When One Size Does Not Protect All: Understanding Why Gender Matters for Standardization

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Author: Michelle Parkouda, Ph.D.
Manager, Research, Standards Council of Canada

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Aussi offert en français sous le titre Quand la taille unique ne convient pas : pourquoi la question du genre est importante pour la normalisation.

One hundred years – that is how long the World Economic Forum estimates it will take to achieve global gender equality.[1] That number masks the variability between regions and countries. Western Europe is expected to close the gap in 54 years while East Asia and the Pacific will need 163 years. North America[2] is estimated to take 151 years, driven largely by the United States (the US is ranked 53rd on the global gender gap index, while Canada is ranked 19th).

Importantly, closing the gender gap worldwide has significant consequences. The World Bank, in a study funded partially by the Government of Canada, estimated that gender inequality in earnings cost the global economy $160.2 trillion USD in 2014.[3] In 2015, McKinsey estimated that closing the gender gap – such that women's participation in the economy equalled men's – would add $28 trillion USD to the global Gross Domestic Product (GDP) in 2020.[4] While the estimates vary, there is agreement that societies pay a heavy price for gender inequality.

In addition to the economic impacts, gender inequality also effects health, safety and well-being. The brunt of these effects is seemingly borne by women and is largely due to women not being accounted for in the research and development phases of products and services.[5] The end result is that women are unnecessarily put at greater risk.

When it comes to health, the exclusion of females in research for medications and medical devices is not limited to humans. Female animals have historically been excluded from preclinical research.[6] Understandably, women who are (or may become) pregnant and women who are breastfeeding are not ideal candidates for medical research. However, the lower participation of females (both animal and human) in medical research has consequences. Specifically, research has shown that medications and medical devices are not as safe for women.[7] In the US, one study found that the reason 8 out of 10 drugs were withdrawn from the market between 1997 and 2000 was because they were not as safe for women as they were for men.[8] Recognizing this dangerous trend, there has been a concerted effort to increase women's participation in clinical trials, however, women are still underrepresented in the earliest stage of research and some therapeutic areas.[9]

1 World Economic Forum. (2019). Global gender gap report 2020. Geneva: World Economic Forum.
2 Defined as only Canada and the US in the report.
3 Wodon, Q. T., & De La Briere, B. (2018). *Unrealized potential: The high cost of gender inequality in earnings.* World Bank.
4 McKinsey Global Institute. "The power of parity: How advancing women's equality can add $12 trillion to global growth." (2015).
5 Perez, C. C. (2019). *Invisible Women: Exposing data bias in a world designed for men.* Random House.
6 Mogil, J. S., & Chanda, M. L. (2005). The case for the inclusion of female subjects in basic science studies of pain. *Pain, 117*(1), 1-5.
7 Canadian Institute for Health Research. (2019). Are medications and medical devices more dangerous for women? Government of Canada.
8 Heinrich, J., Gahart, M. T., Rowe, E. J., & Bradley, L. (2001). Drug safety: most drugs withdrawn in recent years had greater health risks for women. *A letter to The Honorable Tom Harkin, The Honorable Olympia J. Snowe, The Honorable Barbara A. Mikulski, United States Senate, The Honorable Henry Waxman, House of Representatives. Washington DC: United States General Accounting Office.*
9 Canadian Institute for Health Research. (2019). Are medications and medical devices more dangerous for women? Government of Canada.

Research has also shown that automobiles are less safe for women. Despite reductions in fatalities and serious injuries due to car accidents in recent years, women are 73% more likely to be seriously injured or die in a car accident than men.[10] Most car companies rely on crash test dummies designed to resemble men's anthropometry. So, while crash test dummies have served to improve outcomes for men, the absence of widespread tests with crash test dummies designed to resemble women's anthropometry have resulted in unequal protections for men and women.

Even something seemingly more benign like voice-activated technology can exhibit gender bias. Research has found that some speech recognition software is more accurate with male than female voices.[11] One possible explanation is that women's voices are underrepresented in the training data used for the software. With voice-recognition software being used to reduce distracted driving and for medical dictation, among other things, not all errors are benign. Moreover, the impact of those errors may not be limited to the affected female users but could also affect innocent bystanders. While many women may be frustrated by the lack of responsiveness of their voice-activated technology while driving, the poor functioning technology could exacerbate the problem it was intended to combat – distracted driving – with potentially disastrous consequences.

This raises an important point. Women are not the only ones who are harmed by gender inequality. In *Resolution 1325*, the UN Security Council reaffirmed that gender equality is essential for peace.[12] Research sponsored by the US Department of Defence showed that national security is predicated on gender equality.[13] While no country has achieved full gender equality to date, research has shown that the more a country subordinates women the worse it performs in national security, primarily when it comes to economic performance, governance and conflict[14] – everyone loses.

10 Forman, J., Poplin, G. S., Shaw, C. G., McMurry, T. L., Schmidt, K., Ash, J., & Sunnevang, C. (2019). Automobile injury trends in the contemporary fleet: Belted occupants in frontal collisions. *Traffic injury prevention*, *20*(6), 607-612.

11 Tatman, R. (2017, April). Gender and dialect bias in YouTube's automatic captions. In *Proceedings of the First ACL Workshop on Ethics in Natural Language Processing* (pp. 53-59).

12 United Nations Office of the Special Advisor on Gender Issues and Advancement of Women. (2000). Landmark resolution on women, peace and security, (S/RES/1325).

13 Hudson, V. M., Bowen, D. L., & Nielsen, P. L. (2020). *The First Political Order: How Sex Shapes Governance and National Security Worldwide*. Columbia University Press.

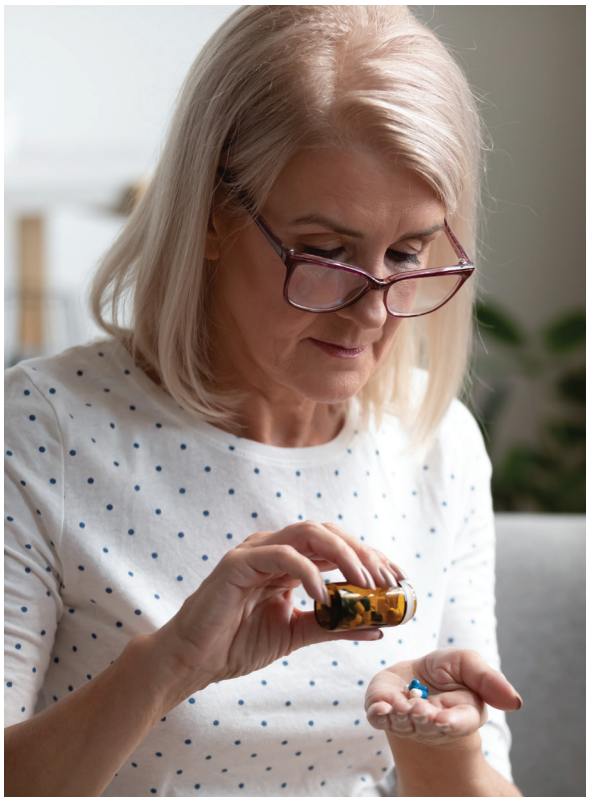
14 Hudson, V. M., Bowen, D. L., & Nielsen, P. L. (2020). *The First Political Order: How Sex Shapes Governance and National Security Worldwide.* Columbia University Press.

What can be done to reduce gender inequality?

A report from the Organization for Economic Co-operation and Development argued that for societies to benefit from gender parity, they must first address discriminatory social institutions, which are increasingly seen as the root cause of gender inequality.[15] Such social institutions include formal and informal law, policies and regulations, as well as social norms and practices that limit women's access to opportunities and their rights. Recognizing the importance of considering gender in the development of policies, programs, and legislation, the Government of Canada has taken action to ensure that Gender-based Analysis + (GBA+)[16] is fully implemented across federal departments and agencies.[17] As a Crown Corporation, the Government requirements for GBA+ apply to the Standards Council of Canada (SCC). While it is a Government requirement, it is also simply good practice.

Fortunately, SCC is not the only standards body to recognize the role that standards can play in promoting gender equality. On May 14, 2019, SCC joined international organizations, national standards bodies, and standards development organizations to sign the United Nations Economic Commission for Europe (UNECE) *Declaration for Gender Responsive Standards and Standards Development*.[18] Signatories committed to, among other things, "acknowledge that representation of women in standards development is almost always below parity and that the outcomes for men and women are not explicitly addressed during the standards development process." They also committed to take action to ensure standards are gender responsive.

Standards specify how to do, test, or identify something. They have been referred to as invisible infrastructure,[19] and while they are pervasive (impacting the products, processes and services we use daily), they often go unnoticed. They are developed by panels of experts using a consensus approach. As the gender declaration acknowledges, women are under-represented in standardization. Extrapolating from other domains, it seems obvious that the under-representation of women in standardization will have consequences. Indeed, there is compelling evidence that standards are not protecting women as well as they are protecting men.[20]



15 Ferrant, G., & Kolev, A. (2016). The economic cost of gender-based discrimination in social institutions. *Organisation for Economic Co-operation and Development Center.*

16 Gender-based Analysis + (GBA+) recognizes the importance of considering how multiple identifies (gender, race, language, ability, etc.) may experience policies, programs and regulations. It also emphasizes the importance of considering the intersectionality between these identities.

17 Status of Women Canada. (2016). Action Plan on Gender-based Analysis (2016-2020). Government of Canada.

18 UNECE. (2019). Gender Responsive Standards Declaration. United Nations.

19 Gorur, R. (2013). The invisible infrastructure of standards. *Critical studies in Education, 54*(2), 132-142.

20 See for example: TUC. (2017). Personal protective equipment and women.

While targeted research is needed to determine whether and how standards differentially affect men and women in specific domains, there is also value in examining this issue at the national level. Previous research has demonstrated that a country's level of involvement in international standards development is associated with a reduction in the number of unintentional fatalities.[21] In other words, standardization can safeguard citizens. The question remains, is standardization equally protective for men *and* women?

Cross-country data is frequently used by researchers to understand what drives national differences in areas such as well-being, health and economic outcomes. National differences in well-being have been attributed to the wealth of nations,[22] economic freedom,[23] and political freedom.[24] Notably, gender differences have also been found to influence population well-being and health. For example, one study found that how national women's soccer teams fared in the World Cup was positively correlated with well-being and life expectancy, whereas the performance on the men's teams was unrelated to national well-being and life expectancy.[25] The argument was made that greater opportunities for disadvantaged groups[26] are beneficial for society as a whole. More recently, researchers found that countries who better support women's economic and social rights exhibit improved population health outcomes, using a sample of 162 countries.[27] Hereto, the authors found that the treatment of women has implications for the health outcomes of the entire population.

Standardization and Unintentional Fatalities by Gender

A cross-country study found an association between participation in standardization and a reduction in the share of unintentional fatalities. A 1% increase in standardization was associated with a 0.19% decrease in the share of unintentional fatalities.[28]

In 2015, unintentional injuries accounted for approximately 6% of all deaths globally.[29] As might be expected, these deaths are not distributed evenly by gender. On average, men were more likely to be the victims of unintentional fatalities than women, representing 8% of all male deaths and 4% of female deaths. While the prevalence of unintentional injuries varies by sex, it is important to understand whether standardization is currently associated with a reduction in unintentional fatalities for men and women.

To understand the relationship between standardization and unintentional fatalities by gender, 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 (WHO) reports on deaths by gender and 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 less developed countries have unavailable or unusable data. Data quality was factored into the analysis (see Appendix A for details).

21 Parkouda, M. (2019). An ounce of prevention: Standards as a tool to prevent accidental fatalities. Ottawa: Standards Council of Canada.
22 Diener, E., & Biswas-Diener, R. (2002). Will money increase subjective well-being? *Social indicators research, 57*(2), 119-169.
23 Spruk, R., & Kešeljević, A. (2016). Institutional origins of subjective well-being: Estimating the effects of economic freedom on national happiness. *Journal of happiness studies, 17*(2), 659-712.
24 Downie, M., Koestner, R., & Chua, S. N. (2007). Political support for self-determination, wealth, and national subjective well-being. *Motivation and Emotion, 31*(3), 174-181.
25 Downie, M., & Koestner, R. (2008). Why faster, higher, stronger isn't necessarily better—The relations of paralympian and women's soccer teams' performance to national well-being. *Social Indicators Research, 88*(2), 273-280.
26 Note, the study was replicated using results from the Olympics and Paralympics.
27 Alaei, K., Akgüngör, S., Chao, W. F., Hasan, S., Marshall, A., Schultz, E., & Alaei, A. (2019). Cross-country analysis of correlation between protection of women's economic and social rights, health improvement and sustainable development. *BMJ open, 9*(6), e021350.
28 Parkouda, M. (2019). An ounce of prevention: Standards as a tool to prevent accidental fatalities. Ottawa: Standards Council of Canada.
29 World Health Organization, Global Health Estimates 2015: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2015. Geneva, World Health Organization; 2016. Note unintentional injuries include: road injury, poisonings, falls, fire, heat and host substances, drowning, exposure to mechanical forces, natural disasters and other unintentional injuries.

A country's level of standardization was defined as the number of technical committees a country participates in at the International Organization for Standardization (ISO). Technical committees develop standards in specific sectors and/or industries. ISO identifies which countries have a seat on each technical committee. By participating in a 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 at the time of the study included 162 national standards bodies.[30]

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 unintentional fatalities,[31] and education has also been shown to have an impact.[32] 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. To determine whether standardization is equally benefiting men and women the analysis disaggregated unintentional fatalities by sex, however, the independent and control variables remained the same as in previous research.[33] Those variables were not disaggregated by sex.

Using data from 2015, we found a significant association between technical committee participation and unintentional fatalities for men. A 1% increase in technical committee participation was associated with a 0.29% decrease in male unintentional deaths, meaning that more national

involvement in standardization corresponds to fewer unintentional 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 had less men dying accidentally. Worldwide, a 1% increase in technical committee participation would have equated to approximately 6,700 fewer men dying from unintentional injuries in 2015.

When the analysis was replicated to determine the association between technical committee participation and unintentional fatalities for women, we found no effect. While increased standardization was associated with fewer unintentional fatalities for men, it had no impact on women. If women realized the same benefits from standardization as men, then a 1% increase in standardization activity worldwide would have been associated with a decrease in the number of women dying from unintentional fatalities by approximately 3,500 in 2015. Instead, we find that in this case, the benefits of standardization for health and safety are not gender neutral.

30 ISO, About ISO, https://www.iso.org/about-us.html. (Accessed: 2017-03-29.)
31 See for example: WHO, Injuries and Violence: The facts. Geneva, World Health Organization, 2014.
32 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.
33 Parkouda, M. (2019). An ounce of prevention: Standards as a tool to prevent accidental fatalities. Ottawa: Standards Council of Canada.

Why are standards not helping women as much as men?

While anecdotal and targeted research have demonstrated that there are instances where standards are not protecting women as well as they protect men, this analysis provides evidence that these are not isolated incidents. Rather, across countries and considering all age groups, we find evidence that the relationship between standardization and unintentional fatalities is indeed gender specific. Men are benefiting more from the protective effects of standardization.

A closer examination of standards provides some indication for why this might be the case. Many standards are not designed with women in mind. For example, standards for personal protective equipment (PPE), which are largely based on male anthropometry, are not protecting women as well as men. During the COVID-19 pandemic, research from the US, Spain and Italy found that female healthcare workers were at a disproportionately higher risk of infection compared to men, and poor fitting PPE has been hypothesized to play a role.[34] While many PPE standards will identify whether the standards were designed for men and/or women, there are other standards where information on sex is completely absent, despite its apparent relevance. For example, a standard for a handheld tool refers to the importance of a strong grip to avoid kickback. Nowhere in the standard is there an indication whether they have accounted for the differential grip strength of men and women. The average grip strength of a 20 to 39 year-old Canadian male is 38.7kg, while it is 28.4kg for a 20 to 39 year-old Canadian female. Clearly, a strong grip is relative.[35] In the absence of explicit detail, it becomes an open question whether standards are equally effective for men and women.

The failure of many standards to account for women may boil down to two inter-related factors: the lack of female representation in the development of standards; and the lack of gender expertise[36] in standards development.

34 See for example: CDC. (2020). Characteristics of Health Care Personnel with COVID-19 — United States, February 12–April 9, 2020, *Weekly* / April 17, 2020 / 69(15); 477–481, https://www.cdc.gov/mmwr/volumes/69/wr/mm6915e6.htm; Algayerova, O. and El-Yassir, A.A. (2020). Op-ed: Personal Protective Equipment standards must respond to women's needs to ensure the safety of all frontline workers during the COVID-19 pandemic, UN Women, https://eca.unwomen.org/en/news/stories/2020/5/op-ed-personal-protective-equipment-standards-must-respond-to-womens-needs.

35 Wong, S. L. (2016). Grip strength reference values for Canadians aged 6 to 79: Canadian Health Measures Survey, 2007 to 2013. Health reports, 27(10), 3.

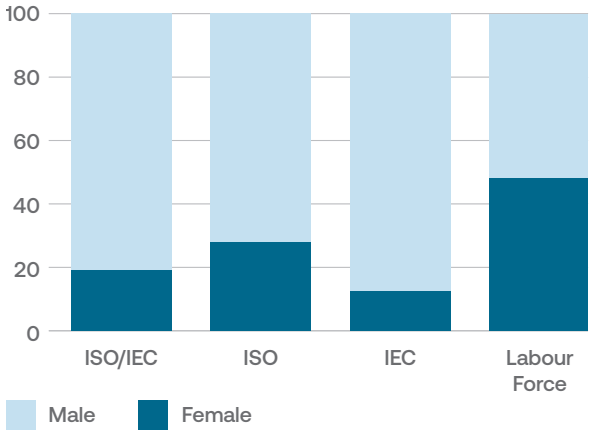
36 In Hoard, S. (2015). *Gender expertise in public policy: Towards a theory of policy success*, Basingstoke and New York: Springer, a gender expert is defined as "(1) an individual with feminist knowledge regarding the cause-and-effect relationship between policies, actions, and/or activities and gender inequalities, and (2) is formally requested to provide [their] knowledge and services".

Female Representation in the Development of Standards

In line with international best practice (i.e. World Trade Organization, Technical Barriers to Trade and ISO/IEC Guide 59 Code of good practice for standardization), SCC requires that standards must be developed with balanced representation.[37] In other words, committees developing standards need to include representation from "interest categories," so no single category of interest can dominate the development. This is intended to ensure that standards meet the needs of diverse user groups (e.g. consumers, regulators, etc.). However, historically, little consideration has been given to the personal attributes of those who develop standards (such as gender) and the potential implications. This is a gap, particularly when we recognize (as we do with stakeholder categories) that it can be difficult to convince others that something is a need, when they do not have the same need.

While numbers globally are scarce, it is widely acknowledged that standards are largely developed by men. In Canada, SCC has tracked who is contributing to the development of international standards. Despite having almost parity in the labour force, when it comes to international standards development, we find women are significantly underrepresented on technical committees for ISO and the International Electrotechnical Commission (IEC) (see Figure 1).

Figure 1: Canadian Women as a Percentage of ISO/IEC Mirror Committees Members[38] and the Labour Force[39] (Year = 2020)



Technical committees that develop standards have typically drawn volunteers from historically male dominated professions. While the antecedents of the gender gap in Sciences, Technology Engineering, Mathematics and Finance (STEM&F) is beyond the scope of this paper, its impact on standardization cannot be dismissed. Standardization requires expert knowledge in particular fields. When those fields are male dominated, the preponderance of men among participants will be reflected in their technical committees.

However, that is not the only challenge. Participation in technical committees relies on volunteers. Research on volunteering has shown that men who are in fulltime employment are more likely to engage in volunteer activity.[40] For women, full-time employment decreases volunteering.[41] Moreover, there is some evidence that employers are less likely to support the volunteering of female than male employees.[42] This presents a further barrier for attracting female volunteers from sectors where female participation may already be low.

37 Standards Council of Canada. (2019). Canadian Standards Development, Requirements and Guidance – Accreditation of Standards Development Organizations.

38 Standards Council of Canada. 2019-2020 Facts and Figures.

39 Statistics Canada. Table 14-10-0287-03 Labour force characteristics by province, monthly, seasonally adjusted DOI: https://doi.org/10.25318/1410028701-eng (accessed June 4, 2020). Labour force participation was calculated for the population aged 25+, as of March 2020.

40 Fyall, R., & Gazley, B. (2015). Applying social role theory to gender and volunteering in professional associations. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations, 26*(1), 288–314. https://doi.org/10.1007/s11266-013-9430-1.

41 Helms, S., & McKenzie, T. (2014). Gender differences in formal and informal volunteering in Germany. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations, 25*(4), 887–904. https://doi.org/10.1007/s11266-013-9378-1.

42 MacPhail, F., & Bowles, P. (2009). Corporate social responsibility as support for employee volunteers: Impacts, gender puzzles and policy implications in Canada. *Journal of Business Ethics, 84*(3), 405.

A further consideration is that for technical committees to benefit from increased female participation, one female on a committee is not sufficient. Rather, research examining the impact of women on boards has found that a critical mass of women is necessary to positively impact performance.[43] Specifically, research from Germany specified that 30% is the critical number of women needed to ensure that women are not marginalized and can have a positive impact on board performance.[44] A study of STEM&F Fortune 500 firms similarly found that board performance improves when there is a critical mass of women on the board.[45] This study concluded that when at least 30% of board members are female, it creates favourable conditions for innovative ideas to flourish. Without a critical mass, it is apparently too easy to dismiss or otherwise discredit the perspectives and contributions of minority group members – in this case women. While the benefit of gender diversity has not been tested on technical committees, there is evidence that it leads to better science,[46] and it seems a natural extension that standardization would similarly benefit.

Consequently, when referring to increasing the participation of women on technical committees, it is important to consider: the limits of the pool where experts are drawn; barriers to women's participation; and the need for a critical mass so that they can fully contribute and have a positive impact on standards development.

Gender Expertise in Standards Development

While increasing female participation on technical committees is essential, it is also challenging and not something that will be accomplished overnight. However, even with lower female participation, standardization can still be more gender responsive. This requires building gender expertise into standards development.

As a starting point, standards developers need to include sex-disaggregated data to input into the standards development process. For example, *ISO 3411:2007*, a standard for *Earth-moving machinery – Physical dimensions of operators and minimum operator space envelope*, based their dimensions on male and female data from the US, Europe and Asia. Accounting for the differences in size for men and women across various ethnicities, the standard is better positioned to meet the needs of more potential users. Also, by specifying that this data was included, users can have greater confidence in the relevance and value of the standard.

43 Joecks, J., Pull, K., & Vetter, K. (2013). Gender diversity in the boardroom and firm performance: What exactly constitutes a "critical mass?" *Journal of business ethics, 118*(1), 61-72.

44 Joecks, J., Pull, K., & Vetter, K. (2013). Gender diversity in the boardroom and firm performance: What exactly constitutes a "critical mass?" *Journal of business ethics, 118*(1), 61-72.

45 Wiley, C., & Monllor-Tormos, M. (2018). Board gender diversity in the STEM&F sectors: the critical mass required to drive firm performance. *Journal of Leadership & Organizational Studies, 25*(3), 290-308.

46 Nielsen, M. W., Alegria, S., Börjeson, L., Etzkowitz, H., Falk-Krzesinski, H. J., Joshi, A., ... & Schiebinger, L. (2017). Opinion: Gender diversity leads to better science. *Proceedings of the National Academy of Sciences, 114*(8), 1740-1742.

Scientific research backs up the necessity of using sex-disaggregated data. For example, research has shown that gender is a mitigating factor for survival after a heart attack. There is evidence that after a heart attack women appear to be "undertreated" and have twice the risk of "hospital mortality".[47] Even the gender of the physician can impact mortality for female heart attack victims.[48] Specifically, female heart attack patients' survival rates are lower when they have a male physician. When it comes to male heart attack patients, the physicians' gender had no impact on survival rates. Importantly, male physicians with more experience treating female patients did have improved survival rates. Consequently, research findings that do not disentangle potential gender differences and biases can result in worse health outcomes and ineffective treatments. As we have seen, this is not only applicable to medical research. Sweden found that a gendered analysis of snow clearing routines was able to reduce hospitalizations which had implications for health care costs and productivity.[49]

Independent of the number of women on a technical committee, by embedding gender expertise into the standards development process, standards developers will be better positioned to understand whether a proposed standard will differentially impact men and women.[50] Moreover, they will be better positioned to address any unintended consequences that could arise due to the absence of data on either men or women. The results of this, and other research, would suggest that the unintended consequences can be potentially fatal for women.

What is SCC doing?

As previously noted, recognizing the importance of considering gender in standards development, SCC – along with other national standards bodies, standards development organizations and international organizations – has signed the UNECE *Declaration for Gender Responsive Standards and Standards Development*. Additionally, SCC has developed a gender strategy that emphasizes:[51]

- Increasing the participation of women on technical committees;
- Building gender expertise into the standards development process; and
- Conducting sound research on the impact of gender on standardization.

Standards can be a force for good in societies. They ensure that products, services and processes work as intended. They support economic growth, facilitate trade, and play a role in protecting health and safety. By taking action to ensure that standards are gender responsive, those responsible for standards development will magnify the positive impact they can have on society as a whole.

47 Kudenchuk, P. J., Maynard, C., Martin, J. S., Wirkus, M., Weaver, W. D., & MITI Project Investigators. (1996). Comparison of presentation, treatment, and outcome of acute myocardial infarction in men versus women (the Myocardial Infarction Triage and Intervention Registry). *The American journal of cardiology, 78*(1), 9-14.

48 Greenwood, B. N., Carnahan, S., & Huang, L. (2018). Patient–physician gender concordance and increased mortality among female heart attack patients. *Proceedings of the National Academy of Sciences, 115*(34), 8569-8574.

49 Include Gender. Gender Equal Snow Clearing in Karlskoga. (2014). Retrieved 14-08-2020 from https://www.includegender.org/gender-equality-in-practice/planning-and-urban-development/gender-equal-snow-clearing-in-karlskoga/.

50 There are resources to help standards developers and others consider the implications of sex, including: http://genderedinnovations.stanford.edu/ and https://cfc-swc.gc.ca/gba-acs/course-cours-en.html.

51 Standards Council of Canada. (2019). Gender Strategy. https://www.scc.ca/en/about-scc/publications/other-publications/gender-and-standardization-strategy.

Appendix A
Technical Results

Methodology

The purpose of this research was to determine the impact of standardization on unintentional deaths by gender. The analyses extended previous research that found a relationship between standardization and accidental fatalities by replicating that analysis and disaggregating the share of unintentional fatalities by gender.[52]

A hierarchical regression analysis was used to determine if greater participation in International Organization for Standardization (ISO) Technical Committees, as a proxy for standardization, is associated with a reduction in unintentional deaths across countries for men and women. 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
- The number of participants on ISO Technical Committees.

52 Parkouda, M. (2019). An ounce of prevention: Standards as a tool to prevent accidental fatalities. Ottawa: Standards Council of Canada.

The model for unintentional deaths by gender is expressed as:

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

To address data quality concerns for the unintentional deaths by gender variable, the analyses were based on data from 99 countries ("i"). GDP per capita was skewed, and as a result, a natural log transformation was applied to all the variables for consistency.

In the analyses, the dependent variable (unintentional deaths by gender), is a function of three independent variables. The variables and their sources are described below.

Unintentional deaths by gender: The World Health Organization (WHO) reports estimated deaths by cause.[53] For this research, the share of deaths attributed to unintentional injuries by gender was used. Causes of unintentional deaths included: road injury; poisonings; falls; fire; heat and hot substances; drowning; exposure to forces of nature; and other causes. The WHO provided guidance on the quality of the data. The analyses excluded data that the WHO had advised are not likely to be informative for "comparisons among countries."[54] The 2015 data were used for this analysis, and the 2012 data was used to replicate the results.

GDP per capita (current US$): Data were from the World Bank's website.[55] 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, and the 2012 data was used to replicate the results.

Average years of schooling: Data were from the *United Nations Human Development Report*.[56] 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, and the 2012 data was used to replicate the results.

ISO Technical Committee (TC) Participation: Data were from the 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, TC participation in 2015 and 2012 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 TC participation was entered in the second step. A hierarchical regression provides a more stringent test of the relationship between ISO TC participation and unintentional deaths by gender. The impact of ISO TC participation was assessed after controlling for the variables that were expected to exert some influence on unintentional deaths by gender.

53 http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html.
54 Global Health Estimates 2015: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2015. Geneva, World Health Organization; 2016.
55 The World Bank. Databank. http://databank.worldbank.org/data/home.aspx.
56 United Nations. (2016). Human Development Report 2016. http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf.

Results

On average, males are more likely to die from unintentional injuries than females. Across 106 countries, the average share of deaths attributed to unintentional injuries for males was 6.27% (SD = 3.12) in 2015. For females, the average was 3.21% (SD = 1.29).

When examining the relationship between the variables, there is a strong correlation between male and female unintentional injuries (see Table 1). Years of schooling is moderately correlated with unintentional fatalities for males and females. However, when it comes to the impact of wealth and standardization on male and female unintentional fatalities, the results diverge. Wealth and standardization are associated with decreased accidental fatalities for males. Though, there is no relationship for females.

Table 1: Correlations Between Independent and Dependent Variables
(N = 99 to 106, depending on data availability for each indicator)

	Unintentional Deaths (Male)	Unintentional Deaths (Female)	Per Capita GDP	Years of Schooling	ISO TC Participation
Unintentional Deaths (Male)	–	0.70***	-0.37***	-0.50***	-0.43***
Unintentional Deaths (Female)		–	0.03	-0.31**	-0.11
Per Capita GDP			–	0.50***	0.41***
Years of Schooling				–	0.46***
ISO TC Participation					–

*** P < 0.001
** P < 0.01

Hierarchical Regression

While previous research has shown a significant relationship between unintentional fatalities and standardization, when the results are disaggregated by gender the effect seems to be limited to males. As further confirmation, the regression analysis was run for both males and females. Table 2 shows the results for male unintentional fatalities.

The adjusted R-squared for the hierarchical regression analysis was 0.38. Stated another way, the model accounted for 38% of the variation in male unintentional deaths. Given that by their nature, these deaths 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 male unintentional fatalities, even after controlling for per capita wealth and average years of education (see Table 2). Comparing the R^2 from Step 1 and Step 2 of the regression (i.e. ΔR^2), we find that TC participation accounted for 5% of the variation in the number of male unintentional fatalities.

Table 2: Statistical Results for Male Unintentional Fatalities
N=99

	Male Unintentional Fatalities	
	Standardized Coefficient	Standard Error
STEP 1		
Constant	5.23***	1.21
Per Capita GDP	-0.13	0.04
Years of Schooling	-0.51***	0.24
STEP 2		
ISO TC Participation	-0.29**	0.02

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

The analysis was repeated for female unintentional fatalities. The results are presented in Table 3. The adjusted R-squared for the hierarchical regression analysis was 0.14, or 14% of the variation in female unintentional deaths, indicating that the model is not as effective for females as it is for males. Moreover, the regression confirms that there is not a significant association between ISO TC participation and female unintentional fatalities (see Table 3).

Table 3: Statistical Results for Female Unintentional Fatalities
N=99

	Female Unintentional Fatalities	
	Standardized Coefficient	Standard Error
STEP 1		
Constant	2.33***	0.54
Per Capita GDP	0.27**	0.04
Years of Schooling	-0.43***	0.25
STEP 2		
ISO TC Participation	-0.13	0.03

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

As expected, based on the correlations, the results further demonstrate that the relationship between unintentional fatalities and ISO TC participation is driven by males. Females are not experiencing the same health protective benefits from standardization as males.

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 male unintentional deaths. However, we did repeat the analysis using the 2012 data, and once again found a significant negative relationship whereby increased standardization reduced unintentional deaths for males,[57] but not females.[58] The consistency of these findings lends further credibility to the gendered relationship between standardization and unintentional injuries.

57 $\beta = -0.28$; $t = -2.86$; $P < 0.01$.
58 $\beta = -0.12$; $t = -1.05$; $P = 0.29$.