversely, women over the age of 65 have higher

rates of hospitalization compared to males, with females aged 75 and older showing the highest rate of injury-related hospitalization.

Primary Risk Factors of Injury. For adults aged 20-64 years, almost half (47%) of all injuries are related to either sport or work activities.[33] Unfortunately, gender differences in exposure, cause and consequences of injury are rarely the focus of research.[57] One-third of all on-the-job injuries occurred among workers in trades, transport and equipment operation.[58] Musculoskeletal conditions, including strains and sprains, are a leading cause of injury for this age group and may increase future vulnerability to further injury.[59] Although less common, head injuries are significant because they can result in severe long-term consequences. In 2009-2010, an estimated 2.4% of the population aged 12 and over sustained a head injury and of those, 57% were working-age adults.[33] Traumatic brain injuries are three times more common in men than women.[60] Higher incidence of traumatic brain injuries among men may result from engagement in more risk-taking recreational activities, occupational hazards and more violence-related injuries as compared with women. Younger male workers report perceiving injury as "part of the job" and therefore are more likely to discount or withhold injury-related information from employers than female workers.[61]

In 2012, the greatest number of motor vehicle-related fatalities in Canada occurred among persons aged 65 years and older (n=395); however, the number of fatalities for adults between the ages of 25 and 34 were a close second (n=309).[62] Although unintentional motor vehicle traffic related mortality and hospitalizations have been steadily declining in Canada over the past ten years, both of these rates remain the highest for males aged 20-24 years.[63] The risk of death in an alcohol-related crash is also much higher for men than women in Canada; in 2010, of all people who died in alcohol-related crashes, 79.1% were males.[64] In addition, the incidence of alcohol in crashes in which a male died (43.0%) was greater than the incidence of alcohol in crashes in which a female died (28.1%).[64]

When suicide deaths are compared across age groups, persons aged 40 to 59 have the highest rates in Canada (45%), compared with 35% for those aged 15 to 39, and 19% for those over the age of 60.38 Most injury deaths in seniors over the age of 65 are due to unintentional injury, especially for the very elderly aged 75 and older.[34] Motor-vehicle related injury is one of the leading causes of injury death for seniors between 70 and 74 years; seniors are also likely involved in pedestrian collisions, with older pedestrians aged 85 and older showing the highest mortality rates.[39] Falls are also an important cause of mortality

for seniors 75 years of age and older. As age increases, so do the percentage of fall-related hospital admissions and the length of hospital stays for fall-related incidents. However, there are striking gender differences with regard to fall-related injury in persons over the age of 65 years; one recent US-based study showed that women sustained fall related injury rates 40–60% higher than men of comparable age, and that women's hospitalization rates for fall injuries were about 81% higher than men's, suggesting that women sustained more severe injuries from falls.[65]

Half of the falls resulting in hospitalization for seniors occur in or around the house with the remainder relatively evenly divided among falls in residential institutions, on the street or highway, and in other locations such as shopping malls or public buildings.[55] Seniors' fall-related injuries can have an enduring and devastating impact, resulting in injury, disability, a reduced quality of life and, in severe cases, death. Thirty-five percent of seniors discharged from a fall-related hospitalization go to continuing care, despite the fact that only 15% of falls leading to hospitalization occur in continuing care settings.

Contributing Factors. Although sport and recreational activities are common contexts for adult injuries, to date most surveillance work on injuries sustained during these activities in Canada has focused on children and youth or on elite athletes, rather than on risk factors that influence injury incidence or severity for adults.[66,67] It is estimated that more than half of these injuries occur during seven activities (ice hockey, baseball, basketball, soccer, jogging, cycling and volleyball), with hockey having the highest rate of injury for adult males.[68] Overall, most sport and recreation related injuries occur during activities that have large numbers of participants and low injury rates.[66]

Numerous factors contribute to motor vehicle crash injuries, including type of vehicle, road conditions, season and time of day, vehicle defect or malfunction, and driver characteristics such as experience, stress, fatigue, distraction, and use of alcohol.[69] While most factors, such as a curve in the road, contribute to increased injury risk for both genders, some factors increase risk for one gender but decrease risk for the other. For example, male drivers who struck a barrier or guardrail experienced an increase in probability of lesser injury severity while female drivers experienced an increase in probability of greater injury severity.[69] In another study, driving without restraints, falling asleep, and overturned/rollover vehicle all resulted in an increased likelihood of injury for older females – more so than their male counterparts. In contrast, factors that increased the likelihood of fatality for only older male drivers included driver illness, fog/smoke/smog, driving in spring, driving a vehicle less than 5 years old, and the number of years over 65 years of age.[70]

Contributing factors for occupational injuries in adults include night shifts and rotating shifts[71] and time of day (late evening or early morning).[72] Musculoskeletal injuries consistently comprise the majority of time loss claims for employees across Canada, with healthcare workers being particularly at risk.[73] Violence-related injury sustained at work is an

emerging issue in Canada, although it has long been identified as a serious public health concern with significant morbidity and mortality.[74]

Among seniors, factors contributing to suicide risk differ significantly from those earlier in life. Later life suicide risk factors can be classified in in three broad domains – mental health, physical health, and social function.[75] Affective disorders are a powerful independent risk factor for suicide in later adulthood. Specifically, clinical depression is the most predominant psychopathology associated with suicide in later life. Additionally, personality traits associated with suicide in seniors include timidity and shyness, reclusiveness, hypochondriasis, hostility and a rigid, independent personality style. Chronic and invalidating physical disorders such as HIV/AIDS, Huntington's Disease, multiple sclerosis, peptic ulcer, renal disease, spinal cord injury, and systemic lupus erythematosus are estimated to contribute to suicide in almost 70% of victims over 65 years of age. Finally, stressful life events occurring in the weeks and months before suicide attempts, such as family discords or the loss of significant loved ones are important risk factors for older adults who end their own lives. Studies examining the living situation of suicide victims using Canadian census data concluded that seniors who commit suicide are more likely than other older adults in the community to have lived alone, suggesting that social isolation and loneliness are important factors.

Factors contributing to injuries due to falls in seniors are numerous, complex, and interactive.[56] Most falls occur as the result of a unique and complex interaction of compounding risk factors that impair the person's abilities and capabilities and that vary according to the life circumstances, health status, health behaviours, economic situation, social supports, and environment. These factors are categorized as biological/intrinsic, behavioural, environmental, and socio-economic. Biological or intrinsic risk factors include those pertaining to the human body and are related to the natural aging process, as well as to the effects of chronic or acute health conditions.[56] Behavioural risk factors include actions, emotions, and choices of the individuals such as alcohol abuse, wearing inappropriate footwear or clothing, poor nutrition or hydration, a sedentary life style, and the inappropriate use of assistive devices.[56] The use of medications that reduce cognitive and physical competences also contributes to increase the risk of injuries. Furthermore, a history of falls combined with fear of falling produce an increase in the likelihood of the occurrence this event. Behavioural risk factors may seem to be ascribable to the adoption of risk-taking behaviour, yet they are better understood considering that it can be difficult for seniors, who may feel no different than they felt in younger years, to accept the natural aging process and to realize that the seemingly ordinary choices they make may greatly increase their chance of injury.

Environmental factors are associated with the physical environment and can be organized into three broad categories: the community, the living environment, and weather and climate.[56] Seniors are more at greater risk for falls if they live in poorly designed or

maintained buildings, or if the type of furniture and other objects in their homes are hazardous. Finally, recent research shows an indirect relationship between injury due to falls and socio-economic determinants of health, including inadequate income, low education, illiteracy/language barriers, scarcity of transportation, inadequate living conditions, and lack of social networking and social interaction.[56] For example, seniors in lower income neighbourhoods in Canada had a fall-related hospitalization rate that was 1.2 times higher than more affluent areas, based on 2008–2009 data.[76] Therefore, fall prevention program targeting low income seniors would have the greatest potential benefit.

Prevention and Intervention Programs. There are a multitude of wide-ranging programs aimed at preventing adult injuries for specific parts of the body (e.g., hamstring, ankle, finger, eye, head injury) incurred during a particular sport or recreational activity, or while on the job. For example, the use of protective equipment[77] (e.g., gloves, helmets and seat belts), stretching and strengthening programs,[78] workplace inspection programs,[79] alcohol and drug screening,[80] training and education programs,[81] and many others have been developed and evaluated to some extent. Workplace violence prevention programs tend to focus one of two areas of emphasis: the prevention of assaults between patients and healthcare workers,[82] or the prevention of robbery and violence to retail workers.[83] Environmental prevention programs include increased lighting to improve visibility and a limited cash-handling policy, while prevention of violence to health care workers mostly includes training and techniques of dealing with combative patients. As with the other age groups discussed, most adult injury prevention programs in the workplace or in sports or recreation programs are not gender-based, and do not target the higher rates of injury typically experienced by men.

Given that injuries for seniors are the results of a complex, interdependent constellation of factors in which multiple causes interact together, the most effective prevention and intervention programs are multifactorial programs that target several factors simultaneously.[56] Current evidence supports interventions that begin with a comprehensive clinical assessment of an individual senior's risk factors for injury followed by the implementation of tailored evidence-based programs. Specifically, multifactorial interventions often combine exercise programs aimed to promote good health, nutrition, increase strength and balance, environmental modifications that remove risks from community and homes, education through information campaigns and health promotion activities, medication modification, and assistance in the correct use of protective devices. One such program is the Canadian Falls Prevention Curriculum (CFPC), which provides

participants with evidence-based knowledge and skills needed to prevent falls and fall-related injury.[84] Another targeting suicide prevention for older adults is the Late Life Suicide Prevention Toolkit: Life Saving Tools for Health Care Providers provided by the Canadian Coalition for Senior's Mental Health.[85] Specific prevention strategies include mental health outreach, treatment of depression in seniors, screening by health care professionals, and utilizing an integrated treatment model.[85] A multifactorial approach that takes into account individual, medical, and social intervention strategies in the context of a multidisciplinary team has also been recommended for elder abuse prevention and treatment.[86]

Conclusion

Although Canadian boys and men are far more likely to sustain an injury than girls and women at virtually any age, most injury prevention programs do not appear to be sensitive to these gender differences, and gender-based evaluations are typically not conducted. Although there are exceptions to this pattern of risk, such as the higher risk for self-harm in teen girls and LGBTQ youth, and fall-related injury in older female adults, more work needs to be done to take the higher risk for injury for men and boys into account, and to reduce the significantly higher rates of morbidity and mortality due to injury for both men and women across the life course.

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Gender
Hypersexualization

Background and Definitions

At first glance, the issue of hypersexualization may not seem related to injury. With further exploration; however, it is apparent that there are a variety of ways in which hypersexualization is linked to causes of injury. As a high-profile campaign in Nova Scotia[*] demonstrated that sex is used to sell everything, even road safety. Hypersexualized media is part of a complex set of factors that influence behaviour. While there are no direct causal links between hypersexualization and poor health outcomes, there are associations and indirect links that make it an important issue to consider in health promotion and prevention, given the predominance of hypersexualized images and messages in our mainstream culture.

Hypersexualization is defined as the media and marketing messages that sex appeal and sexual behaviour are key to an individual's value, the sexual objectification of people, the blurring of lines between adult and child sexuality, the mainstreaming of pornography and the exploitation of sex and sexuality for marketing purposes.[1] Hypersexualization occurs through cultural norms, expectations and values that are conveyed through the media (e.g., movies, TV), video games, music lyrics, toys and advertising images and these cultural norms are internalized. Hypersexualization greatly differs from the normal process of sexual maturation.

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[*] Bridget was a 2012 safe driving public awareness campaign by Halifax Harbour Bridge. It was criticized by some as sexualizing women: http://thechronicleherald.ca/metro/103353-bridge-campaign-sexualizes-women?page=1

Canadian youth are both passively and actively exposed to media through the internet, marketing and advertising, TV, movies, music videos and lyrics, magazines, and video games.[2,3]

Over the last 10-15 years, there has been an unprecedented rise in the volume of hypersexualized images and ads and the extent to which they permeate our public spaces and everyday life.[4,5,6,7] Furthermore, hypersexualized media content is also being generated and shared among youth via methods such as "sexting".[8]

Hypersexualization is an emergent phenomenon and research in this area is growing. The phenomenon of hypersexualization received much attention following the 2007 release of a report by the American Psychological Association entitled *Report of the APA Task Force on the Sexualization of Girls*. While there have been some criticisms of the report, it helped draw attention to hypersexualization as an environmental factor that helps create the conditions for a variety of harms, including injury. Much of the research that exists has been done on young women, with growing recognition that boys and men are impacted as well.

The purpose of this chapter is to provide an overview of the injury related impacts of hypersexualization, not to create moral panic or to encourage the judgment of individuals who participate in or embody the norms set forth by hypersexualized culture. Instead, addressing hypersexualization as an underlying factor in our environment that shapes cultural norms and contributes to injury is part of an upstream approach to injury prevention.

Links Between Hypersexualization and Injury

Sexualized media content has the potential to shape norms about acceptable behaviour and help create conditions supportive of social harms and harms to oneself. Of particular relevance for the injury community are the links between hypersexualization and the perpetuation of traditional gender stereotypes, mental and emotional health, and sexual violence.

Hypersexualization and the Perpetuation of Traditional Gender Stereotypes

Gender is a complex variable that interacts with many other factors. Marketing and media are powerful contributors to gender role socialization.

Primarily girls and women are sexualized in marketing and media, although all genders are affected. It is also important to note that most of the images and messages in media and marketing are heteronormative and/or portray gender binarism (i.e., male/female). Further research is required to determine how hypersexualized media impacts those who are gay,

lesbian, bisexual, or transgender (GLBT).[1] It is plausible that hypersexualization serves to perpetuate homophobia and transphobia because of the emphasis on rigid gender roles and heterosexuality.

Hypersexualization contributes to the acceptance of narrow and stereotypical models by girls of femininity that are focused on a female's physical appearance and sexiness as the source of her worth.[1] Through hypersexualized media, females are socialized to be passive (but good looking) objects rather than strong, active agents. This has implications for females' decision-making and risk taking; for example, the adoption of passivity or submissiveness could mean placing oneself in a risky situation such as being a passenger in a car with a driver engaging in risky driving behaviour.

In terms of masculinity, some research has found that watching sexually objectifying media where women were portrayed as sex objects increased male conformity to masculine gender norms. This in turn mediated gender harassment.[9] Santana et al. (2006) found that traditional masculine gender role ideologies are associated with increased sexual risk taking and perpetration of intimate partner violence in heterosexual relationships.[27] Unhealthy constructs of masculinity that focus on aggressiveness, dominance, strength, emotional restraint and the avoidance of help-seeking are associated with increased injury risk for males.[10] According to Williams (2003) as cited in ACIP (2011) these traits can also result in increased risk-taking and; therefore, increased injury risk for males as cited in Atlantic Collaborative on Injury Prevention (2011).[10]

Another implication for the injury community is that societal norms that reinforce male superiority and female inferiority are a risk factor for intimate partner and sexual violence. The hypersexualization of women intersects with hypermasculine ideals, perpetuating gender inequality and power imbalances. This is a context conducive to sexual violence.[10]

Hypersexualization also intersects with the culture around alcohol consumption. Hypersexualized images and messages, including the association of alcohol consumption with sexual success, are common features of alcohol marketing. Culturally, we have gendered expectations about alcohol, including beliefs that females can or should use alcohol to lower their sexual inhibitions and that drinking a lot of alcohol is a sign of masculinity. This too contributes to an environment that is conducive to sexual and physical violence, and various types of unintentional injury.

Hypersexualization and Mental and Emotional Health

Hypersexualization is associated with various mental and emotional health impacts that have implications for injury. The APA (2010) report noted links between hypersexualization and negative mood, depression and decreased self-esteem in females.[1] Various researchers have looked at the complex interactions between hypersexualization, self-objectification,

body image and body attitudes, self-esteem, depressive symptoms and non-suicidal self-injury (NSSI) and/or suicide ideation.

Self-objectification and body image

Much of the research looking at the mental and emotional health impacts of hypersexualized and objectifying media is rooted in Objectification Theory.[11] According to Objectification Theory, existing in a culture that sexually objectifies females and female bodies socializes women and girls to internalize these cultural norms, to see themselves as sexual objects and to self-objectify. This leads to females participating in routine body monitoring, becoming overly focused on their appearance and on how others see them. This increases the opportunity for body shame (i.e.. when one's body does not live up to cultural ideals of beauty and thinness), anxiety, reduced awareness of internal body states and cumulatively contributes to various mental health issues that disproportionately affect women, such as eating disorders and depression. Choma et al. (2010) suggest that Objectification Theory may be applicable to males as well.[12]

A key point here is that it is not only exposure to hypersexualized media that is a risk factor for negative health outcomes, but internalization of the objectifying media messages contributes to women self-objectifying. Internalization is a precursor to the negative effects of self-objectification.[13] To illustrate, Muehlenkamp et al. (2005) found that self-objectification had an indirect effect on self-harm via negative body regard and depressive symptoms. Self-objectification directly contributed to the development of negative body regard, influencing depressive symptoms that affect self-harm.[14]

Other researchers have found links between sexually objectifying experiences and alcohol and substance use, which are risk factors for injury. Carr & Szymanski (2011) found that sexually objectifying experiences are indirectly related to substance use in that they lead to more self-objectification which leads to greater body shame, leading to more depression and greater substance use. Women who experience high amounts of sexually objectifying experiences are more likely to abuse alcohol and other substances.[15] For young adult women, alcohol and other substance use is positively correlated with both routine (e.g., body evaluation) and extreme (e.g., sexual victimization) forms of sexual objectification.[15]

The APA (2011) report noted that exposure to and internalization of hypersexualized and objectifying images of women and experiencing self-objectification were normal for young women.[1]

Non-Suicidal Self-Injury (NSSI). Body attitudes and self-objectification play an important role in NSSI.16 Nelson and Muehlenkamp (2012) note that the consistency of findings in the self-harm literature highlights the importance of body attitudes and objectification in understanding the risk for NSSI and/or suicide. Poor body image and self-objectification are

risk factors for NSSI. Body objectification is positively correlated with NSSI in females and seems to apply to males as well.[16] Muehlenkamp and Brausch (2012) found that in adolescents (male and female), body image mediates the relationship between negative emotions and NSSI and may play a greater role in NSSI than just the experience of negative emotions.[17] Adolescents who evaluate their own body negatively and who experience a disregard for their bodies may be more likely to engage in NSSI when faced with overwhelming emotional states.[17] Adolescence is a particularly vulnerable time, as body dissatisfaction is reportedly at its highest.[17] Similarly, Erchull et al. (2013) found that body surveillance had an indirect effect on self-harm through body shame and depression.[13] They found that the sense of body shame that comes from internalizing media messages about body and beauty ideals and self-monitoring of one's body can be a source of negative emotions that contributes to self-harming behaviour. According to Flett et al. (2012) self-harm may be an expression of negative emotions coming from body shame and also a way to punish one's body for not living up to internalized standards of body perfection as cited in Erchull et al. (2013)[13]

Suicide. Poor body image is associated with suicide ideation for both males and females.[16,18,19] Brausch & Gutierrez (2009) found that the link between body image and suicidal ideation was indirect, via depressive symptoms. These researchers also found disordered eating had a direct effect on suicide ideation.[18] Disordered eating is another health outcome associated with hypersexualization and while not included in this overview, there is a great deal of literature that looks at the cultural thin-ideal and disordered eating.

Cognitive and Physical Performance. There are links between self-objectification and diminished mental and physical performance. Quinn et al. (2006) note that the consequence of living in an objectifying culture may be that females have fewer attentional resources, as attention is divided between self-monitoring of appearance and performance situations.[20] Objectification theory posits that self-objectification and the constant monitoring of appearance uses up valuable cognitive resources and limits cognitive performance.[21] This has implications for the injury community in terms of distractions and unintentional injury. Self-objectification also predicts diminished motor performance and physical activity in girls, which has implications for physical health, safety and well-being.[21]

Hypersexualization and Sexual Violence

Sexual violence is a gendered crime. Although anyone regardless of gender can be a victim of sexual violence, the majority of reported incidents of sexual assault are perpetrated by males and the victims are primarily female. The vast majority of incidents of sexual violence go unreported.[22]

Hypersexualized marketing and media do not cause sexual violence, but they do shape social norms that are supportive of sexual violence, perpetuate gender stereotypes, normalize the objectification of women and the commodification of sex. It is important to consider the cumulative effect of the consumption of sexually objectifying media.

Research suggests that exposure to hypersexualized and objectifying images and messages affects attitudes and beliefs and contributes to stereotypical gender attitudes, greater acceptance of dating violence, greater acceptance of rape myths, adversarial sexual beliefs, less resistance to sexual harassment and greater acceptance of violence against women.[1, 23, 24] When people are objectified, others have less moral concern for them.[25] As noted previously, hypersexualization shapes social expectations about gender and sexuality and reinforces traditional gender stereotypes in which women are sexually available objects and males are consumers of the female body, always looking for sex. Various studies have shown a connection between stereotypical attitudes about female sexuality and sexually aggressive behavior.[1]

Hypersexualized culture also intersects with the culture of alcohol that normalizes regular and excessive consumption. These norms overlap to create an environment that is conducive to alcohol-facilitated sexual assault. As well, links are emerging between sexualized media and sexually aggressive behaviour. Recent research by Ybarra & Mitchell (2013) found that youth perpetrators of sexual violence reported greater exposure to violent x-rated media.[26]

Discussion

Hypersexualization is a complex, emerging issue that is tied to rapidly changing technology and corporate influence. Experts have suggested various mechanisms for countering hypersexualization, some or all of which can be supported by the injury prevention community: 1) advocating for access to comprehensive sexuality education and media literacy in schools, 2) restrictions on advertising and marketing to children, 3) increasing access to sport and extracurricular programs for girls that focus on girls' achievement rather than their appearance, 4) initiatives to help parents to address the impact of hypersexualization with their children. Given the links between hypersexualization and

injury-related issues, hypersexualization is an important issue to consider in injury prevention and research efforts.

Key Points

Hypersexualization is a harmful factor in our environment that is linked with a number of poor health and social outcomes, including injury.

Hypersexualization is an important issue to consider in injury prevention and research efforts.

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3.9

Health Services - Access to Trauma Care

Introduction

Injuries represent a significant proportion of the global disease burden, accounting for nearly 10% of all deaths worldwide in 2010.[1] Young people (age 10 to 24 years) are particularly affected, with nearly 40% of all deaths in this age group related to injuries, representing a very significant disease burden in terms of potential years of life lost.[1] In Canada, injuries resulted in almost 16,000 deaths in 2010. Economically the toll of injuries in both direct and indirect costs totaled $26.8 billion in 2010; undoubtedly they have climbed ever since.[2]

Although the high economic and social cost of trauma has been recognized for decades, the view of trauma as a treatable disease requiring academic study and policy-based interventions has evolved only recently. In the mid 1960s, a consensus document published by the National Academy of Sciences and the National Research Council identified several policy-level deficiencies in trauma care, and stimulated a transformation in the public's attitude towards injury. This publication suggested that the use of public health methods could create novel interventions to reduce morbidity and mortality from trauma, and effectively set the stage for modern injury control in North America. Over the following decades, tertiary preventative strategies have evolved, aiming to reduce the morbidity and mortality associated with trauma. This chapter will discuss many of these strategies and attempt to highlight the vital role of cohesive and well-researched approaches to post event trauma care as well as some of the unique challenges associated with implementing these strategies in Canada.

Table 10

Designation of trauma centers in Canada

Level	Description
I	Central role in the provincial trauma system, and provides the majority of the tertiary/quaternary major trauma care. Provides academic leadership, research, and teaching.
II	Provides care for major trauma. Some trauma training and outreach programs. Similar to Level I without academic/research programs.
III	Provides initial care for major trauma patients and transfers patients in need of complex care to Level I and II trauma centres.
IV	Major urban hospital with a nearby major trauma centre (Levels I-III). Does large volume of secondary trauma care. Bypass and triage protocols are in place diverting major trauma patients to Level I and II centres.
V	Small rural community hospitals or treatment facilities with little to no immediate access to Level I, II, or III trauma centres. Most trauma patients are stabilized, if possible, and rapidly transferred to a higher level of trauma care.

The landscape of Canadian trauma care has evolved substantially over recent years but maintains adherence, like all medical services, to the guiding principles of the Canada Health Act (public administration, comprehensiveness, universality portability and accessibility).[3] Access to urgent and essential care; therefore, is mandated by law for all Canadian citizens or landed immigrants. Although Canadian trauma care is federally guided through this and other legislature, it is funded and overseen by the individual provinces and territories, which are charged with developing their own standards and systems for trauma care delivery. Consequently the structure of trauma care varies by province and territory, each system has been developing to serve the specific region's unique geography and population and attaining different standards and levels of maturity. Similarly, because not all provinces/territories participate in the national trauma registry comprehensive comparisons of the provincially administered systems are not currently feasible.[4] Despite the regional differences in Canadian trauma care, an understanding of the optimal management of the injured patient is evolving and robust, province-wide trauma systems are increasingly being adopted.

Data from various epidemiological studies have demonstrated that although half of all injury-related deaths are at the scene of the incident and thus most amenable to primary and secondary prevention interventions, timely access to emergency medical services (EMS), trauma systems and trauma centre care can reduce trauma mortality in the other half of victims.[5,6] This landmark observation led to the development of a more systematic approach to trauma care, designed to regionalize care to designated trauma centres (TCs) (Table 10) and improve pre-hospital patient care, transport and trauma protocols. These trauma systems, which can be conceptualized as geographically-based public health interventions consisting of prevention strategies, coordinated acute care delivery, and rehabilitation, have since been implemented continent-wide.[7] Although a truly integrated trauma system cannot be broken down simply into components, the discussion on access to trauma care in this chapter focuses predominantly on the management of the trauma patient from the time of injury until arrival at a TC capable of providing definitive care.

Prehospital Care and Transport Mechanisms

The use of centrally located prehospital transport (ground, fixed wing, rotor wing and other) with associated paramedicine or other allied health care providers, represents the basis for modern prehospital triage, care and interfacility transport. Studies have reproducibly shown that delayed access to definitive care following injury results in a threefold increase in the odds of dying.[6] The presence of skilled providers in the prehospital setting is considerably more recent, and several controversies on the amount of care to deliver in the prehospital setting persist. In many Canadian settings, Advanced Life Support (ALS) paramedics, critical care paramedics (CCP) or physicians capable of initiating intravenous (IV) access, administering medications and performing other basic life-saving procedures are present in the prehospital environment. The thought that these interventions, if administered early, can reduce the magnitude of physiologic deterioration prior to arrival at the TC has driven this practice. Few of these interventions; however, have been demonstrated to yield a survival benefit when delivered in the prehospital setting. For example, two large Canadian studies have found that ALS paramedics or physicians confer no survival advantage over emergency medical technicians (EMTs) administering basic life support (BLS). [8,9] These studies suggest that, at least in urban environments, expeditious transport to definitive care is the primary variable affecting outcome in the prehospital setting.

Helicopter transport of injured patients became commonplace in the Korean and Vietnam conflicts, but more recently its use has burgeoned in the civilian setting as an additional means of expediting access to care for severely injured patients. Despite its widespread use in North America, Europe and Australia, findings of definitive survival benefit associated with aeromedical services have been inconsistent.[10,11] Furthermore, most such studies have taken place in predominantly urban centres, leaving the question of the utility of air transport for rural trauma victims largely unanswered. Although criteria for use by

prehospital providers exist to help decide when aeromedical services should be requested.[12] A recent meta-analysis suggests a significant amount of overtriage exists, suggesting need for further study to identify the subset of patients who would benefit most from helicopter utilization.[13] Undoubtedly, aeromedical transport plays a role within a regional, integrated trauma system. A recent Canadian study across a geographically diverse yet integrated regional trauma system demonstrated a clear survival benefit for severely injured patients transported to a TC by helicopter compared to the utilization of ground transport.[14] Developing triage guidelines to identify the severely injured patient, with the incorporation of geographic variables and resource availability can likely consolidate the role of rotor wing aeromedical transport in the majority of the regional trauma systems.

Effectiveness and Access to Trauma Care

Several groups have examined the effectiveness of timely referral of trauma victims to tertiary care. A retrospective study by MacKenzie et al (2006) examined the effects of TC versus non-trauma centre (NTC) care in the United States and found a significantly lower rate of in-hospital and one year mortality for patients treated at TCs compared to those treated at NTCs [Relative Risk (RR)=0.8 (95%CI: 0.66-0.98 and RR=0.75, 95%CI: 0.60–0.95, respectively].[15] Additionally, a cross-sectional analysis by Nathens et al (2000) demonstrated a reduction in motor vehicle crash mortality ten years following the introduction of trauma care regionalization in the United States.[16] Canadian evidence for the effectiveness of trauma systems was shown by Liberman et al. (2003), demonstrating a reduction in mortality from major trauma from 51.8% to 8.6% in the decade following the introduction of regionalized trauma care in Quebec.[17] Furthermore, Tallon et al (2012) demonstrated a 9% increase in the number of seriously injured persons being referred to a tertiary care centre in Nova Scotia following the implementation of a regionalized trauma care protocol and this corresponded with a trend towards a reduction in mortality.[18] These data provide evidence that policy interventions designed to increase access to trauma care in North America lead to improved outcomes and rationalize efforts to improve the population's access to trauma care.

Access to Trauma Care

It has become well accepted over the past decade that minimizing the time between injury and TC care improves outcomes. Circumstances leading to delays in presentation to definitive care have; therefore, become an area of intense study. Prolonged discovery and transport times have both been identified as important variables contributing to these delays, and because they seem particularly relevant in rural environments careful study of rural trauma victims is necessary to identify ways of improving access to trauma care. Considerable evidence suggests that rural trauma victims experience worse outcomes compared to those in urban environments. As an extreme example, a person injured in rural Texas has a 600-fold increased risk of dying compared to someone injured in Manhattan.[19] Overall, persons injured in rural environments are nearly 50% more likely to experience a fatal outcome.[20] Although the relationships between rural trauma and mortality are multifaceted, available evidence suggests pre-hospital factors are primarily responsible. One small study from a single rural county in the US found that although EMS response times, scene and transport times were short, the time between the incident and EMS arrival was concerning.[21] They noted that most of the fatalities in their study occurred at the scene, and were related to prolonged discovery, the severity of injuries, or both.[21] A retrospective report on a pediatric population came to a similar conclusion when they identified that 87% of rurally injured pediatric patients never made it to hospital.[22]

Access to Trauma Care in Canada

Canada has particularly unique considerations for trauma care access due to its geographic variation, substantial landmass, and wide population distribution. Furthermore, as trauma systems are provincially administered in Canada, policy-based differences in access are possible. Defining which populations have reduced access to trauma care becomes an important prerequisite to designing policy tailored to improving the universality of trauma care for Canadians. A study by Hameed et al. (2010) provided the first systematic description of trauma care access for Canadians, broken down provincially.[7] Although the percentage of the population living within 1 hour of a Level I or II TC is comparable to the US (77.5% vs. 84%, respectively) considerable regional variation exists. A total of 32 Level I or II trauma centres were identified across the country, and although Ontario and Quebec had 84.8% and 86.8% of their respective populations within one hour's drive to one of these TCs, access to comparable centres in the Prairie and Maritime provinces was significantly lower.[7] The authors emphasized improved EMS procedures and better integration of level III and IV trauma systems as a means of improving access for persons living in rural or remote areas. Relating spatial trauma care access to patient outcomes is a study by Lawson et al. (2013), who demonstrated that major traumas resulting in death were more likely to occur in areas with poorer (>1 hour drive to a level I or II TC) spatial access to trauma care.[23] An Ontario-based study also found that patients surviving long enough to reach hospital had a threefold

increased risk of an emergency department death if they were injured in a region with limited access to TC care.[24] This study, conducted in a province with only Level I TCs, provides further support that improved integration of level III and IV TCs in rural regions is an intervention that may have a positive impact on patients injured in rural or remote regions.

It is clear that definitive care of the severely injured patient is best managed in a designated TC where access to resources and personnel is guaranteed. Likewise, there is little debate that referring all injured patients, regardless of injury severity, to a regional TC is an impractical use of resources. Defining the populations that derive the most benefit from triage to a designated regional TC is an important step towards ensuring both optimal resource utilization and quality patient care within a trauma system. The responsibility of appropriate TC referral belongs primarily to pre-hospital providers, NTC physicians and medical and administrative leaders within the system who are guided by pre-established and system-specific field triage and inter-facility transfer agreements.

Recommendations from the National Experts on Field Triage have generated guidelines for use by EMS to identify severely injured patients who could benefit from direct TC referral.[25] Although these guidelines were created for American systems, Canadian trauma systems have adapted them to facilitate the same goal. Unfortunately, these guidelines use only patient factors and injury mechanism data to arrive at a referral recommendation, raising the significant concern associated with the management of certain populations. Indeed, for the more remote and rurally injured patient, it may be necessary to first transport to a local NTC for initial stabilization prior to definitive referral to the regional TC to ensure optimal outcomes.[26] Currently, the proportion of trauma cases admitted directly to a regional TC varies according to local systems, geography and population.[27] Despite regional system triage guidelines; however, provider discretion in referral decisions may contribute to overtriage and resulting higher cost of care of non-major trauma cases within the system.[28]

Despite their inherent limitations, field triage protocols are important components of any mature trauma system, but several studies suggest they remain disorganized processes within Canada. A survey of provincial trauma system stakeholders reported that 80% of provinces had field triage protocols; however, it was unclear how well they are adhered to.[29] In Ontario, although up to 80% of the population has spatial access to TC care within a 1-hour drive, studies by Gomez et al. (2012) reported that approximately two thirds of severely injured patients are initially triaged to a NTC.7,[30] In addition, the patients who are initially triaged to NTCs are not necessarily the rural or remote trauma victims with limited spatial access to care.[31] These discrepancies between potential and realized access to TC care lend themselves well to targeted interventions. By educating pre-hospital providers, and further developing EMS protocols, it should be possible to increase the concordance between potential and realized access to definitive care, while utilizing NTCs only for situations where the severity and geographic location of the injury necessitates initial stabilization prior to TC

transfer by "secondary triage". The requirement for this secondary triage to TCs makes interfacility transfer agreements and EMS interfacility transfer protocols important components of a mature trauma system in Canada.

It has been demonstrated in the critical care literature that patients transferred to a tertiary care centre from peripheral intensive care units (ICUs) have a higher mortality.[32] As may be expected; however, these patients represent a population subset with a higher severity of illness, making evidence-based recommendations difficult.[33] The association between status at time of transfer and mortality in the trauma patient remains controversial with a heterogeneous group of studies arriving at variable conclusions. A recent systematic review conducted by Hill et al. (2011) attempted to clarify any association between trauma patient transfer and overall outcome.[27] Ultimately, they were unable to show any increased mortality or hospital length of stay for transferred patients compared to direct admissions following their review of over thirty studies.[27] This finding appeared robust in a subset analysis of exclusively rurally injured patients. The authors did note that significant heterogeneity of the included studies was a major caveat to their review, concluding there was insufficient evidence to determine if transfer of the trauma patient influences mortality. [27] A more recent retrospective study by Haas et al. (2012) demonstrated a mortality benefit (RR=0.7) for victims of motor vehicle collisions triaged directly to TCs, compared to those originally triaged to NTCs, regardless of any subsequent transfer.[30] The conflicting evidence from available studies underscores the importance of large, prospective studies examining the outcomes of transferred patients who have sustained injuries of varying severities and mechanisms in diverse regions of the country. Such a study would enable policy makers to make informed recommendations on patient selection and timing of transfer.

Despite the known benefits of TC care for the severely injured patient, the practice of interfacility transfer in Canada remains underdeveloped. Surveying trauma stakeholders, it was identified that only two of the ten of provinces had some form of interfacility transfer arrangements for undertriaged patients or trauma victims initially referred to a NTC.[29] Clearly this represents an area in need of further maturation, where the implementation of protocols can improve the regionalization of care for the injured patient. In Ontario, a province with only level I TCs, only one third of severely injured patients were transferred to TCs within 24 hours from the time of presentation.[31] Although the NTCs that provided the definitive care were more likely to have access to axial imaging and surgical care, this finding remains in significant contrast to the known survival benefit of TC care.[15,34]

It is clear that disparities in access between urban and rural centres will not be bridged simply with advances in EMS and transport protocols. Adapted from military applications, telemedicine is an evolving area of trauma care where rural NTCs can be supported remotely by trauma surgeons. The increasingly widespread adoption of telemedicine techniques is an attempt to bridge the gap in trauma care seen between TCs and NTCs. Although efficacy data is still largely lacking from the literature, a published study has

demonstrated increased transfer efficiency and decreased TC costs following institution of telemedicine techniques in rural Mississippi.[35] Other authors have reported subjective improvements in the care of rurally injured patients.[36] The capabilities of telemedicine are not limited to remote consultation. Diagnostic imaging in the form of telesonography is another developing area where unskilled practitioners can obtain useful diagnostic images under the remote mentorship of experienced providers. A "proof of principle" study conducted on the International Space Station demonstrated that despite the slower data transfer speeds inherent to telecommunication in space, clinically useful images could be obtained for a focused assessment with sonography for trauma (FAST) examination.[37] Dyer et al. (2008) adapted these methods to a rural setting by establishing a telesonography link between Banff and Calgary where the providers in Banff were inexperienced with FAST techniques. By using this system they demonstrated they were able to acquire clinically useful images as well as recognize different pathologies in trauma.[38] Although further study is warranted to confirm if outcomes are improved using telemedicine or telesonography programs, initial data suggests there may be a place for these technologies as a complement to a robust trauma system.

Racial disparities in Access to Trauma Care

Given the emergent nature and mandated universal access to care, trauma has traditionally been thought to be devoid of racial biases. With many of its rural and remote communities largely inhabited by First Nations and Inuit peoples, race and spatial access to trauma care may be more relevant in Canada than previously appreciated.[7] Concerning is a recent meta-analysis examining racial disparities in trauma care in the United States, which demonstrated non-white race and socioeconomic status as independent predictors of increased mortality following trauma.[39] Canadian studies are needed to reproduce this finding within our system, with attention paid to potential and realized access to care for visible minorities. Although recommendations for triage to a TC or interfacility transport to a TC based on existing protocols should be independent of race or gender, it is possible that unconscious biases affect access to trauma care for some patients. A Canadian study by Gomez et al. (2012) demonstrated that women were less likely than men to be triaged to a TC from either the prehospital setting or a NTC. This finding remained robust following correction for potential confounders such as injury severity.[40] Although the reasons for this difference are inevitably multifactorial, provider perceptions about injury severity or potential benefit of TC care may be playing a role. Ultimately it is unclear if this bias affected outcome negatively, but further study aimed at identifying the causes of these differences is essential for ensuring universal access to trauma care.

Conclusion

Ensuring accessible health care for injured persons is a decree of the Canada Health Act, and needs to remain an aim of our maturing trauma systems. Although our understanding of the geographic barriers to accessing care has evolved in recent years, targeted interventions aimed at improving prehospital triage protocols and interfacility transfer agreements are largely lacking. Improved integration of lower level trauma centres and economically responsible use of aeromedical services are improvements with probable mortality benefits for rurally injured patients. Furthermore, widespread implementation of telemedicine techniques are likely to improve the system's efficiency by improving the identification of patients in need of higher level care. Finally, further studies of demographic barriers to accessing trauma care are required before interventions can be designed to improve the impartiality of trauma care delivery in Canada. In pursuit of these goals, a comprehensive national trauma registry with participation from all provinces and territories is imperative to facilitate ongoing trauma care research and interventions in Canada.

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3.10.1

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Culture
New Canadians

Introduction

Canada's immigrant population is growing rapidly. According to population projections from Statistics Canada, the immigrant population of Canada could reach between 7 and 9.3 million by 2017.[1] Based on Canada's most recent 2011 census, immigrants now comprise roughly 21% of Canada's population—an increase of 18% from 2001.[2]

Not only is Canada's immigrant population growing, but its demographics are also changing. The majority of immigrants are no longer European; in fact, Chinese and South Asians represented the largest percentage of immigrants in the 2011 census.[2] As this trend continues—which it is likely to do for the foreseeable future1 —immigration populations are also becoming more urban. As of the 2011 census, seventy percent of all immigrants now live in Canada's three largest metropolitan areas: Toronto, Montréal and Vancouver.[2]

The Immigrant Experience

Many researchers point to three stages in the immigrant experience. First is 'arrival', a relatively brief period often accompanied by relief, euphoria and good health. Second is a period of 'resettlement stress', which is often challenging and may be accompanied by disappointment and remorse[3]. On average, it takes ten years for immigrants to establish themselves economically;[4] during this time, approximately one third of immigrant families will live below the poverty line.[5] The final stage may be a multi-year period 'convergence', in

which the immigrant adapts physically, emotionally and culturally to their new country, gradually gaining a deeper sense of acceptance and community.[6,7]

Moving from one's native country to a new place is a stressful life event, even in times of peace and prosperity.[8] This process often involves learning a new language, adjusting to a new environment—often with a different climate—and culture. An individual's sense of community and cultural identity is radically altered by these changes: dress codes, food practices and social customs in the resettlement country can all differ, resulting in a cluster of stressors.[9] Combined with challenging socio-economic prospects—a common issue for immigrants who often struggle to find well-paying jobs that reflect their education and experience—new immigrants tend to experience significant stress.

Immigrant health has been a subject of interest for over a century. Canada is selective about which immigrants it accepts; those who successfully make it through the complicated screening process tend to be healthy, financially stable, well educated, skilled, and highly motivated.[10] Although this selection process is designed to pick the candidates who are most likely to succeed in Canada after relocation, these variables can be difficult to gauge, particularly when it comes to health. While Canada has routinely screened applicants for infectious diseases—particularly tuberculosis—more recent health concerns focus on chronic illnesses such as heart disease, cancer, and mental health, which are likely to require expensive medical care.[11,12,13]

Several studies, including Pérez et al. (2002), found that newly-arrived immigrants had fewer reported chronic conditions when compared to non-immigrants.[14] Pérez also found that the likelihood that an immigrant would report a chronic condition is directly proportionate to the time they had lived in Canada: "newly arrived men had lower odds than non-immigrants of reporting heart disease. With respect to diabetes, high blood pressure, heart disease in women, and cancer in men, immigrant and non-immigrant health were comparable; and there was no clear gradient of worsening health with time since immigration".[14]

Immigrants still confront difficult problems related to health, which are compounded by the need for governments to cut social program spending. In the mid-1990s in Ontario, the Conservative government passed reforms that resulted in the elimination of rent controls and the institution of co-payment of prescription drugs. These changes to such a broad range of social welfare services pushed many social assistance recipients, including recent immigrant and refugee women, even further below the poverty line15 which can impact their health.

As difficult as it is for adult immigrants to adapt to Canadian culture and its approaches to health care, these cultural differences in health beliefs and treatment approaches can be particularly evident when they involve children. Tan et al. (1999) gives an example of a five-year-old patient, recently arrived from Central America, who presents with a bacterial

infection; a Canadian doctor will likely prescribe an antibiotic to cure the infection, but the family may never administer it. This is because many Central Americans believe that disease derives from an imbalance between hot and cold; since penicillin is "hot," like the infection, so a "cold" medication is needed instead to treat it. Tan thus argues that it is important "to increase awareness among Canadian health care providers of cultural aspects and potential health needs of immigrant and refugee children, especially those who have come from difficult living conditions or areas with less than optimal health care".[16]

Immigrant Children in Canada and the Health Care System

According to the 2011 census data, almost a half million recent immigrants fall within the 0-15 year age group.[2] Between 2008 and 2011 alone, 20% of all recent immigrants were between the ages of 0-15 years. Of the close to two million immigrants who moved to Canada in the 1990s, about 17% were school-aged children between five and 16.[17] In Ontario, the 2011 census lists almost 30% of the population as foreign-born. 2 More than one million immigrants to Ontario arrived during the 1990s alone, or 56% of all Canadian immigrants during that period.[18] 17% of school-age children in Toronto were recent immigrants of less than 10 years while 50% of children who arrived in the 1990s had a mother tongue other than English or French.[17]

Despite the growth of the child immigrant population in Canada, there is a scarcity of information about immigrant children's health, particularly as it relates to childhood injuries from falls, motor vehicle collisions, burns, and other causes of injury.

Current strategies for making culturally appropriate injury prevention and health promotion programs widely vary.19 Many intervention efforts are limited to mere translations of health education materials into the most common languages spoken by the immigrant population. [19,20] By failing to deliver this information in a culturally appropriate fashion, injury-reduction strategies in immigrant populations often have low success rates.

Injuries in Adult Immigrants

Current data on injury rates in adult immigrants is limited but suggests that adult immigrants—particularly men—are most likely to experience injury that requires medical attention in the workplace.[21] Male immigrants seem to have a higher risk than women of work injury—who tend to assume responsibility for more of the domestic responsibilities—possibly due to long work weeks.[21] Given the pressure to pay bills or to send money to relatives, many immigrants exceed the standard workweek by working double shifts or having multiple jobs. [22] While data from Canadian Community Health Surveys in 2003 and 2005 reveal that immigrant workers face fewer injuries than their Canadian counterpart in their first five years of Canadian life, these immigrants then sustain significantly higher injury

rates—an incident rate that is comparable to Canadian-born workers—between years six to ten.[21] Similarly, although the 2007-2008 Canadian Community Health Surveys indicate that Canadian workers are three times more vulnerable to workplace injuries than immigrant workers,[23] it is crucial to note that this Canadian Community Health Survey is a self-reported health status survey rather than a labour force survey. Thus, there is a high probability that this data under-represents the amount of workplace injuries that occur in immigrant populations.[24] This may be because financial concerns make immigrant workers less likely to report injuries or to take time off when injury does occur.

Besides work-related injuries, adult immigrants can also experience injuries from sports and physical exercise, leisure activities, travel to and from work and household chores. A 2007-2008 Canadian Community Health Survey revealed that immigrants reported an injury rate four times that of Canadian adults (0.4% vs 0.1%) while traveling to and from work. Interestingly, Canadian adults are three times more likely to be injured in sports and physical exercise—an incident rate of 3.1% for Canadian-born adults vs 1.1% among the immigrant population.[23] This; however, —does not account for the possibility that fewer immigrants engage in sports or exercise than their Canadian counterparts due to financial and social barriers.

Unintentional Injury in Immigrant Children

Injuries represent a serious threat to the well-being of Canadian children. While well-designed prevention programs with a multi-sectoral approach may reduce overall injury rates in the broader Canadian population, this model tends to be a "one size fits all" approach that may not be appropriate in preventing childhood injuries in specific cultural groups. Due to the diversity between and within populations, some injury prevention strategies can be more effective when tailored to specific target populations. This is particularly important since different ages, genders, ethnicities and attitudes, resources, social structure and environments lead to different types of injuries of varying severity.[25]

Although there is limited literature related to injuries among immigrant children in Canada, data from The National Longitudinal Survey of Children and Youth shows that immigrant children have fewer injuries than Canadian born children. The prevalence of injury amongst Canadian born children is 12% compared to 7.7% for immigrant children. Although immigrant children were less likely to be injured, they were more likely to sustain more serious types of injuries than Canadian-born children. Specifically, immigrant children were more likely to suffer multiple injuries (2% vs < 1%), broken/fractured bones (32% vs 27%) or burns/scalds (6% vs 3%).[26] Regardless of the number of years since immigration, children born to immigrants had significantly lower odds of injury than children born to Canadian citizens with the greatest effect evident among individuals who immigrated 5-9 years previously.

Notably, increased exposure to the Canadian context may account for an increased risk of injury, as injury rates positively correlate with the time spent in Canada. While exposure to regular activity and sports is associated with higher injury rates, it is important to note that there may be concurrent barriers for immigrant children to participate in sports and exercise. These may include cultural barriers, poverty, and a perceived sense of safety in the home that may make immigrant children less likely to participate and more likely to get injured when they do.[26] Since physical activity, including participation in sports, is associated with increased injury rates[27] it is important to prevent childhood injury so that children do not lose their interest in sports by associating physical activity with injuries. Successfully preventing physical activity-related injuries in youth therefore has great potential health gains.[28]

Factors Related to Injury

Several factors are responsible for injury rates in immigrant populations, some of which are modifiable and some that are not. Regardless of country of birth, income and social status remains the most important determinant of child health in Canada. There is a well-established relationship between poverty and childhood injury. Faelker et al. (2000), found that children living in poverty had injury rates 1.67 times higher than children with higher income and social status, regardless of the type of injury.[29] Despite this correlation, the association between poverty, immigration, and the uptake of prevention strategies is unclear.

Education plays a significant role in how immigrant families raise children.[30] Although most immigrant parents are highly educated, they may struggle to equivocate their education, experience and training; combined with language difficulties; it can be extremely difficult for immigrants to find well-paying employment in Canada. Although many immigrants know how to prevent minor domestic injuries, low income may prevent the family from relocating to safer neighbourhoods.[31] Wu et al. (2005) compared unmet health needs between immigrants and non-immigrant populations and examined whether help-seeking characteristics accounted for any unmet needs disparities.[32] They found that immigrants have less knowledge about access to health care, tended to believe that the care was inadequate and reported difficulty with language barriers. These are significant constraints that may reduce the likelihood that immigrant populations seek health care when injury occurs.

Poverty, in particular, is a chief contributing factor since financial barriers often limit accessibility to sports and recreational programs. A combination of factors including poor maternal health, single parenthood, inadequate housing, and disadvantaged neighborhoods can upset the balance of family function, affect parenting and child behaviour, and increase the risk of injury.[33-36]

The following chart summarizes some of the potential enablers and barriers for injury prevention in adult and child Canadian newcomers.

Table 11

Potential enablers and barriers for injury prevention in Canadian newcomers

Barriers	Enablers
❖ Lack of linguistically and culturally appropriate information	❖ Immigrant friendly policies
❖ Language	❖ Community support
❖ Lack of available information on injury prevention strategies and policies	❖ Support from friends and family
❖ Lack of safety instructions	❖ Strong safety policy/enforcement
❖ Lack of access to personal protective equipment	❖ Community-based training
❖ Perceived cost	❖ Links between research and policy
❖ Mistrust of authority	❖ Multi-sectoral supports
❖ Social isolation	❖ Free/Subsidized safety equipment supply (such as smoke detectors, CO2 detectors)
❖ Fear of accusation/abuse/ losing job	❖ Health promotion
❖ Poor neighbourhood	❖ Health Education
❖ Unsafe neighbourhood	❖ Policies related to job security for newcomers
❖ Biases of health care providers(Assumptions)	❖ Parent training in child safety*
❖ Unsafe playgrounds*	❖ Free safety equipment supply (such as booster seats, helmets)*
	❖ Car seat/helmet clinic in communities*
	❖ Training for parents on appropriate uses of safety devices/equipment*

* Applies primarily to children[26,29,37-39]

Effective health promotion programs will not only account for these factors but will also address cultural and language barriers. Since arriving in Canada and adjusting to the Canadian culture is a significant hurdle for newcomers,[38] health promotion literature needs to be culturally appropriate—particularly when prevention practices differ markedly from their country of origin. For example, helping an immigrant family understand the importance of child restraints in motor vehicles can be difficult if they originate from a country where seatbelts are not found in cars. It is thus important to consult with

community groups in order to design health promotion and prevention strategies that address specific linguistic and religious needs, are properly translated and culturally appropriate.[26,40,45] Researchers from the University of Toronto recommend that multicultural community organizations provide culturally-specific information for ethnic groups.[33] Romios et al. (2007) further stress the importance of learning about the beliefs and behaviours of different cultural and linguistic communities, particularly as they affect their health and well-being.[41] A recent study of health care service utilization in British Columbia shows the absence of culturally-appropriate health care information in Farsi, for example, is directly correlated with poor awareness levels and low utilization rates of the British Columbia health guide (BCHG) programs.[42]

There are several factors responsible for injury rates among Canada's immigrant population; however, being immigrant can be a protective factor for immigrant children. All immigrants undergo extensive medical screening; which results in healthier immigrants arriving in Canada. These resettling immigrants are healthier than the general Canadian population.[43] Due to this "healthy immigrant effect," immigrants have fewer illnesses than their Canadian counterpart and this effect remains during first ten years of their life in resettling country.[44]

Prevention Strategies

There is not yet enough data regarding the uptake of injury prevention, education and strategies among immigrant families. As a multicultural society, Canada needs to have culturally and linguistically appropriate awareness programs in order to help prevent childhood injuries. More information about barriers to the successful prevention of childhood injuries among immigrant populations would not only help in the development of these prevention programs but also lead to higher success rates.

Enforcement is one strategy that appears to be successful in injury prevention for immigrants. For example, a recent study by Hossain et al. (2011) found that 100% of parents in their focus groups reported working smoke detectors at their homes which was attributed to the strict law requiring active installed smoke detectors in all homes, including apartments where many newcomers live.[26]

Conclusion

Many newcomer families lack information and knowledge about health care services generally, and injury prevention specifically.[26] Culturally-appropriate information would better connect families to appropriate health care and preventative services. Some of the barriers and enablers that immigrant families encounter are listed in Table 12. Ultimately, promoting optimal child health and well-being among new Canadians requires a

collaborative multi-organizational and multi-factorial approach that tailors the programs based on the understanding of the behaviours, cultural norms, lifestyles of these communities is required.

Table 12

Challenges and opportunities for lowering injury rates in Canadian newcomers[26,29,37-39]

Challenges/Barriers	Opportunities
Language Barriers	Policy support for community base services
Lack of available information on injury preventions	Policy development, promoting easy accessible information for newcomers
Linguistically correct information	Policy, providing support of linguistically correct translation of information, which must be culturally appropriate.
Ethno-cultural differences	Links between research and policy, and community involvement in both processes, can better meet the health needs of immigrant population
Biases of health care providers(Assumptions)	Strict policy for discouragement of practicing "one size fit all" methodology
Effects of social determinants of health	Policy support, Research into better defining immigrant health issues including injury
Mistrust of authority	Innovative solution- individual level to macro level
Unsafe neighborhood	Enforcement, policy development, community engagement
Fall Prevention (domestic, travel to and from work)	Policy, health promotion, education

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Rose-Alma J. McDonald, D.Ed.

Culture
Aboriginal Peoples

Introduction

In 2011, an estimated 1.4 million people or about 4.3% of the Canadian population self-identified as Aboriginal.1 The term "Aboriginal" is a general term used to classify the various indigenous nations that are differentiated by their history, language, lifestyle, customs, and traditional political structures. In Canada, "Aboriginal" is applied to three distinct indigenous groups:

❖ **The Inuit** are the inhabitants of the Canadian arctic region, (approximately 59,500 people)[1] who reside in 53 remote communities in for Inuit regions.[2] The Inuit have a distinctively different culture and language (Inuktitut) than other Aboriginal peoples, located farther south.

❖ **The Métis**, who were legally recognized as Aboriginal as recently as 1982,[3] are found in large numbers in the Canadian West. The Métis are the result of marriages between French Canadian, English and Scottish traders and the women of the Cree, Ojibwa, Salteaux and Assiniboine Nations (approximately 451,800 individuals).[1]

❖ **The First Nations** are made up 610 bands that comprise 52 nations or cultural groups speaking 52 separate languages (approximately 851,600 members).[1] Canada's First Nations live in six main cultural regions: from east to west these are the Woodlands First Nations, the south-western Ontario First Nations Iroquois, the Plains and Plateau First Nations, those on the Pacific Coast and within the Mackenzie River and Yukon River basins. The majority of bands have fewer than 2000 members.[4]

The First Nations population of Canada is increasing at a rate almost twice the rest of the Canadian population and this trend is expected to continue over the next two decades.[5] First Nations communities are on average, much younger than the rest of Canada where children and youth comprise the largest portion of the population. It is anticipated that the Aboriginal population will continue to be youthful well into the future.[5]

The Burden of Injury Among Aboriginal Peoples

As in the rest of Canada, injury is the leading cause of death for the Aboriginal population between the ages of 1 to 44;[6] however, among Aboriginal Peoples, injury rates are considerably higher[7] (Figure 20). Further, injury death rates in First Nations communities are far higher for men than for women.[6] Twenty-six percent of all deaths among First Nations people are caused by injuries, compared to six percent of deaths caused by injuries within the Canadian population.[8] More recent data from the First Nations Regional Health Survey (Phase 2, released in 2012) indicated that First Nations people living on-reserve and in northern communities have higher injury rates compared to the general Canadian population.[9] As well as being a major cause of death, fatal injuries among Aboriginal peoples tend to happen at comparatively younger ages and account for approximately half the Potential Years of Life Lost (PYLL)[10] (Figure 21). One study among residents of Nunavut (predominantly Inuit) reported that the rate of PYLL for unintentional injuries was greater for Nunavut at 1711 per 100,000 population, than for Canada as a whole at 640 per 100,000 population.

Figure 20

Leading Causes of Death, both Sexes, First Nations and General Population, Western Canada, 2003-2007[7]
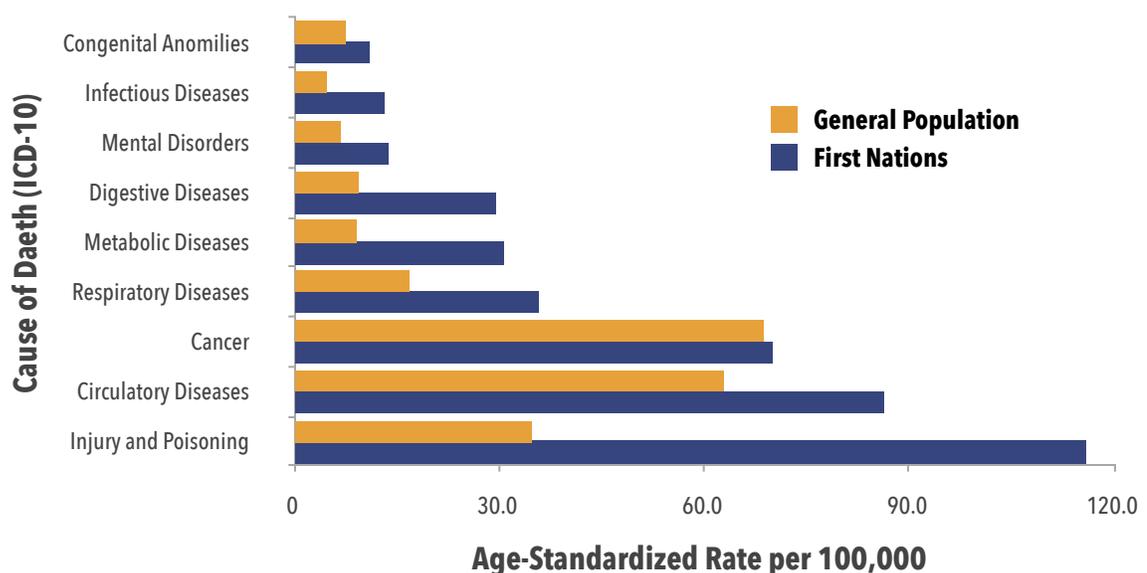
Previous research has shown that Aboriginal Canadians have nearly [4] times the risk of severe trauma[11] and substantial increases in risk of fracture[12] compared with the non-Aboriginal population. In addition, First Nations adults report injuries requiring medical treatment at a rate two times the Canadian average.[13] The disparity between Aboriginal and non-Aboriginal rates of disability corresponds to disparities in rates of injury, collision, violence, self-destructive or suicidal behaviour that can result in permanent disability.[14] Motor vehicle collisions, suicide and accidental drug poisoning are the most common causes of injury death for First Nations people.

Figure 21

Potential Years of Life Lost (PYLL) per 100,000 population, by Cause of Death, Registered First Nations and General Population, Western Canada, 2003-2007[7,15]

PYLL per 100,000
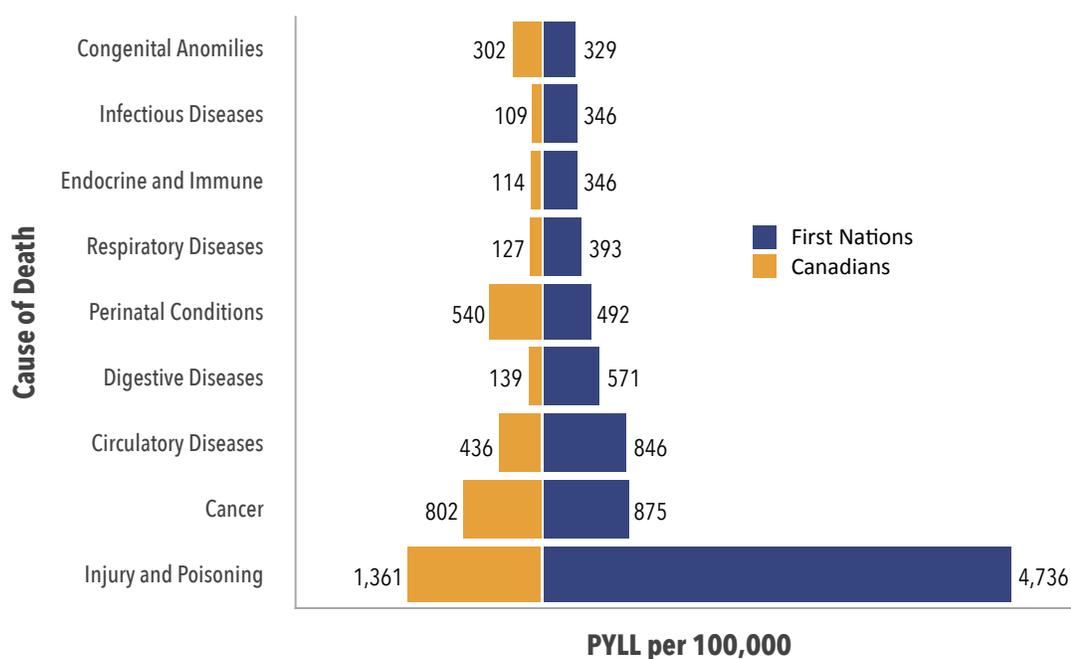
Aboriginal Community-Related Injuries

First Nations people living on-reserve and in northern communities have higher injury rates compared to other Canadians.[16] A 2002-2003 study of First Nations children living on-reserve estimated that 17.5% were injured compared with 12% living off-reserve.[17] In a 2008-2010 update to the same study the proportion of First Nations children living on-reserve that reported injury has fallen to 12.3%.[16] Among First Nations youth living on reserve, 30% sustained a significant injury in the preceding 12 months, and injury among males was higher than for females in all age categories.[18] The Inuit Tapiriit Kanatami (ITK) statistical profile indicates that 7% to 11% of Inuit children younger than 14 years of age sustained an injury severe enough to require medical attention in the preceding 12 months. It is also

suggested this was a conservative estimate, due to underreporting as a result of the lack of health services.[19] The rate of injury in Métis children was similar to the general Canadian population, at 12%.[20]

Aboriginal populations living on reserve and in rural and remote locations are more likely to experience serious injury and are much less likely to be able to access healthcare services due to lack of transportation infrastructure, ability to speak only Aboriginal languages, long wait times, inadequate human resources, and northern climate conditions.[21] Many need to travel to urban areas for anything beyond the most basic care, with significant disruption to their lives and at great cost to governments or themselves. In addition, because many Aboriginal peoples don't have the same level of care in their communities as non-Aboriginal Canadians, their health conditions can become more severe, increasing the amount of care they need.[22] They are also less likely to receive rehabilitation or have access to other post-discharge resources. In Saskatchewan, for example, 66.7% of First Nations had no resources post-discharge for treating or helping those with traumatic brain injury compared with only 9.6% of their non-First Nations peers.[23]

These high rates of injury and mortality among Aboriginal Peoples, particularly on reserve in Canada, indicate the need to explore and fully understand the factors associated with injury and the factors contributing to why Aboriginal People experience these increased rates.[16]

Risk Factors For Aboriginal Populations

The reasons for the differing injury rates and risks for injury among Aboriginal populations are complex. Societal factors, including health, educational, economic and social policies serve to maintain the economic and social inequality between many Aboriginal populations and their mainstream neighbours.[24] Colonization, which affected language, culture, land rights and self-determination, resulted in poverty, substandard housing and overcrowding, inadequate water and sewer facilities, and barriers to education;[25] all recognized risk factors for injury.

Aboriginal Peoples tend to have lower average incomes, experience higher levels of unemployment and have less education. Nationally, fewer than half of First Nations Youth graduate from high school compared to nearly 80% for other Canadians.[26] According to Statistics Canada 2006 census data, 40% of Aboriginal Peoples aged 20 to 24 did not have a high–school diploma, compared to 13% among non–Aboriginal Peoples. The rate of non–completion was even higher for on–reserve Aboriginal Peoples, where 61% had not completed high school, and for Inuit Peoples living in rural or remote communities, 68% had not completed high school. One study revealed that only 35% of students living on reserve completed high school in 2010-2011; a rate less than half the high school completion rate of other Canadians.[26]

Cultural alienation and loss of connectedness with the environment, as well as the negative impacts of residential schools have contributed to depression, alcohol and substance abuse, higher risk-taking behaviours and to inadequate parenting skills for some.[27] Substandard housing, poverty, crowded living conditions and over extended health care systems are other significant factors that contribute to the injury burden.[27] In addition, the Aboriginal population is primarily located in rural areas, many within the western provinces and the Canadian territories.[29] These areas tend to be less safe for a variety of reasons and have local shortages in health care personnel and resources.[27] Poor social conditions, community dysfunction and lack of institutional supports result in greater risks of injury, violence and suicide.[24,29]

Finally, the lack of culturally appropriate injury prevention programs serves as a significant barrier to reducing injury in Aboriginal communities. Rural Aboriginal people in particular, tend not to benefit to the same degree as other Canadians from programs or campaigns designed to increase awareness of injury prevention education and safety laws.[27]

Leading Causes of Injury

The leading causes of injury death for First Nations peoples is illustrated in Figure 22.

Figure 22

Injury Deaths by Cause, First Nations, Western Canada, 2001-2002[30]
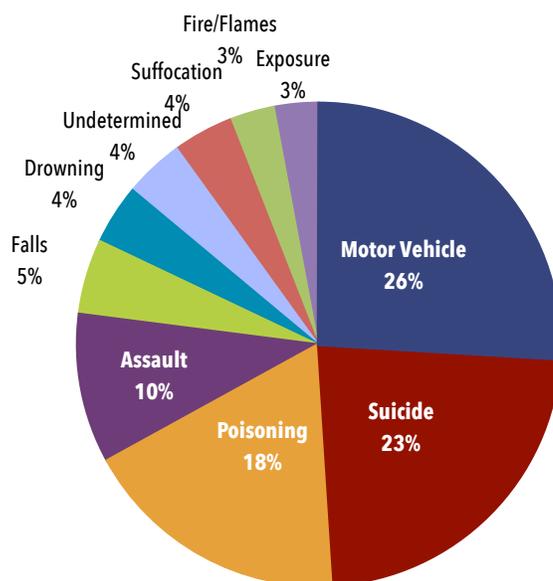
Motor vehicle collisions. The high rates of motor vehicle crash deaths is most often attributed to the fact that Aboriginal communities are remote and isolated, road conditions are generally poor, and more hazardous machines such as all-terrain vehicles and snowmobiles are frequently used for transportation. In addition, when a collision occurs, emergency services and health care facilities are often hard to access.[27] One study found that First Nations people are five times more likely to suffer severe trauma resulting from a motor vehicle collision, compared to non-First Nations people.[27] Other studies have shown seatbelt and child restraint use is lower in rural Aboriginal communities resulting in a significantly increased risk of injury and death.[3!] Additional contributors to collision incidence include inadequate enforcement of restraint legislation, lack of helmet use with all-terrain vehicles, and substance abuse.

Poisoning. Like other types of injury deaths, poisoning related death seems to be more frequent among First Nations populations. In an early study in British Columbia, during the period 1991 - 1998, age standardized mortality rates from poisoning were 4 times higher for First nations peoples than for other BC residents (3.8 versus 0.9 per 10,000 population).[32] In a more recent study in the same province covering the period 1992 - 2003, the rate of death from poisoning among First Nations were on average 4 times higher among First Nations, with rates among 25 to 44 year old people representing the highest in both First Nations (70% of poisoning deaths among Fist Nations were in this age group) and general populations (6.9 versus 1.7 per 10,000 population).[33] A study conducted in the Sioux Lookout area, suggested that accidental poisoning was prevalent in children under the age of 4 (441 per 100,000 for boys and 408 per 100,000 for girls). However, the rate for adults in this area was also high, primarily due to high rates of alcohol poisoning.[34] Alcohol poisoning occurs when the amount of alcohol in the body exceeds tolerable limits. Toxic levels of alcohol can lead to death, either directly or by affecting judgement, coordination, balance and reaction time. In British Columbia, where alcohol level was tested, nearly 90% of all First Nations injury deaths had a blood alcohol concentration of 0.08%, or higher.[33]

Suicide. Suicide accounts for roughly one quarter of all Aboriginal injury deaths with rates 3 - 4 times the Canadian average. Rates of suicide differ by geographical location and age; however, young First Nations and Inuit people are at significantly greater risk.[10] Compared to overall Canadian rates, suicide in many Aboriginal communities and populations has continued to rise over the past decade.[35] Although there are large variations across populations, the overall suicide rate among First Nations communities is approximately 2 - 4 times higher.[35] Over a third of all deaths among Aboriginal youth are attributable to suicide, and between the ages of 10 - 44, Aboriginal people on reserves are 5 - 6 times more likely to die of suicide than their peers in the general population.[35] The rate among Inuit communities is 6 - 11 times greater than the than the Canadian population.[35] From 1999 - 2003, the suicide rate among Inuit was 135 per 100,000 population; five times higher than that of First Nations (24.1 per 100,000 population) and eleven times higher than the rate for all Canadians (11.8 per 100,000 population).[36] Between 2004 and 2008, Inuit children and

teenagers in Inuit Nunangat were more than 30 times more likely to die from suicide as were those in the rest of Canada. Furthermore, half of all deaths of young people in Inuit Nunangat were suicides, compared with approximately 10% in the rest of Canada.[37]

Fire and/or flame. Increased risk of death from fire in Aboriginal communities is due to a higher proportion of smokers in the home, wood-framed, substandard housing, lack of working smoke detectors, increased travel times for fire rescue personnel and equipment, [38] as well as a shortage of trained firefighters.[38] A previous study of First Nations communities in British Columbia demonstrated that injury fatalities due to fire were eight times higher than the provincial average.[39] First Nations children are particularly vulnerable, where studies in Manitoba report children are five times more likely to die in a house fire, and that some 31% of fire deaths in Aboriginal populations occurred in children between 1 and 14 years of age, compared with 16% in the general Canadian population.[40]

Drowning. In 1996, drowning in the Aboriginal population was 6 times higher than the Canadian average, with rates in children as much as 15 times higher.[40, 41] More recent data comparing Aboriginal to non-Aboriginal data were not located. While Aboriginal peoples comprise about 4% of the Canadian population, they account for approximately 26% of drowning cases that involve a snowmobile, 16% of drowning cases after a fall into water, 10% of people who drowned during recreational aquatic activities, and 9% of those who drowned related to boating activities.[40] Aboriginal people are at increased risk of drowning because of proximity to open bodies of water, low use of flotation devices, and alcohol use. It is reported that only 6% of Indigenous drowning victims were wearing a personal floatation device.[40] Alcohol use is also reported as a significant factor in drowning deaths. In the 1998 Red Cross Drowning Report, 64% of victims had a blood alcohol level higher than the legal limit, compared to 27% for non-Indigenous drowning fatalities.[40] Other risk factors include regional location, specifically bodies of water with colder water temperatures; a risk factor for death from hypothermia.

Prevention Strategies for Aboriginal Populations

There have been several organizations that have developed injury prevention strategies specific to Aboriginal populations; for example, the First Nations Regional Longitudinal Health Survey report (2002-2003) provide injury prevention recommendations for

communities.[42] The Assembly of First Nations passed resolutions on the need for action and the development of a National Comprehensive injury prevention strategy guided by the First Nations Regional Injury Prevention Advisory Group.[43] The Pauktuutit Inuit Women of Canada passed a resolution on the need for action on injury prevention and developed an Inuit Five-Year Injury Prevention Strategic Plan for 2010 - 2015. Federal budget cuts; however, largely eliminated or jeopardized such initiatives.[44]

A strategy for injury prevention is essential to reducing death and disability in Aboriginal populations and communities. An effective injury prevention strategy must be Aboriginal driven, demographically sensitive and culturally appropriate. According to the World Health Organization, World Report on Violence and Health[45] the most important measures for prevention of death, disability and impairment are:

❖ Addressing the larger cultural, social and economic factors that contribute to injury and taking steps to change them, including efforts to improve the educational, economic and social status of the least privileged groups;

❖ Identification of types of injury and impairment and their causes within defined geographical areas;

❖ Introduction of intervention measures through better health and prevention practices;

❖ Legislation and regulations that are geared towards prevention;

❖ Modification of unsafe lifestyles, which would address individual injury risk factors and take steps to modify individual risk behaviours;

❖ Education regarding environmental hazards and potential for injuries;

❖ Fostering better informed and strengthened families and communities, including influencing close personal relationships and working to create healthy family environments, as well as, providing professional help and support for dysfunctional families;

❖ Training and regulations to reduce accidents in industry, agriculture, on the roads and in the home; and

❖ Control of the use and abuse of drugs and alcohol.

Multidisciplinary approaches that target individuals, parents, health care providers, community and government leaders both from Aboriginal communities and non-Aboriginal communities are necessary for success in injury prevention.[27] These strategies must be adaptable in order to meet the diverse language, culture and political needs of Aboriginal populations. Key elements of a successful Aboriginal injury prevention strategy align with

the three 'E's of injury prevention: education, engineering, and enforcement, and are specifically adapted for Aboriginal populations and designed to build local capacity and facilitate communication.[27] The adaptation includes three additional 'E's: empowerment, enabling and employment.

❖ **Education** involves identifying champions to help disseminate safety messages over local media and in school-based programs, promoting use of helmets and seat belts, and developing First Aid and CPR training programs, hosting swimming lessons, water safety, fire prevention and emergency preparedness.

❖ **Engineering** provides safer products and environments such as well lit roads and fencing around domestic animals.

❖ **Enforcement** involves First Nation Council leadership in policy implementation and enforcement.[27]

❖ **Empowerment** incorporates indigenous culture, language and beliefs in injury prevention planning and ensures local participation in the design and implementation of injury prevention strategies.

❖ **Enabling** provides easier access and affordability for injury prevention education and devices such as smoke detectors and child safety seats.

❖ **Employment** allows for building capacity while designing and implementing injury prevention programs to enhance community participation and create revenue.

Injuries are preventable and Aboriginal Peoples do not have to accept injury as an inevitable part of life. Injuries and their impacts can be prevented in much the same way as other public health efforts have prevented and reduced violence and infectious disease. This will require commitment at the national, provincial/territorial and local levels to document the injury problem, establish the risk and protective factors, design or select appropriate interventions, and to evaluate and disseminate comprehensive solutions.[24]

Barriers in Injury Prevention Efforts

Barriers to injury prevention efforts must be addressed in order to reduce the injury burden in First Nations populations. It is recommended that efforts align to improve the social

determinants of injury for First Nations communities including: reducing poverty and substandard housing; increasing social support and networks; and increasing access to alcohol and drug rehabilitation programs.[27] The World Health Organization (2007) recommends the following effective interventions to reduce the burden of injury in First Nations communities: enforcement of motor vehicle restraint systems, helmet use, and blood alcohol limits; implementation of child-resistant containers, home hazard modification to prevent falls and drowning (4-sided pool fencing); and increased access to treatment/ education programs to reduce depression to prevent suicide and child maltreatment.[46]

Conclusion

In order to reduce the rates of injury among Aboriginal populations, there is urgent need for enhanced injury surveillance, development and evaluation of effective prevention programs, capacity building, and knowledge translation and dissemination activities. Prevention efforts that focus on Aboriginal populations along with improved awareness and advocacy of the impacts of injury, is required in order to develop First Nations injury prevention strategies that have special relevance to Indigenous communities.[27] Program development should involve sustainable and collaborative approaches that are culturally and linguistically specific and sensitive. Injuries are a major public health concern among Aboriginal populations. Injuries and disabilities can be prevented in Aboriginal communities when holistic, culturally and linguistically sensitive approaches are used. Strategies are required that will result in decreases in injury and morbidity rates and improve health and well-being.

> **"Injury Prevention is not for a day, a week, or a 10-week program; but for a lifetime.**
>
> **If we think or say there is no solution, then we don't look for one."**
>
> **– First Nations Elder**[47]

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4

Sarah A. Richmond, Ph.D.

Injury Topics and Emerging Trends

The final section of this resource describes select injury topics specifically related to the Canadian context. Chapters included in this section will discuss the burden of injury, risk and protective factors, and effective or promising interventions, by injury type. This section highlights the injury topics that represent the greatest burden across Canadian provinces and territories.

Emerging Trends in Injury Prevention

There are certain emerging trends in injury prevention in Canada at the time this resource was published. These include promising injury interventions, as well as emerging determinants of injury due to an ever-changing social and physical environment. Injuries resulting from the risk of operating a motor vehicle (**all-terrain vehicles, and distracted driving, fatigue, and drug use)** and the increased frequency of **concussions**, particularly from sport participation are emerging injury issues, which are discussed in this introductory chapter of this section, and are further highlighted in other chapters of this resource.

Motor vehicle collisions remain a leading cause of injury and death among Canadians. In 2010, there were 2,620 deaths, 28,350 hospitalizations and 290,782 emergency room visits related to motor vehicle collisions across Canada.[1] Transport incidents represent an average of 16.5% of all deaths in Canada each year; a staggering 4.5 billion dollar price tag in total economic cost.[1] The emerging issues specific to motor vehicle collisions in Canada are related to all-terrain vehicle use, distracted driving, fatigue and drug use.

All-terrain vehicle (ATV) use for recreational and vocational purposes among Canadians is growing, and with it the increased risk of injury and fatality, particularly in the pediatric population. It is reported that ATV use among children and youth is high;[2] predominantly in remote areas of Canada, including First Nations, Inuit and Métis communities. In 2010, there were 190 deaths, 4,311 hospitalizations, and over 21,000 emergency room visits related to ATV and snowmobile use alone.[1] ATVs are used primarily for recreational purposes; however, children and youth in rural and remote areas of Canada also use ATVs for transportation. Several factors increase both the risk and severity of ATV-related injuries, including carrying or being a passenger on an ATV, driver error, and poor judgment and loss of control; all important consideration in injury prevention planning due to the significant preventability of incidents related to these risk factors.

Many factors need to be considered in order to reduce the significant burden of injury associated with motor vehicle collisions in Canada. Recently, there has been increased interest in the risks associated with distracted driving. With increased availability of electronic communication devices (ECDs), there has been an increased use in the general population, including use while traveling (e.g., walking, driving). In 2013, an estimated 4.4% of all drivers reported using an ECD (for example, a phone, tablet, or global positioning system) while driving.[3] Distracted driving was established as a significant risk factor for collision in the early 2000's; however, there is a lack of evidence to support effective interventions. Determinants of distracted driving include activities both inside and outside of the vehicle, thus presenting a multi-dimensional issue that requires strategies for prevention at both active and passive levels. Please see Chapter 4.2: Transport Injuries for more information specific to the emerging research in this area. In addition to distracted driving, driving while **fatigued** is garnering increased attention as an important determinant of injury. Driving while fatigued is an established risk factor for collision among drivers of transport vehicles; however, increasing attention has been given to the prevalence of fatigue while driving in the general population. It is estimated that up to 20% of all reported fatal collisions in Canada result from a driver falling asleep at the wheel. (See Chapter 4.2 Transport Injuries). Finally, the use of **drugs** has been cited in recent literature as a significant risk factor for collision, particularly among young Canadian drivers. In 2011, the Traffic Injury Research Foundation (TIRF) reported that almost 20% of young drivers used marijuana immediately before operating a motor vehicle.[4] Research has long established alcohol use as a significant risk factor for motor vehicle collisions that result in serious and fatal injury; however, less attention has been given to the increase in prevalence of drug use. More research documenting the prevalence, associated risks and effective interventions to prevention drug use while driving is necessary. For more information about drug use and the developing interventions to address this injury burden, please see Chapter 4.2 Transport Injuries.

Concussions, specifically those traumatic brain injuries that result from participation in sport and recreational activities, have received a significant amount of attention from sport and non-sport participating Canadians, parents, and policy makers. This is in part due to the increased media attention to the issue. For example, professional athletes who have suffered debilitating, career-limiting injuries as the result of a concussion, in addition to the increase in reported head injuries in youth sport, particularly hockey[5], has resulted in concussion being a common household discussion. In a recent study examining the mechanisms of team sport-related brain injuries among children 5 – 19 years old in Canada, there was an overall increase in the relative frequency of brain injuries among hockey from the early 1990's to 2007-2008.[5] In the period between 2005-2006 and 2007-2008, there was an increase in emergency room visits for brain injuries resulting from soccer, rugby, football and baseball participation.[5] The increased attention surrounding concussion has resulted in increased funding and efforts to reduce the risk of concussion and its potential life-long effects. This includes strategies to examine: underreporting and identification of concussions; examination of body checking as a risk factor in hockey; and the effectiveness of interventions to reduce risk of suffering a concussion, and; post-concussion management strategies (Please see Chapter 4.8 Concussion for more information).

It is important to highlight that the burden, determinants, and effective interventions to address specific injury topics are best addressed within the context in which they exist. In this section, we discusses the prevalent injury issues at the community, local, provincial and territorial levels in Canada and highlight the injury prevention efforts to reduce injuries.

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4.1

Agricultural Injuries

Background

One of the earliest research papers on farm injury in Canada concluded that virtually all farm injuries were either entirely or partially preventable.[1] Sadly, injuries to farmers, farm workers and farm families remain a public health concern in Canada. Occupation related mortality dropped significantly during the 1980s in other industry sectors due to advancements in engineering, safety practices, safety culture and regulation; however, the agricultural industry did not realize these gains largely due its unregulated nature.

This is not a problem that is isolated to Canada. In the United States, the agricultural industry is exceeded only by the durable goods manufacturing and construction sectors for non-fatal injury and is the leading cause of fatal occupational injury.[2,3] In Australia, the situation is similar, with the agriculture industry ranking third for both fatal and compensable occupational injury.[4] In New Zealand, the agricultural industry accounts for about a third of all occupation related fatalities, substantially higher than the construction or manufacturing sectors.[5] Occupational health risks in agriculture are considered so serious that the International Labour Organization has recommended that health and safety be prioritized in the agricultural sector.[6]

In Canada, the agricultural fatality rate ranks fourth behind rates for mining, forestry and fishing.[7]   Farm fatality rates have been stable for many years but are showing some decline in the recent years due to improved safety features found on newer farm equipment (Figures 23 and 26).[8]

Figure 23

Farm fatality rates in Canada 1990-2008[8]

APC-annual percentage change = 0.4 and -4.4*
*=statistically significant
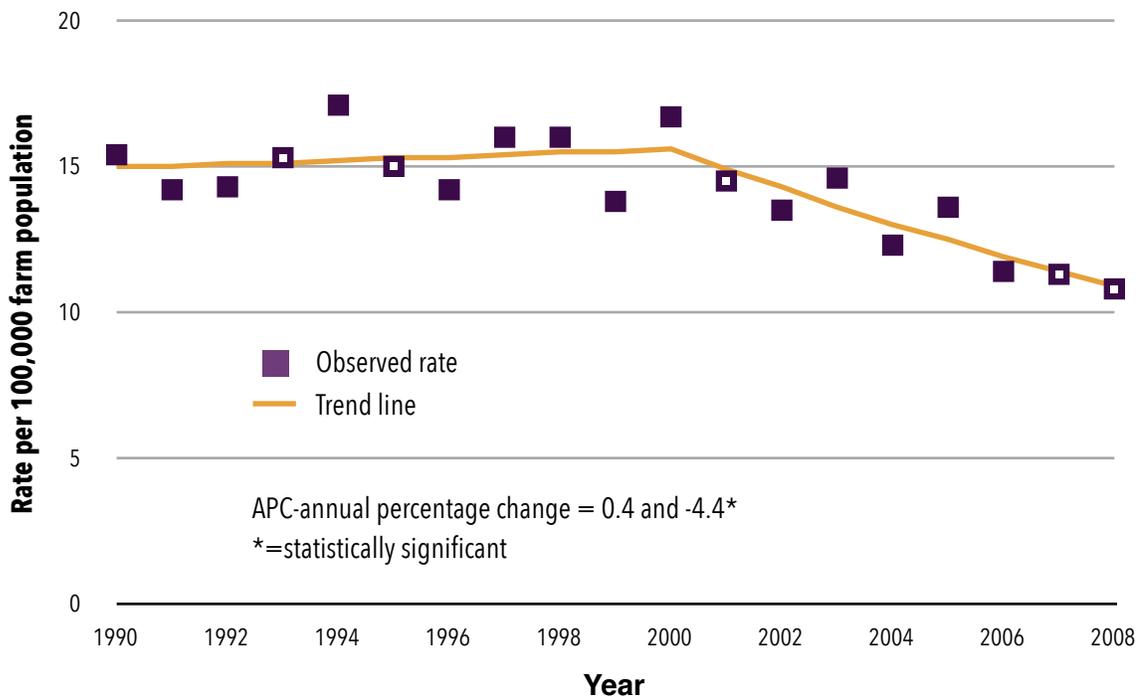
Comparisons for less severe injuries are problematic as most farmers and farm workers have not traditionally been obliged to be part of standard workers' compensation systems where non-fatal injury statistics are compiled. Compounding this, few health systems in Canada have used adjunct location coding to identify non-machinery farm injury as there is no specific farm related code for these injuries as there is for farm machinery. However, the most recent data on hospitalization rates from Ontario range from 79.8 per 100,000 in the very young (0-4 years) to 363 per 100,000 in the very old (80+) and an aggregate rate of 112.8 per 100,000 (Figure 24).[9] Older data from Alberta are higher with the aggregate rate of hospitalized farm injury being 238 per 100,000 for 1990 through 2001 (Injury Prevention Center– Unpublished Data).

In addition to acute traumatic injury it has been estimated that chronic injury such as hearing loss is prevalent among farmers, with estimates ranging from 17% to 72%.[11-12] Musculoskeletal disorders (MSD) resulting from repeated minor traumas and bio-mechanical stresses are also common with yearly prevalence ranging in excess of 60% for any MSD to 14% or greater for low back pain.[13] Numerous less severe injuries such a minor lacerations, bruises, strains and sprains are also common for those involved in farm work.[14-16]

Figure 24

Hospitalization rates for farm- related injuries by age Ontario 1990-2008[9]
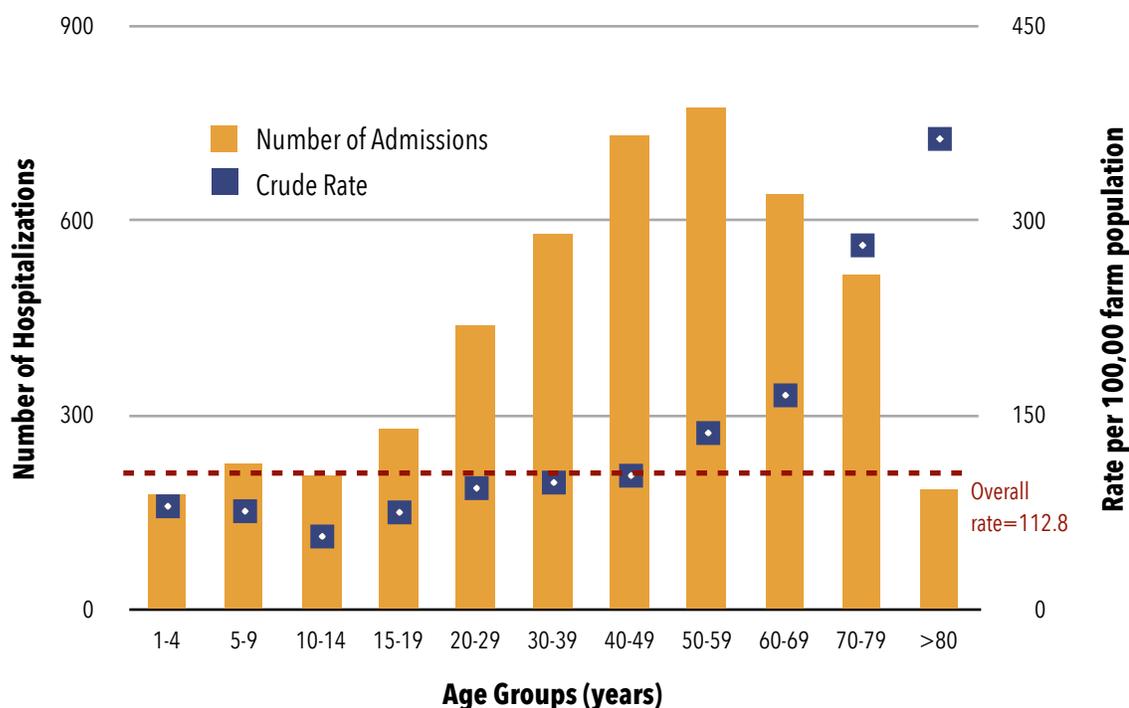
Mechanism of Injury

Farms are dynamic environments where workers and farm families are exposed to a combination of heavy mobile machinery, unpredictable animals, extremes of heat and cold, dust, and toxic chemicals. The home environment often has little separation from the work environment as farmers commonly live at the worksite. This can expose both the very young and the very old to hazards that in other industries would be restricted to the normal working age population.

Fatalities

Between 1950 and 1970 the number of tractors on Canadian farms doubled, leading to a substantial increase in machine related injury.[1]   Machinery currently accounts for two thirds of all farm related fatalities. Rollover of machinery, primarily tractors, is the most common cause of death followed closely by runover of operators and bystanders. Other significant causes of death include entanglements with moving machinery, contact with animals, drowning, and falls from height. Figure 25 illustrates the major causes of farm fatalities in

Canada.[8] The most common machine involved in fatal injuries is the tractor, accounting for 37% of all machine related fatalities.

Common causes of farm fatality in Canada 1990-2008[8]
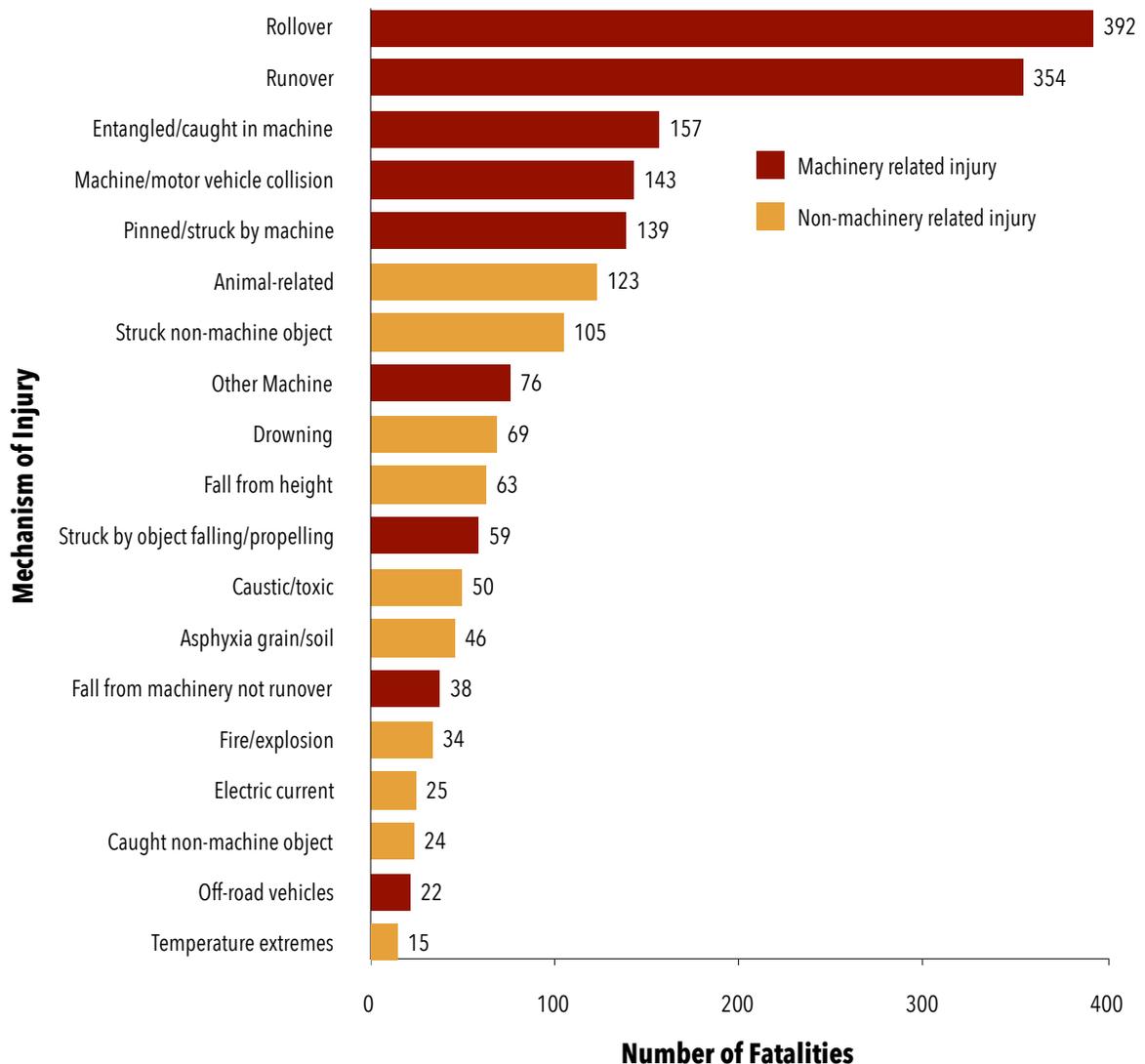
Alighted operator runover (39%) was the most common type of fatal runover. In this type of injury event, the victim is run over by a vehicle they had left running and that was not restrained by the application of brakes or wheel chocks. Bystander runovers caused the second largest percentage of runover fatalities (23%). The majority of animal related deaths are caused by cattle (52%) followed by horses (42%), however, most of the horse related injuries are not work related. Drownings occur mostly in farm dugouts (48%) or lakes/ponds (25%) located on farm property. Incidents involving scaffolding or ladders (40%) are the most common type of fall related fatality.

There have been some shifts in major causes over time. Figure 26 shows that fatalities due to machine rollovers and entanglements in machinery have declined over time.[8] This is likely due to engineering improvements such as rollover protective structures, dead-man switches, and tamper-resistant guarding.

Figure 26

Trends in fatality rates for common causes of death in Canada 1990-2008[8]
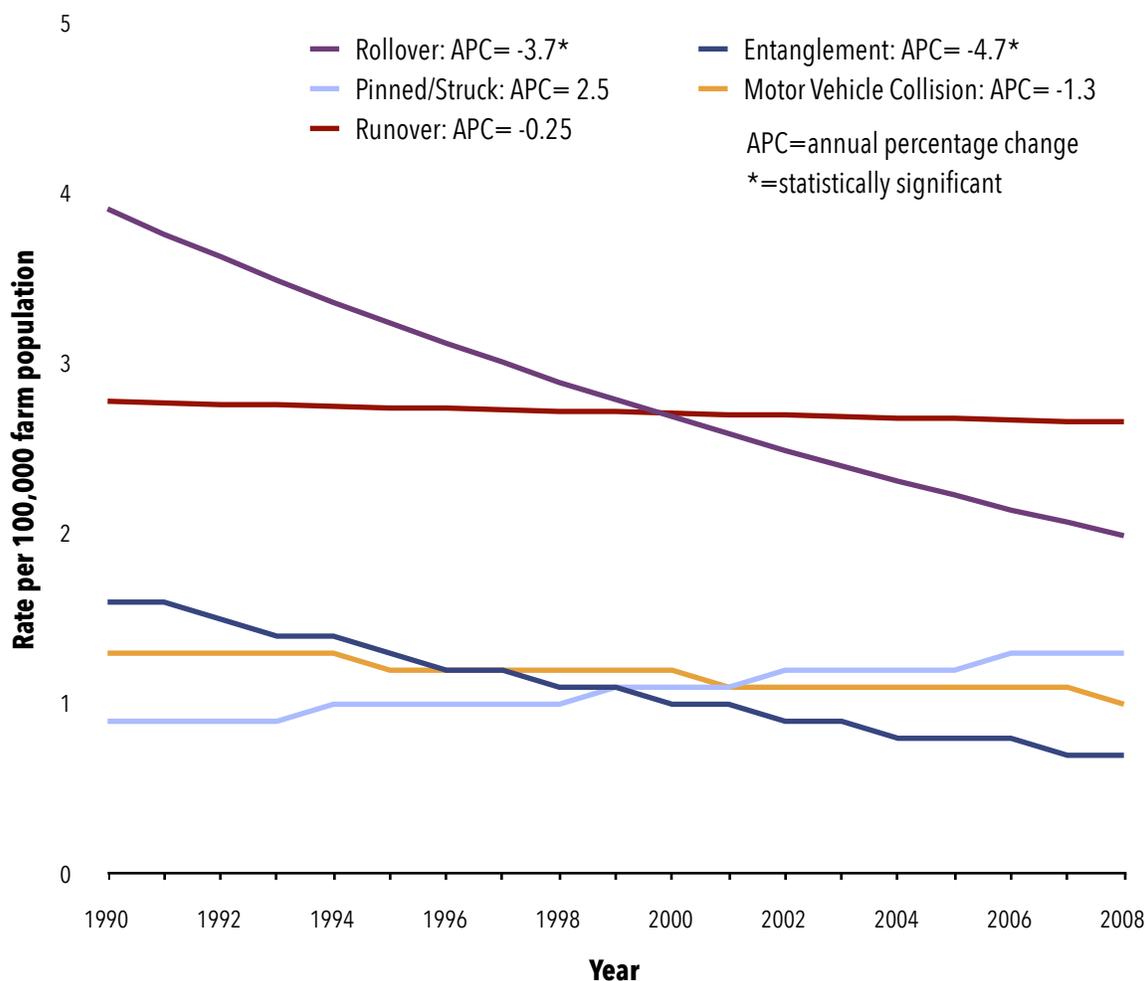
Hospitalizations

Animal related injury, entanglements with machinery and falls from height or machinery are common reasons for agriculture related hospitalizations. Other significant causes of hospitalization include runovers by machinery, falls on the same level and being pinned or struck by machinery. Figure 27 illustrates the most common causes of agriculture related hospital stays for Alberta and Ontario. (Injury Prevention Center– Unpublished Data, 2014).[9]

Figure 27

Common causes of farm related hospitalization Ontario 2000-2008 and Alberta 1990-2000[9]
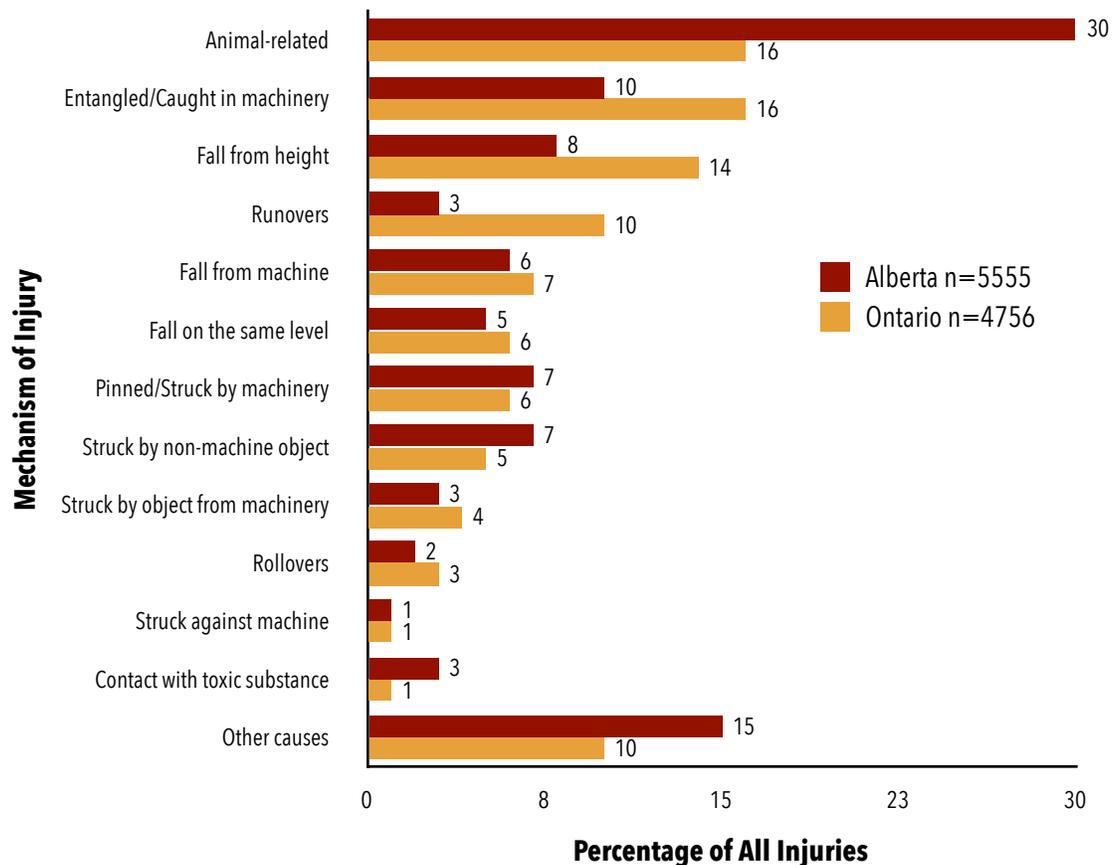
Risk Factors

While studies of potential causes of agricultural injury exist in Canada, this is not a rich literature compared with the evidence base that exists in many other settings. Risk factors that have been identified can be organized conceptually into demographic, behavioural and environmental risk factors. Few studies have been developed based upon an underlying theoretical framework that extends beyond simple exposure-outcome relationships.

Demographic Factors

One of the most consistently identified risk factors for agricultural injury is male gender. [17,18] Boys are differentially exposed to farm work hazards at an early age, and these differences continue to emerge during childhood and are then reflected in gender-based work roles and

patterns during adulthood, including older age.[19] Males are at especially high risk for injury associated with mechanized and vehicular tasks,[20] while other work roles such as the care of animals are distributed more equally between men and women.[21]

There are additional groups of farm people who experience especially high risks for agricultural injury due to unique circumstances. Preschool aged children (ages 1-6) account for large proportions of fatalities.[22] This has been attributed to children, especially boys, being brought in to the farm workplace while adults are engaged in farm work tasks, thereby exposing the children to unusual industrial risks under inadequate methods of supervision.[22-27]

Young workers are killed and injured in high numbers and proportions due to the assignment of dangerous work that sometimes exceeds their developmental abilities,[24] or levels of experience and training.[25] Farm operators and workers account for the majority of traumatic injury events, simply because of their degree and durations of exposure to high risks tasks.[14] Other groups with notable risk experiences include migrant and seasonal workers, often engaged in intensive field work tasks,[26] as well as elder farmers who continue to engage in significant work roles long past normal retirement ages.[27]

Personal and Behavioural Factors

Many of the differential risks observed demographically are in fact mediated or caused by variations in personal and behavioural factors that influence risk circumstances. Some of the more well understood risk factors will be listed here, although this list is not exhaustive.

Farmers and farm workers are known to engage in long work hours, particularly during busy production seasons. This is accentuated during such times due to the need to plant and harvest crops in a limited time period, often while dealing with the stress of unpredictable climate and weather conditions. There is a strong dose-dependent relationship between the amount of work engaged in, and reports of traumatic injury.[14] Much of this has been attributed to worker fatigue associated with such long work hours.[28] However, there are also personal factors that contribute to such risks. Young people are at high risk for occupational injury on farms, both in work and recreational settings.[24] Factors that compound this situation include cultural values surrounding the introduction of children to work and responsibility, poor or absent levels of supervision,[23] experimentation and risk-taking that are normal parts of adolescence,[29] and engagement in work and recreational tasks that are clearly beyond developmental abilities to cope with hazard.[30] Into adulthood, farmers experience a high prevalence of sleep disorders that is sometimes compounded by respiratory conditions such as sleep apnea that are associated with being overweight and obese.[31] The origins of these sleep disorders are not well studied, but could be multifactorial, resulting from a lifestyle that involves long work hours, poor exercise and nutritional choices,

and the stress and uncertainties of commodity prices and the economic viability of farm operations. Such sleep conditions are especially problematic when they go untreated;[31] because the farmer is unable or chooses not to seek primary care for their medical needs. Use and misuse of substances such as alcohol is an important yet unappreciated contributor to many injury events in farmers,[32] as (more speculatively) is the misuse of prescription medications and illicit drugs. Because of the demands of their work, many farm operators also will choose to work through occupation-related pain, and this is especially pronounced when such pain is not fully controlled and hence predisposes workers to injury due to distraction.[33] Other risk factors relate to sensory impairment caused by noised induced hearing loss[34-35] and declines in physical fitness due to an increased reliance on mechanized work practices which minimize the need to engage in labour-intensive work,[36] and the general effects of aging[27] combined with the high demands of specific work tasks.

Environmental Factors

Farms and ranches are dangerous places, compounded by the fact that they are often residential locations combined with an industrial workplace. There are obvious physical hazards associated with this situation. Starting from an early age, farm people are routinely exposed to vehicles, equipment and machinery that generate risks for runover, rollover, and entanglement.[21] Such exposures can be especially hazardous with older equipment that lack safety features such as rollover protection devices and adequate shielding. Other known physical hazards include trauma caused by routine exposure to large and unpredictable animals, especially in intensive production settings.[37] In addition, working at heights (such as in haylofts or on grain bins),[38] drowning hazards,[20] operating machinery on hilly and unpredictable terrain,[20] and operating farm vehicles on public roads with exposure to speed and traffic[39] are all recognized factors that predispose farmer and farm workers to injury.

There are also more subtle underlying determinants of injury on farms that go beyond the physical risks. Some of these are economic. Problems with such things as cash flow, debt, and the unpredictability of agricultural markets can underlie a variety of injury hazards on farms, whether this is mediated by the absence of safe work environment, worry, or excessive work hours by too few individuals. Additional determinants are cultural in nature. Many agricultural populations have held to traditional values and approaches to work that value rather stoic attitudes towards the sanctity of the farm workplace and independence of its operation. While voluntary safety standards are

embraced, such agrarian philosophies often can lead to active resistance of health and safety initiatives, especially those that involve outside regulatory intervention.[40]

Interventions

Many strategies exist from which to base prevention efforts for agricultural injuries. One of the most notable approaches is the "*public health model*" to prevention[41] which recognizes the potential for educational strategies, enforced regulations, and engineered approaches to safety. In farming contexts, while educational strategies such as classroom teaching, safety training in simulated and field environments, and public awareness and social marketing campaigns are popular and accepted, they can be largely ineffective in the absence of more stringent interventions.[42] Implementation of informal and formal policy solutions, including financial incentives, enforcement of occupational health and safety regulations, and incentives and legislation surrounding installation of safety equipment are helpful in those situations which are open to such approaches.[42] A major barrier in that regard is that many farm populations are actively resistant to such interventions, believing that they are inconsistent with the traditions of farming as an independent occupation. Furthermore, most farmers are independent business owners who are exempt from occupational health and safety regulations themselves, and inclusion of their worker population in such regulatory frameworks is inconsistent. Finally, optimization of farm work environments through the implementation of engineered solutions is a highly effective strategy in practice, yet obstacles include the cost of such changes, as well as the willingness of independent farm operators to change production practices and challenge longstanding work traditions.

A second framework that is relatively new to agriculture, yet is considered standard in other occupational and institutional settings, is referred to as the *hierarchy of control*.[43] This outlines six hierarchical steps that could mediate risks for injury. The potential for limiting risks and therefore increased prevention of injury increases with each step. In one version these steps would include: (1) identification of hazards (e.g., farm safety checklists); [25] (2) assessment of risks (e.g., safety audits,[25] assessment of work suitability using tools such as the *North American Guidelines for Children's Agricultural Tasks*[30] that attempt to match the demands of specific work to children's innate developmental abilities); (3) use of personal protective equipment (e.g., safety goggles, hearing protection, industrial footwear); (4) use of administrative control systems (rules and regulations, informal or legislated; certification systems); (5) use of engineered controls (e.g., passive safety barriers to prevent contact with hazards); (6) elimination of hazards (e.g., removal of at-risk persons from the worksite). While the effectiveness of such interventions may increase as one climbs this hierarchy, acceptance and compliance with the higher steps is minimal in some agricultural populations. This contributes to an epidemic of serious injury that is common and persistent.

Conclusion

Farming is a complex industrial activity that presents many opportunities for serious injury. Traditionally, farming has been exempt from legislative policies that apply to other industries including laws that prohibit child workers. Although engineering interventions appear to have been successful in reducing the burden of injury over time, farming still ranks as one of the most dangerous occupations in Canada. As such it is critical to further reduce the burden of injury on Canadian farms. One approach is to ensure that occupational health and labour regulations that apply to other industries are applied to the agricultural sector as well. Other approaches can include the continuous monitoring of farm injury and evaluating control measures as they are enacted.

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4.2

Transport Injuries

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Introduction

Road traffic fatalities and injuries are an underfunded public health challenge and a source of concern worldwide. Nearly 1.2 million people around the globe are fatally injured each year and up to 50 million experience various levels of injury severity. Young people are at the greatest risk as road traffic injuries are the leading cause of death among 15-19 year olds, second among 10-14 year olds and 20-24 year olds and third among 5-9 year olds.[1] While over 90% of these deaths and injuries occur in low- and middle-income countries, the road toll continues to be a source of concern in the developed world as well.

The social and economic costs of road traffic injuries are equally profound. The global cost is estimated to be US$ 518 billion per year;[2] this represents 1% of the gross national product (GNP) in low-income countries, 1.5% in middle-income countries and 2% in high-income countries. In an effort to stimulate action to better address this problem, in March 2010 the United Nations General Assembly proclaimed 2011-2020 as the Decade of Action for Road Safety.

The Canadian Situation

In Canada, road traffic crashes have substantially declined in the past three decades. To illustrate, between 1980 and 2010, the number of road crashes involving an injury or fatality decreased from 184,302 to 123,963 (a 32.7% reduction). In terms of persons killed and

injured, there were 268,438 in 1980 and 167,249 in 2010, representing a 37.7% reduction.[3-8] This has occurred despite significant increases in the number of licensed drivers, registered vehicles and estimates of kilometers driven.[8] Changes over time are reported in Figure 28. While this growth in road traffic has had the potential to dramatically increase the opportunity for negative injury outcomes, in fact the percentage of persons fatally injured has decreased by more than 60%. Injuries have also decreased, although declines have been less substantial at just over 20%.

Figure 28

Changes in Number of Drivers, Vehicles, Fatalities and Injuries in Canada since 1974[* 7]
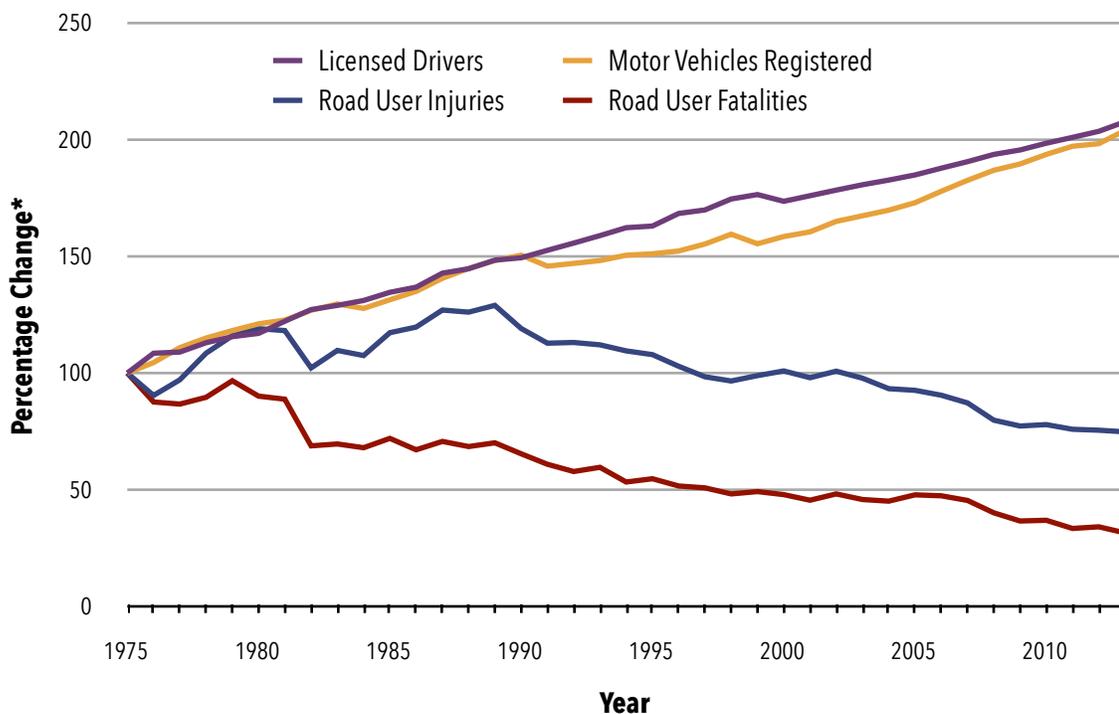
Decreases in the past three decades have been attributed to several positive changes including improved crashworthiness and safety features in motor vehicles, improved highway design based upon more structured road assessment programs, and advances in medical treatment for injured persons at trauma Centers and regional hospitals. Of equal importance, public perceptions have changed dramatically to acknowledge that crashes are preventable and to recognize that drivers and passengers must take responsibility and make 'safer' choices in the vehicle by using seat belts, and avoiding the risks associated with

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[*] 1974 is the baseline year where all percentages are equalized to 100, showing that driver licenses and vehicle registrations have been increasing linearly between 1975 and 2011 and have doubled during this period

speeding, impairing substances, distractions and fatigue. However, the number of people killed and seriously injured in road crashes remains unacceptable and more work is needed to further reduce the problem.

According to Transport Canada's 2012 collision statistics, there were 2,077 persons fatally injured in road crashes and 10,656 were seriously injured.[7]

Responsibility for Road Safety

In Canada road safety is a shared responsibility. The federal government, through Transport Canada, has responsibility for safety standards for new and imported vehicles, tires and child restraints. Justice Canada has responsibility for criminal laws including driving offenses (e.g., careless and criminal negligence, impaired driving) through the Criminal Code of Canada. Provinces and territories have responsibility for driver licensing, vehicle registration and highway traffic acts. In addition, provinces also have responsibility for the administration of justice. With respect to road infrastructure, road authorities in provinces, territories or municipalities are responsible for designing, building and maintaining roadways with the exception of those on federal lands. The activities of these governments are generally coordinated through a series of related organizations reporting to or working with The Council of Ministers Responsible for Transportation and Highway Safety which represents federal, provincial and territorial governments.

In the past three decades, Canada has implemented three large-scale national road safety plans in an effort to reduce deaths and injuries, and to encourage the adoption of evidence-based and coordinated activities. Although Canada's current plan, Road Safety Strategy 2015,[9] does not include specific targets for reductions in fatalities and injuries, it does underscore the need to achieve a continual downward trend and contains a matrix of proven or promising road safety countermeasures that target specific road safety issues at the local level. The foundation of the plan comprises four guiding principles (a) to raise public awareness of road safety issues; (b) to improve communication, cooperation and collaboration among road safety agencies; (c) to enhance enforcement measures; and, (d) to improve national road safety data quality and collection.

Driver Condition (Behaviours)

There are a variety of driver conditions (i.e., behaviours) that contribute to involvement in road crashes. In some instances, the magnitude of the problem and the risks associated with it are well documented and understood, for example in regards to drinking and driving and speeding. In these cases, there are often a variety of countermeasures that are available to deter such behaviours, often in the form of education, legislation, enforcement and sanctions. Conversely, other behaviours have only more recently emerged or become

recognized as problematic; however, the magnitude of the problem and risks associated with it are not well-understood or easily researched. For example, measuring the risks associated with distractions in a laboratory setting does not account for the decision-making process on roadways where people may choose to either engage in or avoid distractions in accordance with the complexity of road conditions. Similarly, there are ethical issues that make it difficult to dose test subjects in a lab with the level and mix of drugs that are often consumed by drivers in a real world setting. In these latter instances, the development of countermeasures has been much more challenging, making solutions less readily available.

Some of the conditions or behaviours that represent the most substantial contributors to road fatalities and injuries are briefly described below including non-use of seat belts, speeding, impaired driving, distraction and fatigue. Each of these issues contains a brief overview of the nature and magnitude of the problem, the risks it poses, and the countermeasures that are either in place or available to address them.

Non-use of seat belts. Seat belts, when worn correctly have been shown to reduce the chances of death in a collision by 47% and the chances of serious injury by 52%.[10] All new vehicles sold in Canada today are equipped with three-point seat belts in all positions.

The percentage of vehicle occupants who wear a seatbelt in Canada has increased approximately 40% since the late 1970s. Research investigating the cumulative number of lives saved between 1990 and 2000 due to the use of seat belts revealed that more than 11,000 lives were saved during this period.[4]

Recent reports reveal seatbelt usage to be estimated at 95.3% among all occupants of light-duty vehicles in Canada, although observational surveys suggest that front seat passengers have higher usage rates (95.5%) than rear seat passengers (89.2%).[7] Of concern, was that in 2011 approximately 1/3 of drivers in fatal crashes and 12% of drivers with serious injuries were unbelted. A higher proportion of fatally injured (34%) and serious injured (21%) passengers were unbelted.[7]

Greater efforts are needed to change behaviour among back seat passengers who report lower usage rates, as well as among younger drivers and drivers of pickup trucks whom research shows are less likely to wear their seat belts. In particular, young males and drivers aged 18-24 are the least likely groups of drivers to wear seat belts, and usage rates among occupants of pick up trucks is just 92%. Among the youngest passengers of vehicles, the

incorrect and inappropriate use of child restraints continues to be a topic of concern. Recent surveys have indicated that a major issue is the promotion of the use of seat belts in children before they are physically ready, thus reducing the effectiveness of seat belts in a collision. The 2010 Canadian National Survey on Child Restraint Use revealed that while 95.8% of the child passengers were restrained, it was estimated that child safety seats were properly used just 64% of the time.[11,12]

A combination of countermeasures to increase seatbelt use have been variously employed including nighttime enforcement when usage rates are lower, feedback signs, sanctions and incentives, seatbelt reminder systems, and employer policies. The effectiveness of these interventions is varied and not well-researched with the exception of enforcement.[13-15]

Speeding. Speed as a causal factor in collisions remains an issue and has been defined in a variety of ways including driving any amount over the posted speed limit, driving too fast for conditions, or racing (i.e., driving 25 km/h or more over the posted speed limit would qualify as excessive speeding).[16,17]

Speed contributes to 18% of fatal and personal injury crashes, which corresponds to 4,000 deaths and injuries a year in Canada that are speed-related.[18] According to the Canadian Council of Motor Transport Administrators (CCMTA), approximately 800 individuals were killed and 3,000 seriously injured due to speed-related crashes in 2008.[19]

There is very strong evidence that shows that speed increases crash risk. For instance, a 1% increase in speed increases a driver's fatality risk by 4%-12%. An increase of the speed limit by 25 km/h on a road increases the fatality rate of drivers by 10%.[16,20] Negative consequences of speeding on driving include less time to react, less distance to stop, and reduced ability to control or manoeuver the vehicle.[16]

Countermeasures most widely used to address this problem include speed campaigns combined with increased enforcement, enhanced penalties in the form of fines and vehicle impoundment for excessive speeding, enhanced penalties for speeding in work, school or construction zones, and automated speed cameras. A recent systematic review of speed cameras for the prevention of road traffic injuries and deaths published by the highly regarded Cochrane Collaboration that specializes in systematic reviews analyzed results from 35 studies that met the inclusion criteria and found reductions in average speed ranging from 1% to 15% and reductions in proportion of vehicles speeding ranging from 14% to 65%. Furthermore, they report that near camera sites pre-post reductions ranged from 8% to 49% for all crashes and 11% to 44% for fatal and serious injury crashes.[21] Of note, despite the effectiveness of cameras, many jurisdictions have been reluctant to adopt this intervention as a result of the misperceptions that the technology is a source of revenue as opposed to a safety strategy.

Impaired driving. Drinking and driving has been widely recognized as a major social problem in Canada for more than three decades. Although a general decreasing trend in the number of persons killed in a traffic crash involving a drinking driver† occurred in Canada between 1995 and 2008, the progress achieved since the late 1990s has been nominal and the number of persons killed and injured in crashes involving drinking drivers remains high. In 2010, (the most recent year for which data are available), 33.6% of fatally injured drivers in Canada had a blood alcohol concentration (BAC) in excess of the legal limit of .08.[22] In addition, in 2010, 744 people were killed in Canada in road crashes that involved a driver who had been drinking and approximately 2,733 drivers (excluding Newfoundland and Labrador) were involved in alcohol-related serious injury crashes in Canada.[22]

The issue of driving while impaired by drugs including illicit, prescription and over-the-counter medications has emerged in the past decade, although there is less concrete evidence regarding the prevalence, risks and implications of drugged driving.[23,24] Research shows that the prevalence of drugs detected in the body of drivers is not insignificant in many Canadian jurisdictions, and in some jurisdictions may rival that of alcohol.[25] However, far fewer fatally injured drivers are tested for drugs (47.2%) compared to more than 80% who are tested for alcohol.[22,26] In 2008, using data from TIRF's National Fatality Database, a study by the Canadian Center on Substance Abuse (CCSA) found that a greater percentage of fatally injured drivers tested positive for drugs compared to alcohol in Ontario, British Columbia and Nova Scotia.[26] Additionally, a roadside survey conducted in 2012 found that approximately 7.4% of all drivers in British Columbia tested positive for at least one psychoactive substance, other than alcohol.[27] Of importance, surveys also reveal that the class of drug differs by age category and the pattern of use is different than is found with alcohol.[27]

Drug-impaired driving among Canadian youth in particular is a cause for concern. In 2011, TIRF released a Road Safety Monitor (RSM) on young drivers that showed that 21.4% of drivers aged 16-24 reported using marijuana. Furthermore, the study showed that 19.7% of young marijuana users reported driving within two hours of using marijuana. The same study also found that 9.5% of young drivers who reported using illegal drugs other than

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† Reported Canadian national data on alcohol-related crashes resulting in fatalities and serious injuries include all drivers that test positive for any amount of alcohol. This means that drivers that are below the legal limit for impairment as well as those above the legal limit are included in these counts. Hence the term drinking driver is used as opposed to impaired driver.

marijuana also reported driving within two hours of taking these drugs.[28] Comparable results among youth have been reported using other data sources.[29]

The risks posed by alcohol in relation to driving have been well-documented[30] as well as the profile and characteristics of these offenders.[31] However, a number of challenges exist with respect to drug impaired driving. There are many substances with different symptoms and effects and many ways to measure them, including looking for metabolites or the active ingredient. In addition, there is very little information on the dose/response relationship to most drugs and how that may affect a person's fitness to drive.[32] The lack of accepted technologies to detect and measure drugs at roadside has made research more difficult and enforcement very challenging. With regard to prescription drugs, medication labels may not adequately warn drivers of the effects of prescription drugs on driving abilities and crash risk.[24]

A variety of common countermeasures are available in Canada for alcohol impaired driving. In addition to criminal penalties imposed under the Criminal Code of Canada, there is also enhanced administrative suspension for alcohol levels between 50 and 80 mg/dL in most provinces.[‡] In British Columbia, research has shown that the new Immediate Roadside Prohibition (IRP) program has dramatically reduced the incidents of impaired driving and significantly reduced related fatalities.[33] Alcohol interlock programs are also used across Canada, in particular for high-BAC and repeat offenders as well as first offenders. To learn more about alcohol ignition interlocks please visit TIRF's Alcohol Interlock Curriculum for Practitioners.[§]

With respect to drugged drivers stopped at roadside, the Criminal Code of Canada (CCC) was strengthened during July of 2008, to enable police officers to request a driver suspected of impaired driving to submit to a number of physical coordination tests known as the Standardized Field Sobriety Tests (SFST).[5] If these tests indicate possible impairment, police officers that are trained in recognizing impairment in drivers under the influence of drugs other than, or in addition to alcohol, called Drug Recognition Evaluators (DREs), may be called in for additional evaluation of the suspected driver. DREs are responsible for determining if the driver is showing signs and symptoms associated with impairment by certain classes of drugs.[34] During this examination, bodily fluid samples can be collected to test for the presence of any drugs in the body.

Educational campaigns with respect to drugged driving are also increasingly prevalent as a preventive measure. In particular they may often be targeted towards young drivers. CCSA recently sponsored a systematic review of the literature, conducted by TIRF, to identify

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[‡] For more information about these penalties in each jurisdiction please visit http://changetheconversation.ca/drinking_and_driving_facts/ offender_programs.php#q2

[§] www.aic.tirf.ca

effective models for preventing drug-impaired driving among youth. The study found that while limited evidence-based information is available, some strategies such as encouraging responsibility and open communication with young drivers; teaching coping and peer pressure avoidance skills; and, involving parents and communities in preventative initiatives against drug-impaired driving appear to have promising implications for future programs.[35]

Distraction. Distracted driving occurs when a driver's attention is diverted away from driving because they are focused on something non-driving related.   Much of the early focus on distracted driving was generated by concerns over cell phone use. For much of the driving public, distracted driving is synonymous with cell phone usage, but the reality is this is just one component of the problem. Distracted driving encompasses a wide range of activities, many of which have become typical in our daily driving environment. Distractions can be inside the vehicle (e.g., reading a newspaper, tending to children, eating) or outside of the vehicle (e.g., looking at billboards, staring at activities on the roadside, reading road signs).[36] Sources of distraction include those that are visual (eyes off the road), manual (hands off the wheel) and cognitive (mind off task), and effects of this behaviour include a reduction of the driver's awareness of changes in the road environment, decision-making about how to respond to changes, and their ability to safely control the vehicle.[37]

An examination of 2008 TIRF national data in Canada revealed that driver distraction was a factor in 13-16% of fatal crashes and between 23-27% of injury crashes. Comparable results were found in an analysis of the National Collision Database maintained by Transport Canada.[38] These data should be interpreted with extreme caution as distraction is clearly under-estimated in some jurisdictions (due to differences in data reporting practices and variations in how 'distraction' is defined, captured and over-estimated in others. More generally, it has been estimated that distraction is a factor in 25% of road crashes.[38]

The combination of experience, driving environment and cognitive limitations places every driver at risk of significant distraction. Humans are 'serial processors' of information, meaning they can only effectively process one thing at a time, or focus their attention on one task at a time. The ability to 'multi-task' is a common misconception. Research shows that distracted drivers commit a wide variety of driving errors, from control sloppiness (wandering/weaving, irregular speed), to loss of situational awareness (following too close, sign/signal disobedience).[38] These errors increase the likelihood of being involved in or causing crashes. For example, distracted drivers are more likely to be involved in rear-end crashes or single vehicle crashes and approximately 70% of

distracted driver crashes involved one of these two crash types.[39] Texting while driving has been found to be 2 to 5 times more risky than driving drunk.[40]

Many people do not recognize the magnitude of the distracted driving problem. While issues related to drinking and driving have been recognized for many years, distracted driving has only gained serious attention in recent years. Road users may not realize that distracted driving can pose an even bigger threat. In 2011, Canadians were asked how often they use their cell phones (hand-held, hands-free, texting) while driving. The survey revealed that 18.1% of respondents reported that they often talk on their hands-free phone while driving, 4.8% indicated that they often talk on their hand-held phone while driving, and 4.0% reported that they often text message on their phone while driving.[41]

Since the first Canadian cellular phone ban was enacted in Newfoundland and Labrador in 2003 all jurisdictions, except Nunavut, have some form of traffic act law banning handheld phone use while driving** that is contained in provincial/territorial highway traffic acts. As of 2014, penalties incurred range from fines of $80 (Quebec) to $250 (Prince Edward Island) and on average about three to four demerit points can be accumulated for the infraction in some jurisdictions. In 2011, Alberta banned a broader range of distracted driving behaviours in addition to the use of hand-held devices. For example, programming navigation systems and personal grooming while driving are also covered under Alberta's distracted driving law. All jurisdictions have the offense of "careless driving" or "driving without due care and attention". In Ontario, as of 2014, if a driver endangers others by using a hand-held or hands-free device, he or she can be charged with careless driving which yields a maximum penalty of a fine of $2,000, six demerit points, six months in jail, and license suspension for up to two years. In Manitoba, as of 2014, if a driver is convicted of careless driving, they can face fines up to $5,000 and one year license suspension. License suspension is also a punishment for careless driving in Prince Edward Island and Nova Scotia.[††]

Recent surveys undertaken by the Canadian Council of Motor Transport Administrators to measure electronic device usage while driving suggests that usage may have decreased after the laws came into effect (CCMTA in press). One of the challenges to conducting research in distracted driving is the changing nature of the devices and how people use them to phone, text or access social media.   In recognizing the distracting effect of cell phones on a driver's cognitive fitness to drive, a number of companies who are members of the U.S. National Safety Council have implemented no electronic device use while driving according to a national survey.[42] However, as yet no Canadian jurisdiction bans hands-free phone usage.

** http://distracteddriving.caa.ca/education/distracted-driving-laws-in-canada.php

†† see http://yndrc.tirf.ca/issues/distraction.php#35

Educational campaigns and programs create awareness about the dangers of distracted driving. A national campaign has been undertaken to promote safe driving called Leave the Phone Alone[‡‡] which has been used by a number of safety groups to raise awareness of the dangers of talking-texting and driving. In addition, grassroots organizations, such as Drop It and Drive (D.I.A.D), use blogs, social media and on-site presentations to spread awareness about distracted driving with the intention of making it as socially unacceptable as drinking and driving.

Fatigue. Driving while drowsy or fatigued has long been an issue related to commercial vehicles, which have hours of service rules they must follow. More recently concern about this issue in relation to drivers of passenger vehicles has grown. A model developed by the Canadian Council of Motor Transport Administrators estimated fatigue was a factor in approximately 20% of fatal collisions between 2000 and 2003. [43] In 2006, a survey in Ontario by TIRF revealed that the problem of driving while fatigued or drowsy was a serious one. It showed that nearly 60% of Ontario drivers, corresponding to some five million, admitted that they had driven while fatigued or drowsy at least sometime, and 14.5% of Ontario drivers, (1,280,000) said they actually fell asleep or nodded off while driving at least once in the past year. Among those 1,280,000 drivers who fell asleep or nodded off while driving, approximately 105,000 of them did so more than five times. Collectively, these drivers accounted for about 5.5 million trips in Ontario during which they fell asleep or nodded off, and during 573,000 of these trips the driver had to brake or steer to avoid being in a collision.[44]

Types of drivers who are more likely to suffer from fatigue or drowsiness include: young males, persons with sleep disorders, drivers under the influence of alcohol, drivers under the influence of certain medications (e.g., some cold medications), night or rotating shift workers (e.g., emergency service workers), and commercial vehicle operators (e.g., tractor trailer drivers).

With regard to commercial vehicles, research has contributed to the development of a fatigue management program to help companies and drivers manage their hours of service. Of particular concern, is that there is no valid and reliable measure of fatigue in a driver at roadside or in a subsequent investigation. There are also no specific laws or regulations

[‡‡] see http://leavethephonealone.ca/pledge.php

regarding fatigued driving, although criminal negligence or dangerous driving charges could be applied when the evidence warrants such measures. To begin to address these issues, a strategy to address fatigued driving was developed by the CCMTA expert working group on fatigue.[§§]

Populations at Risk

There are also some important populations of road users that have a much higher risk of fatality and injury either due to their characteristics or to the ways in which they interact with other road users in the road environment. Young drivers represent a substantial proportion of road deaths and injuries as a result of their young age and inexperience whereas older drivers have an increased risk due to the effects of aging on driving ability and their increased frailty due to older age. Vulnerable road users, including pedestrians, cyclists and motorcyclists, are also more likely to be involved in road crashes due to their lack of protection from larger and heavier vehicles traveling at higher speeds, and the their lower visibility to other road users (i.e., they are more difficult to see). A brief overview of each of these a-risk populations is provided in terms of the magnitude of the problem, risk factors and countermeasures.

Young drivers. Motor vehicle crashes are the leading cause of death and injury for young people (ages 1 through 24),[45] outstripping suicide and other accidents. On average, more than 700 young people (aged 15-24) are killed each year in road crashes in Canada and a further 50,000 are injured, many seriously. Crashes are also the leading cause of hospital admissions among youth and the second leading cause of emergency room visits.

The involvement of young drivers in serious road crashes vastly outweighs their representation in the driving population; they account for nearly 25% of the motor vehicle deaths and injuries but only 13% of the licensed driving population. Young people have the highest death and injury rates (number of deaths/injuries per 100,000 population) of any age group.[46]

Young drivers in general are two to three times more likely to experience a crash. In particular, during the first six months of licensure, young drivers are eight times (8x) more likely to be involved in a fatal crash than more experienced drivers.[47] Several factors[***] contribute to a teen's ability to drive safely.[48] The most basic factors include the skills to operate the vehicle, the ability to recognize hazards and to appropriately react to the unexpected. These skills take time and practice to learn, but are within the reach of young

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[§§] For more information visit http://ccmta.ca/en/members/standing-committees/rsrp-member-page/rsrp-working-groups/strid-expert-working-group-on-fatigue (requires login)

[***] See http://yndrc.tirf.ca/issues/about.php - 3

drivers. In addition, they also must learn traffic rules, procedures and the risks and potential consequences of being on the road which is gained through driving experience. The reality is that young drivers are at a high risk of crashing until they can develop the skills and experience to protect themselves on the road. With increasing experience, drivers can develop good judgment and decision-making, and become safe drivers.

Young drivers also face a variety of risks. For example, teenagers are much less likely to wear their seatbelt[49] and more likely to be distracted while driving than older drivers.[39] The amount of attention that drivers must allocate to driving is a function of the driver's experience, the complexity of the driving task and the nature of the driving environment. As such, someone inexperienced in driving a car, particularly a technologically complex car, has to focus far more on controls and systems than someone familiar with the vehicle.

There has been substantial progress in reducing young driver crashes as a result of the implementation of Graduated Driver Licensing (GDL) programs across Canada, following Ontario's lead in 1994. GDL involves a tiered system of licensing in which novice drivers are gradually exposed to driving situations over an extended period of time spent in low-risk environments. Studies in North America have indicated that GDL is associated with substantial decreases in crashes among 16-year olds and positive but lesser effects among 17-year olds.[50] Effects at ages 18 and 19 are less definitive.[51] Positive, negative, and neutral effects of GDL programs at these ages have all been reported in the literature.[52-54]

As well, other programs with varying levels of evidence-based effectiveness, such as driver education, enhanced driver license testing, and new in-vehicle monitoring technologies, have been increasingly implemented in the hopes of reducing the risk to teen and novice drivers.[55]

Older age and medically at risk drivers. The population in Canada is aging and older adults are the fastest growing population group in Canada. According to population projections from Statistics Canada, it was estimated that there were five million Canadians older than age 65 in 2011, and the number of older adults will reach 10.4 million by 2036.[56] Using today's licensing rates, it can be expected that more than 4.6 million Canadians aged 65 or older will hold a valid driver license after 2021, increasing to 6 million by 2031.[57]

Despite a low crash risk overall, the aging driver population is a source of concern. In Canada, in 2006, older adults, aged 65 and older accounted for the second largest proportion of road deaths at 16% (462 road fatalities) and for 15,545 (7.8%) of road injuries.[4] Canadian older adults have the second highest motor vehicle death rate

among licensed drivers, with an average of 15.7 deaths per 100,000 licensed drivers, compared to 9.6 deaths for drivers aged 45-54.[4]

Notable declines that come with aging can impair older aged drivers, making common driving maneuvers that they have performed for decades, such as turning left in an intersection, much more challenging. Impairments may also come from diseases or conditions that affect drivers such as, for instance, visual impairment (e.g., cataracts, glaucoma, or macular degeneration), physical impairment (e.g., arthritis), and cognitive impairment and dementia.[58-60] To illustrate the problem, between 1997 and 2005, there were 210,000 people in Ontario diagnosed with dementia, 40,000 of which held active driver licences. More worrisome is that 9,000 of these drivers have been in car crashes; a third of whom had taken psychotropic drugs.[61]

Provincial jurisdictions have different systems to assess and report an at risk older adult driver[†††] and other efforts have been undertaken to better assess at risk drivers and to examine specific medical conditions and their impact on driving and examine issues related to driver cessation.[‡‡‡]

Vulnerable road users. Pedestrians and bicyclists are among the most vulnerable road users. In collisions with other road users they suffer the most severe consequences because they are unable to protect themselves against the speed and mass of motor vehicles.[62] Almost 9,000 pedestrians were killed and hundreds of thousands were injured on Canada's roads in a span of two decades (1989-2009). Young children are at high risk as pedestrian-related injuries contribute to almost 12% of all injury-related deaths among children under 14 years of age. Reductions in fatalities and injuries among pedestrians have been much smaller as compared to progress on other road safety issues.[63]

Not only are vulnerable road users at greater risk because they lack the protection provided by safety features like seatbelts and the hard external structure of a vehicle, but they are also frequently at risk for collision since they are less visible to drivers, and there are issues with distraction and impairment.   A range of countermeasures have been put in place to begin to address this problem, including improved roadway design and infrastructure to separate traffic moving at different speeds, vehicle technologies in the form of pedestrian airbags and education campaigns.[63]

Summary

Considerable progress has been achieved in reducing deaths and injuries due to road crashes in the past three decades. However, these numbers remain unacceptable and more

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[†††]see http://lpp.seniordrivers.org/lpp/index.cfm?selection=visionreqs

[‡‡‡] For more information please see www.candrive.ca.

work is needed to increase understanding of road user behaviours that put Canadians at risk, and to identify optimal strategies that can be used to further reduce this problem in the coming years. While knowledge about driver conditions and at risk populations has grown tremendously, important gaps remain. There is evidence to suggest that a portion of road users engage in multiple risky behaviours. For example, impaired drivers often do not wear a seatbelt, and engage in speeding. However, the extent of the problem or the ways that behaviours are intertwined are unclear, making it difficult to draw attention to the problem or to garner support to tackle it. Moreover, behaviours such as distraction are likely less amenable to countermeasures in the form of laws and penalties because a much larger portion of the driving population engage in these behaviours. It may prove to be challenging to build consensus to support more punitive measures for distracted driving. Finally, regardless of the behaviour or population at risk, it must be ensured that the implementation of countermeasures is robust, consistently applied, and sustainable.

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4.3

Poisoning

Scope of the problem

Poisoning and drug overdose cause significant morbidity and mortality in Canada and across the world. Although significant progress had been made in reducing poisoning injury rates following the introduction of product safety laws in the 1960's and 70's, recently poisoning rates have been on the rise in both children and adults.[1,2] The incidence of poison-related injury has surpassed motor vehicle crashes (MVC) in the USA as the leading cause of injury-related death.[1] During the past three decades the number of drug poisoning deaths increased six fold from about 6,100 in 1980 to 36,500 in 2008. The poisoning death rate increased from 4.8 per 100,000 in 1980 to 13.5 per 100,000 in 2008. For comparison the death rate due MVCs in 2008 was 12.5 per 100,000.[1]

Although Canada-wide data is more limited than U.S. data, the trends are similar. In 2003, the incidence of poisoning in British Columbia was 882 per 100,000 population.[3] Since that time the poisoning rate has continued to climb across Canada. In 2007, poisoning accounted for 12% of injury-associated mortality in Canada (excluding Quebec), which is third only to motor vehicle and fall-related mortality.[4] In British Columbia, poisoning accounted for 20% of all injury-related hospitalization and mortality in 2011, and was the most common cause of both unintentional and intentional injury.[5] The annual rates of hospitalization for alcohol and illicit drug overdose have also increased in the last decade.[6-7] Notably, it is prescription - rather than illicit - drugs that account for the majority of Canadian poisonings, with opioids implicated as one of the most important pharmaceutical classes contributing to injury and mortality.[8]

In addition to morbidity and mortality implications, poison injury also generates significant economic pressures. In 2010 the Canadian-wide cost of unintentional poisoning was estimated to be $1.26 billion.[9] With increasing health care costs and a rising incidence of poisoning, the economic burden of poison-related injury is likely greater today.

Historical perspective

North American public health interventions aimed at curbing poison-related injury started to take shape in the 1950s and 1960s with the establishment of the first poison control Centers, labeling laws, the banning of lead from indoor paint and gasoline as well as the implementation of child resistant packaging.

The first North American Poison Center was established in Chicago in 1953, which was closely followed by others across North America. The first poison information service was offered by Health Canada in 1958 and the first Canadian Poison Center opened at Ottawa Civic hospital in 1968.[10] Poison Centers offer treatment advice, provide public education and collect data on toxic exposures including surveillance of potential Chemical Biological Radiological Nuclear and Explosive (CBRNE) events to help inform public health interventions. The first labeling laws in Canada were introduced via the Hazardous Products Act, which required certain substances to display product information and hazard symbols to warn of potential harms.

The most successful Canadian public health intervention to date related to poisoning prevention has been the introduction of mandated child resistant packaging. In 1965, the College of Pharmacists of Ontario started a voluntary program to encourage all pharmacies to dispense drugs in child resistant packaging. However, voluntary enrollment was poor so the Ontario government amended the Pharmacy Act in 1972 to mandate child resistant packaging for all prescription drugs dispensed in Ontario. This was closely followed by similar laws in British Columbia and PEI and it is now federally mandated across Canada under the Food and Drug Act.

At Risk Populations

The populations at risk for poison injury are diverse and vary depending on the source of exposure. Historically, paediatric exposures have been the focus of poison injury prevention efforts. However, other groups, including users of illicit substances, users of long-acting prescription opioids, individuals attempting self-harm and the elderly are also at considerable risk for poison injury and deserve special mention.

Paediatric

Young children represent the population that is most frequently exposed to potentially toxic substances, and children aged less than six years account for 52% of all exposures.[11] The vast majority of these exposures result in minimal or no toxicity - only 0.003% of reported exposures in children under five resulted in death. When paediatric death does occur, prescription opioids, cardiovascular agents and sedatives/hypnotics are most commonly implicated.[2,11] At high doses opioids are quite dangerous as they can cause respiratory compromise and death, and even single tablets may contain lethal doses to small children. Although interventions like child-resistant packaging for such products in Canada have generally been considered a success, recent U.S. data indicates that paediatric injury from pharmaceuticals is increasing once again, which is likely associated with the proliferation of prescription opioids.[2] Additionally, death from unintentional exposure to non-pharmaceutical household products is most likely to occur in children.[11]

Prescription drug use/misuse

Prescription drug use and misuse are growing in North America. The majority of prescription drug-related deaths are unintentional. Increased prescribing of opioid analgesics is related to increase in drug overdose. Patients with depression and anxiety are likely to be prescribed sedative hypnotic agents. Overdose death is much more common in patients who have been prescribed sedative hypnotics as well as opioids.
[12-14] In British Columbia, prescription related opioid deaths were 86% unintentional, and associated with mental illness, use for non-malignant chronic pain and the use of at least one other non-opioid with CNS effects.[15] In Ontario, rates of opioid prescription rose by 29 percent from 1991-2007. Furthermore, there was an 850% increase in oxycodone (the most commonly prescribed opioid) prescriptions over the same time period, which was associated with a doubling of the opioid-related death rate from 13.7 per million to 72.2 per million population.[16]

Intentional self-harm

Intentional self-harm from ingestion is exceedingly rare among the very young, but it can account for as much as 45% toxic exposures in adolescents and adults. A U.S study limited to 8 states, demonstrated that men and the elderly have the highest successful suicide rates while young adults, women and teenagers have the highest attempted suicide rate.[17] According to American data, attempted suicides most commonly involve toxic ingestions whereas successful suicides are more likely to involve other means such as falls from height

or firearms.[18] Aboriginal youth in Canada are of particular concern in this category with reported suicide rates that are 2-5 times higher than comparable non-Aboriginal youth.[19] The most frequently implicated drugs in self-harm attempts are acetaminophen, benzodiazepines and antidepressants.[20]

Older adult populations

Older adults are at risk for drug and poison-related injury largely due to polypharmacy, pharmacokinetic/dynamic changes of aging, increased co-morbidities and cognitive decline leading to drug taking errors.   The incidence and severity of Adverse Drug Events (ADEs) – harm occurring secondary to drugs within normal prescribed or recommended use of a drug - presenting to hospital increase after 65 years of age and continue to increase throughout aging. In 2011, older adults accounted for 57.6% of ADE-related hospitalization despite comprising only 14.2% of the population.   Anticoagulants, antineoplastic drugs, opioids, glucocorticoids and Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) are most commonly implicated.[21] Drug induced harm is also a potential cause of suicides among the elderly, and is the second leading cause of death from injury in the > 65 year olds in BC.[22]

Interventions

Poisoning prevention requires a comprehensive approach that includes interventions targeted to specific populations at risk, as well as the broader public. Areas of intervention include treatment advice from poison centers, public education, modification to the environment, regulation through legislation and engineering of pharmaceuticals and household products.

Poison Control Centers

Poison control centers have a role to play in all stages of poison injury prevention. Specialists at poison centers provide consultations to medical personnel about the management of their patients, provide information to the public about whether treatment is required for toxic exposures, provide public education and collect data. Cost-benefit analyses have found poison centers to be cost effective and decrease hospital length of stay.[23-26] For each dollar spent on Poison Control Center more than seven dollars were avoided in unnecessary healthcare charges.[26] These efficiencies result from diverting unnecessary use of the health system and improved management of poisoned patients. However, there are no studies that examine the effect of poison center advice on morbidity and mortality.   There have been very few studies that evaluate the impact of poison center public educational interventions, and the ones that have been conducted failed to show that there was a significant impact on public behaviour.[27]

Education

Educational interventions delivered in the clinical setting have been studied, but their efficacy has been difficult to determine. These interventions typically involve increasing

awareness of risks and providing information about preventative measures that can be taken at home.   When parents of suicidal teens were educated during their emergency room admissions following suicide attempts about means restriction (i.e. controlling access to medications and removing firearms from the home), they were 16.75 times more likely to restrict means than those parents who did not receive this intervention.[28] However, other studies have failed to demonstrate the efficacy of these interventions in reducing the incidence of poisoning. Of note, these interventions have been cited as having weak designs and/or unclear outcome measures.[29-32]

There is evidence to support educational interventions that are delivered with broader participation in the community. These interventions are often delivered by multidisciplinary teams including pharmacists, nurses, and public health workers.   A community based poison prevention program targeted at mushroom poisoning in Poland, resulted in increased knowledge of poisonous mushrooms and decreased intentions to eat wild mushrooms. The effects on morbidity or mortality; however, were not measured in this study.[33] A randomized control trial found that a community-based educational campaign was an effective means to increase the use of cabinet locks and poison information telephone stickers.[34] Other studies however, found that community-based educational interventions ranging from nurse home visits to radio/television campaigns have failed to show a significant reduction in paediatric poisonings.[35-40]

Engineering

Packaging

Reforms to packaging of prescription drugs have been successful in North America. Interventions that are supported by evidence include child resistant, unit dose and size limited packaging. Child resistant packaging (CRP) is the public health intervention that is supported robustly within scientific evidence. CRPs generally require two dissimilar motions to open the container. They must also comply with at least one of the Canadian Standard Association, European or the United States federal regulations standards. These containers are currently mandated under the Food and Drug Act in the United States. Although efficacy data is limited in Canada, a 40-45% decrease in paediatric unintentional Acetyl Salicylic Acid (ASA) ingestion was tracked following the introduction of child resistant packaging laws[41] and it has been estimated that

similar laws have resulted in a 45% reduction in childhood deaths from prescription drugs annually.[42]

Unit dose packaging includes both blister and strip packages. Following legislation mandating unit dose packaging for iron supplements in the United States, reductions in both the rate of unintentional paediatric iron overdose and mortality were observed.[43] Additionally, since suicidal behaviour is associated with impulsiveness[44] and unit dose packaging decreases the rate at which medications can be accessed, it may also decrease poisoning suicides. Means restriction has been demonstrated to be an effective means of decreasing suicidal behaviour.[45] Blister packaging is also a strategy that is employed to decrease unintentional overdoses in the elderly.

Limiting the package sizes of potentially dangerous medications has met with mixed success. Laws limiting acetaminophen pack size in the United Kingdom resulted in the average total ingested dose of acetaminophen falling by 2 grams for overdose patients presenting to medical attention, but there was no change in the number of patients presenting with massive ingestions of over 50 pills.[46] In Canada when place of sale restrictions on acetaminophen pack size were lifted in 1999, there was no effect on the rate of reported hospitalization related to acetaminophen toxicity.[47] Dose restrictions for iron tablets and pediatric preparations of acetaminophen are still legislated in Canada.

Taste aversion

There is limited evidence to support adding bittering agents to household and automotive products as a means of decreasing both unintentional and intentional consumption. Studies have shown that a common bittering agent (i.e., denatonium benzoate) rendered both windshield fluid and ethylene glycol unpalatable to a panel of tasters[48] and when added to juice and detergent solutions the total amount ingested by children was significantly reduced compared to control solutions without bittering agents.[49-50] However, a law in Oregon (United States) that mandated that bittering agents be added to windshield fluid and antifreeze did not have a significant effect on the number of reported toxic alcohol cases reported in the state.[51] Bittering agents are not currently mandated in Canada though they are used in some products.

Formulation

There is limited evidence to support changing the formulation of pharmaceuticals and household products to decrease unintentional injury. In one Center, admissions for paediatric iron overdoses decreased after the formulation was changed to increase pill size making them difficult to swallow and chew.[52] Another study demonstrated that limiting the concentration of caustic substances to 5% in household cleaning products resulted in a significant reduction of the severity of esophageal burns and frequency of stricture formation following ingestions.[53]

Environment

Storage

Safe storage of medications and household products is important for preventing unintentional exposures. Most unintentional pediatric ingestions occur at home and during the day, when the substances are stored at a level that does not require the child to climb.[54] A widely distributed Australian survey found between 9-30% of the time, parents do not immediately store medications or household products out of reach of their children. They were more likely to store products out of reach when they perceived the substance to be more toxic; however, their understanding of the relative toxicity of different substances was poor. This was a significantly larger issue for household products rather than pharmaceuticals.[55]

Another important source of exposure are hazardous materials stored in inappropriate containers. A study from British Columbia found that there were 307 cases reported to Poison Control over a one year period concerning ingestions of chemical products transferred to commercial food or beverage containers. These included two fatalities and five cases who developed serious symptoms; the majority of these exposures occurred in adults.[56]

This suggests that there is room for improvement for both educating parents about the potential harms associated with household products and for the importance of proper storage. Educational campaigns have included messaging regarding safe storage across Canada, with slogans such as 'put poison in its place' and 'children act fast'; however, these have not been evaluated in a systematic way to determine their effect.[57]

Warning labels/Hazard symbols

In Canada, hazard symbols are mandated on certain household products under the Hazardous Products Act. No studies have evaluated the effectiveness of this intervention. Studies on warning labels – colourful stickers that warn of contents – have demonstrated either negligible effects or negative effects on paediatric handling of hazardous material. The colourful nature of the labels likely serves to attract young children to the material.[58-59] Warning stickers are generally, not a recommended intervention.

Other interventions

Interventions aimed at prescription opioids

The increasing incidence of poisoning has been largely tied to the proliferation of opioid prescriptions in the last two decades. The response to the prescription opioid epidemic, like most public health problems, requires a multi-factoral approach that includes prevention, drug monitoring, education, treatment and enforcement. A full discussion of these interventions is beyond the scope of this chapter; however, prescription drug monitoring programs (PDMPs) and opioid dosing guidelines deserve special mention as they have both recently been shown to be effective interventions.

PDMPs are programs that collect and report data on the prescription of controlled substances. They have been used to identify both potential drug abusers and inappropriate prescription patterns. They can help to target both patients and physicians for educational interventions. Proactively contacting physicians about their drug prescription patterns drawn from PDMPs was found to decrease controlled substance prescribing.[60] Additionally, PDMPs have been associated with a decrease in unintentional opioid ingestions as well as hospital admissions for opioid treatment, however an effect on opioid overdose mortality has not been observed in studies. PDMPs have been implemented to varying degrees in Canada.[61] For instance in British Columbia, all opioids (except Tylenol #3) and many sedatives must be prescribed on triplicate prescription pads, however these are not monitored proactively. The College of Physicians and Surgeons of BC typically uses this information in a reactive fashion when concerns have been raised about the prescription practices of a particular physician.[62] In Ontario, the Narcotics Safety and Awareness Act (2010) went into effect in 2011 and mandates that all prescriptions of controlled substances be entered into a central database, which automatically generates warnings for pharmacists if there are multiple prescribers or if there are abnormal prescribing practices. However the onus is on the pharmacist to interpret these warnings and to contact the physicians should there be an issue with their prescribing practices.[63] The effect of this law has not yet been quantified.

Restrictive opioid dosing guidelines also appear to be an effective means of reducing opioid prescriptions. In 2007, Washington State (United States) introduced new opioid prescription guidelines that emphasized mortality risks associated with high dose opioid therapy.[64] Following the introduction of these guidelines, the proportion of patients on high dose or long acting opioid fell by 35% and 27%, respectively and there was a 50% decrease in the number of opioid related deaths in this population.[65]

Interventions aimed at illicit drug misuse

Decreasing injury related to illicit substance abuse requires many strategies. The four pillars approach which includes prevention, harm reduction, treatment and enforcement has been successfully employed in countries such a Switzerland, Australia and Germany and in cities

like Vancouver in Canada. A full discussion of all four pillars of the approach is beyond the scope of this chapter, however harm reduction deserves special mention. Harm reduction accepts that abstinence may not be a realistic goal for many illicit substance users and employs interventions such as needle exchanges and supervised drug injection sites that aim to increase the health of substance users by limiting the harms associated with drug use. *Insite*, the first medically supervised safer injection site in North America, opened in Vancouver (Canada) in 2003.   This initiative has largely been considered to be a successful example of a harm reduction principle.   Use of the facility has been shown to decrease needle sharing and increase safe injection practices such as using sterile water and swabbing prior to injection. It has also been associated with increased referral to detoxification and treatment services. Importantly, there have been no deaths in the facility since it opened, with patients quickly receiving anti-dotal therapy following potentially dangerous opioid overdoses.[66]

Overdose response programs, which involve distributing naloxone and providing overdose training to at risk individuals have recently been started across Canada. Examples of Canadian naloxone distribution programs include Prevent Overdose in Toronto (POINT) and Take Home Naloxone (THN) in BC. Multiple pilot studies in the United States as well as reviews of Canadian programs have demonstrated the

success of these programs at limiting harm by reversing overdoses in the community.[67-70]

Conclusion

Significant progress in poison prevention was made in the second half of the twentieth century largely due to the advent of legislation governing the packaging and formulation of potentially toxic pharmaceuticals and industrial materials. Other interventions have been met with varied success, but quantifying their success has been a challenge due to the limited nature of available evidence. Data pertaining to the Canadian experience has been particularly limited. Given that Canadian rates of poison injury have increased significantly since the turn of the century, it is important that data collection systems be developed to accurately define the severity of problem both before and after targeted interventions. Although individual poison centers and other agencies collect their own data in Canada, currently, this data is not aggregated in a meaningful way. It would be useful for comparative analysis of interventions if an estimate of the total costs of all poisoning across

Canada were generated and reported on an ongoing basis. A standardized national poison data collection system should be developed to facilitate this process and inform guidelines and best practices for reducing poisoning injury in Canada.

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4.4.1

Falls
Older Adults

Introduction

The risk of falling and suffering an injury from a fall increases with age. One in three adults over the age of 65 and one in two adults over the age of 80 will fall at least once per year.[1] Older adults who have fallen once, are two to three times more likely to fall again.[2] Falls are the leading cause of injury for older adults and can have a devastating and lasting impact resulting in injury, chronic pain, reduced quality of life and in severe cases, death.[3]

Almost half of older adults who fall experience a minor injury, while 5 - 25% will experience a serious injury.[4] The rate of fall-related injuries for older adults is 9 times higher than for younger populations.[5] Falls are the cause of more than 60% of head injuries and over 95% of hip fractures in older adults.[3,6] Approximately 20% of older adults will die within the first year following a hip fracture, and 50% will never regain their pre-fracture functioning.[3] Forty percent of all nursing home admissions are a result of a fall.[7]

In 2009/2010, over 256,000 Canadian older adults reported experiencing a fall-related injury; a 43% increase since 2003.[8] Higher rates were seen among females and those 75 years and over.[8] Half of the falls that resulted in hospitalization occurred in the home and 17% occurred in residential institutions.[9] Fall-related hospitalizations account for approximately 85% of all injury hospitalizations for older adults.[9] The average length of stay for an older adult who was hospitalized after a fall in 2010/2011 was 22 days; nine days longer than the average stay for a senior admitted for any cause.[9] From 2003-2008, there was a 65% increase in the number of deaths due to falls.[10]

In 2010, the direct costs associated with older adults' falls (aged 65 years and older) was estimated at over $3 billion.[11] The impact of older adults' falls goes well beyond health and medical costs. There are significant social and emotional costs to older adults and their families. In 2011, approximately 15% of the Canadian population was 65 years or older.[12] By 2035, this number is expected to double and reach 10.47 million.[12] As the Canadian population ages, fall prevention becomes an even more important public health issue requiring a collaborative, multi-sectoral approach to improve and maintain the quality of life and independence of older adults.

Fall Risk Factors

A fall can be defined as "unintentionally coming to rest on the ground, floor or other lower level with or without injury".[13] Falls are not random, unpreventable events. A fall occurs when an individual is unable to regain his or her balance. Many risk factors have been identified that directly or indirectly impact the ability to maintain and recover balance. While some factors can be changed or compensated for, such as muscle weakness, diet or poor vision, others cannot be modified, such as gender, age or genetics.[13] Fall risk factors can be grouped into biological, behavioural, social/economic and environmental areas.[13] When 2 or more risk factors are present at the same time, the risk of falling increases.[14] As the number of risk factors increases, so does the risk of falling and suffering significant injuries due to the compounding effect of risk factors.[14] Falls are not a normal part of aging and can be indicative of a change occurring for the individual, that needs to be investigated.[15] Understanding what puts a person at risk for falls is a critical step in reducing the number of falls and fall-related injuries.

Biological risk factors relate to the human body and are influenced by the natural aging process and the effects of chronic or acute health conditions.[13] Changes in visual acuity and the development of conditions such as cataracts, macular degeneration and glaucoma can affect the risk of falling.[16] Balance and gait deficits and diseases such as stroke, dementia, Parkinson's, diabetes, depression, arthritis and cardiovascular disorders can also increase the risk of falls.[13] Although osteoporosis does not affect the risk of falling, it does increase the risk of fractures from a fall.[17]

Behavioural risk factors are characteristics or actions that increase the likelihood of a fall.[13] A previous fall is one of the strongest predictors of a future fall.[16] Fear of falling and use of psychotropic medications including those taken for sleep, or in the treatment of depression and anxiety can increase the risk of a fall.[18] Engaging in risky behaviors and lack of exercise are also risk factors. Recent estimates show that only 13% of Canadians, 60 to 79 years of age are meeting Canada guidelines for physical activity.[19] Wearing inappropriate footwear or clothing, poor hydration and nutrition can also increase the chance of a fall.[13]

Social/Economic factors can increase the likelihood of having chronic health conditions that are associated with an increased risk of falling or being injured by a fall. These factors may include low income, low education level, lack of supportive networks, inadequate housing and lack of access to appropriate services.[13]

Environmental hazards can be found everywhere; in the home, in the community, and in facilities. Inadequate lighting, poorly designed stairs and furniture, lack of handrails or grab bars, cluttered rooms and pathways, uneven surfaces and weather conditions may all increase the risk of falls.

Falls can result from the interaction between the individual's physical limitations, mobility, risk taking and exposure to environmental hazards.[20, 21]

Best Practices for Fall Prevention

Research has shown that the most effective fall prevention strategies are those that use a multifactorial approach and are tailored to the risk profile of the individual and setting.[16] Best practice guidelines such as those developed by the American and British Geriatric Societies[22] and the National Institute for Health and Care Excellence (NICE)[23] are available to inform assessment and intervention programs.

The *Canadian Falls Prevention Curriculum*©[24] offers a two-day workshop and a 5 week online course to provide practitioners with the knowledge and skills needed to apply a public health approach to the prevention of falls and fall-related injuries. *Safer Health Care Now! Fall Prevention/Injury Reduction Getting Started Kit*[25] is also a valuable resource for healthcare professionals, containing fall-related tools and resources that reflect long-term, acute and home health care practice.

Fall Risk Assessment

All older adults should be asked annually by their primary healthcare provider if they have fallen in the past year. Those who have fallen more than once, sustained an injury from a fall or have balance or gait difficulties should be seen for a comprehensive multifactorial fall risk assessment to identify the factors that place them at risk for falling and to help guide the most appropriate interventions.[16]

Multifactorial Interventions

Interventions that target multiple risk factors have been found to be highly effective in reducing falls and the risk of falling.[16] Interventions should reflect best available evidence and address the risk profile of the older adult. Recent research has shown the importance of settings-based interventions, whether that be in the community, acute care or residential facilities.[16]

Behaviour change is the common goal for any intervention, regardless of the setting.[13] Most often it will be the behavior of the older adult that is expected to change, however it may also be the behavior of others who are responsible for the older adult's safety and well-being. It is important to understand how falls are viewed and how confident people are in being able to prevent falls.

Education should be a component of any falls prevention program. It is important for primary and secondary prevention and for implementing and sustaining the use of fall prevention strategies.[16] Fall prevention education should increase awareness about the nature and importance of falls in older adults, increase knowledge that prevention is possible and promote learning about fall prevention strategies.[13]

Finding Balance is a public awareness campaign that was originated in Alberta and has now expanded to other regions in Canada. The campaign educates and raises awareness among older adults and the general public about falls and focuses on real life strategies older adults can implement to prevent falls and remain independent.[26] The campaign is evaluated on an annual basis and consists of a website with information for older adults and practitioners, distribution of brochures and posters, TV and radio commercials, municipal proclamations and support of local events.[26]

Many programs include opportunities for older adults to access fall prevention resources and information. For example, the SAIL (Strategies and Actions for Independent Living) program aims to promote the independence and quality of life for home support service clients by reducing their risk of falling and sustaining an injury, and to integrate a comprehensive approach to fall prevention into regular practice.[27] Smart Moves Toolkit provides information to older adults on how to prevent falls focusing on bone health, exercise, medication management and home modifications.[28]

Interventions for Older Adults in the Community

Exercise Programs

Exercise should be a component of any multifactorial intervention.[16] Exercises that target balance, gait and strength have been shown to be the most effective and can be delivered in a group setting or performed individually.[29] Exercise should provide a moderate to high

challenge to balance and be ongoing and of sufficient duration and intensity to be effective. [30] Exercises should be related to day-to-day activities so older adults can see how the activity relates to their daily routines, such as going up and down stairs or getting in and out of the car. [31]

Medication Review and Modification

Higher doses of medications, use of multiple medications, and certain classes of medications such as psychotropics have been shown to increase the risk of falling. [13,16] Drugs that increase the chance of bleeding or reduce bone density can increase the risk and severity of an injury from a fall. [32] Once yearly, older adults should have all their medications including prescription, over-the counter, vitamins, minerals, herbs and other natural health products reviewed and modified if appropriate by a doctor, nurse practitioner and/or pharmacist. [33]

Nutrition and Bone Health

It is estimated that 35 percent of older adults living in the community suffer from malnutrition. [34] Adequate nutrition and hydration are essential for good health and should be encouraged in fall prevention programs. [13] To optimize bone health, Osteoporosis Canada recommends regular active weight bearing exercises, 800-2000 IU of vitamin D daily for adults over 50 and a total intake of 1200 mg of calcium daily from food and supplements. [33] Research suggests that vitamin D in combination with calcium reduces fall risk, particularly for those older adults deficient in vitamin D. [35]

Vision Management

Older adults should be seen for annual vision assessments. Conditions like glaucoma, cataracts or wearing glasses with an incorrect prescription can limit vision and increase the risk of falling. Using single lens distance vision glasses in place of multifocal glasses when outdoors has been shown to be effective in reducing the number of falls. [37]

Foot and Footwear Management

Foot problems such as bunions, toe deformities and deformed nails, are common in older people and can affect balance and the way they walk. Shoes with large contact surfaces on the soles, with closed, low, wide heels have been shown to provide more stability. [13] Wearing anti-slip shoe devices in icy conditions have also been shown to reduce falls. [38] Walking in bare feet, stocking feet or floppy slippers with an open heel should be avoided.

Environmental Management

Identifying and addressing hazards in the environment is another component of an effective fall prevention strategy. Home hazards should be assessed by a trained individual to facilitate removing or modifying hazards, installing devices like grab bars in bathrooms and improving lighting.[16] Making communities "age friendly" and stronger collaboration with those who design, build and regulate safe environments for older adults will facilitate the health and well-being of older adults.[39]

Health Management

Older adults should be seen annually to assess and treat conditions that may adversely affect gait, balance, muscle strength, bone density, cognition, vision, hearing and touch. Appropriate treatment of medical conditions such as postural hypotension and cardiovascular disorders have been shown to decrease falls.[16] Medical assessments are particularly important following a fall to identify underlying factors that may contribute to future falls.

Assistive Devices and Other Protective Equipment

There are a variety of devices to assist older adults with gait and balance. It is important that older adults understand how to properly use the equipment and how to incorporate the devices into their daily activities. Equipment should be checked for proper fit and condition and barriers to access and use be addressed.[13]

Minimizing the impact of falls acknowledges that not all falls can be prevented. Hip protectors have been designed to reduce the impact to the hip from a fall. When worn correctly, hip protectors have the potential to reduce the risk of fall-related hip fractures.[40] Low stiffness flooring is another strategy to reduce the risk of an injury from a fall. A benefit of this intervention is that it is not dependent on compliance of the older adult.[13]

Intervention in Residential Care Setting

Older adults living in residential settings tend to have more complex health problems, take more medications and have more mobility issues putting them at greater risk of falling and sustaining an injury.[13] Research investigating single and multifactorial interventions have had mixed results.[16] Interventions for this population typically focus on reduction of psychotropic medication, use of appropriate assistive devices and other protective equipment such as hip protectors, environmental assessment and modification, staff education and training, vitamin D supplementation, exercise, removal of physical restraints and vision referral and correction.

Interventions in Acute Care

The incidence of falls in acute care has been reported to be three times higher than in the community; however, there has been less research in this setting.[22] Current evidence indicates that targeting multiple risk factors and supervised exercise are effective for those older adults in hospital for 3 weeks or more.[41] Use of physical or chemical restraints is not advised and in some cases may increase the risk of falls.[42] Educating patients on fall risk and establishing senior friendly processes or universal fall precautions may also reduce the number of falls.[25, 43] Accreditation Canada has identified Fall Prevention/Injury Reduction as a Required Organizational Practice, an essential practice that organizations must have in place to enhance client safety and minimize risk.[44]

Novel Fall Prevention Approaches

Mobile fall prevention clinics travel to different locations where older adults gather, such as community Centers and housing for older adults. This unique approach allows older adults the opportunity to meet one-on-one with a variety of healthcare practitioners including registered nurses, pharmacists, dietitians, kinesiologists, occupational therapists, and physiotherapists for 15 to 20 minutes.[45] Various aspects of the senior's fall risk status are assessed and interventions discussed. A detailed report of the recommendations is provided to the participant and then sent to the primary physician and referring health professionals.

Paramedics and firefighters may also be involved in falls prevention. Their role may include education and awareness raising, fall risk assessment, home safety assessment, demonstrating how to safely get up from a fall and linking to community and health resources.[46]

Conclusion

The personal, economical and societal impact of falls among older adults is substantial. As Canada's senior population continues to grow, falls represent an increasing public health concern. Preventing falls is a shared responsibility and can only be achieved through continued multisectoral collaboration. As Ganz et al. (2008) states "It takes a village of

stakeholders working together to prevent falls and fall risk, tasks that no one stakeholder can accomplish alone."[47]

Additional Resources for Falls Prevention for Older Adults

Canadian

Canadian Falls Prevention Curriculum is a training curriculum for those working to address falls and fall-related injury prevention for older adults. It offers a two-day workshop and a 5 week online course to provide practitioners with the knowledge and skills needed to apply a public health approach to the prevention of falls and fall-related injuries. https://www.uvcs.uvic.ca/Course/Canadian-Falls-Prevention-CurriculumC-An-E-Learning-Course/HPCF215/

Center for Hip Health and Mobility from British Columbia aims to deliver research solutions to prevent, detect, and treat falls related hip fractures and arthritis using novel tools and techniques, cost-effective interventions and advanced surgical solutions. http://www.hiphealth.ca/

Finding Balance is a falls prevention program for older adults developed and coordinated by the Injury Prevention Center (formerly the Alberta Center for Injury Control & Research) in partnership with health professionals across the province. The program consists of a public awareness campaign, practitioner toolkit, falls prevention network and an online falls risk assessment and management algorithm. *The Finding Balance program* provides older adults and practitioners with the latest information and resources to help prevent a fall. http://www.findingbalancealberta.ca/

Ontario Falls Prevention Community of Practice brings together multiple stakeholders including planners, researchers, policy makers, front line health care workers, older adults and caregivers who have an interest in falls prevention. The goal is to improve the health and healthcare of older adults in Ontario by sharing falls prevention knowledge, research, best practices and resources. http://seniorshealthknowledgenetwork.com/community/falls-prevention-community-practice

Primary Care Fall Prevention Multimedia Training Package includes written resources for physicians and information to give their older adult patients, as well as a video based on a case study representing frail elderly in the community. The resources reflect the recommendations of the American and British Geriatric Society's fall prevention guidelines for physicians and build on existing practices through an examination of compounding effect of common health conditions. http://www.gpscbc.ca/psp-learning/chronic-disease-management/tools-resources

Public Health Agency of Canada has developed several publications to help older adults and their families learn more about preventing falls, home safety, stair safety, what to do after a fall, etc. http://www.phac-aspc.gc.ca/inj-bles/index-eng.php

Safer Health Care Now! Fall Prevention/Injury Reduction Getting Started Kit was prepared by the Registered Nurses' Association of Ontario in partnership with Safer Health Care Now! and the Canadian Falls Intervention Faculty. It contains fall-related tools, resources and experiences that reflect long-term, acute and home health care practice. http://www.saferhealthcarenow.ca/en/interventions/falls/pages/default.aspx

Seniors' Falls in Canada, Second Report, produced by the Public Health Agency of Canada, provides policy makers, researchers, community programmers and practitioners with current national information to prevent falls among Canadians aged 65 and over. http://www.phac-aspc.gc.ca/seniors-aines/publications/public/injury-blessure/seniors_falls-chutes_aines/assets/pdf/seniors_falls-chutes_aines-eng.pdf

Technology for Injury Prevention in Seniors is a unique university-community partnership for developing new technologies to prevent falls and fall-related injuries in older adults. Research is conducted on topics surrounding older adults falling such as effectiveness of compliant flooring, improving hip protectors, wearable sensors to record falls and video capturing of falls to determine why and how falls occur in older adults. http://www.sfu.ca/tips/research/

American

American Geriatric Society/British Geriatric Society Guidelines, updated in 2010, assist healthcare professionals in their fall risk assessment and management of older adults who have fallen or are at risk of falling. http://www.guideline.gov/content.aspx?id=37707#Section396

Centers for Disease Control and Prevention provides facts, data, publications and resources for older adults. The CDC also provides the STEADI toolkit for healthcare providers who see older adults in their practice who are at risk of falling or who may have fallen in the past. The STEADI Tool Kit gives healthcare providers the information and tools they need to assess and address their older patients' fall risk. http://www.cdc.gov/homeandrecreationalsafety/Falls/steadi/index.html

Falls Center of Excellence was created to ensure the independence, safety and well-being of older adults through fall prevention. Their mission is to provide leadership, create new knowledge and develop sustainable programs for older adults and their families, professionals, program administrators and policy makers. http://stopfalls.org/

National Council on Aging provides a range of resources for professionals, older adults and care providers as well as policy advocates. The Falls Free Initiative led by the NCOA includes

the creation of national action plan; National and State Coalitions along with numerous advocacy, awareness, and educational initiatives; and community infrastructure building to reduce falls among the elderly. http://www.ncoa.org/improve-health/falls-prevention/

International

National Institute for Health and Care Excellence (NICE) offer evidence-based guidelines for older adults on preventing falls. Those aged 50-64 admitted to hospital and judged to be at higher risk of falling are also covered in the guidelines. Information for the public is also included. http://guidance.nice.org.uk/CG161

Prevention of Falls Network Europe (ProFaNe) is an international online community supporting health care providers with evidence based research, forums and online forums to post questions and connect with practitioners around the world. There is currently a small fee to join. http://www.profane.eu.org/

Prevention of Falls Network for Dissemination (ProFouND) is a European network working towards bringing together relevant stakeholders to consolidate fall prevention guidelines and facilitate the communication between service providers and key stakeholders at the national, regional or local level to ensure effective implementation and reach. http://profound.eu.com/

Queensland Health from Australia has created Stay on Your Feet to provide older adults and professionals information to keep older adults healthy, active, independent and on their feet. A toolkit of resources, the Otago Exercise Programme, and recommendations for different care settings are included. http://www.health.qld.gov.au/stayonyourfeet/

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4.4.2

Falls
Children

Introduction

Falls are the leading cause of medically-attended injuries for Canadian children at all ages except 15-19 years when motor-vehicle related injuries dominate.[1] Fall-related injuries are of particular concern for young children as they account for half of all hospitalizations and can result in negative long-term outcomes because of serious injury to the head and/or neck.[2] Canadian statistics mirror those of most other developed nations (e.g., US, European Union) [3,4] and have led to calls for improved surveillance and prevention initiatives specific to childhood falls.[5,6,7]

Not surprisingly, the nature and scope of children's fall-related injuries varies with developmental level. For young children less than 6 years of age, many fall injuries occur in the home. School-age children spend much of their time away from home and, consequently, many fall injuries occur when they are involved in play and/or sports related activities outside the home. The playground, in particular, has been targeted in prevention initiatives for school-age children and will be a focus in this chapter. The following sections consider fall risks and prevention strategies for children at each developmental stage. It must be acknowledged; however, that the research in this area is limited and there are few proven prevention programs. Moreover, systematic reviews on effective childhood injury prevention initiatives often do not include falls when different types of injuries are considered.[8,9] Thus, this review considers some initiatives that are promising but still being evaluated.

Young Children – Fall Injuries In the Home

For Canadian children younger than 5 years of age, falls are the most common cause of hospitalization (i.e., accounting for about 50% of hospitalizations annually), and treatment costs are an estimated $447 million annually or approximately $238 per child.[10] Heterogeneity in study design makes it difficult to identify risk factors for fall injuries, but two that seem to emerge consistently include being male and of low socio-economic status. [11] Fall injuries are more frequent among boys than girls, and children living in poverty compared to those in higher economic groups.

Some types of falls are much more common than others. For example, falls from windows are rare but often result in mortality, and typically involve caregivers misperceiving that window screens are a safety barrier. In contrast, the top three mechanisms of home fall injuries for young children that often result in emergency department visits involve falls on stairs, from furniture (e.g., infants rolling off change tables, toddlers falling when jumping on the bed or climbing up a bunk bed), and same-level stumbles/slips/trips. These top three mechanisms are evident from Ontario-based fall injury data (e.g., INTELIHEALTH12, Ministry of Health and Long Term Care, 2006-2008)[13] as well as national data (Canadian Hospitals Injury Reporting and Prevention Program, CHIRPP).[14] Thus, targeting these common mechanisms should be a priority in fall prevention initiatives for young children.

Despite the burden of childhood falls, there is limited understanding of best practices for prevention, largely because of how few intervention-focused studies have addressed this issue. Kendrick et al. (2008) completed a systematic review and meta-analysis of all studies on falls in children (n = 13 studies) and concluded that there is a "dearth of appropriately designed studies to test the effectiveness of … interventions to improve fall-prevention practices and in reducing injuries due to falls".[15] In fact, the only home-environment intervention for which there was evidence indicating effectiveness to reduce the incidence of falls among young children was the use of stair gates.[15] It is important to note, however, that the high cost of stair gates and the difficulty of installing the device can be barriers to use. For example, evidence suggests usage is improved and injuries reduced when the stair gate is provided in the context of a face-to-face home safety education visit and it is actually installed for the parent;[16,17] simply providing this equipment without cost and leaving it to the parent to install it does not increase usage or reduce injuries.[18] Thus, it seems that the barrier to usage of stair gates is not simply financial. Unfortunately, too few studies have been conducted to advise on how best to impact parents' attitudes and beliefs so that they see the value and necessity of utilizing stair gates.

One approach to the prevention of falls at home that is currently being evaluated in several communities in Ontario is the ALTER for Child Safety program developed by this author and being implemented in collaboration with several Public Health Units (i.e., Niagara, Durham, Wellington/Dufferin/Guelph and Haldiman/Norfolk). This program is a core component of

the Supervising for Home Safety program that was found in a randomized controlled trial to be effective in shifting caregivers' attitudes towards supervising young children more actively.[19] Most importantly, this program also was found to positively improve caregivers' overall supervision practices not specific to a particular type of injury risk, with effects persisting for at least one year.[20] In the ALTER for Child Safety program, caregivers are taught the mnemonic ALTER (see description in the textbox) and encouraged to apply it to reduce their child's risk of fall injuries at home, especially on stairs and furniture. Hence caregivers are alerted to common fall risks for children in the home (e.g., jumping on the bed) but they are not told what they should be doing to manage these. Rather, the ALTER mnemonic provides the flexibility for them to problem solve to address this risk factor however they prefer. Tailoring (i.e., making an intervention individually relevant) is important because it has been shown to improve effectiveness of programs targeting behaviour change.[21] An ongoing evaluation is expected to be completed in 2016; further information about the program is given in the callout box and can be obtained from the author or the website www.ALTERforChildSafety.ca.

> **The mnemonic ALTER provides parents a tool to facilitate problem solving to reduce risk of injury for their child when they cannot watch the child continuously.**
>
> **A** = change your ACTIVITY or that of your child
>
> **L** = change your LOCATION or that of your child
>
> **T** = change the TIMING of what you want to do
>
> **E** = modify the ENVIRONMENT to reduce risk of injury
>
> **R** = use your RESOURCES (e.g., people who can help, online safety tips, etc.)

School-Age Children - Fall Injuries on Playgrounds

Playgrounds have been identified as a major location for injuries to Canadian children.[13] Approximately 28,000 children experience a medically-attended playground-related injury annually in Canada, with most of these affecting elementary-school aged children. Falling from playground equipment is particularly likely to require medical treatment and is the most common mechanism of injury, accounting for about 75% of all medically-attended playground injuries.[22-25] Common types of equipment associated with severe fall injuries include climbers, slides, and swings.[26] For school-age children, injuries are often to the extremities, with fractures being the most common diagnosis.[27] Fracture severity is much higher from falls from playground equipment compared to those from standing height falls.[28,29]

Strategies to prevent playground injuries in Canada often emphasize environmental modifications and compliance with the design, installation and maintenance standards set by the Canadian Standards Association (CSA) for playgrounds and equipment. These CSA standards were first developed in 1990 and are updated periodically. The standards address equipment height, surfacing of playgrounds, entrapment angles, and other safety issues. Significant reductions in playground injuries have been found after replacement of equipment to CSA standards.[30] In addition, children at lower socio-economic schools in the city of Toronto were found to be at increased risk of playground injury on non-CSA conforming playgrounds.[31] With equipment replacement, these socio-economic disparities in playground injuries were eliminated. Surface type is also associated with severity of playground injury.[32] A randomized controlled trial of school playgrounds with CSA approved equipment, found that granitic sand playground surfaces reduced the risk of arm fractures from playground falls when compared with engineered wood fibre surfaces.[33]

More about the "ALTER" child safety program

Although the current focus of the program is on fall prevention, ALTER could be applied to most child injury topics. A key benefit of the ALTER program is that the caregiver can tailor prevention strategies to meet their individual needs based on their home environment, personal values and preferences, and their child's individual behavioral tendencies; the ALTER mnemonic provides the flexibility for them to problem solve to address any injury-risk factor however they prefer. Other important aspects of ALTER include: it does not require a high level of literacy; no specific equipment is needed to implement it; and parents report it to be a useful tool that is easy to remember and broadly applicable to many injury-risk situations at home.

 A high proportion of playground injuries result from inappropriate play practices when using the equipment.[27] Hence, blending environmental modifications with behaviour-change programming will likely maximize reductions in fall injuries on playgrounds. It is important, therefore, that children are made aware of the potential seriousness of fall-related injuries on playgrounds so that they can adjust their behaviours accordingly in the absence of direct supervision.

Given the desire to target and reduce behaviors that can lead to serious fall injuries on playgrounds among children generally, there is a need for evidence-based intervention programs that can be easily administered in community settings with groups of children and by adults with little or no research training. The *Cool 2 Be Safe* program was developed to address this need.[34] Based on a literature review, this appears to be the only evidence-

based, group-administered program that addresses the specific issue of children's fall-risk behaviors on playgrounds.

The *Cool 2 Be Safe* program: (1) focuses on common recreational activities that elevate risk of serious fall injuries from playground equipment; (2) targets children who are 6 through 10 years of age (grades 1 through 6), who are the children most at risk for serious playground injuries; and (3) is based on scientifically rigorous studies that have identified particular activities that alter children's injury-relevant beliefs and predicts reduced fall-risk playground behaviours.

There are four lessons that children complete as part of the *Cool 2 Be Safe* program (see Text Box 3) and each is based on past research that resulted in peer reviewed publications.[35-42] This research confirms that each lesson has a positive impact on children's beliefs about injury on playgrounds (i.e., shifts their beliefs to recognize personal injury vulnerability, consider potential injury severity, and accept responsibility for the preventability of injury) and reduces children's fall-risk behaviours on playgrounds. Note that combining these successful activities into one program maximizes the likelihood of a positive impact on each participant. Initial evaluation of the program revealed positive changes in injury risk beliefs that have been shown to predict reduced fall-risk behaviors on playgrounds. Thus, the *Cool 2 Be Safe* community program holds much promise as a means of addressing the issue of fall-risk behaviors by elementary-school children on playgrounds.

More about the "COOL 2 BE SAFE" program

In the Cool 2 Be Safe program, over the course of four lessons, children participate in four different activities within a group situation. Extensive training materials and resources (e.g., DVDs, webinar session) are provided to the program-delivery staff who need to be experienced in working with children but do not need any formal research training.

The first lesson aims to enhance children's hazard awareness skills, which increases perceived vulnerability and reduces risk taking.[35,36,37] The second involves an induced hypocrisy manipulation in which children publically advocate for avoiding fall-risk behaviors that they previously performed on playgrounds; induced hypocrisy is based on Dissonance Theory[38] and evidence supports that this approach results in reductions in children's fall-risk behaviors on playgrounds.[39] A third lesson involves exposing children to injury stories told by other children in which children engaged in fall-risk behaviors and then experiencing a fall that resulted in a serious injury (e.g., broken bone, head or neck injury); Morrongiello and Matheis[40] found that this increased children's ratings of injury vulnerability and severity and predicted reductions in fall-risk behaviors on playgrounds. Finally, the fourth lesson targets peer communications and aims to teach children how to communicate with peers about risk and safety;[41] this approach has been shown to be quite effective at evoking behavior change.[42]

In addition to programs specific to playground safety, a few other programs target injury-risk behaviors more generally and include some information that addresses fall risk on playgrounds. These include: *Think First for Kids* which is a comprehensive brain and spinal cord injury prevention program for children in grades K to 8 and includes developmentally appropriate classroom interactive activities and homework assignments[*] and *Risk Watch* which is a comprehensive injury prevention program developed by the US National Fire Protection Association (NFPA) and adapted for use in Canada schools by SmartRisk (now part of Parachute) and that provides curricula information about safety for grades 1 – 8.[†] Evaluation of the Think First program among children in grades 1-3 has shown improvements for several of the instruction units, including one focused on playgrounds,[43] and retention of knowledge and behaviour change over time;[44] similar effects have been found for youth in grades 7 and 8.[45] Evaluation of the Risk Watch program has yielded mixed results, with improvements in knowledge reported but not always changes in self-reported behaviors.[46]

Conclusion

Fall-related injuries pose a significant health issue for children. Although risk factors and mechanisms of injury have been identified, surprisingly few prevention initiatives have been rigorously evaluated. For young children, initiatives need to reduce risk behaviors on stairs, furniture and stumble/trips. For school-age children, a focus on safe playgrounds and equipment and eliminating fall-risk behaviors is warranted.

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4.5

Suicide/Self-Harm

Introduction

Suicide is a worldwide problem; each year, more than 800,000 people take their own life.[1] In comparison with the global age-standardized suicide rate of 11.4 per 100,000 population per year (15.0 for men and 8.0 for women), Canada's rate is slightly lower, at 11.0, but higher for men and much lower for women (17.2 for men and 4.9 for women). Overall, suicide rates worldwide have been decreasing over the past 12 years and Canada's rate has declined 11.1% between 2000 and 2012 (-2.8% for women and -13.5% for men). However, declining suicide rates are not occurring in all countries. For example, during the same period, suicides increased by 24.2% in the United States (+36.6% for women and +19.9% for men). Deaths by suicide, often referred to as "completed suicide", are generally defined as when a person intentionally kills himself or herself, although the determination of intentionality is sometimes difficult to ascertain. Based on the World Health Organization (WHO) surveys, for each death by suicide, there are more than 20 people who have made one or more suicide attempts.[1] Since having attempted previously is an important risk factor in predicting completed suicides, suicide is often conceptualized along a continuum from "mild ideation" to "serious intentions, attempts and completed suicide". This chapter limits itself to completed suicides and attempted suicides, and does not include self-harm without the intent to die, such as teenagers with repeated self-cutting without the presence of suicide intent. After presenting data on suicide and suicide attempts in Canada, this chapter briefly summarizes current explanations of suicidal behaviours, and reviews the interventions suggested in the WHO 2014 report on suicide prevention, in terms of the Canadian context.[1]

Suicide and suicide attempts in Canada

In higher income countries, it is usually the elderly who have the highest suicide rates, but the highest rates in Canada in 2011 are for men and women 45 to 59. As found in other developed countries, rates for men in Canada are higher than women for completed suicides, although somewhat more women are hospitalized for suicide attempts than men and more women report having suicidal ideation and attempted suicide.[2] The sex differences can be explained by various hypotheses, including male preferences for more lethal methods, men having more severe mental health problems and the greater reluctance by men to seek help and use social support.[3]

In Canada, the category of "hanging-strangulation-suffocation" is the most common means of completed suicides, accounting for almost half of deaths by suicide.[4] However, hospitalizations for intentional self-harm are most likely from poisoning, which is 10 times more likely to be the method for people seen in hospital for intentional injury than the second most common method; self harm with a sharp object (14,007 hospitalizations for poisoning, 1,414 self-harm with sharp object, 493 hanging-strangulation-suffocation). Death by firearms accounted for 16% of suicides in Canada between 2000 and 2009 and more than 6 times more men died by suicide from firearms than women.

Canadian statistics indicate that in 2011, compared to the ten provinces, there are much higher suicide rates in the Yukon, Northwest Territories and Nunavut, with the Nunavut rate nine times higher than the national average (Figure 29). In the Yukon and Northwest Territories, the higher overall rates are due to the disproportionate rates in men compared to women, where the rates are the lowest Canada. In Nunavut; however, rates for women are five times the national women's average and rates for men are six and a half times the national men's average. Suicide rates in Canadian First Nations and Inuit communities are much higher than for the rest of Canada according to several studies.[5-9] It has been demonstrated that in the Canadian provinces and territories, mortality rates for all causes, including suicide, are much higher in the where there are high-percentage of Aboriginals.[10, 11] Suicide rates in the north are not declining, with 2013 having the record highest level of suicide in Nunavut since the territory was created in 1999. The rate in Nunavut was 13 times higher than the rate for the rest of Canada and the rate among Nunavut men 40 times the rate for men in the Canadian Provinces.[12]

Explanations of Suicide

There is a wide range of approaches to explaining suicidal behaviour, with theories based upon socio-cultural factors, psychological processes, genetic predispositions, as well as anthropological, political and economic analyses.[3] Some theories of suicide are supported by empirical data, while others, such as Freudian theories, are based upon qualitative clinical

experiences. Most of the published research studies mainly focus on at-risks groups, such as suicide attempters and persons with mental disorders.[13] Mental disorders are the most significant risk factors and having good social supports is among the most important factors that may protect against suicide. Despite these research results, no sub-group of the population is spared from suicide and no single risk or protective factor explains a sufficient proportion of the variance to accurately predict the future suicide risk of individuals. For this reason, there is a general consensus among suicidologists that suicide is multi-determined, and a combination of diverse approaches targeting a variety of risk and protective factors is necessary to have a significant impact upon suicide rates.

Figure 29

Age-standardized Suicide Rate per 100,000 by Province and Gender, 2011

Rate per 100,000
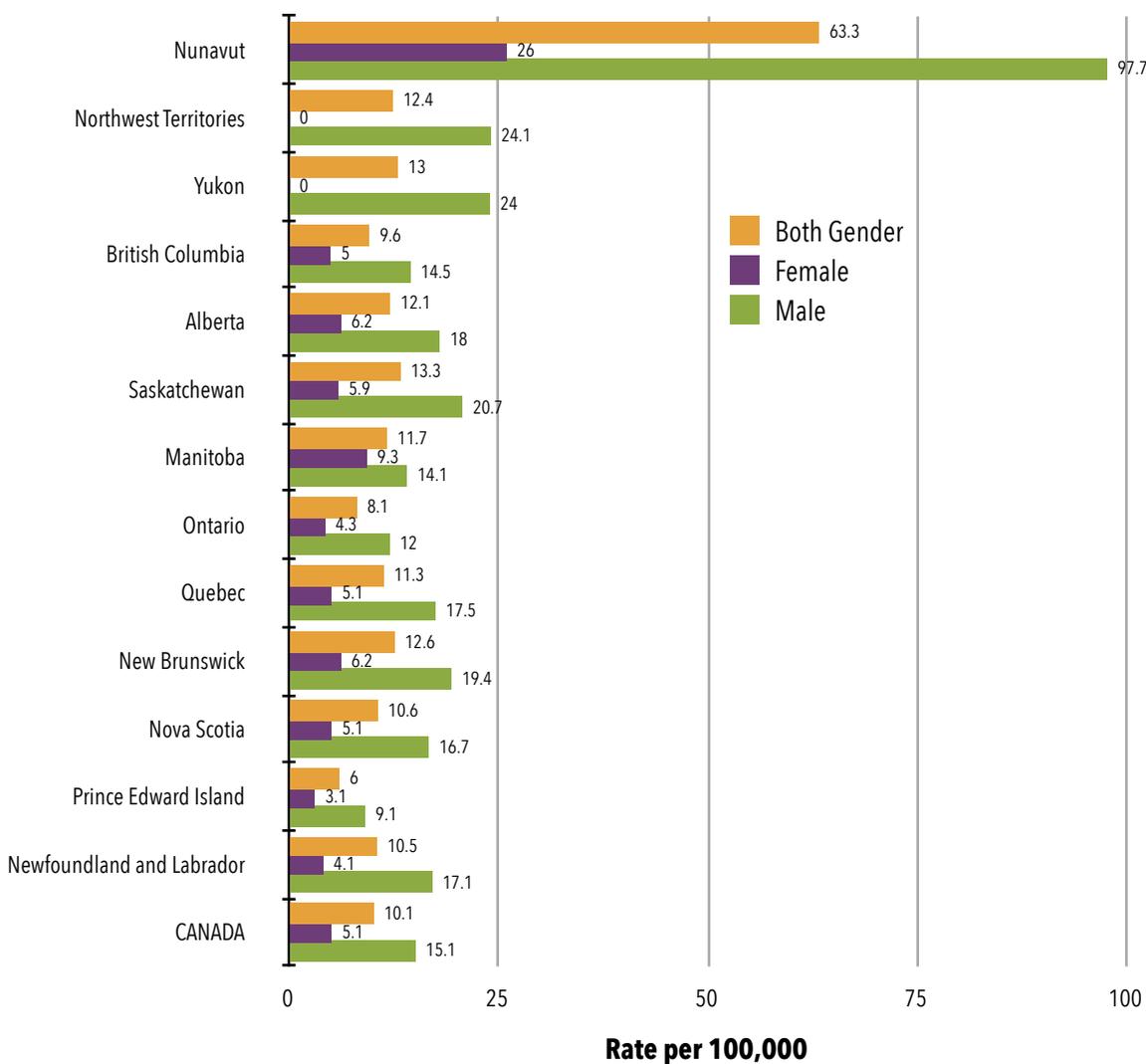
Source: Statistics Canada. (2014).CanSim: Table 102-0552. Deaths and mortality rate, by selected grouped causes and sex, Canada, provinces and territories

Suicide and Mental Health

In Western countries, the highest risk is associated with being male, and this is followed by having a psychiatric disorder. Although studies have shown that 95% of persons who die by suicide have been diagnosed as having a psychiatric disorder or can be classified as having had a psychiatric disorder on the basis of retrospective psychological autopsy studies,[14] it is important to keep in mind that only a small proportion of all persons with psychiatric disorders will attempt or complete suicide. Having a mental health problem increases the risk of suicide. However, there are many other risk factors, and their potential impact is diminished by the presence of protective factors, such as having good social supports. Risks factors are not causes and the presence of any single risk factor is not sufficient to bring about a suicide. Mishara and Chagnon (2011) proposed that there are several alternative explanations of why there is an association between suicide and mental illness.[15] In some instances, symptoms of psychiatric disorders may directly influence suicidal behaviours, such as when depression compromises one's ability to experience hope or when psychotic delusional voices are perceived to incite a person to suicide. However, the association between mental health problems and suicide may also be explained by the fact that both suicide and mental disorders have several common risk factors; suicide may be associated with iatrogenic side effects of the treatment of mental disorders; and the greater risk of suicide among persons with mental health problems may be related to the fact that having a mental disorder increases the risk of also having other well-documented risk factors for suicide, such as being unemployed, being stigmatized and living alone.

Ethical Issues

Some believe that suicide is a choice that people have the right to make as a result of a rational decision-making process.[16] However, others suggest that rational decision-making is rarely observed as part of the process leading to suicide.[17] Most suicides occur in the context of a desperate attempt to stop what is considered by the suicidal individual as an interminable, unavoidable and unbearably painful life situation. This pain, referred to as "psychache" by Shneidman (1993), may be so intense that reasoning becomes illogical.[18] For Shneidman and other researchers, most pain associated with suicide is psychological. Nevertheless, physical pain can be sometimes associated with suicide. Some people feel that suicide is justifiable in persons suffering from physical pain, and they may view these suicides as "rational". Mishara and Weisstub (2008) suggest that when people call suicides "rational," they are usually affirming that this suicide is "understandable" in the eyes of the observer.[17] However, when extreme physical pain is experienced, people simply want the pain to end and rational considerations are generally ignored.

Interventions

Societal Level Actions

The World Health Organization's first report on suicide prevention associates knowledge about key risk and protective factors for suicide with universal, selective and indicated approaches to suicide prevention.[1]

At the societal level, six relevant interventions for health system and societal risk factors are emphasized which can be analyzed in the Canadian context. First, strengthening mental health policies and improving access to mental health services is recommended. Although much progress in this area has been made in Canada, much more can be done.[19] The second intervention is to reduce harmful use of alcohol. In Canada, over half of persons who die by suicide have consumed alcohol at the time of their death and research shows that acute intoxication and patterns of problem drinking are associated with increased suicide risk.[20, 21] Measures suggested by WHO are unlikely to be implemented to a significant extent in Canada because of cultural norms which influence policymakers. For example, it is unlikely that the government will enact WHO suggestions for more severe policies to restrict the availability of alcohol, decreased marketing of alcoholic beverages, significantly increasing the cost of alcohol or severely enforcing and increasing the negative consequences of drinking and alcohol intoxication.

The third WHO recommendation, to improve access to health care, is not an important issue in Canada, where access to medical services is universally available. However, there is a need to encourage people at risk of suicide. For example, men who are considering ending their lives who suffer from depression or other mental health problems, there is a need to support them to seek help and use existing healthcare services in Canada. Although men are at greater risk of suicide, they less frequently call suicide prevention helplines and less often seek medical help for mental health problems.[22] Besides encouraging men to seek help, healthcare professionals must be better trained to recognize how men express their problems less directly when they are in contact with healthcare workers.

One of the most well-documented suicide prevention actions worldwide is restriction of access to means of suicide.[23] Despite current tendencies in Canada to eliminate laws making it more difficult to have access to firearms, research has shown that restricting firearm ownership has been associated with a reduction in firearm suicide rates in many countries,

including Canada.[1,24,25] WHO suggests regulatory actions including tightening of rules for obtaining licenses and registration, limiting personal gun ownership of handguns, extending the waiting period for purchases, enforcing safe-storage requirements, decreeing a minimum age for firearm purchase, and implementing criminal and psychiatric background checks for firearm purchases. Other actions to decrease access to means include adopting policies to promote fencing and other structural interventions to restrict access on bridges, buildings and railroads, which have been successfully introduced at certain suicide "hot spots" in Canada, such as the Jacques Cartier Bridge in Montreal, and do not result in displacement of suicides to other locations or the use of other means.[26] Restricting access to medications used in suicide attempts by limiting the amount of medication dispensed, particularly analgesics available over-the-counter, have been associated with reduced mortality and morbidity by intentional and accidental poisoning.[27] To date, regulations in Canada have not been modified, as in Europe, to restrict the amount of medication dispensed, and to better inform patients and their families of the importance of eliminating unneeded medications from homes.

The nature of reporting suicides in the media can influence suicide rates. Reports of "sensational" and high profile suicide cases can result in more suicides, referred to as copycat suicides (e.g. the increase in Quebec following the wide-spread media coverage of the suicide of the journalist Gaëtan Girouard).[28] The risks associated with suicide reports in media can be minimized by responsible reporting, such as by following the guidelines of the Canadian Psychiatric Association, or the WHO resource for media professionals.[29, 30] For example, these guidelines recommend that suicide methods not be described, that resources to obtain help be included and that photos of the victim not be included.

Community and Local Actions

Many of the community risk factors the WHO report cites as being associated with suicide have been the focus of preventive actions at the national and local levels in Canada. These include reducing discrimination against various subgroups of the population, reducing trauma and abuse in childhood, reducing relationship conflict, discord and loss, and decreasing the sense of isolation and lack of social support that are associated with depression and feelings of despair.

Community and local actions for suicide prevention are developed in a defined area or for a specific group of individuals and involve local organisations that initiate, develop and adapt interventions to their community. Such actions may be implemented in a school, a city, county or workplace.

Figure 30

Risk factors for suicide aligned with relevant interventions[1]
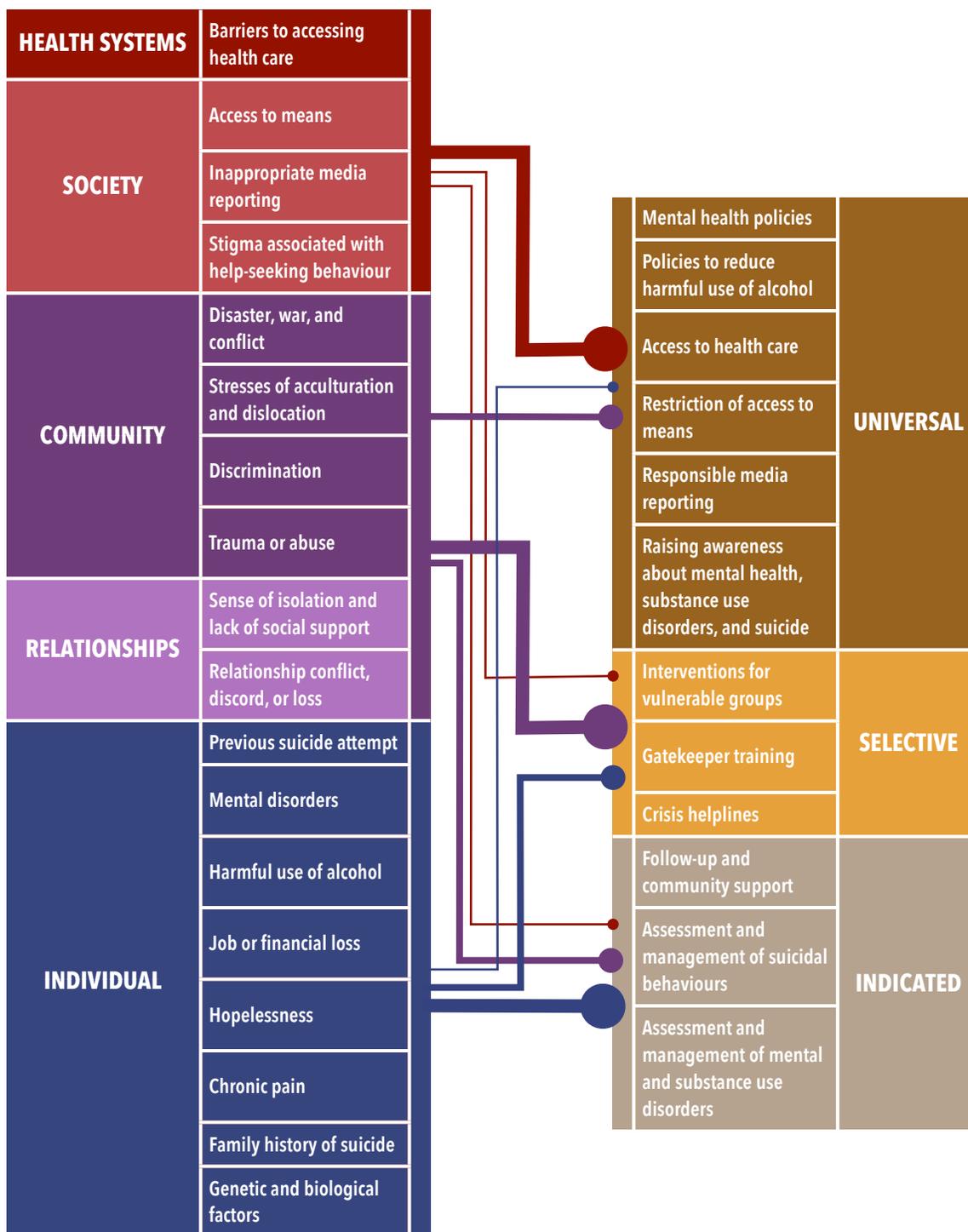
Gatekeeper programs for suicide prevention programs are an example of local community actions.[31] Gatekeepers are defined as individuals who are in a position to identify someone

who is contemplating suicide and who are not normally working in suicide prevention. These gatekeepers include professionals such as police, clergy, general practitioners and teachers. Gatekeepers can also be others whose normal work is not to specifically help others, but who may come into contact at work with suicidal individuals who talk about their troubles, such as janitors, hairdressers and taxi drivers. Training gatekeepers to assess suicide risk and make successful referrals for help, including training peers to serve as gatekeepers in the workplace, have been shown to increase help seeking. For example, a comprehensive workplace training-focused program in the Montreal police force resulted in a 79% decrease in police suicides, compared to a slight increase in suicides among police elsewhere in Quebec.[32]

One of the high risk groups for a completed suicide is persons who have been seen in hospital for a previous suicide attempt. They have over a 10% risk of attempting again or dying by suicide in the following years.[33] The repeated attempts may be explained by the fact that the presence of risk factors and absence of sufficient protective factors often continue to exist after they leave the hospital. Also, a large proportion of people seen in hospital for a suicide attempt do not continue with treatment and follow-up after their discharge.[34] Several studies have shown that even simple, proactive follow-up after discharge, such as short regular telephone calls, or sending weekly text messages of encouragement and expression of concern, may decrease the rates of repeated attempts.[35] Recent research is investigating the use of programs on smartphones that check on previous attempters each day and suggest calling for help when the person seems to be at greater risk. Some programs will also automatically call to inform friends and relatives when there is a risk.[36]

A Canadian Success Story

The WHO report emphasizes the need for a wide range of concerted multi-sectorial suicide prevention actions in order to have a significant impact on population suicide rates. Although suicide rates are generally declining in Canada, there are numerous exceptions, most notably among the Aboriginal population. Furthermore, much more can be done to lower the Canadian suicide rate from its position near the worldwide average. One example of a concerted effort at preventing suicide was the development of the Quebec suicide prevention strategy in 1998.[37] In the latter quarter of the 20th century, Quebec suicide rates rose to become the highest of all Canadian provinces, stimulating grave concerns among policy planners, politicians and the general population. In 1998, a Provincial Suicide Prevention Strategy was launched which included; actions to reinforce a network of suicide prevention Centers and establishing a single toll-free provincial telephone number; providing suicide prevention training for mental health and health providers; improving the treatment of mental health issues supporting provincial campaigns aimed at inciting suicidal persons to seek help; and encouraging friends and family members to provide support and referrals. For the past 14 years, the Quebec suicide rate has decreased each year for men

and women and for all age groups, with Quebec now ranking 5th among Canadian provinces. In fact, the youth and young adult rate in Quebec is now less than half the rate it was 14 years ago. Many other provinces and territories have launched their own suicide prevention strategies.

Challenges in Suicide Prevention

In 2004, the Canadian Association for Suicide Prevention (CASP) released a blueprint of what they proposed as the first Canadian national suicide prevention strategy.[38] In December 2012, the Government of Canada enacted Bill S.C. 2012, c. 30, the Federal Framework for Suicide Prevention Act. This Act recognizes the importance of suicide as a mental health and public health issue and provides for improving public awareness and knowledge about suicide, defining best practices for the prevention of suicide and promoting research, evidenced-based practices and knowledge exchange. Although health care is part of provincial jurisdiction, this Act recognizes the value of increased communication and collaboration across Canada. The benefits of sharing knowledge and best practices developed in Canada are evident. However, new developments in suicide prevention and changes in help-seeking behaviours in the 21st Century now make it imperative to develop more pan-Canadian collaboration.

Conclusion

Canadians increasingly use the Internet to seek help when in a suicidal crisis, looking up information about suicide and mental illness, participating in forums and chat groups, sending email calls for help, and posting their distress and suicidal intention on Facebook and other social media. Sometimes, rather than preventing suicides, people at risk are encouraged to kill themselves, and are provided information on how to commit suicide. People may mistakenly think that posting information about their suicide can glorify their death. The Internet does not respect provincial or local boundaries, and both national and international suicide prevention services are becoming increasingly available.

The Internet is not the only recent development in providing and seeking help that warrants attention in Canada. For example, social media, Google searches and voice-activated

smartphone programs can now identify people at risk of suicide and automatically provide and connect people with a telephone helpline or online suicide prevention service. These new technologies require a single nationwide portal to connect people with services providing the help they need.

It is encouraging that Canadian suicide rates are decreasing, following trends in most of the world. However, Canada's suicide rates are not among the lowest worldwide, and suicides among Native Peoples and Inuit are extraordinarily high and still increasing. There is still a significant lag in incorporating the latest evidence-based practices, and in the evaluation of prevention programs with high risk groups and the determination of best practices

Some differences in suicide rates may be due to differences in reporting and classifications of suicides between provinces and within different regions of Canadian provinces. There is a need for more uniform classifications of suicides and more systematic inclusion of information about the suicide victims and their circumstances, including information on the presence of mental disorders, toxicological analyses and socio-demographic status (employment, marital status, ethnicity, etc.).[39, 40,41]

In terms of suicide attempts, existing data underestimate the rates of hospitalizations for intentional self-injuries. Far too often, the nature of the injury is included in statistical databases without the added indication that the injury was self-inflicted or intentional.[42] Also, those who attempt suicide who receive care from physicians in outpatient settings are generally not counted, and national surveys indicate that the extent of self-reported suicide attempts is much greater than those reported in medical databases.

Canadian expertise in suicide prevention training, intervention techniques and research on understanding suicide has influenced programs and practices around the world. However, there is a gap between the development and implementation of prevention programs and intervention practices and their scientific evaluation. There is a need to better understand the impact of prevention activities in order to develop models for evidence-based best practices and better methods to monitor community and local actions to prevent suicide.

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4.6

Violence

Introduction

Several international surveys place Canada among the average regarding prevalence of victimization for industrialized countries. For example, in the International Study on the Victims of Crime, the percentage of the population 16 years of age or older who were victims of crime was 16%; comparable to the average of the 30 participating countries.[1] Despite these statistics, violence is a problem in Canada. The purpose of this chapter is to describe violence as a Canadian public health problem and to describe the main opportunities available for taking effective preventive action.

Defining violence

To properly define the subject of violence, the World Health Organization (WHO) suggests the following definition:

"The intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation."[2]

According to this definition, it is clear that the use of the word "intentional" implies that violence is based on an individual's malicious intent. This definition is very inclusive in that the use of the word "threat" indicates that acting-out is not required in order for violence to be present. This definition also suggests that violence may be caused by an abuse of power

without the presence of physical contact and that it includes actions performed against oneself, such as self-mutilation, suicide and attempted suicide[*]. Moreover, the range of possible consequences is very broad, extending from death to physical or emotional harm through physical or psychological injury. Finally, the mere fact that the actions might represent a risk to others is enough to speak of violence without the expected harm of the violence actually materializing. This definition gives rise to a typology (Figure 31) that helps better define the many dimensions of violence. The typology identifies the various forms of violence based on the relationships between the aggressor and the victim and the nature of harm perpetrated by the aggressor.

Figure 31

Typology of violence[3]
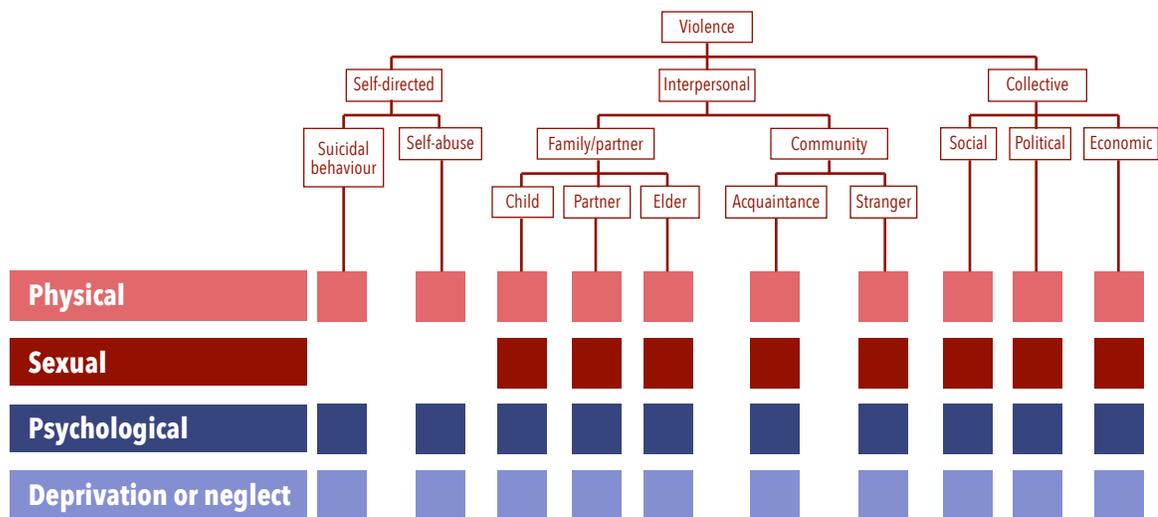
Portrait of violence in Canada

According to data from the case-based Uniform Crime Reporting Program (UCR-2), there was an average of 583 deaths a year due to homicide in Canada between 2008 and 2012, which represents nearly two homicides per day. However, this violence is not distributed equally across the country. For example, the average annual homicide rates between 2002 and 2011 in the four western provinces were clearly above the Canadian average. Thunder Bay, Winnipeg and Regina were the metropolitan areas in 2012, with the highest homicide rates in Canada, i.e. 5.8, 4.1 and 3.1 per 100,000 inhabitants, respectively. The homicide and attempted murder rates in Canada are constantly declining, with rates declining from 2.6 and 3.7 per 100,000 inhabitants in 1982 to 1.7 and 1.9 in 2012, respectively.[4] The same trend

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[*] More information on suicide is covered in Section 4.5

is observed according to the Crime Severity Index and the Violent Crime Severity Index[†.] Canada has the lowest homicide rate in North America, i.e. 14 times lower than the rate seen in Mexico and three times lower than that of the United States.[4]

The recent improvements in statistics on violence in Canada should not, however, obscure the fact that interpersonal violence is still a significant problem at various stages of life. **In childhood**, violence is primarily in the form of abuse. The Canadian Incidence Study of Reported Child Abuse and Neglect indicates that nearly 250,000 investigations on abuse were conducted in Canada in 2008. Abuse was corroborated in 36% of cases, i.e. in 85,440 investigations. Of those, 34% were victims of neglect, 20% of physical abuse, 9% of psychological abuse and 3% of sexual abuse.[5] The portrait of violence **among those under the age of 18** leads to the conclusion that violence is mainly in the form of sexual abuse and bullying. According to the cases reported to police in 2011, five times more cases of sexual abuse on children and youth under 18 years of age were reported compared to adults.[6] Youth were also victims of various forms of bullying[‡] with sometimes disastrous consequences for the victim, the family and the community. According to data from the most recent cycles of the Health Behaviour in School-aged Children (HBSC) survey conducted in Canada among 26,078 youth between the ages of 11 and 15 years, between 3-8% of youth, reported having been the victim of bullying at least once a week, with the youngest children being the most affected. Moreover, 22% of youth reported being victims of bullying and 12% reported having bullied and taken part in acts of bullying in the two months prior to the survey.[8]

Among adults, the 2009 *General Social Survey – Victimization* indicates that a similar proportion of Canadian females (6.4%) and Canadian males (6.0%) reported having been victims of physical or sexual abuse inflicted by a current or former partner in the five years prior to the survey. It should be noted that the violence that victimized females report is more severe than that experienced by males and they continue to be more likely than men to be victims of homicide at the hands of the their spouse (nearly 4 women to 1 man).[9] The sexual victimization rate in Canada was 24 per 1,000 inhabitants, in those ages 15 years or older, with 70% of the sexual assaults perpetrated against a female victim.[10]

[†]The Crime Severity Index is calculated by multiplying the number of cases reported by the police for each crime by the weight attributed to that crime. Then, all of the weighted crimes are added and the total is divided by the corresponding population. The results are divided again by the results for the base year and multiplied by 100. The Violent Crime Severity Index only takes into account violent crimes.[7]

[‡]Bullying is a relationship problem. It is a form of repeated aggression where there is an imbalance of power between the young person who is bullying and the young person who is victimized. Power can be achieved through physical, psychological, social, or systemic advantage, or by knowing another's vulnerability (e.g., obesity, learning problem, sexual orientation, family background) and using that knowledge to cause distress. As a relationship problem, the young people who bully learn to use power and aggression to control others, and the young people who are victimized become increasingly powerless and find themselves in a relationship where they are being abused. With each repeated bullying incident, the young person who is bullying increases in power and the young person who is being victimized finds their power reduced.[8]

Among older adults ages 65 and older, it is estimated that 4% have experienced abuse. Abuse against older adults is most often perpetrated by family or caregiver and can take on many forms with financial abuse being the most common (2.5%), followed by verbal abuse (1.4%), physical abuse (0.5%) and neglect (0.4 %).[11] Older adults are also not immune to spousal abuse. In fact, according to the 1999 and 2004 General Social Survey – Victimization, 6.8% of persons 60 years of age or older were victims of physical, psychological and financial abuse by a spouse in the five years prior to the survey.[12]

In general, nearly three out of four cases of violence involve people who know each other; one out of four cases occurs between intimate partners; and one out of four occurs in a family context.[6]

In addition to the physical and psychological consequences, interpersonal violence has an economic cost that can be attributed both to direct costs, i.e. the costs associated with the resources used to treat the persons, and to indirect costs, i.e. the costs associated with lost productivity, hospitalizations, disabilities and premature deaths. In 2010, these costs were estimated at $1,142 million for Canada.[13]

Opportunities for action in preventing violence

There are several available means to counter violence. They are related to i) organizational initiatives on an international, national or local scale ii) determining the level of available evidence, including identifying the problem, identifying the risk factors and determining effective interventions and iii) the development of health promotion and prevention experience.

i. Organizational initiatives

Several important organizational initiatives have emerged in recent years that represent mobilization on the part of organizations and governments to act on the problem of violence in Canada. These initiatives are important to justify action in the field of violence prevention, to design prevention programs and to establish relationships between professionals. First, the 1996 adoption of resolution WHA49.25[14] by the World Health Assembly at the WHO identifies violence as a public health problem. This resolution identifies violence as a growing problem worldwide that has consequences for people, families, communities, countries and health systems. Resolution WHA49.25 helps legitimize the resource investments made to prevent violence. It places the responsibility to act on the government level and, rather than being confined to the areas of justice and public safety, violence has since been recognized as a problem that calls on all sectors of society (health, education, sports and recreation, family, work, etc.).

In the wake of WHA49.25, the WHO published the *World Report on Violence and Health* in 2002, which provides a conceptual framework and the scientific knowledge available to better understand the problem and develop interventions.[2] The nine recommendations made in the report are also important mainstays for action in the field. Particularly, the importance of channelling efforts through a national action plan and dedicating efforts to understand the problem via good data collection are emphasized. It also emphasizes the importance in intervening upstream with primary prevention activities, and the role of public policy to act on the significant risk factors of violence (e.g. the Policy on the fight against inequality, public safety and employment). Following the publication of the 2002 report, other WHO publications instrumental in supporting the actions, include *Violence prevention: The evidence*, *Preventing intimate partner and sexual violence against women: taking action and generating evidence* and *Preventing child maltreatment: a guide to taking action and generating evidence*.

Although there is still much to be done in the field of violence prevention in Canada, the following are some examples of initiatives:

The National Crime Prevention Strategy (NCPS) is an integral part of the government of Canada's action plan to fight crime and build safe communities. It is a strategic framework for developing crime prevention interventions in Canada.[15]

The Prevention of Violence Canada - Prévention de la violence Canada Network (PVC) was established in 2004 in response to the recommendations of the World Report on Violence and Health. It is essentially a coalition formed of representatives from public health associations, researchers, educators, practitioners and representatives from government and non-government organizations.[16]

PreVAiL (Preventing Violence Across the Lifespan) is an international Center of cooperation in research involving more than 60 researchers and partners from Canada, the United States, the United Kingdom, Europe, Asia and Australia. The mandate of this network consists essentially of promoting the research and use of scientific data in the field of family violence.[17]

The International Center for the Prevention of Crime (ICPC) is a resource Center and unique international forum of discussions and knowledge about crime and daily safety. The action of the ICPC aims to promote crime prevention, encourage the use of thought-provoking practices and support fruitful international discussions between the countries and the cities, the legal system and the organizations of civil society.[18]

The National Clearinghouse on Family Violence (NCFV) is a resource and information Center on the prevention of violence and abuse within the family. It facilitates the exchange of knowledge surrounding the prevention, protection and treatment of violence among the

various stakeholders involved in this problem. It contributes to increasing public knowledge and encourages greater participation from Canadian groups in reducing family violence.[19]

In addition to the aforementioned international and national initiatives, each province relies on different projects, programs, policies and groups of experts specific to the province. All of these initiatives are important because they are the forums available for influencing the policies and prevention programs and for legitimizing actions in the field. These initiatives are also important to solicit the investment of public funds to conduct research or intervention projects.

ii. Evidence

The first three stages of the public health approach (Refer to Section 2.1 Public Health Approach for a complete list of stages involved) will be used to describe this second opportunities lever which proposes a chain of activities; which include collecting data to properly define the problem, identifying the risk factors or related factors and determining effective interventions.

Defining the problem

Many data sources related to violence exist in Canada. Those sources particularly help document the prevalence of homicides, intentional injuries that required hospitalization, child abuse, intimate partner violence and elder abuse (Table 13).

Table 13

Major sources of Canadian data available to document the problem of violence

Types of data	Sources	Problems
Mortality	Vital Statistics – Death Database	Homicides
	Canadian Coroner and Medical Examiner Database (CCMED)	Homicides
Use of services	Canadian Institute for Health Information (CIHI)	Intentional injuries
	Canadian Hospitals Injury Reporting and Prevention Program (CHIRP)	Intentional injuries
	Data on the use of shelters	Intimate partner violence
	Child protection services	Child abuse
Crime	Case-based Uniform Crime Reporting Program (UCR-2)	Crimes against persons
Survey data	General Social Survey (GSS) (Victimization component)	Intimate partner violence Sexual assault Elder abuse
	Canadian Incidence Study of Report Child Abuse and Neglect (CIS)	Child abuse
	International Youth Survey (IYS)	Violence among youth
	Transition House Survey (THS)	Intimate partner violence
	Health Behaviour in School-aged Children – HBSC- Survey	Violence among youth - Bullying

Identifying the risk factors associated with violence

Identifying the factors associated with violence can help gain a better understanding of the issue. It also helps identify the groups or environments that are most at risk. The ecological model proposed by the WHO helps properly categorize the factors associated with the various forms of violence related to four types of factors; individual, relational, community and societal. It is important to note, that associations between violence and a specific factor do not necessarily mean that there is a causal relationship between the two. In fact, it is a complex combination of many factors that result in a situation of violence.[3]

Individual factors are the characteristics of individuals, including a history of violence, mental health problems, drug use and alcohol abuse, that are generally recognized as being associated with violence.

Relational factors focus on the relationships between an individual and their loved ones. This category includes family dysfunction, relational problems between parents and children and peer pressure.

Community factors refer to the environment in which an individual lives. This category includes neighbourhoods in terms of poverty, unemployment, social capital and crime as well as the community's low level of disapproval of violence.

Societal factors refer to the social and cultural context in which an individual develops. These are the social norms regarding, for example, gender relations or the use of force. Inequality based on income, sex, education or access to services are also included in this category, as are the laws and policies regarding, for example, the protection of children or accessibility to firearms.

Table 14 summarizes the main factors associated with the forms of violence previously listed, according to the different life stages.

Table 14

Main factors associated with the various forms of violence based on the stages of life[3,22-31]

Stage of life	Forms of violence	Types of factors*			
		Individual	**Relational**	**Community**	**Societal**
Children (0-11 years)	*Abuse (including sexual abuse)[1]*	• Young age • Gender (female) • Specific characteristics (premature birth, twins, disabled, etc.) • History of parental abuse	• Family structures and resources (young parental age, poverty, unemployment, etc.) • Family size (high number of children) • Family composition changes regularly • Presence of violence within the family	• Poverty • Lack of social capital	• Gender and income inequality • Traditional social norms regarding gender roles • Lack of policies regarding children and family (parental leave, daycare Centers, etc.)
Youth (12-17 years)	*Violence in general[1]*	• Psychological and behavioural characteristics (hyperactivity, impulsiveness, poor control over behaviour, attention difficulties, etc.) (A)	• Family pressure (A) • Poor peer pressure (A)	• Presence of gangs, firearms and narcotics in the community (A) • Lack of social capital (A)	• Income inequality • Lack of laws against violence • Social norms approving resorting to violence to resolve conflicts
	Bullying[2, 3, 4]	• Biological characteristics (obesity, disability, homosexuality, etc.) • Aggressive temperament (A)	• Social maladjustment or deficient social skills (A + V) • Family dysfunction (A) • Lack of social network	• Poverty (A) • High rate of crime in the community (A) • Tolerance in the school environment (lack of rules against bullying, lack of monitoring, lack of reaction from unconcerned students, etc.) (A)	• Pervasiveness of violence in the media (A)
	Sexual abuse [1, 5, 6, 7, 8, 9, 10]	• Young age • Gender (female) • Previous physical or sexual abuse • Special needs (disability, intellectual deficiency, chronic disease, etc.)	• Poor parental supervision • Problems of alcohol or drug use by parents • Parents' mental health problems • Presence of a spouse who is not the child's father	• Community tolerant of sexual abuse • Poor penalties for sexual abuse	• Hypersexualization of youth • Traditional social norms regarding gender roles • Social norms regards men's rights in sexual matters (belief system that gives women few reasons to refuse sexual advances) • Social norms approving sexual abuse

Stage of life	Forms of violence	Types of factors*			
		Individual	**Relational**	**Community**	**Societal**
Adults (18-64 years)	*Intimate partner violence,* [10]	• Young age (A + V) • Low level of education (A + V) • History of family violence (A + V) • Alcohol consumption (A + V) • Personality disorders (A) • - Exposure to violence during childhood (A + V)	• Marital conflicts • Dysfunctional family	• Low socio-economic status (A +V) • Low social capital • Community tolerance for violence (A + V)	• Traditional social norms regarding gender roles (A + V) • Social norms approving violence (A + V)
	Sexual assault [1, 10, 11]	• Young age • Gender (female) • Alcohol and drug use (A + V) • Previous history of raped or been a victim of sexual abuse • Low level of education • Poverty • Psychological factors (A) (hostility towards women, difficulty interpreting the signals sent by women, etc.)	• Multiple partners	• Poverty • Community tolerance for sexual assault	• Lack of laws or policies sanctioning sexual assault and affirming victim support • Social norms regards men's rights in sexual matters (belief system that gives women few reasons to refuse sexual advances)
Older adults (65 yrs.+)	*Abuse* [1]	• Aggressive behaviour by the victim • Personality disorders (A) • Mental health problems (A) • Drug addiction problems (A)	• High level of stress among caregivers (A) • Dysfunctional relations between caregiver and care receiver	• Social isolation	• Social norms and cultural traditions favouring inequality (ageism, sexism) • Social norms approving violence

*   All of these a factors are associated with being of victim of violence. The associations with being the aggressor only, or aggressor and victim are indicated by (A) and (A+V), respectively.

Table 15

Main interventions recognized as effective or promising based on the various forms of violence[20,22]

Intervention	Forms of violence				
	Child abuse	**Violence among youth**	**Sexual assault**	**Intimate partner violence**	**Elder abuse**
Develop safe, stable and healthy relationships between children, their parents and caregivers					
Training for the parent role, home visit by a nurse	●	○			
Support program for vulnerable parents (e.g. Teen mothers, low income parents)	○	○			
Develop children's and teens' daily life skills					
Pre-school enrichment program		○			
Social skills development programs		●			
Reduce access to and harmful consumption of alcohol					
Regulate the sale of alcohol	○	○	○	○	○
Increase the price of alcohol	○	○	○	○	○
Intervention for problems drinkers (e.g. Measures to reduce alcohol consumption, alcohol addiction treatment)				●	
Improving drinking environments (e.g. More user-friendly layout of alcohol consumption environments, training of bar personnel, training of conflict management keepers)		○			
Reduce access to firearms					
Restrictive policies regarding weapons permits and purchases		○			
Promote relations of equality between men and women to prevent violence against women					
Program in the schools to tackle the norms and sexist attitudes			○	●	
Program to reinforce women's financial independence				○	
Programs intended for men or women that question sexist norms and attitudes**				○	
Change social and cultural norms that promote violence					
Interventions to change social norms (e.g. mass media, educational entertainment initiatives - web lines)			○	○	
Victim identification, care and support programs					
Screening of victims and referral to the proper services				○	
Advocacy programs (e.g. Information and counselling, telephone assistance, social services and legal aid assistance)				●	
Psychosocial interventions (e.g. Visit with a psychologist, therapy)	○	○	○	○	○
Protection orders				○	

** A certain number of programs, available exclusively to male peer groups, tackle the values and attitudes associated with violence against women, redefine the concepts of masculinity and encourage men to participate in the prevention of violence.

● Effective intervention: well supported by evidence
○ Promising intervention: emerging evidence

Determining effective interventions

The proof of efficacy of a given intervention directed at violence prevention is not always substantial. This is explained by the very nature of the problem and the interventions, which are difficult to evaluate using experimental or quasi-experimental methods. In addition, research in this area is generally recently evolving, and is not well funded. Table 15 summarizes the main interventions found to be effective or are promising, specific to the forms of violence. These interventions refer to individual, relational, community and societal strategies based on the ecological model described above.

iii. Broader public health and safety promotion context

In addition to the organizational initiatives described above, at least two other factors have contributed to the development of expertise in the field of violence prevention in Canada. The first major influencing factor was the Ottawa Charter adopted in 1986,[21] which defined health promotion[§] and proposed actions, including the development of public policies and the creation of environments favourable to health. It also proposed the reinforcement of community action, the acquisition of individual skills and the redirection of health services. The Charter has helped enrich the actions traditionally focused on individuals and lifestyle habits with more global actions involving policies, institutions and services. Such a vision can only be the result of trans-sectorial action and the mobilization of community groups. The Ottawa Charter has influenced many of the actions to promote the health of Canadians. More specifically, the Charter has impacted the actions of the health sector and of other sectors to advance the safety field[**] and the prevention of violence in Canada.

Secondly, social movements have resulted in greater intolerance for violence in recent decades. Intimate partner violence, sexual assault and bullying for example, have ceased to be problems specific to the private sector and have become a societal problem involving various sectors such as health, public safety and justice. This awareness has incited governments to invest in the development of expertise in research and intervention in violence prevention. Despite limited resources, several research networks have been created on the national scale and in each of the provinces. Furthermore, several policies, programs and action plans affecting, in particular, intimate partner violence, child abuse, elder abuse, and gender inequality have also emerged. Similar to what was recommended in the Ottawa Charter, those initiatives are generally based on a multi-sectorial partnership and on overall action plans targeting individual, relational, community and societal factors. These initiatives

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[§] Health promotion is the process of enabling people to increase control over, and to improve, their health. To reach a state of complete physical mental and social wellbeing, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. Health is, therefore, seen as a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities. Therefore, health promotion is not just the responsibility of the health sector, but goes beyond healthy lifestyles to wellbeing.[21]

[**] The concept of the advancement of safety is presented in Chapter 1.2 The relationship between intentional and unintentional injuries.

have also helped bring together researchers and stakeholders on concrete projects conducted on a community scale.

Conclusion

Over the last three decades, considerable expertise has been acquired in Canada in the field of violence prevention. Increasing knowledge is being developed regarding the scope of the problem, the causes, and effective or promising interventions. In addition, the research, intervention and community action networks have developed considerable expertise and therefore can be supported by a significant number of initiatives on the international, national and regional scale. However, in order to be able to act more effectively to counter the phenomenon of violence in all of its forms, it is important for greater investment in prevention. The various forms of violence have a tendency to be examined individually while they are often related and are part of an individual's life span. Therefore, it would be relevant to develop an overall vision to help better integrate the actions related to the various forms of violence. There are also relatively few connections between those who work in violence prevention and those who work in non-intentional injury prevention, (see Chapter 1.2 - The Relationship Between Intentional and Unintentional Injuries). A model integrating the efforts of both sides would likely consolidate the connections between the two networks, thereby helping to benefit from the expertise available and better articulate the action taken.

Case study

Faced with a higher prevalence of intimate partner violence compared to the rest of the province, a region in Québec took action to implement preventive measures. As such, in January 2010, the *Institut national de santé publique du Québec* was given the mandate to conduct a study to better understand the factors to counter the phenomenon in the region. More specifically, the purpose of that study was to achieve the following objectives:

❖ Determine the scope of intimate partner violence in the region;

❖ Identify the factors that might explain the excessive number of cases of intimate partner violence observed;

❖ Identify the areas of prevention adapted to the reality of the region.

To achieve the objectives listed above, a four-step process took place. It consisted of an in-depth analysis of the official statistics on intimate partner violence, a summary of documents on the factors associated with intimate partner violence experienced by women,

a regional analysis of those factors compared to the rest of Québec and a consultation with key informants to validate and identify the areas for intervention.

The analysis of the statistics of crime committed in a marital context indicated that the regional rate of offenses had been increasing since 2003 and that it was significantly higher than elsewhere in Québec. It also showed that some sectors and areas in that region recorded higher rates.

The analysis of the factors associated with intimate partner violence took into account the following factors: socio-economic characteristics (unemployment, social and material deprivation, level of education), health determinants (social support, alcohol consumption, perception of health, mental health) and violence (child abuse, delinquency and violent crime). It was found that the region was underprivileged compared to the rest of Québec both in terms of socio-economic characteristics and the state of health and its determinants. Finally, a review of the factors more directly related to violence showed a high prevalence of problems and violent behaviours at different stages of life.

The information gathered from key informants helped specify certain details regarding intimate partner violence in the region. As such, tolerance for violence and, to a lesser extent, the presence of stereotyped gender roles, were the themes that were most often addressed. Furthermore, those themes were considered to be closely related to the economic conditions of the region. The informants also stated barriers to reporting and controlling intimate partner violence specific to certain communities, particularly those that were isolated or remote.

The whole process led to the conclusion that the region had several factors associated with violence, which were unequal based on the communities and geographic regions. The intervention strategy was developed based on the recommendation that the sectors with the greatest number of factors associated with intimate partner violence be addressed first. It was also recommended that better access to services be offered to the victims of intimate partner violence or to the violent spouses in the geographically or socially isolated communities. Aside from the priority areas or groups, the portrait of intimate partner violence in that region revealed the relevance of focusing on early prevention both among children and youth, particularly in the school setting, to promote healthy romantic relationships. At the same time, interventions for children and youth were also recommended to reduce the adulthood consequences of exposure to intimate partner violence at a young age. Finally, awareness-raising activities were recommended to reduce the tolerance for violence and to influence social norms.

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4.7

Alcohol

Introduction

Alcohol use is a significant risk factor for intentional and unintentional injuries. It is reported that even low blood alcohol content increases risk for injury, including those incurred as the result of motor vehicle collisions, falls, violence, and suicide or attempted suicide.[1] Alcohol also increases the likelihood that the injury will be severe enough to require medical attention.[2]

Alcohol use increases injury risk due to both its acute physiological and psychological effects. As a neurological depressant, alcohol can result in both cognitive and motor impairment. This includes impairment to vision, balance and movement, lengthened reaction time, and impairment of judgment.[3] Psychologically, alcohol can affect mood and cause emotional changes. It may also reduce inhibition and impair impulse control, both of which can result in increased propensity to take risks that may result in an injury. The physiological effects of alcohol interact with psychological effects that are influenced by social and cultural norms and beliefs about its use along with the behaviours that may result or are acceptable while consuming alcohol.[3] Acute harms may be experienced as the result of ones own alcohol use or as a result of alcohol use by another individual.[4]

Motor vehicle collisions that occur as the result of alcohol impaired driving remain a common cause of serious and fatal injuries in Canada despite the presence of federal and provincial laws to reduce the burden of drunk driving, and decades of awareness campaigns. Approximately 30% of motor vehicle fatalities in Canada are alcohol related.[5] Risk for

numerous other unintentional injuries such as falls also increase with alcohol consumption[2] Violence is heavily associated with alcohol including physical assaults, homicides, family violence, and intimate partner violence.[2] Estimates of alcohol involvement in sexual violence range from 35-70%.[6] Acute and chronic use of alcohol increases risk for suicide and the likelihood of using a more lethal means.[7]

Population Consumption

The pattern of alcohol consumption in a population is predictive of injury rates along with other negative health impacts. This includes measures such as frequency of consumption, amount consumed per sitting, and underage drinking. In 2012, the majority of Canadians (78.4%) reported past year alcohol use. Amongst drinkers of all ages, 15.8% of males and 9.7% of females exceeded the acute-risk guideline[*] in Canada's Low Risk Drinking Guidelines. [4]

Most provinces and all territories in Canada prohibit the use of alcohol under the age of 19 while three provinces prohibit its use for those under the age of 18 years.[8] These restrictions are in recognition of the negative effect of alcohol on the developing brain. Despite these restrictions, underage use of alcohol is a common issue in Canada. In 2012, Canadians reported their average age of initiation of alcohol consumption at 16.2 years.[4] In some provinces the average is significantly lower.

The ways in which alcohol is consumed in a population and the resulting health outcomes are heavily influenced by policies that govern the access, price, and marketing of alcohol. As will be described below, these policy levers have been shown to impact various indicators of injury.

Access

Access policies govern the availability of alcohol to a population including the age at which alcohol can be legally purchased, where alcohol can be purchased, the density of alcohol outlets, and the hours and days of sale. This includes purchases where alcohol can be consumed on-premises such as bars or restaurants and those where alcohol is purchased. Policies that regulate access to alcohol aim to reduce harms by increasing the economic and opportunity costs to obtaining the product.[3]

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[*] To stay within the acute risk guideline "Guideline 2" in Canada's Low Risk Drinking Guidelines, women should not exceed 3 drinks and men should not exceed 4 drinks on any one occasion. There must be a plan to drink in a safe environment. In addition, the individual should not exceed the weekly limits outlined in the chronic risk guideline "Guideline 1".

Legal drinking age is a component of alcohol access policy, which addresses the ability to purchase, possess and consume alcohol. The research literature recommends age 21 years as the optimal minimum legal drinking age based on documented reductions in consumption and harms including alcohol-impaired driving and violence.[3]

Another component of alcohol access policy is density of alcohol outlets. Numerous studies have documented the impact of increasing the density of alcohol outlets on rates of consumption and injury. The proportion of liquor outlets in a neighbourhood has been linked to consumption patterns and the associated harms.[9] More specifically, the frequency of alcohol consumption, the average number of drinks consumed in one sitting, and overall consumption rates, increase with higher outlet density.[10] The impact on injury rates is significant; increases in alcohol impaired driving and collisions, suicide, physical violence including family and intimate partner violence, and sexual violence have all been demonstrated. Similar patterns of changes to consumption patterns and rates of harm have been found to result from changes in hours and days of sale.[11]

Price

The manner in which alcohol is priced has an impact on both population consumption and injury rates. The Law of Demand states that the price of a product is inversely related to the quantity of the product demanded by the consumer.[12] As base prices for alcohol or taxes on alcohol increase, demand for the product tends to go down along with population consumption of alcohol. Minimum pricing for a standard drink of alcohol is an effective method for reducing consumption[13] and alcohol-related harms.[3] Discounted alcohol or an absence of minimum base prices and taxation are associated with increased consumption and harms.[3]

Although pricing can impact purchase patterns across demographics, youth and young adults are particularly price sensitive. Binge drinking in that population declines significantly with higher prices.[12] Several studies have examined the impact of pricing on rates of intentional and unintentional injury and have shown that alcohol prices and taxes are inversely related to rates of violence, motor vehicle fatalities and incidents of impaired driving, and overall alcohol related morbidity and mortality.[14] Beer taxes alone have been shown to impact rates of homicide, physical assault, intimate partner violence, and rape.[12] Suicide rates also decrease with increases to alcohol price. [3]

Marketing

Marketing is a term that encompasses a wide range of tactics that are intended to attract new users to purchase a product, increase use by existing users, and build loyalty to brands and items. These tactics include, but are not limited to, advertising, price promotions, product placement, and corporate social responsibility.[15] The marketing of alcohol by industry may affect injury risk both in terms of its role in increasing consumption and by the content in the marketing campaigns themselves. Restricting alcohol marketing is a policy lever that could contribute to a reduction in alcohol-related harms. [16]

Exposure to alcohol related media and marketing, prevalent in North American society, impacts consumption patterns. Alcohol advertising has been shown to increase the likelihood of initiating consumption among young non-drinkers and to increase consumption among current drinkers.[17] Children and youth are especially susceptible to the messages and influence of marketing. [18] These messages not only affect consumption patterns; they also impact cultural norms for expected behavior while drinking and shape expectations of the drinking experience.[19] Alcohol marketing that depicts physically risky behavior, over consumption, or sexism, objectification, and/or sexual connotations all contribute to shaping expectations of what is normal or expected when using alcohol.[19] While women are frequently sexually objectified in alcohol marketing, men are targeted with messages promoting hyper-masculinity and aggression.[20]

Government Monopoly

In Canada, the sale of alcohol is governed at a provincial/territorial level. The model by which alcohol is sold varies, but the majority of provincial/territorial governments maintain a partial government monopoly. One province, Alberta, is fully privatized.[16] For those provinces with a government monopoly, the extent to which access, price and marketing are regulated with public health and safety in mind, varies considerably. Research from Canada, the US, and Europe has demonstrated that privatized models of alcohol sales consistently result in increased consumption and increased harms.[21] There is also research to support that access to alcohol by minors, increases with privatization.[3] Government monopolies provide the best method for addressing issues of access, pricing, and marketing; however, this model is not without flaw. When revenue generation is the primary mandate of a government model, alcohol control policies tend to not be of optimal strength for supporting public health and safety. The marketing of alcoholic beverages along with price promotions and increased accessibility are all strategies for increasing sales and revenue that have been shown to negatively affect health outcomes.[3] Government monopolies that have a strong mandate for protecting public health ensure the availability of alcohol to citizens via policies that reduce alcohol related harms.

Conclusion

The culture of alcohol use in Canada and the policies that govern its sale and promotion have significant implications for injury rates and injury prevention initiatives. Strategies to reduce alcohol-related injuries frequently focus on education or enforcement initiatives related to specific behaviours such as impaired driving. While these measures are important, the evidence also points to the need to address patterns of alcohol consumption in the population in order to impact rates of injury. Injury prevention practitioners can enhance the effectiveness of their efforts by seeking to influence policies on the pricing, marketing, and availability of alcohol.

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4.8

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Concussion

Brain Injury

It is estimated that 100 billion nerve cells are interwoven to form the jelly-like fabric we know as the human brain. These intricate networks are responsible for the highly complex behaviours that humans exhibit and observe every day. Although the structural units indicate a common mind, the functional networks are what ultimately define our individuality. One example of this paradox is in the area of brain injury where seemingly similar injuries can result in very different manifestations.

This variance in outcomes following concussion is highlighted by very different courses of recovery. A concussion is defined as a mild traumatic brain injury caused directly by a hit to the head or indirectly by a hit to the body. These impacts result in movement of the brain within the skull.[1] Although sport-related concussions are better documented, a 2010 report by the American Association of Neurological Surgeons (AANS) and a recent study by Theadom et al. (2014) both suggest that only 21% of head injuries are sport-related.[2,3] Although violent collisions in sport are commonly perceived as the main mechanism of concussions, other common mechanisms include recreational activities, motor vehicle collisions and falls.

The majority of individuals recover in the initial period following injury.[4] However, some individuals are left with symptoms and functional limitations that persist. Some of the most commonly reported symptoms include headaches, dizziness, difficulty concentrating, cognitive difficulties, increased fatigue, irritability, sound and light sensitivity.[5] Alterations in

balance and changes in performance on neurocognitive testing have been documented and may persist.[5,6] Thus, mild Traumatic Brain Injury can result in longer-term functional alterations affecting quality of life.

There has been a trend to unify concussion management regardless of the initial mechanism of injury. To date, the management of non-sport-related concussion has largely focused on acute management and the Glasgow Coma Scale (GCS) which differentiates head injuries into mild, moderate and severe.[7] The primary goal in this initial assessment was to determine whether imaging and further medical intervention is required. In contrast, the field of sport concussion has developed a standardized sideline evaluation to diagnose injured players (SCAT3) which includes the GCS. In addition, one of the great advances of sport-related concussion is the development of a standardized long-term management tool for "return to play" or "return to practice." On a graded scale, players are required to successfully graduate from a series of stages (ranging from no initial activity to full contact practice) before they are cleared to return to full sport participation.[4] It is important to note that loss of consciousness is not required for a concussion diagnosis, as this occurs in less than 10%of cases.[8] Furthermore symptoms of concussion can be subtle and may not appear for hours or several days. Individuals may experience many different signs and symptoms ranging from physical, cognitive, emotional and sleep-related disturbances. The recommended treatment for concussion includes both physical and mental rest.[4] Ultimately, while 70-80 percent of concussions may resolve themselves within seven to ten days, recovery time is usually longer for children and adolescents.[9]

A complicating factor influencing recovery is the plasticity of the developing human brain. Children under the age of thirteen will report symptoms differently than older children, and therefore require a different method of evaluation.[4] A 2013 study by Colvin et al. estimates that 173,000 children present to emergency rooms with concussions related to a sport or recreation in the United States every year however the actual incidence is unknown.[10] Often, children try to hide their symptoms in order to impress and not to appear weak or cowardly by their peers, coaches, and parents. According to the 1532 varsity students examined, 35.3% of the athlete participants admitted that they would not report an injury to make themselves look tough.[11]

Brain injuries and more specifically concussions have received a tremendous amount of attention, both in medical research and in the mainstream media. Professional athletes have raised the bar and are now speaking up regarding the importance of recognizing the impact of such injury and what life-changing effects it can have on an individual if appropriate care is not given and treatment is not adhered to. Education and awareness at all levels, including health practitioners, parents/players/coaches and educators, is vital to ensuring the safety of children and adolescents.

In the words of Dr. Mark Aubrey, Chief Medical Officer Hockey Canada and International Ice Hockey Federation, "we're at the end of the beginning, we know so much, yet so little".

Intrinsic risk factors for brain injury

The recursive model of sport injury can be applied to concussion to examine risk factors that are both intrinsic and extrinsic to an individual.[12] An intrinsic risk factor refers to a risk factor that is specific to an individual and may include previous injury, past medical history, genetic susceptibility and neuromuscular control. One of the most commonly reported intrinsic risk factors for concussion is a previous history of concussion (i.e. individuals who have suffered a previous concussion have been shown to have a higher risk of concussion than individuals who have not previously suffered a concussion). A three fold increased risk of incident concussions has been reported in collegiate football players who have a history of three or more concussions.[13] A study of 15,802 high school athletes involved in twelve different sports found that previous history of a concussion increased the rate of incident concussion 2.28 fold (95% CI; 1.24, 4.19).[22] Studies evaluating previous history of concussion as a risk factor for incident concussion vary from 2 to 11-fold increased odds of concussion depending on the sport and age of participants.[14] Previous history of concussion is an example of an intrinsic risk factor for incident concussion.

There are inherent differences between males and females physiologically.[15] Factors such as poorer neck strength in females and smaller size have been postulated to increase risk of concussion in females. Females may be more likely to report symptoms of concussion and thus concussions in females may also be more likely to be captured in injury surveillance studies. However, there is greater participation by males in contact sports, thus studies in this area often evaluate larger number of male participants. Despite these factors, discrepancy in the literature is evident regarding the risk of concussion associated with gender.[14]

There are inherent differences in rules and regulations as well as protective equipment in some sports making comparisons between sports difficult.   Reports of neck pain and headaches at baseline have also been reported to be risk factors for concussion in male youth athletes.[16] Individuals reporting neck pain at baseline were 1.67 times (95% CI: 1.15-2.41) more likely to suffer a concussion in the following season and those reporting headaches at baseline were 1.47 times (95% CI: 1.01-2.13) times more likely to suffer a

concussion than individuals not reporting a headache. Individuals reporting any two of dizziness, neck pain and headaches on the SCAT were more likely to sustain a concussion than those individuals not reporting any of these three symptoms (Pee Wee non-body checking cohort IRR = 3.65 (95% CI: 1.20-11.05) and Bantam cohort IRR = 2.40 (95% CI: 1.15-4.97)).[16] These findings appear biologically plausible, as alterations in cervical neuromotor control may alter the body's ability to accept and transmit forces, but further research to examine the mechanism by which this may occur is needed.

Older age in youth has reportedly been found to be associated with increased risk of concussion. When compared to Atom (9-10 years of age) players, Pee Wee (11-12 years of age) and Bantam (13-14 years of age) players had an increased risk of concussion (3.13 and 4.04 respectively).[17] More recently, Pee Wee ice players have been found to have a higher risk of concussion than Bantam and Midget players.[18,19] Additionally, younger sport participants may take longer to recover.[20] Limited literature is currently available evaluating the contribution of genetics and behavioural characteristics to concussion risk.[14]

Extrinsic risk factors for brain injury

Extrinsic risk factors are those risk factors that occur in the environment and are "external" to the individual.[12] Examples of extrinsic risk factors include the rules of a sport, protective equipment and field conditions. Body checking in youth ice hockey is one example of an extrinsic risk factor for concussion. Participating in a league that allows body checking at the Pee Wee (11-12 year old) level has been shown to increase the risk of concussion 3.88 times (95% CI; 1.91, 7.89) that of individuals participating in a league where body checking is not allowed.[21] This finding is consistent with a systematic review by Emery et al (2010).[21] Increased rates of concussion have been reported in high school athletes participating in full contact sports, when compared to individuals participating in non-contact sport with a reported adjusted incidence rate ratio of 3.28 (95% CI; 1.26, 8.58).[22] Game play has demonstrated a higher rate of concussion than practice.[21]

Wearing appropriate protective equipment has been evaluated in terms of risk reduction.[23] Helmets have demonstrated a decrease in risk of head injury and evacuation by ambulance for head injury in snowboarders and skiers.[23,24] Some individuals have hypothesized that the wearing of protective equipment may alter behaviour, instilling a sense of false confidence and thus increasing the likelihood of risk taking behaviours.[25] This has often been termed "risk compensation", but has not been consistently supported by research findings.[25,26] The use of mouthguards have consistently demonstrated a decrease in oral and facial injuries in multiple sports[27] but there is not any current strong evidence that mouthguards alone decrease the risk of concussion.[24,27] The use of a visor in ice hockey has not demonstrated a protective effect for concussion in ice hockey.[28] However, intercollegiate ice hockey players who wore a half face shield lost significantly more playing time. Players without a

mouthguard who were wearing a half face shield at the time of a concussion lost significantly more playing time compared with players who wore a mouthguard with a half face shield.[29] Mouthguards are not mandatory in all youth ice hockey associations despite the protective effect demonstrated in the literature. Padded headgear has been proposed to have a protective effect on concussion but minimal evaluation has occurred in high quality studies. [14] Future research is needed to better understand the risk of concussion associated with type of surface (artificial turf versus grass), impact location, past medical history and other potential risk factors.

A good understanding of an athlete's intrinsic and extrinsic factors at a particular moment in time is imperative in the prevention of potential injury, in this case specifically concussion. The risk set of an athlete is in a constant state of flux and awareness of potential risk factors may prevent susceptible athletes who encounter a potentially 'inciting' event from becoming injured.

Prevention of brain injury

Prevention strategies aimed at prevention of concussion focus on modifiable risk factors. Some of the factors presented above are non-modifiable (i.e. previous history of concussion). Thus, identification of prevention strategies to address factors that are modifiable is of utmost importance. The majority of literature focusing on prevention strategies for brain injury has focused on extrinsic risk factors such as protective equipment and rule changes.

The wealth of literature demonstrating an increased risk of concussion in youth ice hockey players participating in a league that allows body checking has recently lead Hockey Canada to a decision to move the age at which body checking is allowed to 13 years (Bantam). A similar decision was made by USA Hockey in 2011. There is ongoing discussion related to the appropriate level of play in which to allow body checking in older age groups (ages 13-17). In some provinces in Canada only the most elite players (upper 30% by level of play) compete in leagues that allow body checking but this is not the case in all jurisdictions. Helmets have demonstrated a protective effect for skull fracture and more severe brain injury in many sport and recreation activities, such as skiing, snowboarding and cycling. Helmets are mandated to be worn while cycling in many provinces. Similarly, helmets are recommended for skiers and snowboarders in many

terrain parks in Canada. There is currently no evidence to support the use of a helmet to prevent mild traumatic brain injury despite evidence demonstrating a reduction in impact forces. This may be due to the rotational acceleration involved in concussion.   St. Clair and colleagues (2007) concluded that for the majority of cases considered, a helmet can provide life saving protection during typical linear impacts and, in addition, the typical level of rotational acceleration observed using a helmeted head form (in a laboratory setting) would generally be no more injurious than expected for a bare human head. They concluded that a greater understanding is therefore needed to allow an accurate assessment of injury tolerance in oblique impacts.[30]

Mouth guards are used to protect against oro-facial injury and are mandated in many contact sports. However, the literature does not support a significant decrease in risk of concussion with the use of a mouth guard. Neck strengthening has been postulated as a potential concussion prevention program; however, the current literature has not identified a significant alteration in concussion risk.

Secondary and tertiary prevention strategies may be implemented to optimize the management of concussive injuries. There is an ongoing problem with underreporting of concussions. Thus, identifying the most appropriate tools and measures is of utmost importance in concussion. The heterogeneous nature of concussion makes such testing challenging. The Sport Concussion Assessment Tool 3 (SCAT3) is a commonly used tool that includes evaluation of symptoms, a brief cognitive, balance and coordination screen.[4] This tool can be used at the sideline or in the office and provides assessment of a variety of domains that may be injured at the time of concussion. It is intended for use in individuals over the age of 12 and a pediatric version of this tool (Child-SCAT3) is available for younger athletes.[4]

Tertiary prevention strategies for concussion injury are limited.[31] The typical treatment for individuals who have suffered a concussion is a period of rest until the acute symptoms resolve followed by a protocol of graded exertion.[4] There is a paucity of literature evaluating the effects of rest and treatment for individuals who have persistent symptoms following a concussion.[31] However, consensus statements recommend that individuals who have symptoms that persist be treated in a multidisciplinary fashion.[4] A recent randomized controlled trial has identified that a combination of cervical and vestibular physiotherapy may be of benefit for individuals with persistent symptoms of dizziness, neck pain and headaches following a concussion.[32] In children and adults with persistent symptoms following concussion, low level aerobic exercise may be of benefit.[33,34]

Summary and future directions

Concussion is among the most common sport and recreational injury types in today's society and has significant public health implications. When evaluating the risk of concussion in sport, one must take into account all of the risk factors at hand. Many of the risk factors discussed above are modifiable while others are not. Further research to evaluate the effectiveness of prevention strategies aimed at modifiable risk factors is warranted. Similarly, future literature to identify optimal outcome measures and evaluate the effects of treatment in individuals who have suffered a concussion is warranted.

The prevention of concussion will require the involvement of key stakeholders (i.e. athletes, parents, coaches, associations and governing bodies). Integrated knowledge translation is critical to facilitate evidence-based knowledge uptake and appropriate behaviours related to primary, secondary and tertiary concussion prevention strategies to reduce the public health impact of concussion in youth. Studies report that many parents are not familiar with the current return to sport guidelines following a concussion.[35,36] Without knowledge of potential risk factors and risk profiles, prevention is challenging. Future literature to further identify modifiable risk factors and effective prevention strategies is necessary to decrease the number of incident concussions and thus decrease the overall public health burden from this commonly occurring injury.

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4.9

Drowning

Drowning in Canada

Canada is a country that has an abundance of bodies of water – both natural and artificial. While these bodies of water provide Canadians with opportunities for travel, recreation, and enjoyment, they also pose risks for those who use them, particularly in the warmer months of May to August.[1] Drowning represents an important cause of unintentional injury fatalities in Canada. From 2001 to 2007, drowning accounted for 3% of deaths from unintentional injury,[2] with an annual average of 525 water-related fatalities.[1] Drowning can be the result of the following activities: boating (32%), aquatic activities (22%), unexpected falls into water (19%), transportation (e.g. snowmobiles, 7%), bathing (7%), and unknown (4%).[1] There are certain behaviours that can increase the risk of drowning. For example, the majority of boaters that drown had either consumed alcohol or were not wearing lifejackets.[1]

Particular groups of individuals in Canada are over-represented in drowning statistics. For instance, those 18 – 24 years of age have the highest rate of drowning of any age group in Canada at 2.2 per 100,000 population.[3] A larger age range, the 18-34 year old age population, accounted for a 19% increase in 2006-2010 drowning incidences, despite the fact that this segment of the population only increased in size by 5% between 2006-2010.[3] Nine out of 10 of these deaths are males.[3] Drowning risk factors for young men ages 18-34 years of age include a number of factors: Not wearing a PFD (80%); alcoholic beverage consumption (47%); cold water (46%); swimming alone (35%) or with companion(s) that could not rescue them (65%).[4] Drowning related deaths have huge personal, emotional, and

economic costs. According to the Canadian Red Cross (CRC), the annual economic burden of drowning is $106 million.[5]

In this chapter, the social determinants of health will be described as well as why they are important for understanding and preventing drowning in Canada. The focus will be on addressing drowning prevention in populations that are most at risk of drowning within the Canadian context. Finally, several case studies will be provided that serve as examples of innovative methods in which drowning prevention can be promoted.

Drowning and the social determinants of health

The World Health Organization (WHO) defines the social determinants of health as "the conditions in which people are born, grow, live, work and age. (See Chapter 3.1 on Socio-Economic status and the social determinants of health) These circumstances are shaped by the distribution of money, power and resources at global, national and local levels."[6] Within a Canadian context, the Public Health Agency of Canada identified twelve health determinants: income and social status, social support networks, education and literacy, employment/ working conditions, social environments, physical environments, personal health practices and coping skills, healthy child development, biology and genetic endowment, health services, gender, and culture.[7] All of these complex factors interact to determine one's health, including one's risk of injury. (See Section 3.0 for more information on the Key Determinants of Health)

While many people view drowning as an individual responsibility related to not knowing how to swim, failure to supervise children, or failure to wear a lifejacket, some researchers have argued that drowning and other unintentional injuries are directly related to the social determinants of health.[8,9] For example, a study based in Saskatoon found much higher rates of injuries, including drowning, in low-income neighbourhoods in comparison to high-income neighbourhoods.[10] Drowning is also associated with being a member of a racial or ethnic minority, lack of higher education, and living in a rural community.[11] In fact, drowning rates are up to ten times higher for Aboriginal peoples in comparison to non-Aboriginal peoples in Canada.[1] Due to colonialism, Aboriginal populations typically suffer from higher rates of poverty and lower levels of education attainment than the national average, and often live in rural communities.[12] It is possible to begin understanding complex intersecting factors that contribute to the many Canadian lives lost each year from drowning, when the social determinants of health and their impact on drowning are considered. This approach is crucial if the risks of drowning are to be reduced and water safety is to be increased throughout Canada.

Given that men and Aboriginal peoples represent the greatest proportions of Canadians who drown, in this chapter, the focus will be on two social determinants of health: gender and culture.

Gender

Boys and men drown much more often than girls and women: 83% of all drowning victims are male.[1] It may be that men are more likely to participate in activities in, on, and around aquatic environments (e.g., recreational boating, fishing, and snowmobiling on ice).[1] Another possibility is that men are more likely than women to participate in high risk behaviours. Byrnes, Miller, and Schafer reviewed 150 studies that examined males' and females' risk-taking tendencies.[13] They found that men and boys were more likely than women and girls to take risks "even when it was clear that it was a bad idea to take a risk."[13] On the other hand, they found that women and girls were unlikely to take risks even in low risk situations. Risk-taking differences in gender likely are related to risk perception. Flynn, Slovice, and Mertze argued that men judge risks as "smaller and less problematic than do women."[14] If males judge risks to be smaller than women and they are more likely to take risks, this will influence the likelihood that they may make decisions that put themselves in risky aquatic situations, such as consuming alcohol while boating. Gender in and of itself is a risk factor, but gender can also interact with culture to enhance vulnerability to drowning, which will be discussed in the following section.

Socio-Economic Status

According to the Centers for Disease Control (CDC), socio-economic status is a composite measure that "typically incorporates economic, social, and work status. Economic status is measured by income. Social status is measured by education, and work status is measured by occupation. Each status is considered an indicator" .[15] Laflamme, Burrows, & Hasselberg found that "people from low socio-economic status and from less affluent areas tend to die by injury to a greater extent than others".[16] The Canadian Institute of Health Information (CIHI) reported that the rate of injuries among the poorest Canadians is 1.3 times greater than the wealthiest.[17] Brownell, Friesen, & Mayer found that in Manitoba, children in lowest income group households were 1.5 times more likely to die from drowning.[18] Furthermore, the World Health Organization has found that in many countries, a lack of higher education is associated with drowning.[19] A low level of parental education, especially in impoverished areas, has been found to have a negative impact on child survival, which could be due parents and caregivers lacking knowledge about preventative measures.[20] Due to

colonialism's ongoing effects, Aboriginal peoples in Canada are at the bottom of almost every available index of socio-economic well-being.[21]As a result, Aboriginal peoples are over-represented in drowning statistics. (See Chapter 3.10.2 Aboriginal Peoples)

Culture

Globally, ethnic and racial minority group members have been found to have higher drowning rates in comparison to a nation's population as a whole.[22] (See Chapter 3.10 Culture) Certainly, one's culture can influence an individual's beliefs, attitudes, and subsequent behaviours as they relate to water safety. For example, Quan, Gore, Bennet, and Gomez found that Vietnamese parents and adolescents in their study believed that fate, spirits, and circumstances out of the individual's control were the reasons why people drown.[23] The participants stated that open water drowning occurs because "spirits pull you down."[23] These findings demonstrate the need for the creation of drowning prevention programs that take culture into consideration, which has been found to be lacking in existing Canadian programs.

Drowning in Aboriginal communities

Within Canada, Aboriginal peoples appear to be the population most vulnerable to drowning. According to Statistics Canada,[24] 4.3 percent of the Canadian population identifies as Aboriginal. Rates of unintentional injury are higher in Aboriginal populations than in non-Aboriginal populations,[1] and rates of drowning are no exception. Drowning rates amongst Aboriginal populations are up to 10 times higher than non-Aboriginal populations in Canada. [1, 25] More specifically, Aboriginal children drown at a rate that is fifteen times the national average.[25] Aboriginal peoples account for 26% of all snowmobile drowning incidences, 16% of all drowning incidences in general, and 9% of all boating drowning incidences.[25] Importantly, within this population, as with the non-Aboriginal population, males are overrepresented.

Several reasons have been identified for increased rates of drowning amongst Aboriginal populations: low levels of personal flotation device use, lower level of household income, farther distances to help, lack of access to swimming lessons, greater amounts of time spent on or close to the water, use of alcohol,[26-28] and failure to provide culturally and geographically relevant water safety programs.

Baker and Giles argue that there is a widespread failure to recognize the legitimacy of Aboriginal knowledge in drowning prevention, which can result in ineffective programming.[26] The authors further suggest that prevention education must be collaborative, culturally relevant, and recognize the geographical context of remote communities in order to address the disparity in drowning rates between Aboriginal and non-Aboriginal peoples in Canadians.

In line with such recommendations, Banerji and the Canadian Paedeatric Society reported that several organizations including the Assembly of First Nations, Pauktuutit Inuit Women of Canada, and the National Indian and Inuit Community Health Representatives created tailored prevention strategies for injury prevention among Indigenous populations; however, these were short-lived due to recent drastic funding cuts to programming.[29] (See Chapter 3.10.2 Aboriginal Peoples)

Drowning in the Canadian North

Rates of drowning are highest in the Yukon, Northwest Territories, and Nunavut.[1] In the Canadian North risk factors for drowning are also influenced by geography and culture. The omnipresence of lakes, rivers and oceans, and lower water temperatures enhance risk.[27-29] Durkalec, Furgal, Skinner, and Sheldon contended that there is a need to consider environmental determinants of injury in the Arctic, as many northerners, including Aboriginal peoples, face risks of cold exposure or falling through the ice; experiences that may not be captured in general programming.[30] The researchers further noted that there is a lack of access to culturally appropriate injury prevention programming,[30] which can compromise the effectiveness of drowning prevention efforts.

Effective Injury Prevention

Injury prevention efforts tend to focus on the "three E's": education to change behaviour choices, enforcement through the use of legal requirements, and engineering, which refers to environmental modification to "create safer surroundings and products."[31] (See Section 2.2 for more information on the three E's of injury prevention.) These three approaches have been applied to drowning prevention.

Education: Water safety education programs are extremely popular in Canada. For example, the two largest providers of water safety education in Canada, the Canadian Red Cross Society and the Lifesaving Society of Canada, each report having over one million participants in their swimming and water safety education programs every year. Additionally, water safety education also occurs in snowmobile and boating safety programs that are offered by various organizations. In some jurisdictions, water safety is also included in school curriculum. Importantly, however,

swimming lessons' role in preventing drowning is controversial. Brenner, Saluja, and Smith argued that "evidence suggests that many drowning victims are able to swim" and that swimming lessons may increase children's risk of drowning because they provide them with greater exposure to the hazard (water) and may lead them to feel overly confident.[32] Moran and Stanley found that parents who enrolled their toddlers in swimming lessons overestimated these lessons' role in preventing toddler drownings.[33] Conversely, using United States data, Brenner et al. found that swimming lessons significantly reduced the risk of drowning in children aged 1 to 4 years, but not in older children.[34] Education efforts have also focused on adults and their supervision of infants and toddlers and those with medical conditions around water which is especially important to reduce drowning.[35]

Enforcement: There are several different enforcement mechanisms that can be used to ensure the safe operation of swimming pools, watercraft, and snowmobiles. The operation of swimming pools must adhere to each province's or territory's Public Health Act, while the Canadian Shipping Act (2001) and its regulations govern pleasure craft operation in Canada.[36] This Act and its regulations provide rules concerning boating equipment, operation, competency, etc. The Criminal Code of Canada also applies to boating and snowmobiling– for example, operating a boat or snowmobile while intoxicated is a criminal act.[37] Various jurisdictions across Canada also have rules and regulations concerning the age at which one is allowed to operate snowmobiles.

Engineering: Water-related injury prevention strategies often draw heavily on water safety equipment. For example, adequate pool fencing[38] – i.e., on all four sides, with secure, self-closing, self-latching gates - can reduce three-quarters of child drownings in swimming pools. Lifejackets,[1] helmets, and survival suits[39, 40] can also make important contributions to injury prevention.

Beyond the three E's, there are other factors that can help to make injury prevention efforts more effective. Effective injury prevention strategies need to account for the influence of a variety of factors on risk communication, including gender, age, ethnicity,[41, 42] feelings,[43] place,[44] trust and power.[45-47] For example, there is evidence that lifejackets may be perceived by some northern Aboriginal residents to be inaccessible and/or not endorsed by community members as a strategy for drowning prevention,[26] which contributes to some northerners' lack of willingness to wear these important pieces of safety equipment. These findings suggest that people process risk messages differently. Injury prevention strategies that involve community members in their design have been found to be particularly effective.[48] As risk factors and risk perception for injury differ among groups, an effective drowning prevention strategy must acknowledge and address these differences.

Case Studies

An example of an effective water safety campaign that targeted Indigenous men occurred in Alaska, where Native Alaskan whalers expressed their dislike of the bright colours of conventional flotation devices. The whalers believed that flotation devices should be white so as not to scare the animals they were hunting. A collaborative effort between the Alaska Eskimo Whaling Commission, the United States Coast Guard, the Alaska Native Tribal Health Consortium, and Mustang Survival (which manufactures flotation devices) resulted in the creation of a custom white "float coat" (i.e., similar to the top half of a survival suit), which has been very popular amongst the whalers.[49]

Giles, Strachan, Doucette, Stadig, and the Municipality of Pangnirtung used a community-based approach with Inuit peoples in Pangnirtung, Nunavut in an attempt to improve boat safety.[50] Community members identified that they believed that individuals were boating without being fully prepared for their travels. As a result, Giles et al. worked with community members to adapt Transport Canada's[51] Minimum Safety Requirements for Boating so that they better met northerners' needs. For instance, Pangnirtung residents spoke of the importance of carrying ammunition, rifles, knives, and harpoons in one's boat, all of which could be incredibly important for survival in the Arctic. Based on community members' input, Giles et al. added these and other items to the Minimum Safety Requirements for Boating and had all of the items printed in English and Inuktitut on fridge magnets and thermoses, as Pangnirtung residents said they were likely to see these magnets every day and take the thermoses on boating trips.[50] As such, community members believed they would serve as effective reminders of safety equipment that should be brought on boating trips.

Conclusion

There are a number of factors that influence a person's risk of drowning. With rates of drowning disproportionately affecting certain groups of Canadians, such as men, individuals between the ages of 18-24 years, and Aboriginal peoples, drowning prevention programs need to go beyond the three E's to understand what shapes a person's perception of risk and participation in risk-taking behaviours. In order to do this, drowning prevention campaigns need to consider participants' social determinants of health so that they can better meet participants' needs and thus be more effective.

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4.10

Burns

Overview of the burden

Burns are caused by exposure to hot liquids (scalds), hot solids (such as household appliances), or flames. Injuries due to exposure to radiation, radioactivity, electricity, or some chemicals are less common, but also considered in this category. In Canada, burns are a fairly common reason for hospitalization. For example, from 2001-2011, 4,736 British Columbians were hospitalized for a burn.[1]

Few people realize that hot water burns like fire. Yet Canadians continue to be treated in hospital for scald injuries caused by hot tap water.   These types of burns are extremely painful and have a significant economic impact on families and society in general.   The real tragedy is these injuries are predictable and preventable.

Burn rates are highest at both ends of the age spectrum. Infants less than one year had a hospitalization rate for burns in British Columbia of 21/100,000 population, while those 75+ had hospitalization rates of 13/100,000 versus 8/100,000 for adults ages 20-64 years to 16.2 per 100,000.[2] In children, scalds represent the most common mechanism for burn injuries, representing 50% of all hospitalizations.[3] Burns are the third leading cause for hospital admissions due to injury for those 0-4 years. Three hundred and forty six children ages 0-4 years and fifty-nine children ages 5-9 years were admitted to hospital as a result of a burn in 2010/11.[4] These admissions are just the tip of the iceberg as most children sustaining burns are only seen in an emergency room or at a clinic, and are not admitted to hospital.[5]

Older adults are also frequently injured due to burns and scalds.   For example, in the province of Ontario, Canada, in 2002-2003, there were 765 Emergency Department (ED) visits for scalds, and 296 for fire and flame among older adults.[6] The two key mechanisms of injury for older adults are from hot water scalds and flame from cooking.[7] More older adults die from fire and flame related injuries than from scalds (0.66 and 0.33 per 100,000 respectively).[6] The kitchen and bathroom have been reported as common places of burn injuries in older adults, and hot-water scalds from spilling boiling liquids as well as immersion in bathtubs containing water that is too hot, have been common causes of scald burns.[8]

Mechanisms of burn injury

Scalds and hot tap water

Many Canadian homes have hot water that is 60°C (140°F). This can cause a third-degree burn on a child's skin in just one second.[9] A slight reduction in temperature would have a significant impact on reducing the number and severity of injuries.   The higher the water temperature, the shorter the time of exposure required to produce a full thickness scald. [9] A third degree burn (characterized by blistering, intense pain and permanent tissue damage) will occur in children in only 1 second when water temperature is 60°C (140°F). At 55°C (130°F), a third degree burn will occur in 10 seconds, while the time to produce a third degree burn extends to at least 10 minutes when water temperature is 49°C (120°F) (See Table 16). Drs. Moritz and Henriques, illustrated this point as far back as 1947 showing the temperature and duration of exposure needed to produce a severe scald.[10] The table below describes hot water temperatures in relation to the time in which an injury can occur.

Table 16

Temperature of hot water and its relation to the time in which injury can occur[9]

Water / liquid Temperature		Time in which a young child can suffer a full thickness (3rd degree) burn*	This is as hot as ...
212F	100C	less than 1 second	Just-boiled water from a kettle.
160 F	**70 C**	**less than 1 second**	**Maximum setting on home hot water heaters.** Freshly poured tea and coffee (approx. 70 - 85C or 160 – 175 F)
148 F	64 C	less than 1 second	
140 F	**60 C**	**1 second**	**Factory setting for Canadian hot water heaters.**
130 F	55 C	10 seconds	Hot water from a kettle 5 to 10 minutes after boiling.
127 F	52 C	1 minute	
120 F	**49 C**	**10 minutes**	**Recommended safe setting for home hot water heaters.**
100 F	37 C	Safe temperature for bathing children	Body temperature - bath will feel "just warm" to adults, fine for children.

*Times in this table are adjusted to indicate the time required to produce a serious burn in children.[9]

There have been some concerns regarding decreasing the temperature in hot water tanks causing an increase in legionella. This controversy continues; however, a key study in the state of Washington where water tanks were pre-set at the recommended temperature found that no increase in legionella was experienced yet there was a 50% reduction in tap water scald admission rates.[11]

Hot objects

Hot household appliances are another source of burn injuries. Objects such as stoves, ovens, and fireplaces are common sources of burn injuries. For children, there is particular risk from the glass barriers on gas fireplaces. For example, the glass barrier on a gas fireplace can heat up to over 200°C (400°F) in about six minutes during use. It takes an average of 45 minutes for the fireplace to cool to a safe temperature after the fire is switched off.[12]

Fire and flame

Smoke detectors have been proven to reduce the risk of death in a house fire. The risk of fire-related deaths is three times higher in homes without working smoke detectors than those with smoke detectors. Most children who died in residential fires were in homes without smoke detectors or without working smoke detectors. Alarms should be tested every month and batteries changed each year.[13]

For older adults, there have been calls for mandatory sprinkler systems, particularly in institutional settings where residents may have challenges with mobility. As these requirements are expanded it is hoped that there will be fewer tragedies from fires in these settings.

Overview of the risk factors

Age

Children

Children learn about their surroundings by exploration. Infants and toddlers are at high risk for scalds and burns because of their natural curiosity and desire to handle objects. Preschoolers (3 to 5 years old) love to imitate adult work. As they play at pretend cooking, they often do not separate fantasy and reality. Children this age lack a clear sense of danger and even in older ages their sense of danger is not reliable. Children are at high risk for burns because their skin is thinner than an adult's skin. A child's skin burns four times more quickly and deeply than an adult's at the same temperature.[1] In the case of gas fireplaces, young children, under five years of age, and especially those under two years, are most at

risk. When young children begin walking, they often fall. Hands and fingers are burned on the glass and metal parts of the door as young children raise their arms to stop their fall. Also, young children are attracted to the flames and want to touch them.

Serious burns can have long-term consequences for a child. They often must have many skin grafts and may have to wear compression garments for up to two years. Because children are always growing, they are likely to have scarring and contracting of the skin and underlying tissue as they heal. Many children are left with disfigurement, permanent physical disability and emotional difficulties.[14]

Older adults

It has been well documented that an older aged population is at higher risk for burn injury as a result of several predisposing factors that are associated with increased age. These factors include; chronic diseases or disabilities that may affect the sensitivity of extremities, produce slower reaction times, or result in poorer dexterity, decreased mobility or senility.[15] As with children, burns can also have long-term consequences and result in permanent scars, disfigurement or disabilities in older adults.

Gender

There are different risks for burn injuries according to gender, by the type of burn injury. According to CIHI data, males at all ages are more likely than females to visit the emergency department for injuries due to fire/flame, with the most marked differences in the 15-24 age category (101/100,000 versus 32/100,000) and the 25-64 age category (69/100,000 versus 23/100,000). However, females are more likely to visit the ED for hot objects/scald injuries in the youngest age group, 15-24 (196/100,000 versus 178/100,000) and the oldest age group 65+ (54/100,00 versus 45/100,000), with no sex differences in adults ages 25-64.[6]

Socio-Economic Status

A consistent social gradient has generally been reported world-wide with those of lower Socio-Economic Status (SES) having an increased risk of burns. A study conducted using the provincial trauma registry in British Columbia of adults hospitalized from severe burn/fire-related injury found that there was an association between lower SES and burn injury, which was most pronounced among inhalation-related injuries occurring in home and within urban areas. People with lower SES experienced both higher rates and relative odds of severe injury; however, this relationship was less pronounced and sometimes non-existent in rural areas.[16]

Disabilities or Physical Impairments

People with disabilities or physical impairments are at increased risk of burns worldwide. In children aged younger than 12 years in Ohio, the risk of burn injuries was significantly higher for disabled (i.e. children limited or unable to perform age-appropriate social activities because of a chronic physical or mental condition) versus able children after controlling for gender, race and age. This may indicate that a disabled child's ability to recognize and physically avoid a potential burn risk may be impaired by sensory and motor deficits.[17]

Other studies have also found that children and adults with sensorimotor disabilities are more prone to burn injury and face significantly higher mortality risks.[18]   A ten year chart review of hospitalized patients with tap water scalds in Wisconsin found that almost a third of patients were physically or mentally disabled.[19]

Prevention strategies

Hospital data show that burn injuries and deaths have declined in Canada between 1994 and 2003.[3] This is likely due to a combination of improved building and product regulations, promotion of safety products such as smoke detectors, public education on fire and burn prevention, as well as advances in emergency response and hospital treatment. Environmental strategies (such as smoke detector legislation, child-resistant lighters and flammability standards for children's sleepwear and, in other countries, safe hot water temperatures) have greatly reduced the number of burns.

Here are some specific prevention actions that can be taken:

❖ Ensure there are working smoke alarms on every level of the home.

❖ Lower the temperature of the hot water heater (49°C or 120°F)[5]

❖ If the hot water tank temperature cannot be lowered (e.g. in units that don't have individual tanks, in long term care facilities and other senior's facilities), install an anti-scald device to regulate the temperature of the hot water.

❖ Put a lid on hot liquids. Put tea, coffee and other hot liquids in a cup or mug that has a lid, for example a travel mug.

❖ Burn prevention campaigns for older adults should focus on reducing flame and scald burns that occur in the home, preferably using television, news, and poster media.[7]

❖ Supervise young children

  • Never leave a young child alone near a gas fireplace; they can be burned before, during and after use of the fireplace.

- Separate children from hot objects, particularly in the kitchen. Cooking on the back burners and turning the pot handles in prevents children from being able to reach the pots.

❖ Keep cords from your kettle and other appliances out of children's reach. Children can pull at the cords of the kettle hanging over the edge of the counter and scald themselves with the hot water from the kettle.[20]

❖ Place a barrier around the gas fireplace

❖ Install safety gates around the gas fireplace or at doorways to the room that has the fireplace. Teach children about the dangers of fire, and supervise.

❖ Teaching alone will not prevent your child from an injury. Young children, especially toddlers, may know a safety rule but will not necessarily follow it.[12]

Link to Product Safety

Many improvements have been made to products to eliminate and reduce injuries from burns/scalds. These include shorter cords on kitchen appliances, heat resistant glass on oven doors, child-resistant lighters, flammability standards for clothing, and anti-scald devices. These products play an important role in reducing or eliminating burns/scalds.

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4.11

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Sports and Recreation

Burden of Sports and Recreational Injuries

The benefits of participating in sport, recreational and physical (SRP) activity are many. Research has resoundingly demonstrated the impact SRP activity can have in reducing health risks, such as heart disease and type II diabetes; improving mental and emotional health; fostering self-esteem; promoting team building; and enhancing social skills. In this age of modern technology, children and youth are spending more and more time sitting in front of screens: televisions, video games, computers, tablets and phones. It has been estimated that Canadian children spend an average of 7 hours and 48 minutes in front of electronic devices over the course of one week.[1] Furthermore, the proportion of overweight and obese children and youth in Canada has grown from 15-26% of the population over 25 years from 1978/1979 to 2004, with obesity among 12-17 year olds tripling over this time period.[2] A similar trend of the prevalence of obesity was observed for adults aged 18 years and older. Canadian data indicate that the proportion of obese adults increased from 14% in 1978 to 25% in 2008.[3]

SRP activity is highly promoted and encouraged as part of a healthy and balanced lifestyle; however it is important to recognize the significant number of injuries that occur when participating in such activities and to also recognize that these injuries, for the most part, are predictable and preventable. In 2010, the Economic Burden of Injury in Canada calculated the total cost of injuries (direct and indirect costs) caused by being struck by or against sports equipment at $187 million annually.[4] But, since this study does not include many

other circumstances of injuries (e.g. falls or collisions against another participant), this is arguably an underestimation of the true socio-economic costs of SRP activity injuries.

SRP activity injuries represent a frequent and significant burden affecting children and youth. According to the Public Health Agency of Canada, SRP activity-related injuries among children and youth seen in emergency departments account for up to 40 % of injury visits, with 68 % of these occurring among youth 10 to 14 years of age, 55 % among youth 15 to 19 years, and 30 % among children 5 to 9 years. SRP activities also account for more than 40 % of head injuries seen in emergency departments among children and youth 10 to 19 years of age.[5-7] In the province of Québec alone, it is estimated that during the year 2009-2010, 671,000 residents aged between six and seventy-four years consulted a health professional to treat a SRP activity injury, equivalent to a rate of 111/1,000 participants.[8]

Risk factors relating to SRP activity play an important part in injury mitigation and in the development of injury prevention strategies. Age and gender are both factors associated with the risk of injury. In addition, injury type and severity of injury varies among differing SRP activities. These factors, therefore, need to be taken into consideration when developing intervention strategies. However, of utmost importance, consideration should include the 3E's of injury prevention (i.e. education, enforcement and engineering), as well as the inclusion of active and passive elements, when planning and implementing SRP activity injury prevention measures (see Chapter 2.2 Injury Prevention Spectrum and the 3E's).

SRP activity is crucial to a healthy lifestyle at every level of play. It is important not only to encourage such activity among all ages, but also to engage with public health and SRP activity sectors in taking the necessary precautions to reduce and mitigate SRP activity injuries. The overriding objective of injury prevention as it relates to SRP activities is therefore to reduce the negative consequences of SRP activity participation, while continuing to benefit from the healthy benefits of SRP activity participation.

Risk Factors for Sports and Recreational Injuries

One of the most important steps in the process of implementing SRP activity injury prevention strategies is to identify the risk factors, and mechanisms that contribute to injury occurrence. The work of engineer and physician William Haddon Jr. has led to the creation of a conceptual framework for injury prevention, known as the Haddon Matrix.[9] This matrix makes it possible to determine the various risk factors contributing to SRP activity injury, and to define the various strategies or countermeasures that can be utilized to prevent injuries related to a given SRP activity (see Chapter 2.2 Injury Prevention Spectrum and the 3E's).

Although originally developed for motor vehicle injury prevention, the Haddon Matrix has been adapted to the specificity of SRP activity-related injuries. Table 17 presents an example of the matrix applied to snow-sports (alpine skiing and snowboarding) related injuries.

Table 17

Adapted Haddon Matrix: Examples of Risk Factors Associated with Snow-Sports (alpine skiing, snowboarding)

Phases	Attitudes and behaviours	Supervision	Personal equipment	Physical environment
Pre-event[**]	• Not respecting the Alpine Responsibility Code • Selecting slopes or modules too difficult for their skill level	• Coaches or instructors not well trained • Exercises proposed to alpine skiers or snowboarders are too difficult	• Alpine skis or snowboard not well adapted to morphology or skill level • Bindings not well adjusted	• Modules of snow-park not well designed • Maintenance of snow-park and slope not adequate • Signage on the hill not adequate
Event[**]	• Low physical fitness status • Not wearing appropriate protective equipment (e.g. helmet, wrist guards)	• Emergency action plan not well known by coaches, instructors or patrollers	• Not wearing appropriate protective equipment (e.g. helmet, wrist guards) • Bindings do not release	• Safety nets or absorbent material on obstacles not in place
Post-event[**]	• Not complying with rehabilitation program • Coming back to activity too soon	• Patrollers not well trained	• First aid equipment not adequate	• No rapid access to care or trauma Centers

** Before, during or after the injury occurs.

We have defined four types of risk or protective factors based on general intervention areas. First are factors associated with the attitudes and the behaviours of participants. Second are factors associated with the quality of the supervision offered by coaches, teachers, instructors, first aid personnel, etc. Third, are factors linked to personal equipment (e.g. skis, snowboards, boots, helmets), and fourth, are the factors related to the physical environment or associated facilities (e.g. snow-parks, slopes, signalization). The temporal axis on the matrix denotes the events before, during, or after the injury that contribute to the occurrence, and/or severity of the injury.

This matrix highlights the fact that SRP activity-related injuries result from multiple factors. Consequently, whenever possible, it is preferable to opt for mixed strategies to prevent or

reduce injuries and their severity.[10] As such, while injuries are considered a public health problem, preventing them cannot be the sole responsibility of the health sector, and must include other disciplines, such as policy makers, engineering, education, and product safety.

In the following section, primary risk factors identified in the research literature are summarized for some of the most popular SRP activities in Canada, particularly those associated with a substantial proportion of injuries. These activities include ice hockey, snow-sports (alpine skiing, snowboarding), bicycling, and soccer.[8,11] Playground injuries are also highlighted as they are also a common cause of injury.[12-14]

Ice hockey

In Canada, ice hockey is one of the most popular sports. In 2013, more than 625,000 players were members of Hockey Canada.[15] However, due to the speed of the game, the equipment that is used, and the allowance for body checking, ice hockey has quickly been recognized as a high-risk sport.[16] Canadian data suggest that hockey injuries account for up to 10% of injuries for all ages, including adolescents.[8,17] In a systematic review of the literature on risk factors for injury and severe injuries in youth hockey, Emery and colleagues[16] identified risk factors that should be considered from an injury prevention perspective. Participation in games, compared with practices, was associated with an increased risk of injury. Age, level of play, and player position produced inconsistent findings. Body checking was identified as a significant risk factor for all injuries as well as concussion.[16,18] A review of the literature conducted by Lau and Benson[19] on risk factors for injury among players of all ages demonstrated that having been previously injured, not wearing full facial protection, and illegal play were significant risk factors for injury. Body checking was also identified as a significant risk factor for players of all ages.[19] It also worth mentioning that early exposure to body checking does not seem to have any protective effect.[20]

Snow-sports (alpine skiing, snowboarding)

The Canadian Ski Council estimates that there are 2.5 million skiers and snowboarders in Canada.[21] The vast majority of them participate in recreational settings, and the injury literature published to date is based primarily on recreational skiers and snowboarders, with very few studies focusing on competitive and elite level participants.[22] Therefore, the information presented in this section refers solely to recreational participation. In Canada, twice as many hospitalizations resulted from skiing and snowboarding than from hockey during the 2010-2011 season (2,329 versus 1,114).[23] Reviews of the literature completed by Flørenes and Ekeland[22] for alpine skiing injuries, and Russell and colleagues[24] for snowboarding injuries, revealed that being a beginner in both activities is a risk factor. However, the efficiency of lessons to reduce the risk of injury is not clearly identified.[22] Using rented equipment is a risk factor of injury for both activities,[22,24] and using bindings that are not well adjusted is a risk factor for alpine skiers.[22] Subsequently, not using a helmet is a risk factor for both skiers and snowboarders,[25] and not using wrist guards is a risk factor for snowboarders.[24] Snow-parks (SP) contain man-made features that allow snowboarders and

skiers to perform acrobatic manoeuvres and tricks, and are very popular in ski areas. SP injuries are more severe than regular slope injuries.[26] Russell and colleagues also demonstrated that the injury rate was almost 6 times higher on the jumps and half-pipe as opposed to using rails.[27]

Soccer

With more than 865,000 player members of Soccer Canada, soccer is one of the most popular organized sports in the country.[28] Canadian data suggest that hockey injuries account for up to 10% of injuries for all ages, including adolescents.[8,17] A systematic review by Scanlan, et al. identified age as one of the risk factors associated with soccer injuries, with the incidence of injury appearing to increase with the age of the players.[29] This is thought to be a result of increased strength, speed and aggressiveness in older players, and a greater force when players collide. Higher levels of play are also associated with greater risk of injury than lower levels.[30] With respect to the playing surface, studies that have examined the risk of injury on natural grass as compared to artificial turf have produced inconsistent results.[29,30] In her review of the literature, Emery[30] identified some risk factors associated with strength and neuromuscular control and balance. She suggested that despite the absence of significant findings examining all injury risk, there was certainly a trend toward increased risk associated with low hamstring/quadriceps strength ratio for lower extremity and hamstring strain injury in soccer.[30] From the Emery review,[30] it can be deduced that the level of neuromuscular control and balance that an athlete has, could be associated with the risk of injury. Indeed, neuromuscular training programs including a balance-training component have been consistently effective in decreasing the risk of injury among soccer players.

Bicycling

Canadian data shows that bicycling is a very popular activity among all age groups, but specifically among children and youth.[8] However, bicycling injuries are an important issue, not only because of their prevalence, but also because they can have very serious consequences.[8,11] The circumstances associated with fatal injuries are clearly different from conditions related to less severe injuries. In Canada, most of fatal injuries result from collisions with motor vehicles.[29] Not using a helmet has also been shown to be a risk factor for injury.[31,32] The study by Rivara, et al. suggests that some risk factors for serious injury include self reported speed of more than 24 km/h, younger age group (less than 6 years),

and being older than 39 years of age.[33] Brown suggested that cycling infrastructures and design that are not well adapted to cyclists are also risk factors to be considered.[34] The results of a systematic review by Richmond, et al. suggest that bicycling education and skills training programs may increase knowledge of cycling safety, but this does not seem to translate into a decrease in injury rate, or improved bicycle handling ability and attitudes.[35]

Playground

Participation in playground activities can significantly and positively contribute to the psychomotor, psychological, and social skill development of children. It has been estimated that at least 28,500 Canadian children are treated in emergency department each year for playground related injuries.[36] It has been demonstrated that the height of fall, and the quality of the playing surface are important risk factors for injury.[37-41] In addition, not adhering to the Canadian Standards Association (CSA) for playground equipment has also been shown to be a risk factor.[42] The literature suggests that supervision at the playground, preferably by parents or siblings, may potentially reduce the risk of severe injuries.[43]

Prevention Strategies

As presented in Section 2.1 with respect to the public health approach to injury prevention, the steps following the identification of significant risk factors for SRP activity injuries should be focused on identifying effective intervention strategies. The Three E's of injury prevention is an approach that involves classifying and targeting intervention efforts into three groups: Education, Engineering, and Enforcement. (See Section 2.2 for details) The aim of this section is to briefly present effective SRP activity injury prevention strategies based on those categories.

Education – The aim of education interventions are mainly to change the attitudes and behaviours of targeted groups. In SRP activities, targeted groups could be the general population, coaches, athletes, and any other key stakeholders in the sports and recreation communities. The implementation of multifaceted neuromuscular warm-up programs or concussion awareness programs are two examples of the educational approach to injury prevention.[44,45]

Engineering – Most interventions where the physical environment is modified to reduce the risk of injury can be defined as an engineering intervention. The use of personal protective equipment is also associated with this approach. Examples of effective personal protective equipment include helmets for alpine skiers and snowboarders,[25] and for bicyclists,[31] as well as wrist guard for snowboarders.[24] The CSA standards for the design and maintenance of playgrounds are also examples of an effective engineering approach.[42]

Enforcement – The development and enforcement of regulations, legislation, rules, or policies are associated with this approach. Regulations on mandatory the use of helmet for children when cycling,[46] or the mandatory use of full-face protectors for adult ice hockey players[47] are two examples of effective enforcement interventions. Specific to ice hockey, the banning body checking at Pee Wee level, as regulated by Hockey Canada is also an example of an effective enforcement strategy and intervention.[18]

The active-passive continuum of prevention strategies – In the process of selecting the appropriate SRP activity injury prevention strategy, the required action to be taken by an individual towards preventing or minimizing the risk of injury should also be considered. As explained in Chapter 2.3.3 Selecting or Designing an Intervention, the active-passive continuum of prevention strategies illustrates the level of responsibility an individual has towards his/her protection (Figure 32). "Active" measures require a conscious effort by an individual to prevent or minimize the risk of injury.[10,48] Respecting the Alpine Responsibility Code is an example of active measure. The education approach of the three E's of injury prevention includes active measures. Interventions aiming at protective equipment (e.g., wearing a helmet, or wrist guards) are often mid-way along the active-passive continuum as they require the individual to adopt the safety behaviour. But, once the protective device is used it provides protection without requiring further individual action. At the other end of the continuum, "passive" or automatic measures do not require the individual to do anything personally, in order to be protected.[10] Examples of this include the safe design and maintenance of sport and recreational facilities, and playgrounds.[38-42]

Figure 32

The passive-active continuum of prevention strategies (adapted from Brown & Massé)[49]
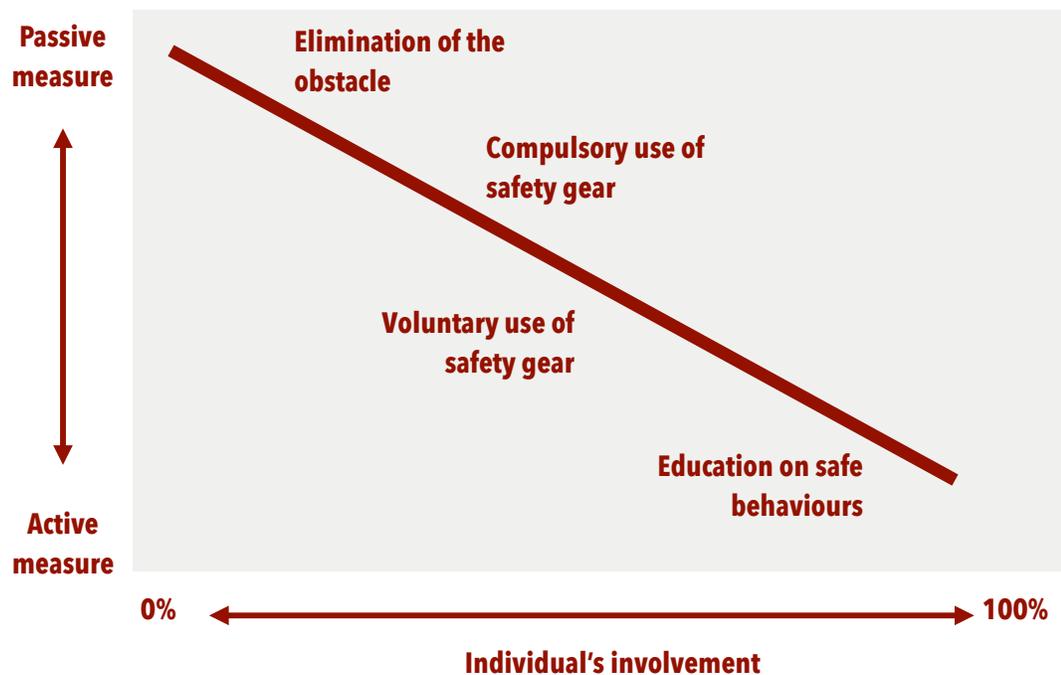
Conclusions

SRP activity-related injuries are the most ironic of injuries. On the one hand, public health authorities are actively promoting regular participation in physical activity, while on the other hand, if not practiced in safe environments and using proper equipment, injuries can significantly reduce the benefits of regular participation, and in fact, participation itself. Therefore, public health and safety issues have to be addressed in tandem.

As illustrated in this chapter, the prevention strategies for SRP activity-related injuries are multifactorial and many key stakeholders from different fields of intervention (e.g. education, public health, different levels of governmental agencies, sport and recreation) are needed to implement effective strategies.

Safety and injury prevention is often perceived by many as something that will take the enjoyment out of participation in SRP activities, and can cause some to think that we are overprotecting our kids and SRP activity participants. However, through effective safety measures and injury prevention practices, which includes the 3E's approach together with active and passive interventions, SRP activity participants can use good judgment and positive behaviours to navigate the risks and participate in SRP activities with a greater sense

of security. Through a coordinated approach, interventions can be put in place to prevent or reduce the risk of injury in sport, recreation and physical activity.

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4.12

Workplace

Introduction

While most developed countries have made progress in improving population health over the past two decades, reductions in the burden of mortality, morbidity and disability attributed to injury has been uneven.[1] While the age-standardized death rate due to motor vehicle collisions declined by 30% between 1990 and 2010 in North America, deaths attributed to falls increased by 70%.[2] In Canada, the share of all-cause mortality attributed to injury has increased over the past decade.[3] Injury remains the leading cause of death among persons under the age of 45 years.[4]

The burden of injury among working age adults arises from both occupational and non occupational exposures. While the reduction in hazardous exposures arising from work has been listed as among the 10 most important public health contributions to the improvement in population health over the past 100 years, 5 work exposures continue to cause a large fraction of injury morbidity, responsible for as much as 25% of the burden of injury in working-age adults.[6]

This chapter presents a brief summary of the burden of work injury in Canada, describes aspects of the information resources available in Canada for occupational injury surveillance and briefly describes the regulatory context guiding employer practices in the protection of the health of employees. The chapter concludes with important observations about diverging trends in occupational and non-occupational injury among working-age adults in Ontario.

The Burden of Work Injury in Canada

In 2012, there were almost 800,000 work-related injuries and illnesses reported to provincial workers compensation authorities in Canada; a reduction of almost 25% from the more than 1,000,000 work-related morbidity episodes recorded a decade previously.[7] This decline in injury burden arising from work exposures is substantial, and has occurred in most developed economies.

Yet the burden of injury caused by work exposures remains very high. Working conditions associated with elevated risk of work injury include medium to heavy lifting requirements, awkward or repetitive body postures, working in outdoor environments, motor vehicle or heavy equipment operation, exposure to electrical hazards, hot surfaces, hazardous machinery, equipment or tools, exposure to vibration and exposure to dangerous locations. While some degree of hazardous working conditions are present in all economic sectors, the most substantial concentration of hazardous working conditions are found in the construction sectors, some manufacturing sectors and in the primary production sectors (mining, oil and gas, forestry and agriculture).

In addition to the hazardous exposures specific to an industry or an occupation, the risk of work injury is influenced by a number of other factors. Work injury risk is higher among new employees in early or short tenure of employment.[8] Injury risk is higher in work settings with limited or poor supervision. And injury risk increases with longer work hour schedules or where work hours are scheduled over evening or night periods.[9,10] There is concerning evidence that Canadian immigrants participating in the labour force are at higher risk of work injury.[11-13]

It is important to recognize that as much as 40% of all disabling work injuries are attributed to non-traumatic musculoskeletal disorders. A typical case definition describes musculoskeletal disorders as 'cases where the nature of injury or illness is sprains, strains, tears; back pain, hurt back; soreness, pain hurt except the back, carpal tunnel syndrome, or musculoskeletal system and connective tissue disorders, when the event or exposure leading to the injury or illness is bodily reaction/bending, climbing, crawling, reaching, twisting; overexertion; or repetition'. [14] While the etiology of these disorders is complex, the role of work exposures in the initiation and progression of non-traumatic musculoskeletal disorders is well-established[15-19] and some jurisdictions have introduced regulatory standards over the past two decades requiring employers to control adverse bio-mechanical exposures at work.[20,21] A recent study from the Institute for Work & Health has documented reductions in the incidence of work-related non-traumatic musculoskeletal disorders in three independent data sources in the province of Ontario.[22] Over the eight year observation period, the annual percent change (APC) in the incidence of work-related musculoskeletal disorders was -3.4% in emergency departments administrative records, -7.2% in lost-time workers' compensation claims and -5.3% among participants in the national health

interview survey.[22] While the results of this study are consistent with an interpretation that the burden of exposure to adverse bio-mechanical work exposures is declining, there is currently in Canada no source of comprehensive surveillance of these work exposures.

The Surveillance of Work injury in Canada

Provincial regulatory authorities in Canada rely on workers' compensation claims as the primary source of information on temporal, sectoral and regional trends in work-related injury and illness. These administrative records are a valuable source of information on the nature of injury and injury event and have been a very important source of surveillance information for many decades. However, there are concerns about the reliance on workers' compensation claims as the sole source of surveillance of the health of the Canadian workforce. For example, approximately 2 million workers (30% of labour force) in Ontario are not in employment relationships that provide insured coverage by the Ontario workers compensation authority, the Workplace Safety & Insurance Board. Concerns about the integrity of workplace reporting of work-related injury also impair confidence in the use of workers' compensation administrative records as a reliable source of surveillance information on the incidence of work-related injury and illness.

In recent decades, the international surveillance of injury morbidity has strengthened the use of health interview surveys[6,23,24] and administrative records of health care utilization, particularly emergency department records.[25-31] Two valuable data sources have been established in Canada over the past two decades that can be used to document the incidence of work-related injury. The National Population Health Survey (NPHS) and the Canadian Community Health Survey (CCHS), administered by Statistics Canada are health interview surveys that obtain self-reported health characteristics for representative samples of Canadians aged 12 years and older.[32] Beginning in 1994, these surveys have administered a questionnaire module on injury incidence which obtains information on the nature of injury, the injury event, if the injury occurred in the course of employment and if the injury required medical attention.

Of CCHS respondents who report a work-related injury that required medical attention, approximately 40% report received medical care in a hospital emergency department.[30] In the late 1990s, the Canadian Institute for Health Information established a national electronic record standard for documenting ambulatory health care services.[33] All

emergency department visits in Ontario have been reported to the National Ambulatory Care Reporting System Level III standard (NACRS) since 2000 and an equivalent reporting mandate was established in Alberta in 2010. These two provinces have the capacity to monitor occupational and non-occupational injury presenting for treatment in provincial emergency departments with finely detailed information on the nature and cause of injury.

Workplace injury prevention: the regulatory context

The protection of the health of workers is predominantly a provincial responsibility. Provincial Ministries of Labour have the authority to establish regulatory standards defining employers' responsibilities to protect the health of employees and the enforcement of employers compliance with regulatory standards. The federal government has jurisdiction over occupational health and safety regulatory standards and Occupational Health and Safety (OHS) inspection and enforcement services for industries regulated by the federal government.

Regulatory authority expenditures on worker health protection are generally similar across Canadian provinces. For example, the province of Ontario employs approximately 400 labour inspectors who conduct 90,000 workplace inspections annually in support of efforts to protect the health of the 6 million workers in Ontario. Including expenditures on occupation health training and consulting services, provincial prevention service expenditures are in the range of $30-$40 per worker per year. [34]

In addition to the role of a provincial Ministry of Labour, all Canadian provinces have workers' compensation boards that administer mandatory employer insurance schemes, reimbursing health care services and providing wage replacement benefits in the event of disability attributed to a work-related injury or illness. These benefits are funded by premiums paid by employers and represent an average employer expenditure of $500 per worker per year. Premium rates are typically scheduled by the economic sector, such that employers in higher hazard industries, such as construction, will pay higher premium rates than employers in low hazard sectors. Most provincial workers' compensation schemes have adopted the use of experience-rated insurance premiums, where employers within a sector with a low incidence of compensation claims will be eligible for a premium reduction and employers with a high incidence of claims will be charged a premium surcharge.

A detailed description of occupational health and safety regulatory standards in Canadian provinces is beyond the scope of this chapter. However, one dimension of Canadian regulatory practice deserves mention. Under provisions of most provincial occupational health and safety statutes introduced in the 1970s are requirements that workplaces establish standing committees comprised of managers and workers with the responsibility to advise the employer on workplace health hazards and the mitigation of those hazards. The intent of this

regulatory standard is to provide a mechanism for worker participation in decisions concerning the organization of work that may influence the health and wellbeing of the workforce. There is good evidence over the past four decades that workplace health and safety committees continue to function well in a significant number of workplaces and that workplace health and safety practices are improved through the joint participation of workers and managers in committee deliberations. [35-39]

Employers in Canada are under substantial regulatory requirements to ensure the health and safety of employees is protected. While high quality information is not available in Canada on the typical employer's annual expenditures to meet these regulatory requirements, a recent international study estimates that employer investments in worker health protection represent an annual expenditure per employee per year of more than €1,000.[40]

The purpose of this brief summary of the regulatory framework defining Canadian employers' responsibilities in the area of worker health protection is to illustrate the very substantial regulatory and financial responsibilities held by Canadian employers to protect the health of employees.

Current Injury Trends among Working-Age Adults

The decline in work-related morbidity documented by provincial workers' compensation authorities is concordant with trends in the national health interview surveys and with trends in emergency department visits in the province of Ontario. A recent surveillance report conducted by the Institute for Work & Health has estimated trends in the incidence of occupational and non-occupational injury in Ontario among working-age adults over the period 2004-2011, for 15 prominent injury causes. [41] The study is based on population-based administrative records of injury presenting for care in hospital emergency departments in Ontario, supplemented with a conceptually concordant measures of injury incidence provided by representative samples of Ontario workers participating in five consecutive waves of a national health interview survey. Over the observation period, the annual percent change (APC) in the incidence of occupational injury was -5.9% in emergency department administrative records and -7.4% among participants in the national health interview survey. In contrast, the annual percent change in the incidence of non occupational injury was -0.3% in emergency department administrative records and 1.0% among participants in the national health interview survey. Among working-age adults receiving treatment in emergency departments, the percent of all injuries attributed to work exposures declined from 20.0% in 2004 to 15.2% in 2011. The percent of all injuries attributed to work exposures among respondents to the national health interview survey declined from 27.7% in 2001 to 16.9% in 2010.[41]

Table 18 provides estimates of the annual percent change in the incidence of occupational injury and non-occupational injury for 15 causes.[42] There are four causes of injury where the

change in occupational and non-occupation injury incidence is similar over the 8 year observation period. Similar incidence declines were observed for injuries arising from motor vehicle collisions, from natural/environmental causes, and from intentional injury. In the case of injuries arising from 'animate mechanical forces', there was a similar increase in the incidence of both occupational and non-occupation injury. However, for the majority of injury causes, the incidence of occupational injury declined much more substantially than the incidence of non-occupational injury.

Table 18

Annual percent change (APC) of annual incidence of occupational and non-occupational by external cause for 15-64 year olds (2004-2001)*

External Cause#	Non-Occupational			Occupational		
	Annual % Change	95% CI		Annual % Change	95% CI	
Pedestrian	**1.15**	0.32,	1.98	**-3.72**	-6.05,	-1.33
Cyclist	0.52	-0.07,	1.11	**-4.48**	-8.36,	-0.42
Motor vehicle occupant	**-3.56**	-4.16,	-2.95	**-4.39**	-5.36,	-3.41
Other land transport	0.29	-0.88,	1.48	**-5.10**	-7.45,	-2.68
Other transport	0.20	-1.67,	2.10	-1.93	-6.64,	3.01
Fall	**0.82**	0.06,	1.60	**-3.48**	-4.98,	-1.95
Inanimate mechanical force	**-0.78**	-1.11,	-0.45	**-7.01**	-8.53,	-5.47
Animate mechanical force	**1.70**	1.25,	2.16	**1.60**	0.83,	2.38
Electricity / fire / hot object	**-2.35**	-3.02,	-1.68	**-7.61**	-9.19,	-6.00
Natural/environmental	-3.64	0.70,	-7.80	-3.94	-9.23,	1.66
Poisoning	0.60	-0.32,	1.53	**-7.11**	-8.61,	-5.59
Overexertion	**-1.28**	-1.65,	-0.91	**-5.96**	-7.38,	-4.51
Intentional Injury	**-2.28**	-2.76,	-1.80	**-1.66**	-2.60,	-0.71
Event of undetermined intent	**-4.37**	-6.04,	-2.67	**-12.22**	-15.44,	-8.87
Other or not specified	**2.54**	2.10,	2.98	**-4.59**	-5.98,	-3.18
Total, all external causes	**-0.25**	**-0.44,**	**-0.04**	**-5.95**	**-7.30,**	**-4.57**

- Drowning and suffocation were excluded from the regression analysis due to small cell counts.

* - Results of a negative binomial regression, 2004-2011, Emergency department records (NACRS)

Bold APC values represent statistically significant changes.

Over an eight year period, there has been a 29% reduction in the incidence of occupational injury in the Ontario population of occupationally active adults. In contrast, the all-cause incidence of non-occupational injury did not change over this same period. The parallel reduction in occupational and non-occupational motor vehicle injury indicates the effectiveness of vehicle safety design standards and road engineering investments in the prevention of both occupational and non-occupational road injury. However, for the majority of injury causes, the incidence of occupational injury declined much more substantially than non-occupational injury. It is reasonable to interpret the much more substantial reduction in adult injury arising from work exposures as due to employer investments and to the influence of relatively stringent occupational health and safety regulatory standards. A recent international report estimates that employer investments in worker health protection represent an annual expenditure per employee per year of more than €1,000.[40] In contrast, per capita expenditures on public health in Canada are in the range of $300, of which a very small fraction is allocated to injury prevention.[43]

This chapter has presented a summary of the burden of work injury in Canada, described aspects of the information resources available in Canada for occupational injury surveillance and outlined the regulatory context guiding employer practices in the protection of the health of employees. The chapter concludes with an important observations about diverging trends in occupational and non-occupational injury among working-age adults in Ontario. Among working-age adults in Ontario, nearly all the observed decline in injury incidence over the period 2004-2011 is attributed to reductions in occupational injury. If the incidence of non-occupational injury had declined at the same rate of occupational injury over the eight years of this observation period, the population of Ontario would have experienced more than 200,000 fewer annual injuries requiring medical attention among adults aged 15-64. The absence of a similar reduction in injury burden due to non-work exposures raises concerns about the level of investment in population injury prevention in Ontario.[44,45]

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