

## Health Reports

# Canadians vulnerable to workplace noise

by Pamela L. Ramage-Morin and Marc Gosselin

Release date: August 15, 2018



Statistics  
Canada

Statistique  
Canada

Canada

---

## How to obtain more information

For information about this product or the wide range of services and data available from Statistics Canada, visit our website, [www.statcan.gc.ca](http://www.statcan.gc.ca).

You can also contact us by

**email at** [STATCAN.infostats-infostats.STATCAN@canada.ca](mailto:STATCAN.infostats-infostats.STATCAN@canada.ca)

**telephone**, from Monday to Friday, 8:30 a.m. to 4:30 p.m., at the following numbers:

- Statistical Information Service 1-800-263-1136
- National telecommunications device for the hearing impaired 1-800-363-7629
- Fax line 1-514-283-9350

### Depository Services Program

- Inquiries line 1-800-635-7943
- Fax line 1-800-565-7757

## Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner. To this end, Statistics Canada has developed standards of service that its employees observe. To obtain a copy of these service standards, please contact Statistics Canada toll-free at 1-800-263-1136. The service standards are also published on [www.statcan.gc.ca](http://www.statcan.gc.ca) under “Contact us” > “Standards of service to the public.”

## Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

Published by authority of the Minister responsible for Statistics Canada

© Her Majesty the Queen in Right of Canada as represented by the Minister of Industry, 2018

All rights reserved. Use of this publication is governed by the Statistics Canada [Open Licence Agreement](#).

**An HTML version is also available.**

*Cette publication est aussi disponible en français.*

---

# Canadians vulnerable to workplace noise

by Pamela L. Ramage-Morin and Marc Gosselin

## Abstract

**Background:** Health and safety legislation is designed to protect workers from hazards, including excessive noise. However, some workers are not required to use hearing protection when exposed to loud noise and may be vulnerable to adverse outcomes, including hearing difficulties and tinnitus.

**Data and methods:** Data for 19- to 79-year-olds (n=6,571) were collected from 2012 through 2015 as part of the Canadian Health Measures Survey. People exposed to loud workplace noise were defined as those who had to raise their voices to communicate at arm's length. Vulnerable workers were defined as those who were not required to use hearing protection when working in noisy environments and who only used hearing protection sometimes, rarely or never.

**Results:** An estimated 11 million Canadians (43%) have worked in noisy environments, and over 6 million of them (56%) were classified as vulnerable to workplace noise. Although the percentage of vulnerable women (72%) was greater than that of men (48%), men outnumbered women in these circumstances at 3.7 million, compared with 2.4 million. The self-employed were more likely than employees to be vulnerable, as were those in white-collar versus blue-collar occupations. Vulnerable workers were more likely to report hearing difficulties and tinnitus than those who had never worked in a noisy environment.

**Interpretation:** A large percentage of workers exposed to noisy workplaces were vulnerable because hearing protection was neither required nor routinely used. Further work is required to assess whether this reflects gaps in health and safety legislation or its implementation.

**Keywords:** Hazardous noise, self-reported hearing difficulties, hearing impaired persons, occupational health and safety, tinnitus, hearing protection

Excessive workplace noise can contribute to elevated blood pressure, sleep disturbance, stress, noise-induced hearing loss (NIHL), tinnitus and other negative health conditions.<sup>1-5</sup> An estimated 22.4 million U.S. workers (17%) reported that, in their current jobs, they had to speak in raised voices to be heard.<sup>6</sup> This is indicative of a hazardous noise level equivalent to at least 85 dB.<sup>7,8</sup> Over 11 million Canadians (42%) worked in noisy environments in 2012 and 2013, or had done so in the past.<sup>9</sup>

Occupational health and safety legislation is designed to help protect workers from workplace hazards, including excessive noise.<sup>10</sup> Many workers in Canada are covered by provincial, territorial or federal legislation,<sup>11</sup> with each jurisdiction defining its own occupational exposure limits for loudness and duration of noise. For example, in most provinces, the daily limit is equivalent to 85 dB of continuous noise over an eight-hour period (Appendix A). The legislation specifies a hierarchy of employer and employee responsibilities to manage noise.<sup>4,10-12</sup> Employers are required to prevent the generation of unacceptable noise levels or, alternatively, to reduce workers' exposure to noise through measures such as shorter shifts. The final defence against potentially excessive noise is to provide hearing protection and education on its use.<sup>4</sup> Despite these measures, workplace noise remains a hazard. For example, it resulted in almost 30,000 NIHL claims accepted by the Workplace Safety and Insurance Board in Ontario from 2006 to 2015.<sup>13</sup>

There is an information gap on Canadian workers exposed to hazardous workplace noise but for whom hearing protection is not mandatory.<sup>9</sup> Using data from cycles 3 (2012 to 2013) and 4 (2014 to 2015) of the Canadian Health Measures Survey (CHMS), this study describes Canadians aged 19 to 79 who,

when working in noisy environments, were not required to wear hearing protection and only did so sometimes, rarely or never—henceforth referred to as “vulnerable” workers. Characteristics of these workers are examined, as well as sources of noise, years worked in noisy environments, and adverse outcomes—specifically, self-reported hearing difficulties and tinnitus.

## Methods

### Data source

The Canadian Health Measures Survey (CHMS) is an ongoing cross-sectional survey that samples households from five regions across Canada (Atlantic, Quebec, Ontario, Prairies and British Columbia). Participants provided demographic, socioeconomic, health and lifestyle information through an inperson, computer-assisted household interview, followed by direct physical measurements collected at a mobile examination centre (MEC). The CHMS excludes full-time members of the Canadian Armed Forces; residents of the three territories, First Nations reserves and other Aboriginal settlements, and certain remote regions; and residents of institutions such as nursing homes. Altogether, these exclusions represent approximately 4% of the target population. Proxy interviews were accepted in cases of physical or intellectual impairment.

This analysis used data from cycles 3 (2012 to 2013) and 4 (2014 to 2015). The combined cycle 3 and 4 response rate for the household and MEC components was 52.7%. Further details are available in the CHMS user guides and in the *Instructions for Combining Multiple Cycles of Canadian Health Measures Survey (CHMS) Data*.<sup>14-16</sup> Ethics approval for the CHMS was obtained from Health Canada's Research Ethics Board.<sup>17</sup>

## Study sample

This study was based on a sample of 6,571 respondents (3,250 men and 3,321 women) aged 19 to 79. The weighted sample from cycles 3 (n=3,288) and 4 (n=3,283) represented a population of 25.9 million Canadians.

## Definitions

“Ever worked in a noisy environment” and “currently working in a noisy environment” were established with two questions: “At any time in your life, have you worked in a noisy environment? By noisy, I mean so loud that you and your co-workers had to speak in a raised voice to be understood by or communicate with someone standing an arm’s length away.” Respondents were instructed to include unpaid work. Those who responded “yes” were then asked “Are you currently working in a noisy environment?”

Respondents who had worked in a noisy environment reported on the duration (less than 5 years, 5 to less than 10 years, 10 years or more); whether they were required to wear hearing protection at work (yes, no); and how often they used hearing protection at work when in a noisy area, dichotomized as “used” (always, often) or “not used” (sometimes, rarely, never). The last two variables were combined to group respondents as: required and used, required but not used, not required but used, and not required and not used. Workers in the “not required and not used” category are referred to as “vulnerable” in this study.

Sources of loud workplace noise were identified from a predefined list. Machinery such as bulldozers, backhoes and sawmill equipment was grouped with modes of transportation, which included trains, airplanes, cars and trucks. Loud noise from people was combined with that from music at concerts or other amplified music. The “Other” noise source category was combined with munitions such as guns or cannons, as the sample size for the latter was too small to present separately.

Self-reported “hearing difficulty” was based on the hearing attribute of the Health Utilities Index Mark 3.<sup>18,19</sup>

Respondents were asked “Are you usually able to hear what is said in a group conversation with at least three other people without a hearing aid?” Those who responded “no” were asked follow-up questions: “Are you usually able to hear what is said in a group conversation with at least three other people with a hearing aid?” “Are you able to hear at all?” “Are you usually able to hear what is said in a conversation with one other person in a quiet room without a hearing aid?” and “Are you usually able to hear what is said in a conversation with one other person in a quiet room with a hearing aid?” Responses were scored according to an established algorithm and classified from level 1 (no hearing problems) to level 6 (unable to hear at all). A dichotomous variable identified individuals with hearing problems (levels 2 to 6) versus no hearing problems (level 1).

Respondents were asked whether they had ever experienced tinnitus (yes, no), described as “the presence of hissing, buzzing, ringing, rushing or roaring sounds in your ears when there is no other sound around you.”

In addition to sex and age group, respondents aged 25 or older were grouped by level of education: less than postsecondary graduation versus postsecondary graduation or more. Employment status was determined for people who had worked at a job or business in the past 12 months. This was established with the question “Were you an employee or self-employed?” Those working in a family business without pay were grouped with the self-employed. Job category was derived from a variant of the 2011 National Occupational Classification.<sup>20</sup> Categories A to F (management, professional, technical and paraprofessional, administration and administrative support, sales, and personal and customer information services) comprised “white-collar” workers, and categories G to J (industrial, construction and equipment operation trades; workers and labourers in transport and construction; natural resources, agriculture and related production occupations; and occupations in manufacturing and utilities) comprised “blue-collar”

workers. The terms “blue-collar” and “white-collar” are used to make broad distinctions between the work environments of different occupational groups. It is acknowledged that these terms may not reflect the current reality of the Canadian workforce. They have been used in the absence of better alternatives and because they still provide a useful, albeit very general, distinction in work environments.

## Analytical techniques

Data from cycles 3 and 4 were pooled and weighted with combined survey weights generated by Statistics Canada.<sup>16</sup> To account for the complex survey design variance estimation, coefficients of variation and significance testing (95% confidence intervals [CIs]) were completed using the bootstrap technique with 22 degrees of freedom.<sup>21</sup> Estimates represent the average Canadian household population during the survey timeframe (2012 to 2015). Analyses were conducted using SAS 9.3 and SAS-Callable SUDAAN 11.0 software.

Weighted frequencies and cross-tabulations were calculated to examine the percentage of people who worked in noisy environments by selected characteristics, with a focus on those considered vulnerable (hearing protection not required and not used). Estimates of self-reported hearing difficulties and tinnitus are presented. Logistic regression models adjusted for age (continuous) were used to examine whether bivariate results for hearing difficulties and tinnitus were confounded by age.

## Results

An estimated 11.0 million Canadians (43%) aged 19 to 79 have worked in noisy environments, defined as the need to speak in a raised voice to communicate with co-workers at arm’s length. More men (7.7 million) than women (3.3 million) had experienced noisy workplaces (Table 1). For women, younger ages (19 to 39 years) and a lower level of education were associated with a history of work in noisy environments.

Among people who had experienced noisy work environments, 6.1 million (56%) were classified as “vulnerable” to noise—they were not required to use hearing protection and only did so sometimes, rarely or never. Although the percentage of vulnerable women (72%) was greater than that of men (48%) (Figure 1), men outnumbered women in

these circumstances at 3.7 million, compared with 2.4 million.

Over the 2012-to-2015 period, 3.6 million Canadians (14%) were currently working in noisy environments (Table 2). Of these workers, half were vulnerable to loud noise. Similar proportions of employees and the self-employed worked in noisy environments, but the

latter were significantly more likely to be vulnerable—72%, compared with 47% of employees. People in blue-collar occupations were more likely than those in white-collar occupations to work in noisy environments, but were less likely to be vulnerable to excessive noise—39%, compared with 66%.

**Table 1**  
**Number and percent who ever worked in a noisy environment by sex, age group and education, household population aged 19 to 79, Canada excluding territories, 2012 to 2015**

Characteristics	Both sexes				Men				Women			
	Number '000	%	95% confidence interval from to		Number '000	%	95% confidence interval from to		Number '000	%	95% confidence interval from to	
<b>Total</b>	10,978	42.6	39.4	45.9	7,666	60.1	55.4	64.7	3,312	25.5 <sup>†</sup>	22.0	29.3
<b>Age group (years)</b>												
19 to 39 <sup>†</sup>	4,577	46.6	41.6	51.7	2,936	59.7	54.7	64.4	1,641	33.5	26.7	41.1
40 to 59	4,211	42.5	38.0	47.2	3,042	61.9	53.5	69.6	1,169	23.5*	18.8	28.9
60 to 79	2,190	36.3*	32.8	39.9	1,688	57.9	51.0	64.6	501	16.1*	13.0	19.6
<b>Education (25 or older)</b>												
Postsecondary graduation or more <sup>†</sup>	5,890	39.9	36.2	43.7	4,254	60.3	54.6	65.7	1,635	21.2	17.7	25.2
Less than postsecondary graduation	3,780	47.9	43.1	52.7	2,636	63.1	56.2	69.6	1,144	30.8*	24.6	37.7

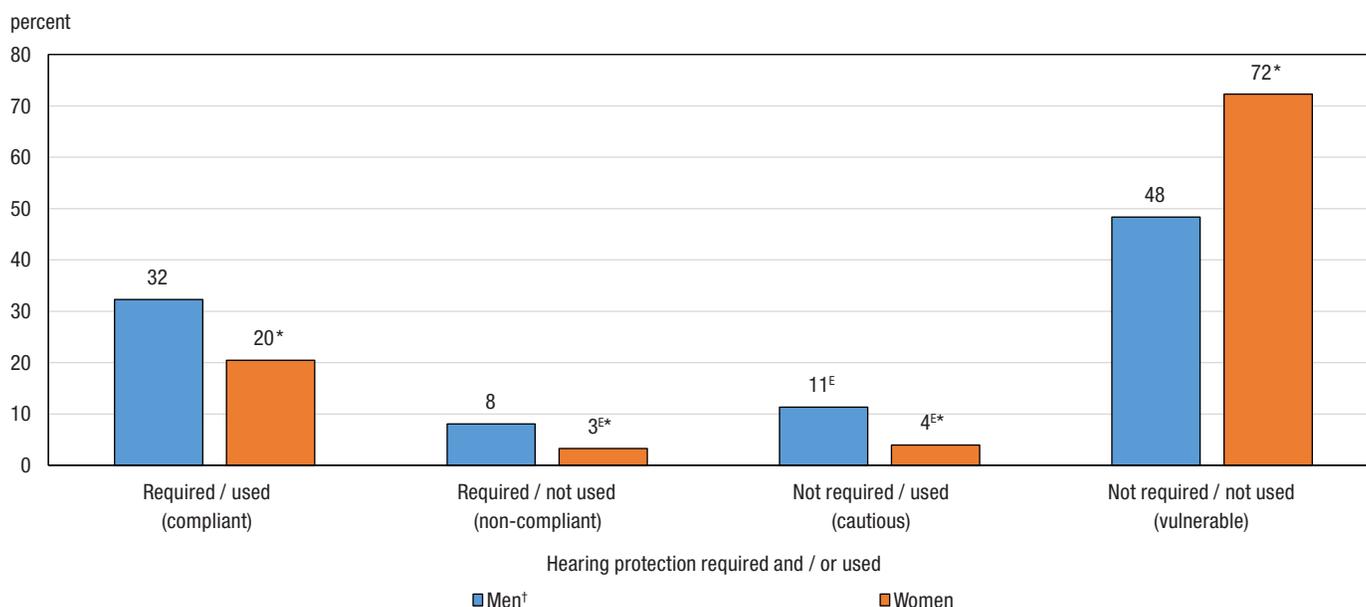
\* significantly different from reference category (p < 0.05)

<sup>†</sup> reference category

<sup>‡</sup> significantly different from men (p < 0.05)

Source: 2012 to 2013 and 2014 to 2015 Canadian Health Measures Survey, combined.

**Figure 1**  
**Percent who reported hearing protection required and/or used when working in noisy environment by sex, household population aged 19 to 79 who had ever worked in a noisy environment, Canada excluding territories, 2012 to 2015**



<sup>E</sup> use with caution

\* significantly different from reference category (p<0.05)

<sup>†</sup> reference category

Source: 2012 to 2013 and 2014 to 2015 Canadian Health Measures Surveys, combined.

## Sources and duration of occupational noise

Among vulnerable workers, men were more likely than women—81% versus 51%—to identify machinery (such as bulldozers and sawmill equipment) and modes of transportation (trains, airplanes, cars, trucks, etc.) as the sources of loud workplace noise (Table 3). Women were more likely than men to experience loud workplace noise caused by amplified music and noise from people—43%, compared with 20%. No difference was evident between men and women for

other sources of noise. Most vulnerable women (61%) had worked in noisy environments for less than five years, compared with 45% of men. Vulnerable men were more likely than women to have worked in noisy environments for 10 years or more—38%, compared with 23%.

## Tinnitus and self-reported hearing difficulties

An estimated 54% of men and 49% of women who were vulnerable to workplace noise had experienced tinnitus,

significantly more than the 39% of men and women who had never worked in noisy environments (Figure 2). Those who were vulnerable were also more likely than those in the comparison group to report hearing difficulties. Logistic regression models taking age (continuous) into account revealed that men who were vulnerable to noise had higher odds than those who had never experienced noisy work environments of having tinnitus (odds ratio [OR] 1.9; 95% CI: 1.4 to 2.5) and hearing difficulties (OR 2.0; 95% CI: 1.1 to 3.8). For vulnerable women, the age-adjusted odds of having hearing difficulties were significant (OR 5.0; 95% CI: 2.7 to 9.5), while the association with tinnitus lost significance once age was taken into account (OR 1.5; 95% CI: 1.0 to 2.3).

**Table 2**

**Number and percent currently working in a noisy environment and vulnerable to noise by sex, employment status and occupational category, household population aged 19 to 79, Canada excluding territories, 2012 to 2015**

Characteristics	Currently working in a noisy environment				Vulnerable to noise <sup>‡</sup>			
	Number '000	%	95% confidence interval		Number '000	%	95% confidence interval	
			from	to			from	to
<b>Total</b>	3,550	13.8	11.8	16.0	1,776	50.1	42.4	57.9
<b>Sex</b>								
Men <sup>†</sup>	2,709	21.2	17.9	25.1	1,148	42.4	33.9	51.3
Women	842	6.5*	4.9	8.5	628	75.3*	61.4	85.3
<b>Employment</b>								
Employee <sup>†</sup>	3,026	18.9	16.2	21.9	1,411	46.7	38.5	55.2
Self-employed / unpaid family business	477 <sup>E</sup>	15.0 <sup>E</sup>	10.2	21.6	344 <sup>E</sup>	72.1*	58.3	82.7
<b>Occupational category</b>								
White-collar <sup>†</sup>	1,457	10.2	8.7	11.9	960	66.2	55.9	75.2
Blue-collar	1,895	52.1*	44.4	59.7	729 <sup>E</sup>	38.5*	26.4	52.2

<sup>E</sup> use with caution

\* significantly different from reference category ( $p < 0.05$ )

<sup>†</sup> reference category

<sup>‡</sup> Among those currently working in a noisy environment.

Source: 2012 to 2013 and 2014 to 2015 Canadian Health Measures Survey, combined.

**Table 3**

**Percent of vulnerable workers exposed to occupational noise by source, duration and sex, household population aged 19 to 79, Canada excluding territories, 2012 to 2015**

Occupational noise	Men <sup>†</sup>			Women		
	%	95% confidence interval		%	95% confidence interval	
		from	to		from	to
<b>Source of noise<sup>‡</sup></b>						
Machines or modes of transportation	81.4	74.7	86.7	50.5*	42.1	58.9
Music or people	20.1	15.5	25.6	42.7*	35.2	50.6
Munitions (guns, cannons) or other	13.0	9.9	16.9	11.7 <sup>E</sup>	7.6	17.4
<b>Years in noisy environment</b>						
Less than 5 years	44.6	37.5	51.9	60.8*	52.9	68.2
5 years to less than 10 years	17.9 <sup>E</sup>	12.3	25.3	16.2	11.9	21.7
10 years or more	37.5	30.9	44.6	22.9*	17.7	29.2

<sup>E</sup> use with caution

\* significantly different from reference category ( $p < 0.05$ )

<sup>†</sup> reference category

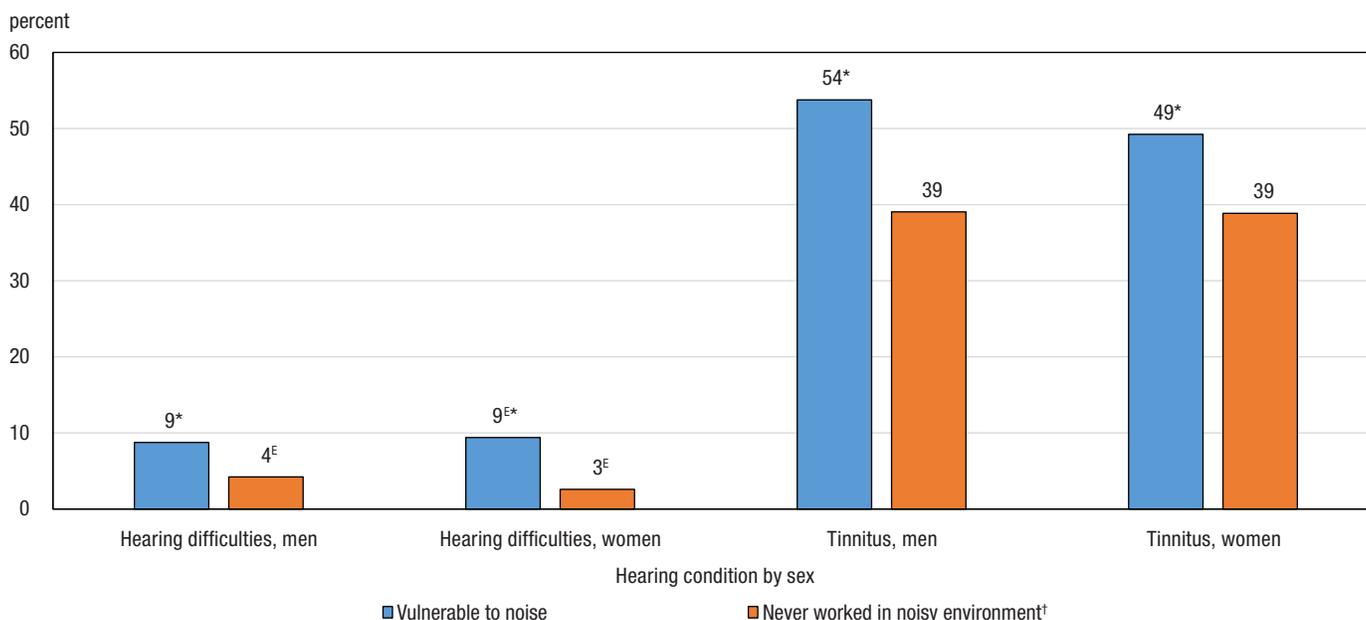
<sup>‡</sup> Respondents selected all sources that applied.

Source: 2012 to 2013 and 2014 to 2015 Canadian Health Measures Survey, combined.

## Discussion

Key findings of this study relate to differences between men and women exposed to noisy workplaces. The likelihood of having worked in a noisy environment was no different for men of different ages, whereas younger women were more likely than women of older ages to have experienced a noisy workplace, despite having fewer potential years of exposure. Women's growing participation in the labour force over the past decades likely contributes to the higher exposure to noisy environments among younger women.<sup>22</sup> This may also reflect the movement of younger women into trades and other traditionally male-dominated sectors, such as construction and manufacturing.<sup>23</sup> Additionally, workplaces may be becoming noisier, particularly with the proliferation of electronic devices.<sup>3</sup> Even if the work itself is relatively quiet, there may be an abundance of second-hand noise—noise that surrounds people, but is not produced by them. For example, the constant noise of pagers in hospitals has been identified as a source of excessive noise for hospital workers<sup>3,5</sup>, as has noise from restaurant-related activities for staff from cooks to servers.<sup>6,24</sup>

**Figure 2**  
**Prevalence of self-reported hearing difficulties and tinnitus by work environment and sex, household population aged 19 to 79, Canada excluding territories, 2012 to 2015**



<sup>E</sup> use with caution

\* significantly different from reference category (p<0.05)

† reference category

Source: 2012 to 2013 and 2014 to 2015 Canadian Health Measures Surveys, combined.

Although fewer women than men worked in noisy environments, women were proportionately more likely to be vulnerable. To some extent, this difference could be attributed to the industrial roots of workplace health and safety legislation, which evolved in response to the hazards associated with the factories and manufacturing activities characteristic of male-dominated occupations.<sup>25</sup> Legislation built around these industries may not be so easily applied to non-industrial, female-dominated settings such as the health, education and service sectors, even though hazardous noise may be present.<sup>3,24,26,27</sup> Also, volunteer positions and occupations in non-profit organizations are not necessarily covered by health and safety legislation in all Canadian jurisdictions, and women are more likely than men to work in these sectors.<sup>25,28</sup>

**Blue-collar workers—more noise, less vulnerable**

Although blue-collar workers were more likely than white-collar workers to work

in noisy environments, the latter were more likely to be vulnerable. The workplaces of many blue-collar workers likely expose employees to noise that exceeds the occupational exposure limits and therefore require the use of hearing protection. Rabinowitz et al.<sup>29</sup> found that, in noisier environments, workers were more likely to require and use hearing protection and less likely to experience hearing loss than workers exposed to lower ambient noise. Many factories and industrial workplaces have hearing conservation programs with trained personnel to test and monitor employees’ hearing acuity and to educate employees on noise-induced hearing loss and preventative measures, including the use of hearing protection. By the nature of their occupations, white-collar workers may have less exposure to noise—in level or duration—and therefore face no requirement to use hearing protection. Ironically, this may place them at greater risk of hazardous noise than workers in blue-collar occupations. That said, many blue-collar workers have the

added workplace risk of exposure to ototoxic substances, such as heavy metals and carbon monoxide, which can have a negative impact on hearing acuity.<sup>4,30</sup>

At one time, unionization may have explained the greater protection and lower vulnerability of blue-collar workers compared with people in white-collar occupations. However, unionization of industrial workers has been in decline over the past few decades, while more female-dominated workplaces such as offices, schools and hospitals have seen an increase in union membership.<sup>31</sup> A more feasible explanation may be that of Tak, Davis and Calvert,<sup>6</sup> who found that in sectors where the proportion of workers exposed to loud noise is high, non-use of hearing protection is low. This was the case for the mining industry, whereas the opposite was true for health care and social services. This suggests that a culture of hearing protection use has developed in industries that typically have noisy work environments. It is also possible that noise exposure is more constant for blue-collar workers and more

intermittent for people in white-collar occupations. When loud noise is of a shorter duration, the need for hearing protection may be less obvious—during shift changes in a hospital setting, for example. Noise that peaks at excessive levels has been recorded in these situations.<sup>32</sup>

### **Self-employed more vulnerable to noise than employees**

Employers have a duty to ensure the safety of their employees under health and safety regulations, including protection from hazardous noise. Many employees benefit from workplace occupational health and safety committees with associated policies and practices. For example, in Ontario, workplaces that regularly employ 20 or more workers are required to have a health and safety committee.<sup>33</sup> Smaller workplaces, which may not have a committee or even a safety representative, have been associated with a greater likelihood of exposure to occupational hazards and inadequate policies and procedures.<sup>34</sup> The self-employed are exempt from health and safety regulations and therefore are not required to use hearing protection. This includes farmers, who have been identified as a group at risk of hearing difficulties and loss from work-related noise exposure.<sup>35,36</sup>

### **Source of occupational noise**

Noise from machinery and transportation—identified as a source of workplace noise by men more often than by women—is an undesirable and unintentional by-product of work. Some female-dominated work environments, such as many classrooms and hospitals, also have unintentional and excessive levels of noise.<sup>5,26</sup> Workers in these sectors are among the least likely to use hearing protection,<sup>6</sup> perhaps because of the necessity for verbal communication in health care and teaching environments, because of a lack of awareness, or because of work cultures that do not include the use of hearing protection.

Women were more likely than men to identify loud music and people as a source of workplace noise. In some

circumstances, this workplace noise is not only intentional, but also desirable. Marketers, retailers, restaurateurs and other service providers have long been aware that they can attract or repel particular types of clientele and influence their behaviour through the volume, tempo and selection of music.<sup>37</sup> Venues that wish to attract a young clientele likely also want to hire younger workers, who may then be exposed to hazardous noise without the benefit of hearing protection. Wait staff, for example, often do not use hearing protection in noisy work environments.<sup>6</sup>

### **Adverse outcomes for workers who were vulnerable to noise**

Associations between occupational noise and hearing difficulties and tinnitus found in this study are consistent with earlier research.<sup>1,4,36,38,39</sup> Tinnitus frequently coexists in individuals with hearing loss, serves as a warning sign of potential hearing damage and can have a negative impact on individuals' quality of life.<sup>2,40-43</sup> The World Health Organization estimates annual global costs of \$105 billion from loss of productivity, premature retirement and unemployment among people with hearing loss.<sup>38</sup> These costs do not take into account those from other adverse effects, such as stress and fatigue. Workplace safety is a concern for people with hearing difficulties and tinnitus, as these conditions can increase the risk of harmful incidents.<sup>4,13,44</sup> Limiting workplace noise becomes even more important when the addition of non-occupational exposure is considered. Noise from electronic devices, commuting and recreational activities all add to daily exposure and cumulatively threaten to exceed the recommended daily limits.<sup>4,44-46</sup>

### **Strengths and limitations**

A major strength of this study is the large sample size achieved by combining two CHMS cycles. This facilitates the analysis of a subgroup of workers who were not required to use hearing protection and generally did not do so.

### ***What is already known on this subject?***

- Excessive workplace noise is a hazard that contributes to hearing loss and tinnitus.
- Legislation that specifies occupational exposure limits to noise differs by federal, provincial and territorial jurisdiction and does not cover all workers, such as the self-employed and those performing unpaid work.

### ***What does this study add?***

- Among the 11 million Canadians who have worked in noisy environments, over 6 million (56%) were “vulnerable” to excessive noise, having reported that they were not required to wear hearing protection and only did so sometimes, rarely or never.
- Although more men than women worked in noisy workplaces, women were more likely to be vulnerable, at 72%, compared with 48% for men.
- Vulnerable workers were more likely than those who have never worked in a noisy environment to report hearing difficulties and tinnitus.

Additionally, the sample size permitted most analyses to be stratified by sex, which revealed key differences between men and women exposed to loud occupational noise. The study is representative of the Canadian population aged 19 to 79 over the study period.

Nevertheless, this study has some limitations. Occupational noise levels were not measured or verified; they were based on the self-reported need to raise one's voice to converse at arm's length. Data on employment status (employee or self-employed) and job category (white-collar or blue-collar) referred to respondents' circumstances at the time of the survey. Analyses with these variables

were limited to those currently working in a noisy environment and were not stratified by sex because of insufficient sample. The use of occupational codes does not take into account industry- and workplace-specific factors that are associated with noise exposure.<sup>2</sup> Requirements on the use of hearing protection could not be verified; workers could be misclassified if they were not aware of the health and safety regulations. Information is available on whether people worked in noisy environments and over what period of time, but it is not possible to establish whether exposures met or exceeded accepted health and safety thresholds.

This study does not account for exposure to recreational or other non-occupational noise exposure, such as commuting,<sup>45,46</sup> or other potential contributing factors, such as exposure to ototoxic substances and head trauma.<sup>4</sup>

## Conclusion

A unique aspect of this study is the focus on a large subgroup of workers who are vulnerable to loud workplace noise because hearing protection was neither required nor routinely used. These men and women were more likely to have hearing difficulties and tinnitus than

those who had never worked in a noisy environment. Future work to assess the effectiveness and gaps of occupational health and safety legislation could help enhance protection against the adverse effects of excessive noise. There may be a need for increased awareness, training and enforcement. That said, workplace-related legislation cannot account for the cumulative noise exposure experienced during leisure, commuting and other non-workplace activities. Protection against excessive noise is not only a workplace issue, but also a broader public health concern. ■

## References

- Masterson EA, Themann CL, Luckhaupt SE, et al. Hearing difficulty and tinnitus among U.S. workers and non-workers in 2007. *American Journal of Industrial Medicine* 2016; 59(4): 290-300.
- Nelson DI, Nelson RY, Concha-Barrientos M, Fingerhut M. The global burden of occupational noise-induced hearing loss. *American Journal of Industrial Medicine* 2005; 48(6):446-58.
- Chepesiuk R. Decibel Hell: The Effects of Living in a Noisy World. *Environmental Health Perspectives*. 2005; 113(1):A34-A41.
- May JJ. Occupational hearing loss. *American Journal of Industrial Medicine* 2000; 37:112-120.
- Ulrich R, Quan X, Zimring C, et al. The role of the physical environment in the hospital of the 21<sup>st</sup> century: A once-in-a-lifetime opportunity. Report to The Center for Health Design for the *Designing the 21<sup>st</sup> Century Hospital Project* 2004. Available at: <https://www.healthdesign.org/chd/knowledge-repository/role-physical-environment-hospital-21st-century-once-lifetime-opportunity-0>.
- Tak S, Davis RR, Calvert GM. Exposure to hazardous workplace noise and use of hearing protection devices among US workers – NHANES, 1999-2004. *American Journal of Industrial Medicine* 2009; 52(5):358-371.
- Ahmed HO, Dennis JH, Ballal SG. The accuracy of self-reported high noise exposure level and hearing loss in a working population in Eastern Saudi Arabia. *International Journal of Hygiene and Environmental Health* 2004; 207(3): 227-234.
- Health and Safety Executive. *Controlling noise at work. Guidance on regulations*. London: HMSO, 2005. Available at: <http://www.hse.gov.uk/pUbn/priced/1108.pdf>.
- Feder K, Michaud D, McNamee J, et al. Prevalence of occupational noise exposure, hearing loss, and hearing protection usage among a representative sample of working Canadians. *Journal of Occupational and Environmental Medicine* 2017; 59(1): 92-113.
- Canadian Centre for Occupational Health and Safety (CCOHS). Noise. *Health and Safety Fact Sheets (OSH Answers)*. Available at: <http://www.ccohs.ca/topics/hazards/physical/noise/>.
- Employment and Social Development Canada (ESDC). *Federally regulated businesses and industries*. Available at: <https://www.canada.ca/en/employment-social-development/programs/employment-equity/regulated-industries.html>.
- Government of Alberta, Employment and Immigration. Noise in the Workplace. *Workplace Health and Safety Bulletin* (HS003). Revised November 2009. Available at: [https://work.alberta.ca/documents/WHS-PUB\\_hs003.pdf](https://work.alberta.ca/documents/WHS-PUB_hs003.pdf).
- Canadian Occupational Safety. WSIB asking workers 'How old are your ears?' *Canadian Occupational Safety Magazine*, 2017. Available at: <http://www.cos-mag.com/personal-process-safety/32351-wsib-asking-workers-how-old-are-your-ears/>.
- Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 3*. September 2015. Available at: [http://www23.statcan.gc.ca/imdb-bmdi/document/5071\\_D4\\_T9\\_V2-eng.htm](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm)
- Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 4*. October 2017. Available at: [http://www23.statcan.gc.ca/imdb-bmdi/document/5071\\_D4\\_T9\\_V2-eng.htm](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm)
- Statistics Canada. *Instructions for Combining Multiple Cycles of Canadian Health Measures Survey (CHMS) Data*. Ottawa: Statistics Canada, 2017. Available at: [http://www23.statcan.gc.ca/imdb-bmdi/document/5071\\_D4\\_T9\\_V2-eng.htm](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm)
- Day B, Langlois R, Tremblay MS, Knoppers B-M. Canadian Health Measures Survey: Ethical, legal and social issues. *Health Reports* 2007; 18(Suppl): 37-51.
- Feeny D, Furlong W, Torrance GW, et al. Multiattribute and single-attribute utility functions for the Health Utilities Index Mark 3 System. *Medical Care* 2002; 40(2): 113-28.
- Feng Y, Bernier J, McIntosh C, Orpana H. Validation of disability categories derived from Health Utilities Index Mark 3 scores. *Health Reports* 2009; 20(2): 43-50.
- Statistics Canada. *National Occupational Classification (NOC), 2011* (Catalogue 12-853-x) Ottawa: Statistics Canada, 2012.
- Rust KF, Rao JNK. Variance estimation for complex surveys using replication techniques. *Statistical Methods in Medical Research* 1996; 5: 281-310.
- Statistics Canada. *CANSIM Table 282-0002. Labour Force Survey estimates (LFS), by sex and detailed age group, annual*. CANSIM (database). Available at: <http://www5.statcan.gc.ca/cansim/a47>. Accessed: November 21, 2017.
- Construction Sector Council (CSC). The state of women in construction in Canada. February 2010. Available at: [www.csc-ca.org](http://www.csc-ca.org).

24. Green DR, Anthony TR. Occupational Noise Exposure of Employees at Locally-Owned Restaurants in a College Town. *Journal of occupational and environmental hygiene* 2015; 12(7):489-499.
25. Kosny A. Invisible workplaces and forgotten workers? A case study of occupational safety and health and workers' compensation coverage in Canadian non-profit organizations. *Policy and Practice in Health and Safety* 2009; 7(2): 93-113.
26. Martins RHG, Tavares ELM, Neto ACL, Fioravanti MP. Occupational hearing loss in teachers: a probable diagnosis. *Revista Brasileira de Otorrinolaringologia* 2007; 73(2): 239-44.
27. Statistics Canada. *CANSIM Table 282-0008. Labour force survey estimates (LFS), by North American Industry Classification System (NAICS), sex and age group*. CANSIM (database). Available at: <http://www5.statcan.gc.ca/cansim/a47>. Accessed: November 17, 2017.
28. Sinha, M. *Volunteering in Canada, 2004 to 2013* (Catalogue 89-652-X) Ottawa: Statistics Canada, 2015.
29. Rabinowitz PM, Galusha D, Dixon-Ernst C, et al. Do ambient noise exposure levels predict hearing loss in a modern industrial cohort? *Occupational and Environmental Medicine* 2007; 64(1): 53-59.
30. Fechter LD, Pouyatos B. Ototoxicity. *Environmental Health Perspectives* 2005; 113(7):A443-A444.
31. Galameau D, Sohn T. Long-term trends in unionization. *Insights on Canadian Society* (Catalogue 89-652-X) Ottawa: Statistics Canada, 2013.
32. Cmiel CA, Karr DM, Glasser DM, et al. Noise control: A nursing team's approach to sleep promotion. *American Journal of Nursing* 2004; 104(2): 40-48.
33. Ontario Ministry of Labour. *Occupational Health and Safety Act (OHS Act)*. Available at: <https://www.ontario.ca/laws/statute/90o01>.
34. Lay AM, Saunders R, Lifshen M, et al. Individual, Occupational, and workplace correlates of occupational health and safety vulnerability in a sample of Canadian workers. *American Journal of Industrial Medicine* 2016; 59(2): 119-128.
35. Plakke BL, Dare E. Occupational hearing loss in farmers. *Public Health Reports* 1992; 107(2):188-192.
36. Tak S, Calvert GM. Hearing Difficulty Attributable to Employment by Industry and Occupation: An Analysis of the National Health Interview Survey—United States, 1997 to 2003. *Journal of Occupational and Environmental Medicine* 2008; 50(1):46-56.
37. Oakes S. The influence of the musicscape within service environments. *Journal of Services Marketing* 2000; 14(7): 539-556.
38. World Health Organization. *Global costs of unaddressed hearing loss and cost-effectiveness of interventions: A WHO report, 2017*. Geneva: World Health Organization; 2017. Available at: <http://apps.who.int/iris/bitstream/10665/254659/1/9789241512046-eng.pdf>. Accessed: November 22, 2017.
39. Le TN, Straatman LV, Lea J, Westerberg B. Current insights in noise-induced hearing loss: a literature review of the underlying mechanism, pathophysiology, asymmetry, and management options. *Journal of Otolaryngology – Head and Neck Surgery* 2017; 46(1):41.
40. Hasson D, Theorell T, Westerlund H, Canlon B. Prevalence and characteristics of hearing problems in a working and non-working Swedish population. *Journal of Epidemiology and Community Health* 2010; 64:453–460.
41. Baguley D, McFerran D, Hall D. Tinnitus. *The Lancet* 2013; 382(9904): 1600-07.
42. Kim H-J, Lee H-J, An S-Y, et al. Analysis of the prevalence and associated risk factors of tinnitus in adults. *PLoS ONE* 2015; 10(5): e0127578. Doi: 10.1371/journal.pone.0127578.
43. Bhatt IS. Prevalence of and risk factors for tinnitus and tinnitus-related handicap in a collage-aged population. *Ear and Hearing* 2017. Available at: [https://www.researchgate.net/publication/320604351\\_Prevalence\\_of\\_and\\_Risk\\_Factors\\_for\\_Tinnitus\\_and\\_Tinnitus-Related\\_Handicap\\_in\\_a\\_College-Aged\\_Population](https://www.researchgate.net/publication/320604351_Prevalence_of_and_Risk_Factors_for_Tinnitus_and_Tinnitus-Related_Handicap_in_a_College-Aged_Population).
44. Kirchner DB, Evenson E, Dobie RA, et al. (ACOEM Task Force on Occupational Hearing Loss). Occupational Noise-induced hearing loss: ACOEM Guidance Statement. *Journal of Occupational and Environmental Medicine* 2012; 54(1): 106-108.
45. Yao CMKL, Ma AK, Cushing SL, Lin VYW. Noise exposure while commuting in Toronto – a study of personal and public transportation in Toronto. *Journal of Otolaryngology – Head and Neck Surgery* 2017; 46:62.
46. Gershon RRM, Neitzel R, Barrera MA, Akram M. Pilot survey of subway and bus stop noise levels. *Journal of Urban Health: Bulletin of the New York Academy of Medicine* 2006; 83(5): 802-812.
47. IAC Acoustics. Comparative Examples of Noise Levels. Available at: <http://www.industrialnoisecontrol.com/comparative-noise-examples.htm>.

## Appendix A

### Occupational exposure limits

Occupational exposure limits specify the maximum duration and loudness of noise to which workers can be exposed over the course of their work day without the use of hearing protection.

A criterion level indicates a maximum exposure equivalent to  $x$  dB (decibels) of continuous noise for 8 hours.

The exchange rate specifies the relationship between sound levels and duration of exposure.

For example, a criterion level of 85 dB(A) and an exchange rate of 3 dB(A) indicate that a worker can be exposed on a daily basis to 85 dB(A) for 8 hours or 97 dB(A) for 30 minutes (Table A). For context: normal conversation is around 55 dB with increasingly loud noise generated from vacuum cleaners (70 dB), diesel trucks (85 dB, 20 metres away at 50 km/hour) and power mowers (96 dB at 1 metre away).<sup>10,47</sup>

In most Canadian provinces, the criterion level is 85 dB(A) with a 3 dB(A) exchange rate. This is more stringent than federally regulated workplaces, which have a criterion level of 87 dB(A) and a 3 dB(A) exchange rate. Quebec has the least stringent standards, with a criterion level of 90 dB(A) and a 5 dB(A) exchange rate.

**Table A**  
**Noise exposure limits at different criterion levels and exchange rates**

Criterion level: 85 dB(A) Exchange rate: 3 dB(A)	Maximum permitted daily duration (hours)	Criterion level: 90 dB(A) Exchange rate: 5 dB(A)
Allowable level, db(A)		Allowable level, db(A)
85	8.00	90
88	4.00	95
91	2.00	100
94	1.00	105
97	0.50	110
100	0.25	115

Source: Noise – Occupational Exposure Limits in Canada, adapted from tables 1A and 1B ([http://www.ccohs.ca/oshanswers/phys\\_agents/exposure\\_can.html](http://www.ccohs.ca/oshanswers/phys_agents/exposure_can.html)).<sup>10</sup>