Standards Council of Canada
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AN OUNCE OF PREVENTION:

STANDARDS AS A TOOL TO PREVENT ACCIDENTAL FATALITIES

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Published: Ottawa: 2019

Aussi offert en français sous le titre *Une touche de prévention : les normes comme outils pour prévenir les accidents mortels.*

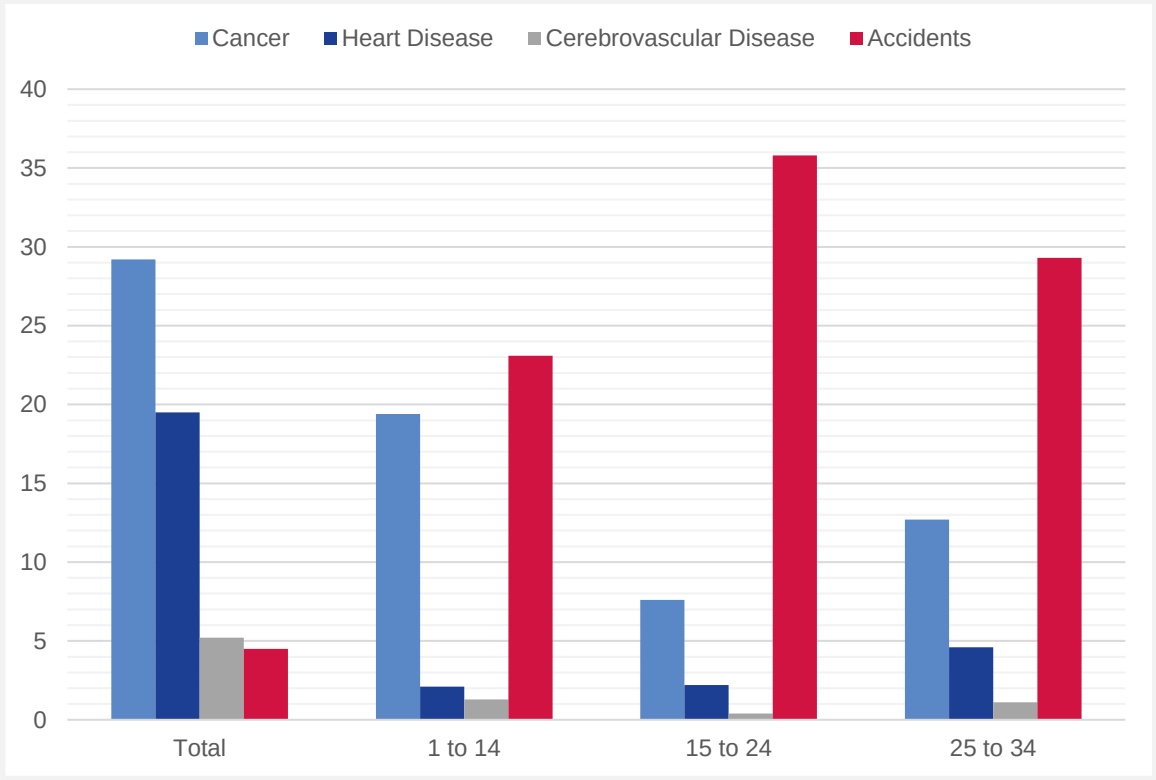
AN OUNCE OF PREVENTION: STANDARDS AS A TOOL TO PREVENT ACCIDENTAL FATALITIES

“Accidents happen.” We often invoke this expression to minimize an event or absolve someone of responsibility. While some accidents are rightfully downplayed, at other times the apparent trivialization of accidents belies their devastating consequences. In Canada, accidents are the fifth leading cause of death for the population as a whole, accounting for 4.5% of all deaths in 2015 (see Chart: Leading Causes of Mortality by Age Group).[1] For Canadians between the ages of one and 34, accidents are the leading cause of death. The impact of accidents wanes as the population ages, but accidents still rank second to cancer as the leading cause of death for Canadians aged 35 and 44.

1 Statistics Canada. Table 102-0561 – Leading causes of death, total population, by age group and sex, Canada, annual, CANSIM (database). (Accessed: 2018-05-09.)

Chart 1
Leading Causes of Mortality by Age Group, 2015

(Share of all deaths)



Source: CANSIM 102-0561.

By disproportionately affecting the young, accidental deaths are a tremendous burden on societies. There are direct costs to the health care system as well as economic costs due to lost potential. In 2012, the unintentional deaths of 11,290[2] Canadians resulted in approximately 183,867 potential years of lost life.[3,4] There is also an incalculable emotional cost. By their nature, accidental deaths are sudden, unexpected and frequently violent; these qualities have been found to intensify the grieving process for survivors.[5]

2 Statistics Canada. Table 102-0561 – Leading causes of death, total population, by age group and sex, Canada, annual, CANSIM (database). (Accessed: 2018-05-09..

3 Statistics Canada. Table *102-4313 – Mortality and potential years of life lost, by selected causes of death and sex, three-year average, Canada, provinces, territories, health regions and peer groups, occasional,* CANSIM (database). (Accessed: 2018-05-09.)

4 Potential years of life lost quantify “premature” deaths by calculating the number of years that were potentially not lived. Deaths before the age of 75 are considered premature. Statistics Canada reports on deaths over a three-year span. We used a ratio to estimate the potential years lost for 2012, the latest year for which data were available.

5 Vigilant, Lee Garth, and John B. Williamson. "To die, by mistake: Accidental deaths." Handbook of death and dying 1 (2003): 211-222.

Accidents Are a Global Problem

Canada is not unique; accidents are a problem worldwide. The World Health Organization (WHO) estimated that approximately 3.9 million people—almost 11,000 people each day—died as a result of unintentional injuries in 2015.[6] That number is projected to rise to 4.7 million in 2030. That would represent a marginal increase in the share of all deaths attributed to unintentional accidents to 6.8% in 2030 from 6.7% in 2015.

While accidents are an issue in every country, the magnitude of the problem varies considerably between countries and categories of countries. [7] In high-income countries, on average 3.9% of all deaths were attributed to unintentional injuries in 2015.[8] For low- and middle-income countries, unintentional injuries were responsible for 7.3% of all deaths that year. High-income countries can expect to see a *decrease* of approximately 0.3% in the number of accidental deaths by 2030, but for low- and middle-income countries, there will be a slight *increase* of almost 0.1%. Consequently, the odds of an accident happening are at least partially contingent on where a person lives.

The discrepancy in the incidence of accidents by country region is largely attributed to differences in road injuries. Ninety percent of traffic accident fatalities occur in low- and middle-income countries, even though these countries only account for slightly more than half of registered vehicles in the world.[9] On average, individuals living in low- or middle-income countries are more than twice as likely to die from a traffic accident than individuals living in high-income countries.[10]

While wealthier countries have devoted resources to making vehicles and roads safer, this is frequently not the case in parts of the developing world. In some developing countries, it is not uncommon to see multiple people precariously riding on a single motorcycle or scooter. Seatbelt use is often infrequent and unenforced, and the number of available seatbelts may not be sufficient for the number of vehicle occupants. Additionally, roadways may not have safe crossings or be designed with distinct users in mind (e.g., pedestrians, cyclists, motorcycles, cars, donkeys, etc.). Some Kenyan students have learned firsthand the tragic consequences of poor road design. In Kibera, Kenya, the Nesco School is situated near multilane highways that lack safe crossings. One in four students at this school has been in a traffic accident and one in three has witnessed a close relative getting injured or killed.[11]

6 WHO, Global Health Estimates Summary Tables: Projection of Deaths by Cause, Age and Sex. Geneva, World Health Organization; 2013. The WHO and many other organizations differentiate between unintentional and intentional injuries. Unintentional injury causes include road accidents; poisonings; falls, fires, heat and hot substances; drownings; exposure to mechanical forces; natural disasters; and other unintentional causes. Intentional injuries include self-harm, interpersonal violence, collective violence and legal intervention.

7 WHO, Global Health Estimates 2015: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2015. Geneva, World Health Organization, 2016.

8 WHO, Global Health Estimates Summary Tables: Projection of Deaths by Cause, Age and Sex. Geneva, World Health Organization; 2013.

9 WHO, Global status report on road safety. Geneva, World Health Organization, 2015 (http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/).

10 WHO, Global status report on road safety. Geneva, World Health Organization, 2015 (http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/).

11 The Economist. Road Deaths: Driving to an early grave. The Economist Newspaper Ltd., London, United Kingdom, 2014.

There is a significant price to pay for accidental fatalities, and the burden is, in some ways, greatest for those who can least afford it. The International Road Assessment Programme (iRAP) estimated that the annual economic cost of deaths and serious injuries resulting from traffic accidents is 2% of GDP in high-income countries and 5% of GDP in low-income countries.[12] Strategic investments to reduce traffic accidents are a cost-effective means to help alleviate poverty globally.

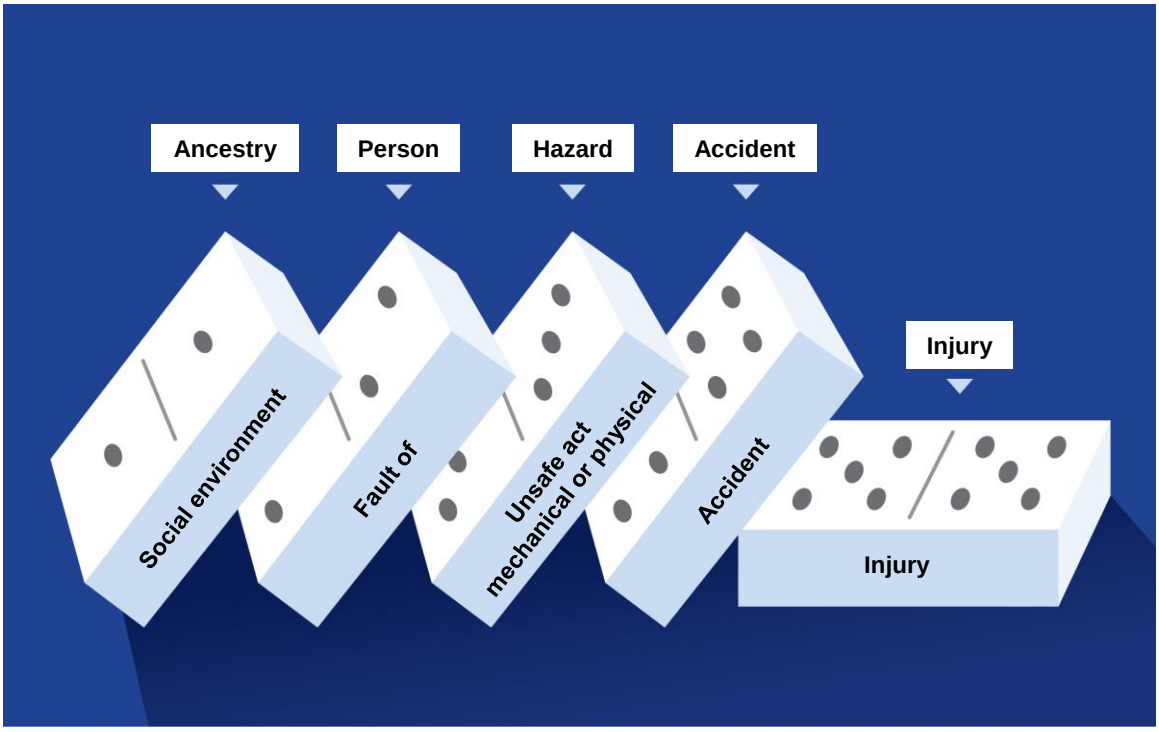
While a great deal of research has been done specifically on traffic accidents, there is evidence that poverty increases the risk of injuries generally both between countries and *within* countries. The likelihood of dying in a house fire is 16 times higher for a child living in poverty in the United Kingdom than for a child in a wealthy family.[13] Undoubtedly, there are numerous factors that increase the prevalence of accidents among economically disadvantaged populations. At the same time, it has been demonstrated that modest investments in prevention can reduce the devastating effects of accidents worldwide.[14]

12 International Road Assessment Programme. Vaccines for Roads, Third Edition. United Kingdom: International Road Assessment Programme, 2015.
13 WHO, Injuries and Violence: The facts. Geneva, World Health Organization, 2014.
14 See for example the International Road Assessment Programme. Vaccines for Roads, Third edition. United Kingdom: International Road Assessment Programme, 2015 and Haddix, Anne C., Sue Mallonee, Rick Waxweiler, and M. R. Douglas. "Cost effectiveness analysis of a smoke alarm giveaway program in Oklahoma City, Oklahoma." *Injury Prevention* 7, no. 4 (2001): 276-281.

Understanding the Causes of Accidents

The stubbornly high number of accidental fatalities is particularly frustrating given that accidents are often predictable and preventable. Researchers have developed numerous theories to determine the root causes of accidents. The domino effect is one of the first sequential models to investigate accident causation.[15] The model is based on the premise that accidents and resulting injuries are "the natural culmination of a series of events or circumstances, which invariably occur in a fixed or logical order."[16] Accidents are seen as chains of events (see figure 1: The Domino Effect); a disruption at any point in the chain would prevent the accident.

Figure 1: The Domino Effect



Source: Toft, Dell, Klockner, and Hutton, 2012.

15 Toft, Yvonne, Geoffrey Dell, K. K. Klockner, and Allison Hutton. "Models of causation: safety." Safety Institute of Australia, Tullamarine, Victoria (2012).
16 Heinrich, H. W. Industrial Accident Prevention: A scientific approach. New York: McGraw-Hill, 1931. P. 14.

Since this original theory was developed, accident models have become increasingly complex and non-linear. In other words, newer models recognize that accidents are occurring in an increasingly complicated world where numerous factors can interact.[17] Understanding how and when factors (such as humans, technology and the environment) interact is essential to understanding and preventing accidents.

By applying accident causation theories, investigators regularly find that tragic events have small beginnings.[18] More often than not, human error is a contributing factor. Researchers have estimated that 80% to 90% of accidents can be attributed to human error.[19] Yet global health agendas often overlook accidents. [20] Until the critical role of human fallibility in accidents is fully appreciated and further steps are taken to mitigate the consequences of human error, accidents will continue to be a leading cause of death and disability.

Can Standards Help?

The fact that most accidents can be attributed, at least in part, to human error reflects the fallibility of people; after all, to err is human. It's also human nature to think "this could never happen to me." However, once an accident has occurred, the value of preventative action is more fully appreciated as individuals often think, "If only I had/hadn't…"

In June 2016, Ikea issued a voluntary recall of 35.5 million dressers sold in Canada and the US.[21] Over the course of multiple years, the dressers had tipped over, tragically killing several children. While these dressers were sold with wall anchors, it seems some consumers did not avail themselves of this safety feature—with disastrous consequences. As the events became more known and publicized, Ikea offered to provide wall anchors or refund consumers. The store also committed to ensuring that dressers sold in its stores would meet a *voluntary standard* on free-standing stability to protect against future tragedies.[22]

Essentially, a standard can be anything that specifies how to do, test or identify something. In Canada, the Standards Council of Canada oversees the standardization network. There are approximately 3,000 voluntary Canadian standards. These standards are developed by panels of experts and designed to ensure better, safer and more efficient products and processes.[23] Standards have been applied, developed or enhanced (e.g., through an amended, new edition) in the aftermath of tragedies as one means to mitigate future tragedies.[24]

17 For a more thorough description of the evolution of accident causation theories, see: Toft, Yvonne, Geoffrey Dell, K. K. Klockner, and Allison Hutton. "Models of causation: safety." Safety Institute of Australia, Tullamarine, Victoria (2012).
18 Perrow, Charles. Normal Accidents: Living With High-Risk Technologies. New York: Basic Books, 1984.
19 Hale, Andrew R., and A. Ian Glendon. *Individual behaviour in the control of danger*. Elsevier Science, 1987.
20 WHO, Injuries and Violence: The facts. Geneva, World Health Organization, 2014.
21 IKEA, Corporate News, 2013-11-04, http://www.ikea.com/us/en/about_ikea/newsitem/110416_IKEA-recalls-chest-of-drawers-new-update. (Accessed: 2017-04-07.)
22 IKEA, Important Safety Notice, 2016-06-28, http://www.ikea.com/ms/en_CA/customer_service/current_important_chestofdrawer.html. (Accessed: 2017-04-07.)
23 For more information on standards, see for example: https://www.scc.ca/en/standards and http://ses-standards.site-ym.com/?58.
24 See for example: http://www.cba.org/cba/cle/PDF/ENV11_Abouchar_paper.pdf.

More recently, ISO published the first edition of ISO 45001:2018 – Occupational health and safety management systems – Requirements with guidance for use. The standard is a management system for occupational health and safety. Applying the standard will protect employees and help prevent some of the almost 3 million workplace fatalities that occur annually and worldwide, as well as illness and injuries.[25] The standard was based on one from the British Standards Institute (BSI 18001). However, as a testament to the utility of this type of standard, other Standard Development Organizations (SDOs)—including the Canadian Standards Association (CSA)—have developed similar standards. CSA first published CSA Z1000 – Occupational health and safety management in 2006.

The use of standards to respond to accidents would suggest that they can be an effective tool to reduce accidents. While isolated incidents demonstrate the preventative potential of standards, it is worth considering whether standardization can have a broader impact on the severity and prevalence of accidents. One way to consider the influence of standards on accidents is to compare countries. Countries do differ in the extent to which they are involved in standardization; they also differ with respect to the number of accidental fatalities. Determining if there is a relationship between these factors would illuminate whether standardization can be part of a broader strategy to reduce unintentional fatalities.

Standardization and Unintentional Fatalities

To understand the relationship between standardization and unintentional fatalities, we analyzed international data to determine if there is a significant association between these factors. To ensure the data were comparable, we relied on single sources of information for each indicator (see Appendix A for a detailed description of the indicators, methodology and results). The World Health Organization reports on deaths by cause for 183 countries; however, it notes that the quality of the data varies across countries. Generally speaking, more developed countries have better-quality data whereas some of the least-developed countries have unavailable or unusable data. Data quality was factored into the analysis.

A country's level of standardization was defined as the country's participation in the International Organization for Standardization's (ISO's) technical committees. Technical committees develop standards in specific sectors and/or industries. ISO identifies which countries have a seat on each technical committee. By participating in the committee, countries can have a voice to share their expertise and shape resulting standards. Participation in ISO technical committees is a proxy for standardization activity. While it may not reflect a country's overall engagement in standardization (as some countries may be more involved nationally than internationally), arguably, countries that prioritize standardization are more likely to be active in this international organization. ISO's membership currently includes 162 national standards bodies.[26]

25 Steedman, Scott. The Way of Work. ISO focus, March-April 2018.
26 ISO, About ISO, https://www.iso.org/about-us.html. (Accessed: 2017-03-29.)

When examining a relationship between two indicators, it is essential to rule out obvious alternative explanations. With respect to standardization and unintentional fatalities, two things that could play a role are wealth and education. As noted previously, wealth does reduce the incidence of accidental fatalities;[27] education has also been shown to have an impact.[28] Presumably, greater wealth and education would also increase the likelihood of a country having the resources and expertise to participate on technical committees. Consequently, any association between technical committee participation and unintentional fatalities would need to account for these two factors.

Using data from 2015, we find a significant association between technical committee participation and unintentional fatalities, such that more standardization corresponds to fewer accidental deaths. Importantly, the relationship holds even when data quality, wealth and education are taken into account (see Appendix A for a detailed explanation of results). Countries that are more involved in standardization have less of their population dying accidentally. A 1% increase in technical committee participation is associated with a 0.19% decrease in unintentional deaths. Worldwide, that equated to approximately 7,400 fewer people dying accidentally in 2015.

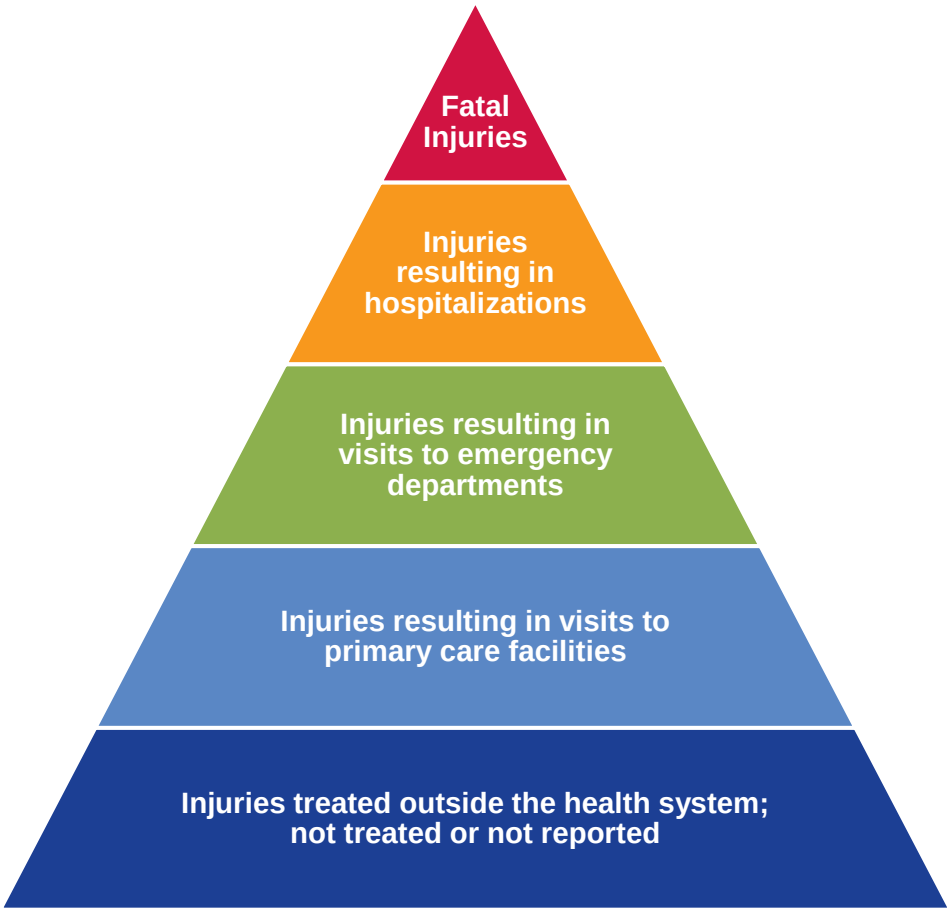
It follows that if Canada participated in four more ISO technical committees, this would have been associated with 20 fewer accidental deaths in 2015. For China, participation on seven more technical committees would have corresponded to over 1,000 fewer deaths. And for Guatemala, participating on one more committee would have equated to 18 fewer accidental deaths. These are not huge numbers; however, a 1% increase in technical committee participation is also not a particularly large investment for most countries. The critical point is that most unintentional injuries are predictable and preventable. This research demonstrates that increased involvement in standardization is one means to reduce the number of tragic accidents.

27 See for example: WHO, Injuries and Violence: The facts. Geneva, World Health Organization, 2014.
28 See for example: Harper, Sam, Thomas J. Charters, and Erin C. Strumpf. "Trends in Socioeconomic Inequalities in Motor Vehicle Accident Deaths in the United States, 1995–2010." *American journal of epidemiology* (2015): kwv099.

The Broader Impact of Injuries

While we were able to demonstrate a link between increasing standardization and decreasing accidental fatalities, the implications of this research are likely more far-reaching. Most accidents don't result in fatalities. There is a whole continuum for the possible outcomes of accidents, with fatalities at the far end of the spectrum. The World Health Organization graphically represents the range of unintentional injuries as a pyramid (see Figure 2: Injury Pyramid). The pyramid is intended to illustrate the various demands that accidents can place on the health care system, as well as the toll they take on people.

Figure 2: Injury Pyramid



Source: WHO, Injuries and Violence: The facts. Geneva, World Health Organization, 2014.

Examining the broader impact in Canada, unintentional injuries accounted for 10,866 deaths, 204,104 hospitalizations, and more than 3.3 million emergency room visits in 2010.[29] They were also responsible for permanently disabling 53,591 Canadians partially or totally.[30] These injuries are projected to cost $22.1 billion over the injured individuals' lifespans.[31] The cost of injuries is growing exponentially. It is estimated that if the trends remain the same, injuries will cost Canadians $75 billion in 2035—a 180% increase from the cost in 2010.[32] By investing in the development and implementation of effective standards, Canada and other countries can decrease fatalities and injuries, and save the economy billions of dollars.

Daily, thousands of lives are lost and countless others are forever altered due to "accidents." In 1961, Edward Suchman, a medical sociologist, stated:

"When the public is willing to accept the same type of preventative program for accidents as it demands for the communicable diseases, we may expect to witness tremendous gains in removing accidents from its current position as one of the major causes of death and disability."[33]

Standards are one tool that can help to prevent accidents. In fact, governments recognize that using standards in regulations can help to safeguard the public. In Canada, the Federal Food and Drug Regulations references ISO 8317 – Child-resistant packaging and CSA Z76.1 – Reclosable child-resistant packages (among other standards). Research from the United States has demonstrated the life-saving effects of child-resistant packaging for prescription drugs.[34] Whether applied voluntarily by a company or regulated by law standards, their design can be instrumental in protecting citizens.

While accidents are clearly a complex problem with a myriad of contributing factors, this research indicates that standardization can play an important role in reducing the devastating impact of accidents. When effectively implemented and adhered to, standards serve as a critical resource for protecting the health and safety of populations. Standards can save lives.

29 Parachute. (2015). *The Cost of Injury in Canada.* Parachute: Toronto, ON. Note, the report calculated these figures for intentional and unintentional injuries; using the data provided in the report, we excluded intentional and undetermined intent/other.
30 Parachute. (2015).
31 Parachute. (2015).
32 Parachute. (2015).
33 Suchman, Edward A. "A Conceptual Analysis of the Accident Phenomenon." Social Problems 9 241–53 1961, p. 249.
34 Rodgers, Gregory B. "The safety effects of child-resistant packaging for oral prescription drugs: two decades of experience." Jama 275, no. 21 (1996): 1661-1665.

APPENDIX A

Technical Results

Methodology

The purpose of this research was to determine the impact of standardization on unintentional deaths. A hierarchical regression analysis was used to determine if greater participation in ISO Technical Committees, as a proxy for standardization, is associated with a reduction in unintentional deaths across countries. A hierarchical regression analysis was used to control for potentially confounding variables. The model includes the following variables:

- Gross Domestic Product (GDP) per capita,
- The adult population's average years of schooling, and
- Number of participants on ISO Technical Committees.

The model for unintentional deaths is expressed as:

$$\text{UNINTENTIONAL DEATHS}_i = \text{CONSTANT} + B_1 * \text{Ln}(\text{PC GDP}_i) + B_2 * \text{Ln}(\text{AVERAGE YEARS OF SCHOOLING}_i) + B_3 * \text{Ln}(\text{ISO TC}_i)$$

The analyses were based on data from 152 countries ("i"). GDP per capita was skewed; as a result, a natural log transformation was applied to all the variables for consistency.

In the analysis, the dependent variable, unintentional deaths, is a function of three independent variables. The variables and their sources are described below:

Unintentional deaths. The World Health Organization reports estimated deaths by cause.[35] For this research, the share of deaths attributed to unintentional injuries was used. Causes of unintentional deaths include: road injury; poisonings; falls, fire, heat and hot substances; drowning; exposure to forces of nature; and other. The World Health Organization provides guidance on the quality of the data. The analyses were completed on the entire data set. We then repeated the analysis, excluding data that the World Health Organization has advised are not likely to be informative for "comparisons among countries."[36] This was done to determine if data quality had a significant impact on the results. The 2015 data were used for this analysis.

GDP per capita (current US$). Data are from the World Bank's website.[37] The site provides key development statistics for more than 200 countries. GDP per capita was selected because it correlated more highly with unintentional deaths than GDP, making it a more stringent control variable to test our hypothesis. The 2015 data were used for this analysis.

Average years of schooling. Data are from the United Nations Human Development Report. [38] To control for the education of the population, we used the average years of schooling for the population over the age of 25. The average years of schooling allows for greater consistency across countries relative to the share of the population with post-secondary education, since what is considered post-secondary education varies from country to country. Data were from 2015.

ISO Technical Committee (TC) Participation. Data are from the International Organization for Standardization (ISO). For each country, we counted the number of technical committees or sub-committees a country participates or observes on. Involvement in technical committees at ISO allows for a consistent indicator of the cross-country differences in standardization. Data from 2015 were used due to some limitations in the availability of ISO data. Technical Committee participation in 2015 was limited to technical committees that were active at the time the data were accessed (i.e., 2016).

We entered the independent variables into the equation in two steps. In this hierarchical regression analysis, per capita GDP and average years of schooling were entered first. ISO technical committee participation was entered in the second step. A hierarchical regression provides a more stringent test of the relationship between ISO TC participation and accidental deaths. The impact of ISO TC participation is assessed after controlling for the variables that are expected to exert some influence on accidental deaths.

35 http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html.
36 Global Health Estimates 2015: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2015. Geneva, World Health Organization; 2016.
37 http://databank.worldbank.org/data/home.aspx.
38 http://hdr.undp.org/sites/default/files/2015_human_development_report.pdf.

Results

Prior to doing a hierarchical regression, it was important to confirm that a significant relationship exists between the transformed independent and dependent variables. As expected, the dependent variable, accidental deaths, was negatively correlated with each of the independent variables (see Table 1). In other words, as wealth, education and ISO TC participation increases, the number of unintentional deaths decreases.

Table 1: Correlations Between Independent and Dependent Variables

(N = 157 to 181, depending on data availability for each indicator)

	UNINTENTIONAL DEATHS	PER CAPITA GDP	YEARS OF SCHOOLING	ISO TC PARTICIPATION
Unintentional Deaths	--	–0.54***	–0.62***	–0.47***
Per Capita GDP		--	0.78***	0.55***
Years of Schooling			--	0.57***
ISO TC Participation				--

****P* < 0.001.

Having confirmed the relationship among the variables, the next step was to determine whether the relationship between unintentional deaths and ISO TC participation would hold after controlling for wealth and education. Given that wealth and education are correlated with ISO TC participation, the hierarchical regression will demonstrate whether ISO TC participation has a unique impact on unintentional deaths that cannot be accounted for by wealth and education.

The adjusted R-squared for the hierarchical regression analysis was 0.43; stated another way, the model accounted for 43% of the variation in unintentional deaths. Given that these deaths by their nature are difficult to predict, it is an indication of the effectiveness of the model that it was able to account for a moderate amount of the variation. Importantly, ISO TC participation is a significant predictor of unintentional deaths, even after controlling for per capita wealth and average years of education (see Table 2).

Table 2: Statistical Results for 152 Countries

	UNINTENTIONAL INJURIES	
	COEFFICIENT	STANDARD ERROR
Step 1		
Constant	3.21***	1.21
Per Capita GDP	–0.12	0.03
Years of Schooling	–0.54***	0.11
Step 2		
ISO TC Participation	–0.19**	0.02

*$P < 0.05$
** $P < 0.01$
*** $P < 0.001$

As previously noted, the World Health Organization specified that data from some countries should be used with caution. Consequently, we repeated the analysis excluding 57 countries deemed to have lower-quality data. The results remained significant:[39] increased TC participation is associated with decreased accidental fatalities.

When interpreting the results, it is important to recognize the limits of regression analysis. Regression analyses do not prove causation. Further analysis with time series data is necessary to unequivocally determine whether ISO TC participation *causes* decreases in unintentional deaths. However, we did repeat the analysis using 2012 data, and once again found a significant negative relationship whereby increased standardization reduced unintentional deaths.[40] The consistency of these findings lends further credibility to the relationship between standardization and unintentional injuries.

39 β = –0.26; t = –2.65; P < = 0.01.
40 β = –0.28; t = –3.40; P < = 0.001.