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. 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. 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. The one exception to this trend is sport and recreation related injuries which tend to increase with income. 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. 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. The rate of intentional and unintentional injuries among indigenous populations in Canada is significantly higher than the non-indigenous population. 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.

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. Experiences of social and material deprivation result in a great deal of stress and can contribute to feelings of anxiety, sadness, and hopelessness. 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.

References


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.\textsuperscript{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.\textsuperscript{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 person's 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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{17} Brownell and colleagues (year) confirmed that people with lower SES were at greater risk of injury hospitalizations.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{21} Potter and colleagues (2005) assessed SES and its association with recreational and non-recreational injuries.\textsuperscript{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 sustain5. 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.
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. 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 distribution by SES.

Key Determinants of Injury
association with SES as do injuries related to the participation in a team or sport.\textsuperscript{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.\textsuperscript{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.\textsuperscript{25} The cost of a helmet is a barrier for some in lower SES groups.\textsuperscript{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. There have also been non-legislative interventions aimed at the general public or broad groups of young people and interventions to increase helmet uptake among people in low SES groups. 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. 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. 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. In essence, this implicates poverty reduction strategies and a continuing emphasis on underlying social and economic conditions that promote health and safety.

**References**


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. Completion of post-secondary education has been associated with a lower risk of injury, whereas those with lower levels of education demonstrate greater serious or severe injury rates. 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. 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. Other associations have been found between low education and specific types of injuries including: pedestrian, bicycling, driver injuries, and fires in addition to homicides and suicides.

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 and also found to have a protective effect on hospitalization for burns among their children, as compared to children of less well educated mothers. 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.

### 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. Educated populations are better positioned to access information and understand the impact of health from lifestyle options. Risk-taking behaviours can include drinking, smoking, drug use, violent behaviours, risky sexual practices, and risky driving. 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. 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. Finally, level of education is likely to influence a parent’s perception of risk as well as parenting behaviours.

### 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. 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.

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. With healthy policies integrated across the spectrum oriented around optimal human development, the foundation for successful educational and health outcomes is built. 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.

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References


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.
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 than 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. 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>
<thead>
<tr>
<th>Sequence of Questions to Be Answered</th>
<th>Consequences of Answering “No” at Each Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Are the risks serious enough if protective action is not taken?</td>
<td>Unconflicted Inertia</td>
</tr>
<tr>
<td>2 Are the risks serious if the most readily available protective action is taken?</td>
<td>Unconflicted Change</td>
</tr>
<tr>
<td>3 Is it realistic to try and find a better means of escape?</td>
<td>Defensive Avoidance – Tendency to satisfice rather than solve the problem.</td>
</tr>
<tr>
<td>4 Is there sufficient time to search and deliberate?</td>
<td>Hypervigilance – Tendency to keep searching for alternative courses of action, in a non-systematic or thorough way. Often results in panic.</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Table 6</th>
<th>Bolstering Strategies³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Exaggerating favourable consequences</strong> of the favoured course of action focuses attention on gains to be made.</td>
<td></td>
</tr>
<tr>
<td>2. <strong>Minimizing the unfavourable consequence</strong> is frequently associated with the (often self-induced) belief that if worst comes to worst, it will not be so bad.</td>
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<tr>
<td>3. <strong>Bolstering the belief that the decision is reversible</strong> is exemplified by the rationalization, &quot;I can always stop if it's hurting me.&quot;</td>
<td></td>
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<tr>
<td>4. <strong>Denying aversive feelings</strong> anticipated in connection with unfavourable consequences. (For example believing that being under qualified for a job will be challenging, not frustrating).</td>
<td></td>
</tr>
<tr>
<td>5. <strong>Exaggerating the remoteness of the reckoning</strong> is the principle feature of rationalizations of recklessness.</td>
<td></td>
</tr>
<tr>
<td>6. <strong>Minimizing personal responsibility</strong>.</td>
<td></td>
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</tbody>
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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
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, 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. 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>
<thead>
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<th>Table 7</th>
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| **Four Grid-Group Culture Biases**

<table>
<thead>
<tr>
<th>High Grid</th>
<th>Low Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Group</td>
<td>Low Group</td>
</tr>
<tr>
<td>Hierarchists</td>
<td>Fatalists</td>
</tr>
<tr>
<td>Sectarians/Egalitarians</td>
<td>Individualists</td>
</tr>
</tbody>
</table>

Each of the above orientations can also be linked to one of four beliefs about the nature of nature itself. 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.

There is a research tradition that has found that subjects in groups are willing to make riskier decisions than subjects evaluated on their own. 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.*

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. 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.

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.

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. 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). 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).

The Protection Motivation Theory (PMT) was originally introduced by Rogers 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. 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. 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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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

References


Key Determinants of Injury Canadian Injury Prevention Resource


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. 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.

An additional aspect of work with important links to health is a lack of job security. In Canada, the main health challenge as related to job security is not chronic-unemployment, but intermittent or precarious work. 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. 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. Long working hours have been linked to health problems such as high blood pressure and heart disease. 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. Results suggested that Canadians exposed to unemployment may experience an increased risk of mortality including those related to accidents and violence. 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. In another study, a survey of Canadians determined that 30% felt that their employment was a risk to their health and safety.

* 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. 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. This partly explains a heightened risk of injury for males, especially young males. 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. In addition, women are more likely to experience violence in the workplace.

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. 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.

**Intensification of work.** In the context of the workplace, intensification refers to increased effort, tighter timelines, and increased demand. This is an increasing trend noted in the literature since the 1980s, demonstrated across many workplaces. Studies have shown that intensification is associated with increased stress, back problems, neck and shoulder pain, and other injuries. 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.
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\(^\dagger\))

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.\(^{16}\)

\(^{1}\) 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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Social Environment

Introduction

Injury is a complex health outcome with multiple individual, social, and physical environmental risk factors. 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. Public health has long recognized that improving the social environment can improve health. 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, and Canadian youth living in areas with higher levels of social cohesion reported fewer injuries.

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) or earlier by Bronfenbrenner (1994). 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)
Specific Pathways of Social Influence

Simultaneous consideration of multiple individual, physical, contextual, and social factors has been suggested for exploring the etiology of injuries. 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. 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, 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.

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). 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. 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. Finally, it has been shown that having delinquent friends is strongly associated with violent behaviours among youth.

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. 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. 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. 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.

The eco-social model can also be used to explain how social capital influences various health outcomes including injuries. 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. 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. 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. Similar impacts have been reported for unintentional injuries in youth populations but with less clear pathways.

The relationship between social capital and injury is somewhat unclear, 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. A systematic review of literature from Latin American countries suggested that social capital could play a protective role in certain health outcomes including injuries. Another study in Australia specifically investigated the vulnerable population of adolescents and showed that building social capital among friends will reduce risk-taking behaviours. 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 and are less likely to wear seat belts and bicycle helmets.

**Social Norms and Injury.** Social norms generally define social organizations. 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. 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) 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.\textsuperscript{28} As compared with medical interventions,\textsuperscript{28,29} social interventions have been shown to be effective for reaching larger proportions of the population,\textsuperscript{30} and can lead to overall improvement in health of populations.\textsuperscript{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.

References


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. 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. 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’ 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.  

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.

References


Introduction

The Ottawa Charter on Health Promotion identifies housing as a prerequisite for health. 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. Research shows that housing conditions such as exposures to damp, mould, and overcrowding are related to serious chronic health conditions. In addition, housing interacts with other determinants such as income and food security, and relates significantly to injury and fatality risk. 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.

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. 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. 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. Housing as a determinant refers to lack of access to affordable, quality, and safe housing. 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. Housing insecurity also leads to increased risk for injury.

The Canada Mortgage and Housing Corporation devised the term core housing need to identify the number of Canadian households with housing problems. 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. Over 3 million (25.2%) Canadian households paid 30% or more of their incomes on housing in 2011. 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.
Several factors have contributed to this problem. First, household incomes have failed to keep pace with housing costs in most Canadian municipalities. 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. 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.

### Injury Risk in the Home

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

Structural conditions in the home are associated with increased injury risk. 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.

The lack of safety equipment such as gates or handrails can increase the risk of injury for seniors and children. 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. 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%.

The home environment is identified as a primary factor leading to unintentional injuries in children in low-income households. Secure and safe housing is important for the wellbeing of children, as it is a significant determinant. Risk factors associated with increased risk for injury in children include their natural inquisitiveness, and the amount of time spent in the home. 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. In Canada, low socioeconomic status is highly related to most causes of injury,
particularly fire/burn injuries.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.

**References**


3.5.1: Physical and Built Environments - Housing


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.⁵-⁷ 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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residents who sustain a hip fracture able to regain pre-fracture ambulation status.\textsuperscript{10} Furthermore, one quarter of fall-related traumatic brain injuries in older adults occur in LTC facilities.\textsuperscript{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\textsuperscript{12} and 44-60% of these events result in injury.\textsuperscript{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,\textsuperscript{15} with approximately 50% of patients dying within one year after the fracture.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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

\(†\) 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; 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. 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. Window coverings should also be used to prevent large patches of distracting light.

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. This is especially concerning given that falls in bathrooms are more likely to result in injury compared to those in bedrooms; however, clear visual input can decrease fall risk associated with overnight toileting amongst hospitalized older adults. 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. 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. 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\textsuperscript{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,\textsuperscript{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\textsuperscript{31} but unfortunately are less able to execute rapid “reach to grasp responses.”\textsuperscript{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.\textsuperscript{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”.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.  

### 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. Research suggests that the use of some types of assistive devices may actually increase an individual's risk of a fall and injury. 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.

**Hip protectors.** Hip protectors consist of soft foam padding or hard shield domes inserted into the hip region of specialized garments or undergarments worn 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. When in place (and correctly positioned) at the time of falling, specific types of hip protectors reduce fracture risk between 69-80%. The clinical value of protectors, however, has been compromised by lack of regulations assuring the quality of available models and limited user adherence in wearing the devices (often less than 50%) resulting in a large number of falls occurring without hip protection.

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\textsuperscript{30} 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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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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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. 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).

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. Road traffic injury was ranked the eighth leading cause of mortality globally, and is predicted to be in the top 5 by 2030.

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. Internationally, Canada’s road safety ranking has slipped, relative to other countries. 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.

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. 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. 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). 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.

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.\textsuperscript{13} Traditional road safety interventions have targeted individual road use behaviour change, but these have not realized impressive results.\textsuperscript{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.\textsuperscript{18} Almost half of the strategies promoted through Canada’s Road Safety Strategy 2015 are directed at street design.\textsuperscript{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.\textsuperscript{21}

**Speed control.** Motor vehicle speed is the major risk factor for all crashes, and directly influences injury severity.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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,\textsuperscript{25} and road narrowing.\textsuperscript{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;\textsuperscript{25} another found an 15% reduction in injuries, with greater reductions on residential roads than major streets.\textsuperscript{27} There is evidence that narrower roads have fewer pedestrian collisions, primarily due to reduced vehicular speed.\textsuperscript{26} There are also reviews indicating the effectiveness of red light cameras,\textsuperscript{19} speed enforcement detection devices,\textsuperscript{28} and street lighting in reducing motor vehicle crashes.\textsuperscript{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. Another example is roundabouts, which are widely promoted for their safety benefits for motorists and pedestrians, however a review found that multi-lane roundabouts are more hazardous to cyclists than other types of intersections, unless separated cycle tracks are, and a recent study in Vancouver and Toronto traffic circles (single lane roundabouts on residential roads) were the most dangerous intersection type for cyclists. 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, 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. Recent research supports a safety benefit for cycle tracks.

For pedestrians, there is strong evidence supporting safety benefits of pedestrian refuges (islands that allow rest points mid-crossing), and for overpasses and underpasses. Some evidence supports safety benefits of sidewalks, especially in residential areas. 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.

There is a similar lack of consensus related to the injury risk for children cycling on sidewalks, with one study reporting decreased risk, and others increased risk, 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.
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 and pedestrians at night, especially in unlit conditions. Increasing the intensity of light at pedestrian crossings has been associated with a decrease in nighttime pedestrian collisions. Clear lighting of crosswalks through automatically activated in-pavement flashing lights have reduced vehicle speeds and conflicts. 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. There is new research on cycling safety suggesting promising effects of ‘blue crossings’ at intersections for cyclists, painted bike boxes, and painted bicycle lanes. Parked cars can also obscure the vision of both pedestrians and drivers; the presence of parked cars has been associated with child pedestrian collisions, and cyclists’ injury risk on major streets is higher when there are parked cars, compared to when there are not.

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.
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3.5.3: Physical and Built Environments - Street Design


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**Key Determinants of Injury**

**Canadian Injury Prevention Resource**
3.5.3: Physical and Built Environments - Street Design


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.\textsuperscript{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.\textsuperscript{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\textsuperscript{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.\textsuperscript{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.\textsuperscript{13} Further distances to advanced trauma centres and to emergency care is associated with worse outcomes, and may contribute to higher fatality rates.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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\%).\textsuperscript{11,17} Finally, an older study done in Winnipeg found that urban bicycling helmet use was 2.5 times higher than rural use.\textsuperscript{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%.\textsuperscript{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.\textsuperscript{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.\textsuperscript{21} (See Chapter 4.2 Transport Injuries).

All-terrain vehicles, or ATVs, represent an increasing mechanism for injury and fatality in Canadians, particularly in pediatric populations in remote areas of Canada including First Nations, Inuit, and Métis communities.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{22} For children, inexperienced drivers and lack of supervision from adults are contributing factors to the high rates of injury in this age group.\textsuperscript{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:\textsuperscript{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 flotation 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.**

### References


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. This trend has limited children's access to the outdoors and nearly eliminated challenging play from today's playgrounds.

Research suggests that the impulse to make children's outdoor environments structured and 'safe' by eliminating risky play has harmful long-term impacts. 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. Offering children risky play opportunities within their play environments provides them with the physical and cognitive challenge necessary for healthy development.

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). The KFC playground has been criticized for offering little challenge and few natural elements.

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. 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. The Seven Cs design guidelines can be used to increase the amount of challenging play on a playground. 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. 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:
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.’

Key Determinants of Injury  Canadian Injury Prevention Resource
Center A
Before and After the Seven C’s Intervention

Plan 1: Center A Pre-Intervention

Plan 2: Center A Post-Intervention
Center B
Before and After the Seven C’s Intervention

Center B Pre-Intervention

Center B Post-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.

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

21
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.\(^{18}\)

**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.
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. 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.

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.
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
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.

References


Key Determinants of Injury  Canadian Injury Prevention Resource


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.


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.”

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).
### 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. 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. 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”. 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.

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.” 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. 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.

References


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.\textsuperscript{5}

Resilience is used in child psychology to describe success against odds.\textsuperscript{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.\textsuperscript{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.


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. 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.

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. 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.

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.

The body has incredible self-righting capacity. 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.

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. Learned helplessness is a feature associated with low resilience. 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.

### 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. 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.
The word “crisis” in Chinese is formed with the characters of danger and opportunity. 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.

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.

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.

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. 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.

References


Introduction

Injuries are the leading cause of mortality and a significant cause of morbidity for Canadian children and adolescents. 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. In Canada, the leading causes of injury hospitalizations reflect these age-related differences. 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

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

MVC = Motor Vehicle Collision. Source: Canadian Pediatric Society

**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. Falls on the same level become more prevalent around the first year, when children gain mobility and begin to explore their surroundings. 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. Poisonings and foreign body injuries are more prevalent among children 0 to 36 months of age, who tend to explore the world orally. Furthermore, children's lower body mass relative to that of adults' renders poisonous substances more toxic for children. Burns and scalds are more frequent among infants and toddlers, because their skin burns at lower temperatures, more quickly, and deeper, compared with adults. 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.

**Children and adolescents.** Falls represent the main cause of unintentional injury among children and adolescents; however, the circumstances of injury incidents differ across age.
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. 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. However, unintentional sport injuries are rare among younger groups.

Rates of MVC and pedestrian injuries increase steadily as children develop. Pedestrian injuries occur more often between 5 and 8 years of age, 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. 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. Injuries while cycling are more common between the ages of 5 and 16 years, 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, 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. By the time children reach 5 years and spend increasingly more time outside their homes; however, more than half of injuries take place elsewhere. Injuries on footpaths or playgrounds (outside schools) increase by at least three times among children 5 to 7 years old compared with toddlers. With age, roads become a more prevalent injury location as children spend more time cycling and then driving.

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, and are frequently under parental supervision. The impact of parental supervision on injury risk is not uniform across all age groups, because it decreases as children gain more independence. 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. Consistent parenting regarding rules and consequences for undesirable behaviours is associated with a lower risk of injury among children 4 to 11 years old. Further, social norms, including those instilled by parents, are associated with use of safety equipment among adolescents.

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).\textsuperscript{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.\textsuperscript{24} Research has raised concerns; however, regarding the potential deleterious effects that limiting risk taking (particularly during play) could have on child development.\textsuperscript{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.\textsuperscript{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.\textsuperscript{29}

A similar tension arises around unintentional injuries in adolescents, whose risk taking behaviour is often considered a normal part of their development.\textsuperscript{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 and unsafe risks.\textsuperscript{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) \textsuperscript{5} (Refer to Chapter 2.2 Injury Prevention Spectrum and the 3Es) 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.\textsuperscript{30} 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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.
References


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. Adaptive risk taking behaviours are positive, satisfying adolescent needs such as autonomy, mastery and intimacy. Adaptive risk behavior can be a part of healthy social development, for example, public speaking where one can exercise autonomy.

Conversely, maladaptive risk behaviours can carry negative consequences, both for the individual and society as a whole. 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. 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.”

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. Socio-emotional development occurs rapidly around puberty. This results in heightened sensitivity to social and emotional stimuli, as well as reward responses in the brain. 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. The cognitive control centers of the brain are responsible for the executive functions of the brain: forward thought, planning and self-regulation. 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. 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.\textsuperscript{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\textsuperscript{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.”\textsuperscript{11} Parental support can counteract negative peer influence and involvement in risky behaviours, especially during adolescent growth and development of personal autonomy.\textsuperscript{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.\textsuperscript{11}

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

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.

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. 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.” 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.”

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. 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.”

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. 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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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.” 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. 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 lifespan -- 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” 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:

\[
\text{factor of risk} = \frac{\text{applied force}}{\text{failure force}}
\]

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. 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.

**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 ($k_b$) and the stiffness of the impact surface ($k_s$). 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)

![Diagram showing energy exchanges during impact](image)

conservation of energy:

\[
mgh = \frac{1}{2}mv^2 = \frac{1}{2} \frac{F^2}{k} \Rightarrow F = \sqrt{2kmgh} = v \sqrt{mk}
\]

\[
k = \frac{k_b k_s}{k_b + k_s}
\]

Must have $k_s \leq k_b$ 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

\[
E = mgh = \frac{1}{2}(mv^2)
\]

where $g$ is the gravitational constant (9.81 m/s\(^2\)).
This provides us with an estimate of the impact velocity, which theoretically scales with the square root of the fall height:

\[ v = \sqrt{2gh} \]

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):

\[ E = mgh = \frac{1}{2}(mv^2) = \frac{1}{2}(kx^2) \]

At this same instant, the body spring has developed a peak force \( F \) (in N) according to the relation:

\[ F = kx \]

We can then expand our statement of conservation of energy as follows:

\[ E = mgh = \frac{1}{2}(mv^2) = \frac{1}{2}(kx^2) = \frac{1}{2}\left(\frac{F^2}{k}\right) \]

finally arriving at two expressions for the estimated peak force \( F \) during the impact:

\[ F = \sqrt{2kmgh} = v\sqrt{mk} \]

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 \( \hat{k} \) 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:

\[ \hat{k} = \frac{(k_b k_s)}{(k_b + k_s)} \]
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.\textsuperscript{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\textsuperscript{15} and 3980 (SD = 1600) N for the proximal femur.\textsuperscript{16,17} Furthermore, the failure force of the proximal femur is higher when tested under impact loading than slowly applied loading.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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 $\sigma$ in Pascals (Pa = N/m$^2$) and strain $\varepsilon$ (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 $\sigma$ 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), 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, 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 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. 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, but not for a fall on the outstretched hand, which requires a two-mass model to describe the essential impact dynamics.

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.

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. We also modulate leg stiffness in landing from a jump, and arm stiffness in arresting a sudden fall, 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. 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.” 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.

**References**


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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{9} In 2013, 7.2\% or 350,000 of Canadian older adults lived in poverty.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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. 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. 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. 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. 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. Social networks can reduce stress, promote positive coping strategies, and enhance overall wellbeing all of which contributes to reduced injury risk.

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.

References


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." 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. 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. 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. 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. In contrast, drowning is a leading cause of death for preschoolers aged 1-4 years, followed by traffic collisions for both males and females. Children under four are most often seen or admitted to emergency departments for closed head injuries.

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. 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. 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. For younger children, injuries occur more often at home, while for older children, injuries occur more often at school and at sporting events.
**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 differences 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. 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. 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.

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, 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. 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.

**Contributing Factors.** A variety of factors contribute to gender differences in injury in childhood. 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. 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. Vigilant parent supervision of young children at home has been linked to decreased injury risk, 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. 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. 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.
injuries than females; these injuries were typically, fractures, strains or sprains. 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).

**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. 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. 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.

Programs that promote home-based environmental modifications for children under the age of five have not yet been rigorously evaluated; 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, bans on unsafe equipment (e.g., infant walkers), 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, although gender differences have been found between mothers and fathers in their reported usage of booster seats.

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. 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. For higher risk sports such as snowboarding, helmets may have a stronger protective effect among males than among females. Effective education programs targeting school-aged children include pedestrian safety programs that improve children’s knowledge and road crossing behaviour, self-care when home alone, and more recently, specific training for supervising siblings. School-based anti-bullying and dating violence prevention programs have also been shown to be effective.

**Gender Differences in Injury in Adolescence**

Adolescents aged 12 to 19 have the highest likelihood of injury of any age group, 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. 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.

**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. 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. 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. 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.

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. 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. 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. However, suicide mortality is consistently higher for males than females throughout adolescence, accounting for almost 80% of these deaths. 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. 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.

Male teens have higher mortality, hospitalization, and emergency department visit rates for most leading causes of injury than females. 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. Sport-related falls typically involve cycling, skiing, snowboarding, hockey, skateboarding, and football/rugby. Teens are also less likely to use helmets and sport-specific protective equipment prior to sports and recreation activities. The use of all-terrain vehicles are more likely to result in hospitalization mainly due to concussions and non-concussion head injuries. 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.

**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. 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.

As noted, risky behaviors during adolescence are associated with, if not casually influenced by, various age-related biological, cognitive, emotional, and socio-developmental factors. 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. 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. 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.

**Prevention and Intervention Programs.** Given the high direct and indirect costs of injury, 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. 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.

Regarding depression, suicide and self-harm, combined psychosocial and pharmacological treatments have been shown to be effective. 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. 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. The gender disparity in unintentional and violence-related injury mortality was greater, with rare exception, than ethnic and age group disparities in fatal injury. In Canada, the third leading cause of death for adult males in 2011 was unintentional injuries, while this cause ranked fifth for adult females.

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. Rates of mortality and hospitalization due to injury are highest amongst the very elderly—those aged 85 years and older. Significant gender differences have been found in the injury-related mortality and hospitalization rates of seniors. 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. Unfortunately, gender differences in exposure, cause and consequences of injury are rarely the focus of research. One-third of all on-the-job injuries occurred among workers in trades, transport and equipment operation. Musculoskeletal conditions, including strains and sprains, are a leading cause of injury for this age group and may increase future vulnerability to further injury. 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. Traumatic brain injuries are three times more common in men than women. 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.

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). 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. 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. 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%).

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. Most injury deaths in seniors over the age of 65 are due to unintentional injury, especially for the very elderly aged 75 and older. 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. 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. 

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. 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. 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. Overall, most sport and recreation related injuries occur during activities that have large numbers of participants and low injury rates.

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. 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. 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.

Contributing factors for occupational injuries in adults include night shifts and rotating shifts and time of day (late evening or early morning). Musculoskeletal injuries consistently comprise the majority of time loss claims for employees across Canada, with healthcare workers being particularly at risk. 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.\textsuperscript{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.\textsuperscript{76} Therefore, fall prevention programs 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\textsuperscript{77} (e.g., gloves, helmets and seat belts), stretching and strengthening programs,\textsuperscript{78} workplace inspection programs,\textsuperscript{79} alcohol and drug screening,\textsuperscript{80} training and education programs,\textsuperscript{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,\textsuperscript{82} or the prevention of robbery and violence to retail workers.\textsuperscript{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.\textsuperscript{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. 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. Specific prevention strategies include mental health outreach, treatment of depression in seniors, screening by health care professionals, and utilizing an integrated treatment model. 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.

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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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](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). 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. 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. 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. 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. 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).

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.

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. 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. 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.

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. 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.

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. 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.

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.

**Non-Suicidal Self-Injury (NSSI).** Body attitudes and self-objectification play an important role in NSSI. 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. 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. 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. Adolescence is a particularly vulnerable time, as body dissatisfaction is reportedly at its highest. Similarly, Erchull et al. (2013) found that body surveillance had an indirect effect on self-harm through body shame and depression. 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)

**Suicide.** Poor body image is associated with suicide ideation for both males and females. 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. 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. Objectification theory posits that self-objectification and the constant monitoring of appearance uses up valuable cognitive resources and limits cognitive performance. 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.
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.\(^\text{22}\)

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.\(^\text{1, 23, 24}\) When people are objectified, others have less moral concern for them.\(^\text{25}\) 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.\(^\text{1}\)

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.\(^\text{26}\)

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.

References


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

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Central role in the provincial trauma system, and provides the majority of the tertiary/quaternary major trauma care. Provides academic leadership, research, and teaching.</td>
</tr>
<tr>
<td>II</td>
<td>Provides care for major trauma. Some trauma training and outreach programs. Similar to Level I without academic/research programs.</td>
</tr>
<tr>
<td>III</td>
<td>Provides initial care for major trauma patients and transfers patients in need of complex care to Level I and II trauma centres.</td>
</tr>
<tr>
<td>IV</td>
<td>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.</td>
</tr>
<tr>
<td>V</td>
<td>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.</td>
</tr>
</tbody>
</table>

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). 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. 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. 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. 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. 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). 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. 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. 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. 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. Overall, persons injured in rural environments are nearly 50% more likely to experience a fatal outcome. 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. 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. 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.

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. 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. 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. 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. 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. 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. Currently, the proportion of trauma cases admitted directly to a regional TC varies according to local systems, geography and population. 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. 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. 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. 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. 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.\textsuperscript{32} As may be expected; however, these patients represent a population subset with a higher severity of illness, making evidence-based recommendations difficult.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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. Other authors have reported subjective improvements in the care of rurally injured patients. 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. 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. 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. 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. 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. 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.

References


**Additional Resources**

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 remorse³. 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.\textsuperscript{6,7}

Moving from one's native country to a new place is a stressful life event, even in times of peace and prosperity.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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".\textsuperscript{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 line\textsuperscript{15} 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”.

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. 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. In Ontario, the 2011 census lists almost 30% of the population as foreign-born. More than one million immigrants to Ontario arrived during the 1990s alone, or 56% of all Canadian immigrants during that period. In Toronto, 17% of school-age children 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.

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. Many intervention efforts are limited to mere translations of health education materials into the most common languages spoken by the immigrant population. 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. 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. 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. 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. Similarly, although the 2007-2008 Canadian Community Health Surveys indicate that Canadian workers are three times more vulnerable to workplace injuries than immigrant workers, 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. 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. 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.

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%). 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. Since physical activity, including participation in sports, is associated with increased injury rates, 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.

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. 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. 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. 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. 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.
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

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Enablers</th>
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</thead>
<tbody>
<tr>
<td>❖ Lack of linguistically and culturally appropriate information</td>
<td>❖ Immigrant friendly policies</td>
</tr>
<tr>
<td>❖ Language</td>
<td>❖ Community support</td>
</tr>
<tr>
<td>❖ Lack of available information on injury prevention strategies and policies</td>
<td>❖ Support from friends and family</td>
</tr>
<tr>
<td>❖ Lack of safety instructions</td>
<td>❖ Strong safety policy/enforcement</td>
</tr>
<tr>
<td>❖ Lack of access to personal protective equipment</td>
<td>❖ Community-based training</td>
</tr>
<tr>
<td>❖ Perceived cost</td>
<td>❖ Links between research and policy</td>
</tr>
<tr>
<td>❖ Mistrust of authority</td>
<td>❖ Multi-sectoral supports</td>
</tr>
<tr>
<td>❖ Social isolation</td>
<td>❖ Free/Subsidized safety equipment supply (such as smoke detectors, CO2 detectors)</td>
</tr>
<tr>
<td>❖ Fear of accusation/abuse/ losing job</td>
<td>❖ Health promotion</td>
</tr>
<tr>
<td>❖ Poor neighbourhood</td>
<td>❖ Health Education</td>
</tr>
<tr>
<td>❖ Unsafe neighbourhood</td>
<td>❖ Policies related to job security for newcomers</td>
</tr>
<tr>
<td>❖ Biases of health care providers(Assumptions)</td>
<td>❖ Parent training in child safety*</td>
</tr>
<tr>
<td>❖ Unsafe playgrounds*</td>
<td>❖ Free safety equipment supply (such as booster seats, helmets)*</td>
</tr>
<tr>
<td></td>
<td>❖ Car seat/helmet clinic in communities*</td>
</tr>
<tr>
<td></td>
<td>❖ Training for parents on appropriate uses of safety devices/equipment*</td>
</tr>
</tbody>
</table>

* Applies primarily to children

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,\textsuperscript{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.\textsuperscript{26,40,45} Researchers from the University of Toronto recommend that multicultural community organizations provide culturally-specific information for ethnic groups.\textsuperscript{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 wellbeing.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{26}

### Conclusion

Many newcomer families lack information and knowledge about health care services generally, and injury prevention specifically.\textsuperscript{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

<table>
<thead>
<tr>
<th>Challenges/Barriers</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Barriers</td>
<td>Policy support for community base services</td>
</tr>
<tr>
<td>Lack of available information on injury preventions</td>
<td>Policy development, promoting easy accessible information for newcomers</td>
</tr>
<tr>
<td>Linguistically correct information</td>
<td>Policy, providing support of linguistically correct translation of information, which must be culturally appropriate.</td>
</tr>
<tr>
<td>Ethno-cultural differences</td>
<td>Links between research and policy, and community involvement in both processes, can better meet the health needs of immigrant population</td>
</tr>
<tr>
<td>Biases of health care providers (Assumptions)</td>
<td>Strict policy for discouragement of practicing &quot;one size fit all&quot; methodology</td>
</tr>
<tr>
<td>Effects of social determinants of health</td>
<td>Policy support, Research into better defining immigrant health issues including injury</td>
</tr>
<tr>
<td>Mistrust of authority</td>
<td>Innovative solution- individual level to macro level</td>
</tr>
<tr>
<td>Unsafe neighborhood</td>
<td>Enforcement, policy development, community engagement</td>
</tr>
<tr>
<td>Fall Prevention (domestic, travel to and from work)</td>
<td>Policy, health promotion, education</td>
</tr>
</tbody>
</table>

References


Introduction

In 2011, an estimated 1.4 million people or about 4.3% of the Canadian population self-identified as Aboriginal. 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) who reside in 53 remote communities in for Inuit regions. 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, 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).

❖ **The First Nations** are made up 610 bands that comprise 52 nations or cultural groups speaking 52 separate languages (approximately 851,600 members). 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.
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. 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.

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; however, among Aboriginal Peoples, injury rates are considerably higher (Figure 20). Further, injury death rates in First Nations communities are far higher for men than for women. 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. 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. 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) (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

Key Determinants of Injury

Canadian Injury Prevention Resource
Previous research has shown that Aboriginal Canadians have nearly 4 times the risk of severe trauma\(^\text{11}\) and substantial increases in risk of fracture\(^\text{12}\) compared with the non-Aboriginal population. In addition, First Nations adults report injuries requiring medical treatment at a rate two times the Canadian average.\(^\text{13}\) 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.\(^\text{14}\) 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\(^\text{7,15}\)**

Aboriginal Community-Related Injuries

First Nations people living on-reserve and in northern communities have higher injury rates compared to other Canadians.\(^\text{16}\) A 2002-2003 study of First Nations children living on-reserve estimated that 17.5% were injured compared with 12% living off-reserve.\(^\text{17}\) 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%.\(^\text{16}\) 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.\(^\text{18}\) 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.\textsuperscript{19} The rate of injury in Métis children was similar to the general Canadian population, at 12%.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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;\textsuperscript{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.\textsuperscript{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.\textsuperscript{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. Substandard housing, poverty, crowded living conditions and over extended health care systems are other significant factors that contribute to the injury burden. In addition, the Aboriginal population is primarily located in rural areas, many within the western provinces and the Canadian territories. These areas tend to be less safe for a variety of reasons and have local shortages in health care personnel and resources. Poor social conditions, community dysfunction and lack of institutional supports result in greater risks of injury, violence and suicide.

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.

**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*
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. 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. 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. 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). 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). 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. 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.

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. Compared to overall Canadian rates, suicide in many Aboriginal communities and populations has continued to rise over the past decade. Although there are large variations across populations, the overall suicide rate among First Nations communities is approximately 2 - 4 times higher. 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. The rate among Inuit communities is 6 - 11 times greater than the than the Canadian population. 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). 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 flotation 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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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\textsuperscript{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.\textsuperscript{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. 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.

- **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.

### 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. 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.

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. 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.

References


