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Prevalence of Hazardous Occupational Noise Exposure, Hearing Loss, and Hearing Protection Usage Among a Representative Sample of Working Canadians

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Objective: The aim of this study was to estimate the prevalence of hearing loss (HL), self-reported occupational noise exposure, and hearing protection usage among Canadians. **Methods:** In-person household interviews were conducted with 3666 participants, aged 16 to 79 years (1811 males) with 94% completing audiometry and distortion-product otoacoustic emission (DPOAE) evaluations. Occupational noise exposure was defined as hazardous when communicating with coworkers at an arm's length distance required speaking in a raised voice. **Results:** An estimated 42% of respondents reported hazardous occupational noise exposure; 10 years or more was associated with HL regardless of age, sex or education. Absent DPOAEs, tinnitus, and the Wilson audiometric notch were significantly more prevalent in hazardous workplace noise-exposed workers than in nonexposed. When mandatory, 80% reported wearing hearing protection. **Conclusions:** These findings are consistent with other industrialized countries, underscoring the need for ongoing awareness of noise-induced occupational HL.

igh levels of occupational noise exposure pose a significant risk to health, safety, and hearing acuity.¹⁻³ It has been estimated that worldwide, 16% to 24% of hearing impairment is work-related with quantification of the health impact estimated to be over 4 million disability-adjusted life-years (DALYs).⁴ The DALYs is a measure of the years lost from the ideal lifespan due to morbidity and premature death, and therefore represents the gap between the current and ideal situation where everyone achieves standard life expectancy in perfect health.⁴

A national British survey found that occupational noise exposure (so high that a speaker needed to shout to be heard at arm's length) was responsible for severe hearing difficulties in an estimated 153,000 men and 26,000 women, aged 35 to 64 years with persistent tinnitus far more prevalent (266,000 men, 84,000 women) than hearing difficulties.⁵ In the US, noise-induced hearing loss (NIHL) accounted for approximately 11% of all occupational illnesses.⁶ The 1999 to 2004 National Health and Nutrition Examination Survey (NHANES) found that 17% of US workers reported hazardous

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noise exposure in their workplace.⁷ Several surveys have defined self-reported "hazardous" occupational noise exposure as noise "so loud it required one to speak in a raised voice to be heard" and "at arm's length" as this vocal effort suggests noise exposures exceeding 85 to 90 dBA.^{5,7,8}

The highest occupational noise exposures and hearing loss 7.9^{-11} (HL) risks were found among mining and construction workers.⁷ According to Tak et al,⁷ 76% of U.S. miners reported hazardous noise exposure, while Masterson et al¹⁰ reported a HL prevalence estimate of nearly 30% among U.S. miners; lumber and manufacturing were ranked second highest for noise exposure $(55\% \text{ for each})^7$ with corresponding high HL prevalence rates for these industries as documented in a retrospective study that analyzed 1,122,722 worker audiograms.10 However, many industry types not previously associated with excessive noise such as roofing, dry cleaning, telemarketing, and education have noise exposure levels above 85 dBA over 8 hours.^{12,13} Recently, health care and social assistance workers were found to have a high risk of HL, ranking third highest for HL incidence (7%) during 2006 to 2010 in a retrospective U.S. study of audiograms.¹¹ Despite hearing conservation programs, some studies have shown that proper and diligent usage of hearing protection (HP) was rare¹⁴⁻¹⁶ and a Cochrane meta-analyses of 24 studies found little evidence for the effectiveness of HL prevention programs.¹⁷ Although there are a few industry-specific Canadian studies, HP usage in a representative working population encompassing a variety of workplaces is unknown. One study of Albertan construction workers (n=299) found that approximately 50% (electricians, plumbers, pipefitters) "always" used HP compared with 70.5% of boilermakers, a higher noise occupation.¹⁸ These findings are consistent with a U.S. study wherein HP usage among construction workers (n = 400) was 50% of the time or less with consistent usage (95% or more of the time) even lower (3 to 25%).¹⁹ Among Canadian lumber mill workers exposed to between 85 and 95 dBA of occupational noise, over 8 to 12 hours, high self-reported HP usage was found (73 to 84% of the time), but the authors concluded this was unlikely to provide complete protection against NIHL.²⁰

The negative consequences related to hazardous occupational noise exposure range from NIHL, where an audiometric "threshold dip" or "hearing notch" between 4 and 6 kHz is typically noted, to depression, social isolation, and increased risk of accidents in the workplace.^{2,21–24} Continued noise exposure can result in HL spreading to adjacent frequencies or the notch becoming more pronounced. Most HL is insidious in onset and therefore many workers may be unaware that they are losing their hearing.²⁵ Audiometry is traditionally used to monitor hearing in industrial workplaces; however, distortion product otoacoustic emissions (DPOAE) testing has received attention as a promising hearing surveillance tool and a potential adjunct to the audiogram in the diagnosis and monitoring of occupational NIHL.^{26–29} Several occupational noise studies have found that DPOAEs can detect subtle changes in cochlear function, in particular early outer hair cell damage, allowing NIHL to be identified at an early stage before audiometric HL.^{26,30–33}

In Canada, there are no population-based studies examining workplace noise exposures across industries and HL prevalence

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and/or tinnitus among workers. Tinnitus frequently coexists in individuals with NIHL^{34,35}; however, it may also serve as a warning sign that hearing is at risk.³⁶ A Swedish population-based study found that 31% of the working population and 36% of the non-working population, aged 16 to 64 years, had HL and/or tinnitus using self-report.³⁷ In those aged 40 years and younger, every fifth individual reported either tinnitus or HL, with severe hearing problems already present in those who reported exposure to work-related noise.³⁷ In Canada, an informal estimate based on provincial insurance claim data found that 9000 Canadians had hearing impairment or tinnitus attributed to occupational noise exposure.³⁸ In Quebec³⁹ and British Columbia,⁴⁰ up to 4300 and 150,000 workers, respectively, reported daily exposure to hazardous noise levels of 100 dB or greater; however, HL and/or tinnitus prevalence rates are unknown.

The present study, based on 2012 to 2013 Cycle 3 Canadian Health Measures Survey (CHMS) data, was designed to address knowledge gaps regarding occupational noise exposure and HL in Canadian workers. The CHMS Cycle 3 Hearing Module, modeled after NHANES, included direct audiologic measures and workplace noise questions for the first time allowing national estimates based on a representative sampling of Canadians to be presented. The objectives of this study were to provide prevalence estimates of a) self-reported exposure to hazardous workplace noise, b) HP usage, c) audiometric HL, d) absent DPOAEs, and e) self-reported tinnitus, in a representative Canadian working population.

METHODS

Participants

Recruitment of Cycle 3 CHMS participants took place between January 2012 and December 2013. In this ongoing cross-sectional survey, one or two individuals per household were randomly selected from households across five regions of Canada: Atlantic, Quebec, Ontario, Prairies, and British Columbia. The CHMS excludes full-time members of the Canadian Forces, residents of the three territories, First Nations Reserves and other Aboriginal settlements, certain remote regions, and institutional residents. Despite these exclusions, CHMS data are considered to be representative of the Canadian population. Each respondent has a weight that accounts for the age and sex distribution of the population, nonresponse, and the survey sampling strategy. These weights allow frequency calculations that are representative of the population and not just the sample itself.

Individuals were invited to complete a household questionnaire and to take part in a physical measures component including a hearing evaluation. Participants who agreed to take part in the physical measures component were allotted a \$100 honorarium. The response rate for participants, aged 16 to 79 years, was 88.4% for the household questionnaire and 78.8% for the hearing evaluation component. Proxy interviews were accepted in cases of physical and/or intellectual impairment. See CHMS Data User Guide Cycle 3^{41} for additional details. Figure 1 identifies exclusions and the derivation of the final unweighted study sample for audiometry.

Household in-person interviews/questionnaires including occupation-related questions were administered to participants, aged 16 to 79 years (n = 3667). The analysis for hearing, based on individuals with valid bilateral audiometric results, comprised 3431 participants, representing 25.3 million Canadians (12.6 million males, 12.7 million females).

Data Collection

Household Questionnaire

Self-reported data were collected in-person, in English or French, using a computer-assisted personal interview to gather demographic, socioeconomic, health, and lifestyle information, including type of occupation and noise exposure history.⁴¹ To estimate past and current exposure to hazardous occupational noise, participants were asked: "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." Those who responded "yes" were asked if they currently worked in a noisy environment. Individuals who indicated either "no" or that they had never worked in a noisy environment were grouped together. Participants who replied affirmatively to having ever worked in a noisy environment at any time in their life were asked about 1) duration (less than 12 months, 1 to less than 5 years, 5 to less than 10 years, 10 years or more), 2) whether they were required to wear HP at work (yes, no), and 3) how often they used HP at work when in a noisy area (always, often, sometimes, rarely, never). The latter two variables were combined to group participants into four distinct groups based on whether they were required to and used HP (required and used always or often, required but did not use, not required but used, not required and not used).

Participants were also asked to indicate the source of loud noise at work. Due to small sample sizes, the following noise exposure categories were formed: Machinery (ie, bulldozers, backhoes, sawmill equipment) that included transportation noise sources (ie, trains, airplanes, cars, trucks); loud "people noise" was combined with concert music or other amplified music sources; noise from munitions (ie, guns, cannons) was combined with the "other" category, that is, unspecified loud noise sources.

Participants were also asked whether they had ever experienced tinnitus, described as "the presence of hissing, buzzing, ringing, rushing or roaring sounds in your ears when there is no other sound around you." Those who replied affirmatively were asked when they last experienced tinnitus (within the last 7 days, 8 days to less than a month ago, 1 month to less than 6 months ago, 6 months to less than 1 year ago, 1 year ago or more). Individuals who experienced tinnitus in the past month were asked: "When it is quiet, do you experience these sounds in your ears?" (always, often, sometimes, rarely, never) and those who responded "always" or "often" were asked how long they had had tinnitus. Responses were dichotomized into "less than 5 years" or "5 years or longer." Participants who had experienced tinnitus within the past year were asked: "Did this bother you? For example, did it affect your sleep, concentration or mood?" Participants who responded affirmatively to this question were categorized as having "bothersome" tinnitus.

Physical Measures

Participants were evaluated in a mobile examination clinic (MEC). The possibility that a temporary threshold shift (ie, a temporary increase in hearing threshold following loud noise exposure) may have influenced measurements was considered by asking participants to recall their exposure to loud noise/music in the 24 hours before testing. While loud noise/music exposure was reported by 7.8% of the study sample, no significant differences were observed in four frequency pure tone average HL between the exposed and nonexposed group.

All testing was carried out by health measures specialists with training/supervision provided by a certified audiologist who conducted periodic on-site visits to ensure quality control. Hearing tests, with the exception of otoscopy and tympanometry, were carried out while participants were seated in a portable audiometric booth (Eckel, AB-4230; Eckel Industries of Canada Ltd, Morrisburg, Ontario, Canada), with the door closed. Individuals who refused or had apparent cognitive deficits that could potentially interfere with testing were excluded from DPOAE testing and audiometric evaluation.

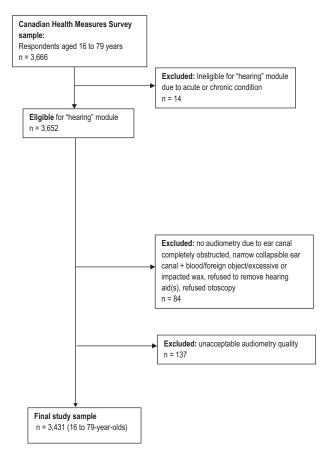


FIGURE 1. Final study sample (unweighted) for audiometry. The final study sample includes 3,431 16- to 79-year-olds with valid audiometric results in both ears.

Ambient Sound Level Measurements

A Casella CEL-633 sound level meter monitored ambient sound pressure levels inside the sound booth. Testing was paused if sound pressure levels exceeded 55 dB for more than 2 seconds.

Hearing Evaluation Protocol

The testing consisted of otoscopy, tympanometry, DPOAEs, and audiometric evaluation (0.5 to 8 kHz). Before testing, a visual inspection of the pinna and ear canal was performed to identify possible signs of infection, obstruction, and other conditions/circumstances that might interfere with testing.

Otoscopy was performed using the Welch Allyn otoscope (Model 25020; Welch Allyn Inc, Skaneateles Falls, NY) to identify gross abnormalities, including the presence of blood, pus, excessive or impacted ear wax, a growth, tumor or foreign object in the ear canal, a collapsed ear canal, or other occlusion. Criteria for otoscopic exclusion included obstructed ear canal, acute pain or infection, open wounds or bandages covering the ear(s), refusal to remove hearing aid, or chronic abnormalities, including congenital atresia or microtia of the ear canal (one or both ears). No further testing was performed if the individual was excluded by otoscopy (see Fig. 1).

Tympanometry was conducted using the GSI 39 Auto Tympanometer (Grason-Stadler, Eden Prairie, MN). A normal tympanogram was defined as compliance between 0.2 and 1.8 cm^3 with middle ear pressure between -150 and +50 daPa in an equivalent ear canal volume of between 0.75 and 2.0 cm^3 . Tympanometry was

not administered when blood, pus or impacted wax, eardrum perforation, growth in the ear canal, and/or significant skin abnormality or discharge was observed during otoscopy.

Audiometric evaluation was carried out using a computercontrolled CCA-100 mini audiometer (Benson Medical Instruments, Minneapolis, MN) with insert earphones (EAR 5A case; 3M Auditory Systems, Indianapolis, IN). In cases where a participant was excluded from tympanometry for the reasons noted above, audiometry was performed using supra-aural headphones (TDH-39; Interacoustics USA, Eden Prairie, MN) instead of insert earphones. The audiometer was calibrated daily using the Bio-Acoustic simulator BAS-200 (Benson Medical Instruments, Minneapolis, MN), which served as a baseline. Hearing thresholds were assessed at 0.5, 1, 2, 3, 4, 6, and 8 kHz. Testing followed procedures recommended for standard audiometry using automatic mode, except when the respondent could not physically press the response button, had very slow response times, or when difficulties were noted with automatic mode. Manual mode was carried out using the modified Hughson-Westlake ascending method.⁴² To avoid interference with audiometric evaluation, subjects were asked to refrain from chewing.

DPOAE testing was conducted using the OtoRead Standard and Clinical-OAE instrument and OtoAccess software program. The OtoRead instrument indicates "Pass" or "Refer" following DPOAE test administration for each ear. "Refer" is equivalent to an absent DPOAE. The custom protocol set for the instrument required that the individual "Pass" three out of four test frequencies (2, 3, 4, and 5 kHz) using a signal-to-noise ratio of 6 dB. DPOAE was not administered when otoscopic examination could not be conducted or in cases of bilateral occlusions, presence of blood, a foreign object/substance in both ears, impacted wax in both ears, the participant was unwilling or unable to remove his/her hearing aids from both ears.

Definitions

HL was defined as an impairment of more than 20 dB HL for 16 to 18 year olds and at least 26 dB HL for 19 year olds or older, in one or more of the following pure tone averages: four frequency (0.5, 1, 2, and 4 kHz) pure tone average (FFPTA), high frequency (3, 4, 6, and 8 kHz) pure tone average (HFPTA), low frequency (0.5, 1, and 2 kHz) pure tone average (LFPTA). An adult HL threshold (\geq 26 dB) was applied to participants over 18 years olds in accordance with the American Academy of Audiologists (AAA) and the American Speech Language Hearing Association (ASHA) pediatric/childhood audiologic screening guidelines.^{43,44} Individuals with either bilateral or unilateral loss were classified as having hearing impairment. For bilateral HL, the average in the worse ear was used to categorize the degree of hearing impairment.

An audiometric "notch" was defined using two different definitions:

- a) Thresholds at 2 and 8 kHz are both minimally at hearing levels 10 dB lower or better than the threshold at 4 kHz, unilaterally or bilaterally.⁴⁵
- b) Thresholds at 0.5 and 1 kHz are less than or equal to 15 dB, and the maximal threshold at 3, 4, or 6 kHz is greater than or equal to 15 dB higher or worse than the highest threshold for 0.5 and 1 kHz, and the threshold at 8 kHz is greater than or equal to 10 dB lower or better than the maximal threshold for 3, 4, or 6 kHz, unilaterally or bilaterally.⁴⁶

"White collar" and "blue collar" occupations were categorized on the basis of a variant of the National Occupational Classification (NOC) developed jointly by Statistics Canada and Employment and Social Development Canada and utilized widely as a nationally accepted reference on occupations in Canada.⁴⁷ Occupations in categories A to F (management, professional, technical and paraprofessional, administration and administrative support, sales, personal and customer information services) were classified as "white collar," while jobs in categories G to J (industrial, construction and equipment operation trades, workers and laborers in transport and construction, natural resources, agriculture and related production occupations, occupations in manufacturing and utilities) were classified as "blue collar."

Statistical Analysis

Weighted frequencies and cross-tabulations were used to explore work-related characteristics (noisy environment, HP) by demographic characteristics. Bivariate analyses included HL, the presence of an audiometric notch pattern (definition a or b) and absent DPOAE by selected demographic and work-related characteristics. All estimates were weighted at the person level to represent the population. Logistic regression was conducted to determine if longer duration in a noisy work environment was associated with HL, notch pattern, or absent DPOAE while controlling for demographic factors (sex, age, and household education). Analyses were conducted using SAS (version 9.3; SAS Institute Inc, Cary, NC) and SAS-Callable SUDAAN (version 11.0.0; SAS Institute Inc, Cary, NC) software. To account for the complex survey design, P values, 95% confidence intervals, and coefficients of variation (CVs) were estimated using the bootstrap technique with 11 degrees of freedom.^{48,49} Statistical significance was specified as a P value of less than 0.05. The CV is a measure of data quality and provides an indication of the scope of the sampling error associated with the estimate. The CV is obtained by dividing the standard error of the estimate by the estimate itself, and is expressed as a percentage of the estimate: SE/Estimate x 100 = CV. CV estimates between 16.6% and 33.3% were flagged "E" indicating a marginally acceptable estimate due to the high sampling variability associated with it, and advising users to interpret with caution. CV estimates that exceeded 33.3% were designated "F" indicating that these data could not be released as it is of questionable validity.

RESULTS

Hazardous Occupational Noise Exposure

Among participants, aged 16 to 79 years, an estimated 42% [95% confidence interval (95% CI), 36.5 to 47.8], representing 11.2 million Canadians, reported current or past hazardous occupational noise exposure, defined as "so loud that one had to speak in a raised voice to communicate with co-workers standing within an arm's length" with significantly more men (P < 0.01; 61%; 95% CI, 53.9 to 67.3) than women (24%; 95% CI, 17.4 to 30.9) reporting this exposure (Table 1). Approximately 14% (95% CI, 11.0 to 17.0) of participants representing 3.7 million Canadians reported that they currently were exposed to hazardous occupational noise, with significantly more men than women exposed (P < 0.01; 22% of men; 95% CI, 16.8 to 27.5; 6%^E of women; 95% CI, 4.0 to 8.6). Participants without a post-secondary education were significantly more likely to have worked in a noisy environment (P < 0.05; 48% versus 41% for post-secondary graduates, respectively).

Among participants who had ever worked in a noisy work environment, significantly more men (53%) than women (34%) had done so for at least 5 years or more (Table 1). Overall, an estimated 3.5 million Canadians have spent at least 10 years in noisy workplaces. Among those who worked in a noisy environment for less than 10 years, there were no significant differences between men and women (Table 2). However, among those who had ever worked in a noisy environment, men were significantly more likely than women to have done so for 10 years or more (P < 0.05; 36% compared with 20%^E, respectively). Among individuals who had ever worked in a noisy workplace, 36% indicated that HP was required in their jobs and of those, 79.7% reported they "always" or "often" complied (Table 3). Overall, among those who had ever worked in a noisy environment, regardless of whether they were required to wear HP in their jobs, 38.2% indicated they "always" or "often" used HP (Table 3).

"Blue collar" compared with "white collar" workers were significantly more likely to have 1) HL in one or more categories (FFPTA, HFPTA, LFPTA) (P < 0.05), 2) an absent DPOAE (P < 0.01), 3) a notch pattern consistent with both definitions (P < 0.01) (Tables 4 to 9).

Sources of Noise

The majority of participants (81%) who worked in a noisy workplace reported the noise source as either from machinery (ie, bulldozers, backhoes, or sawmill equipment) or transportation (ie, trains, planes, or road vehicles), with men significantly more likely than women to report these workplace noise sources (P < 0.01; 89% vs 62%, respectively) (Table 10). Approximately 18% overall reported loud "people or music noise" in the workplace, with women significantly more likely than men to report this workplace noise source (P < 0.01; 31% vs 13%, respectively). Furthermore, individuals aged 16 to 29 years were two to three times more likely than those in older age groups to report loud "people/music noise" as their main source of occupational noise.

Tinnitus

An estimated 43% of participants, representing 11.5 million Canadians, have experienced tinnitus at some point in their lives with men significantly more likely to have had tinnitus compared to women; P < 0.01; 48% versus 39%, respectively (men: 95% CI, 41.8 to 53.595; women: 95% CI, 35.0 to 42.8) (Table 11). Among those aged 16 to 29 years, over half (53%) reported tinnitus (at some point in their lives) compared with approximately 40% of individuals in the older age groups. While younger participants were more likely to have experienced it, older participants were more likely to have experienced it "always," "often," or "sometimes" when it was quiet (84% vs 69% among 16 to 29 year olds). Overall, 35.3% of participants, aged 15 to 75 years, reported tinnitus within the past year (data not shown).

Of those who "ever worked in a noisy environment," 51% had experienced tinnitus at some point in their lives compared with 41% who had "never experienced a noisy workplace." Participants who currently worked in a noisy environment were more likely to report tinnitus (55%) than those in quieter environments (41%). However, for "blue collar" and "white collar" workers who reported having experienced tinnitus at some point in their lives, similar estimates of tinnitus were found (42.4% and 43.2%, respectively). Among participants whose tinnitus occurred within the past month, 19% (95% CI, 14.0 to 24.0) reported "bothersome" tinnitus, defined as affecting their sleep, concentration, or mood.

Hearing Loss, Notch Pattern, and Absent DPOAE

Among working Canadians, approximately 35% (95% CI, 33.2 to 37.6) of participants, aged 16 to 79 years, had measured HL on the basis of one or more PTA, including FFPTA, HFPTA, or LFPTA (Tables 4 to 9). Approximately 18% (95% CI, 16.1 to 20.7) had FFPTA HL, 34% (95% CI, 31.5 to 35.9) had HFPTA HL, while 15% (95% CI, 13.1 to 16.7) had LFPTA HL. Among participants who reported ever having worked in a noisy environment, 38% (95% CI, 33.9 to 42.2) had HL in one or more PTA compared with 33.5% (95% CI, 29.7 to 37.6) who never worked in such an environment. No significant differences in HL were found between those who currently worked in a noisy environment and those who did not. However, individuals who reported ever working in a noisy workplace were significantly more likely (P < 0.05 for FFPTA; P < 0.01 for LFPTA) to have HL than those who reported never working in such an environment, where a higher prevalence of both

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| \mathbf{Women}^{\dagger} | 102 | 791 | Щ | 5.9 | 1.0 | 4.0 | 8.6 | Щ | | | 3,160 | 23.5 | .5 3.1 | 17.4 | 4 30.9 | 6 | 195 | | 88 | 33.8 | | | | 5 | |
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| $16-29 \text{ years}^{\dagger}$ | 113 | 113 1,178 | | 18.3 | | 14.2 | 23.4 | | | 295 | 2,619 | 40.7 | .7 3.7 | 7 33.0 | | 0 | 38 | | | 17.0 | 0 4.2 | | 6 28.2 | 2 E | |
| 30–49 years | 216 | 1,590 | | 16.8 | 3.7 | 10.2 | 26.5 | Щ | | | 4,333 | 45. | | | 2 56.8 | ×. | 27 | 0 1,848 | 48 E | | | 5 32.9 | | 1 | · |
| 50-79 years | 125 | 898 | Щ | 8.3 | 1.4 | 5.7 | 11.9 | Щ | | | 4,288 | 39. | | | | 1 | 4 | | 80 | 70. | | | | 6 | ÷ |
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| Post secondary or more ^{\dagger} | 329 | 329 2,476 | | 12.5 | | 9.2 | 16.6 | | 1, | | 8,090 | 40.7 | 7 2.7 | 7 34.8 | | œ. | 503 | 3 3,444 | 4 | 42.6 | 6 2.8 | | | 8 | |
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| \$100,000 or more | 125 | 1,181 | | 14.2 | | 9.6 | 20.4 | Ш | | | 3,474 | 41. | | | | 9 | 15 | 1 1,311 | Ξ | 37. | | | | 3 | |
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| Source: 2012/2013 Canadian Health Measures Survey (Cycle 3). | n Healt | h Meas | ures Sı | urvey (C | Sycle 3). | | | | | | | | | | | | | | | | | | | | ĺ |

| | | | | Botl | Both Sexes ^{\dagger} | | | | | | | V | \mathbf{Men}^{\dagger} | | | | | | | M | Women [†] | | | |
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| | u | N | CV | N CV % SE | | % From To | To | CV | u | N | CV | % SI | SE % H | From To CV | $\mathbf{T_0}$ | | u | N | CV | % SE % From To | 3 % F | rom | | CV * |
| Time worked in a noisy environment | ıt | 000, | | | | | | | | 000, | | | | | | | | 000 | | | | | | |
| Less than 1 year | 368 | 368 2,680 | 0 | 23.8 | 3.4 | 17.1 | 32.2 | | | 1,732 | 2 | | 3.8 | | 31.1 | Е 1 | 11 | 948 | 3 | | 4.3 2 | | 40.2 | |
| 1 year to less than 5 years | 395 | 3,236 | 5 | 28.8 | 3.4 | 22.0 | 36.7 | | 259 2 | ,092 | 3 | 25.9 | | 19.6 | 33.4 | 1 | - | 144 | Е 3 | 36.2 6 | | 23.7 | 50.9 | Щ |
| 5 years to less than 10 years | 211 | 1,806 | <i>ر</i> | 16.1 | 1.3 | 13.4 | 19.1 | | | ,382 | Ľ | | 1.7 | | 21.1 | | 75 | 424 | Е 1 | | | | 19.3 | Щ |
| 10 years or more | 524 | 3,516 | 2 | 31.3 | 2.1 | 26.9 | 36.0 | | | .,871 | ŝ | | | | 43.4 | 1 | | 644 | 5 | | | | 29.3 | ж Ш |
| Number and percentage worked in a noisy environment by time worked and sex, household population aged 16–79 years. Canada excluding territories. 2012/2013. | noisv en | ivironm | ent by | time wo | rked and | sex. hous | chold p | ppulatic | m aged | 16-79 | /ears. C | anada e. | xcluding | territori | es. 201 | 2/2013. | | | | | | | | |
| E use with caution (coefficient of variation 16.6–33.3%) | riation 1 | 6.6–33. | 3%). | | | | 1 | J. | 0 | , , , | | | D | | | | | | | | | | | |
| *Significantly different from estimate for men $(P < 0.05)$. | e for mei | n (P < C |).05). | | | | | | | | | | | | | | | | | | | | | |
| ^T Among respondents who have ever worked in a noisy environment. | worked a | in a noi | sy envi. | ronment | | | | | | | | | | | | | | | | | | | | |
| Source: 2012/2013 Canadian Health Measures Survey (Cycle 3). | Measure | es Surve | y (Cyci | le 3). | | | | | | | | | | | | | | | | | | | | |

FFPTA HL (22%; 95% CI, 17.5 to 26.3, compared with 16%; 95% CI, 13.6 to 18.7, respectively) and LFPTA HL (18%; 95% CI, 15.2 to 21.5 compared with 12%; 95% CI, 10.5 to 14.5, respectively) was observed. Also, individuals who reported ever working a noisy environment were significantly more likely to have the Wilson audiometric notch⁴⁵ than those who never worked in a noisy environment (16.6%: 95% CI, 12.6 to 21.5, compared with 9.2%; 95% CI, 7.4 to 11.4, respectively). Although a greater prevalence of participants who reported ever working in a noisy environment than those who never worked in such an environment also demonstrated the Niskar notch⁴⁶ (26%; 95% CI, 20.2 to 32.8 vs 19%; 95% CI, 15.4 to 23.2, respectively), there was no significant difference observed. When duration of occupational exposure was considered, individuals who worked in a noisy environment for 10 years or more were significantly more likely to have HL in one or more PTA categories (FFPTA, HFPTA, LFPTA) than those with shorter durations of occupational noise exposure. For example, 46% of people with 10 or more years in a noisy work environment had FFPTA compared with 13% of those who had worked in a noisy environment for less than a year. Men, low household income participants, 50 to 79 year olds, and individuals with less than post-secondary education were more likely to have HL in one or more PTA categories (FFPTA, HFPTA, LFPTA).

When these demographic factors and duration in a noisy work environment were considered together, being male and increasing age generally remained significantly associated with HL (P < 0.05) (Table 12). Lower education was only associated with FFPTA HL whereby those from households with less than postsecondary education had higher odds of having FFPTA than those from households with post-secondary education [odds ratio (OR): 1.8; 95% CI, 1.2 to 2.7]. Working in a noisy environment remained significantly associated (P < 0.05) with both FFPTA and LFPTA HL when demographic factors were taken into account. The odds of having FFPTA and LFPTA were higher (2.0 and 2.2-fold, respectively) for individuals who had worked in a noisy environment for 10 years or more than for those who had never worked in a noisy environment. In the bivariate analysis, associations were evident between some demographic factors and noisy work environment duration with the presence of a notch pattern (Table 12). However, when considered together, only sex was significantly associated with having a notch whereby men had nearly twice the odds compared with women of having a notch using the definition by Niskar et al⁴⁶ (OR: 1.8; 95% CI, 1.1 to 2.9). Also, the odds of having an absent DPOAE were nearly four times higher for men (OR: 3.7; 95% CI, 2.1 to 6.8) compared with women and increased by a factor of 1.1 for every 1-year increase in age.

DISCUSSION

This is the first study to provide national prevalence estimates regarding occupational noise, audiometric HL, and HP usage among representative Canadian workers. More than 4 out of every 10 Canadians, between the ages of 16 and 79 years, reported being exposed to hazardous workplace noise, either in a present or past job. Of these individuals, 38% of workers (an estimated 4 million Canadians) had some degree of measured HL compared with 33.5% who reported not being exposed to hazardous workplace noise. This is somewhat higher than reported in a U.S. study⁵⁰ based on a 2007 National Health Interview Survey (NHIS), which found that among individuals who had ever been exposed to loud workplace noise, 30% self-reported hearing difficulty compared with 10% of those not exposed (P < 0.0001).⁵⁰ However, the higher prevalence of measured HL in the present study compared to the self-reported hearing difficulty prevalence reported by Masterson et al⁵⁰ is not unexpected given the findings by Feder et al⁵¹ showing a large disparity between self-reported and measured HL in an adult population.

| TABLE 3. Self-Reported Hearing Protection Usage at Work Among Canadians, Aged 16 to 79 Years | ted Hearin _c | g Pro | tectio | n Us | age at | Work . | Among | Cana | dians, | , Age | d 16 to 7 | '9 Years | | | | | | | | | | |
|--|--------------------------|------------------------|--|-----------------------------|--|--------|-----------|-------------------|---|-------------------------------------|----------------|-------------------------|--------------------------------|-------------------------------|--|--------|-------------------------|------------------------------|---------------------------|--|------------------------|----------|
| | Alw | ays or Prote Amc | ys or Often Use He. Protection at Work, Among Workers [‡] | t Use J at Woi orkers | Always or Often Use Hearing Protection at Work, Among Workers [‡] | | | Req Heari ź | Required to Use Hearing Protection at Work [‡] | to Use otectio k [‡] | , E | Alwa Proi Those] | tys or (tection Require | Offien U at Woi vd to U | Always or Often Use Hearing Protection at Work, Among Those Required to Use Protection | | Alw: Protec Not I | ays or tion at Require | Often Work, ed to U | Always or Often Use Hearing Protection at Work, Among Those Not Required to Use Protection | ring Those ction | <u>م</u> |
| | | | | 6 | 95% CI | | | | | 95 | 95% CI | | | | 95% CI | | | | | 95% | CI | |
| Characteristics | n N | CV % | % SE | % Fr | SE % From To | CV * ' | n N | CV % | SE | % Fro | % From To CV * | n N | CV % | | SE % From To CV * | CV * n | N | CV % | SE | SE % From To CV * | T0 C | * • |
| | 000. | | | | | | 000, | | | | | 000. | | | | | ,000 | | | | | |
| Total | 508 4,182 | 38 | 38.2 2.7 | 7 32 | 2.7 32.4 44.3 | 4 | 496 3,962 | 36.1 | .1 2.9 | | 30.1 42.6 | 373 3,153 | 7.9 <i>T</i> | 7 3.0 | 72.3 85.4 | 135 | 135 1,029 | E 14.7 | .7 2.8 | 9.6 | 22 | ш |
| Men | 408 3,350 | 42 | 42.8 3.8 | | 1.7 51.2 | * | 391 3,161 | 40. | .3 4.2 | 31.4 | .4 49.9 | 288 2,431 | 77.0 | | 67.7 84.3 | 120 | 919 | E 19.7 | .7 3.3 | 13.3 | 28 | ш |
| Women [†] | 100 832 | E 26 | | | 16.8 39.6 | Щ | 105 801 | E 25.7 | | | | 85 722 | E 90.1 | | 72.0 97.0 | | | [L | | | | Щ |
| Age group | | | | | | | | | | | | | | | | | | | | | | |
| 16-29 years [†] | | Щ | | | 5.7 55.4 | ш | 85 876 | E 34.8 | | | | 69 757 | | | 67.0 95.2 | 27 | 241 | Щ | | | | щ |
| 30–49 years | 244 1.818 | Щ | 2.7 5.3 | | 31.7 54.5 | 0 | | E 41.7 | .7 3.9 | | | 186 1,385 | E 77.9 | 5.8 | 62.6 88.2 | | | ц | | | | ц |
| 50-79 years | 168 1,365 | 32 | 32.7 3.1 | | 5.2 39.9 | 1 | 172 1,309 | 31. | | 1 24.4 | .4 39.1 | 118 1,011 | <i>11.5</i> | | 65.1 86.4 | 50 | 355 | | .3 3.7 | 6.3 | 22.9 | Щ |
| Education (highest level in household) | in household) | ~ | | | | | | | | | | | | | | | | | | | | |
| Post secondary or more ^{\dagger} 367 2,842 | e [†] 367 2,842 | 35 | | | 29.4 43 | | \sim | 37.1 | | | | Ч | 78.5 | | | 93 | | Щ | | 9 | | Щ |
| Less than postsecondary 128 1,210 | ry 128 1,210 | Ш | 44.5 4.9 | | 34.2 55.3 | | 119 945 | E 34.7 | .7 5.0 |) 24.7 | .7 46.3 | 93 790 | E 83.6 | 6.3 | 65.1 93.3 | | 420 | E 23.6 | .6 5.1 | 14.3 | 36.5 | * ш |
| Household income | | | | | | | | | | | | | | | | | | | | | | |
| $< $50,000^{\circ}$ | 189 1,533 | 38 | | | 30.9 47 | | 181 1,241 | 31.2 | | | .0 38.3 | | E 79.9 | | 65.2 89.4 | 54 | | Щ | 5.5 | 10.5 | | Щ |
| 50,000 - < 100,000 | 171 1, 140 | | 31.9 3.2 | | 25.3 39.2 | | 180 1,298 | 36. | | | | 128 943 | 72.7 | 4.8 | | 43 | | Щ 8 | | 4.6 | | Щ |
| \$100,000 or more | 148 1,509 | Щ | 44.2 6.5 | | 0.7 58.7 | | 135 1,423 | E 41.7 | .7 6.1 | 29.2 | .2 55.4 | 110 1,222 | E 85.9 | | 70.1 94.1 | 38 | 287 | E 14.4 | .4 4.1 | 7.5 | 25.8 | ш |
| E use with caution (coefficient of variation 16.6-33.3%) | ficient of variat | tion 16. | .6-33.3 | <i>1%</i>). | | | | | | | | | | | | | | | | | | |
| *Significantly different from estimate for reference category $(P < 0.05)$. | rom estimate fo | or refer | ence ca | itegory | (P < 0.05) | ÷ | | | | | | | | | | | | | | | | |
| [‡] Among respondents who have ever worked in a noisy environment. | o have ever wo | vrked in | ı a nois | y envir | onment. | | | | | | | | | | | | | | | | | |
| Source: 2012/2013 Canadian Health Measures Survey (Cycle 3). | idian Health Mt | easures | : Survey | (Cycle | e 3). | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |

| | | | FFI | FFPTA $(n = 3, 431)$ | 3,431) | | | | | HFPT | HFPTA $(n = 3,431)$ | (31) | | | | | LFPT | LFPTA $(n = 3, 431)$ | (431) | | |
|--|---|--|---|--|---|--|---|---|---------------------------|------------------|---------------------|-----------|-------------|------------|-----------|------------|----------|----------------------|----------|-----------|--------|
| >20 dB (16-18 Years) | | | | | | | | | | | | | | | | | | | | | |
| > 25 dB (19-79 Years) | | | | | 95% | CI | | | | | | 95% CI | CI | | | | | | 95% CI | CI | |
| Characteristics | u | Ν | % | SE % | From | \mathbf{T}_{0} | | и | N | % | SE % | From | To | | и | Ν | % | SE % | From | To | * |
| | | 000, | | | | | | | 000, | | | | | | | 000. | | | | | |
| Total | 665 | 4,632 | 18.3 | 1.0 | 16.1 | 20.7 | | 1,214 | 8,520 | 33.7 | 1.0 | 31.5 | 35.9 | | 535 3 | 3,744 | 14.8 | 0.8 | 13.1 | 16.7 | |
| Demographic characteristics | | | | | | | | | | | | | | | | | | | | | |
| Men | 401 | 3.018 | 24.0 | 2.1 | 19.7 | 28.9 | ++ | 695 | 4.895 | 38.9 | 2.1 | 34.5 | 43.5 | * | 291 2 | 2.212 | 17.6 | 1.3 | 14.9 | 20.6 | ÷ |
| Women [†] | 264 | 1,614 | 12.7 | 1.0 | 10.7 | 15.1 | | 519 | 3,624 | 28.5 | 2.2 | 24.0 | 33.5 | | | | 12.0 | 1.0 | 10.0 | 14.5 | |
| Age group | | | | | | | | | | | | | | | | | | | | | |
| 16–29 years years | 36 | 369 | 5.9 | 1.8 | 3.0 | 11.4 | с,Е | 55 | 455 | 7.3 | 2.1 | 3.8 | 13.4 | е,Е | 39 | | 6.4 | 1.8 | 3.4 | 11.8 | е,Е |
| 30–49 years | 98 | 805 | 9.1 | 1.5 | 6.3 | 13.0 | e | 199 | 1,386 | 15.7 | 2.2 | 11.5 | 21.1 | * | 95 | 842 | 9.5 | 1.3 | 7.1 | 12.7 | |
| 50–79 years | 531 | 3,458 | 33.8 | 1.7 | 30.3 | 37.6 | ++ | 096 | 6,678 | 65.4 | 1.8 | 61.3 | 69.2 | ++ | 401 2 | 2,502 | 24.5 | 1.5 | 21.4 | 27.8 | ++ |
| Education (highest level in household) | ousehold | (p | | | | | | | | | | | | | | | | | | | |
| Post secondary or more ^{\dagger} | 427 | 2,920 | 15.5 | 1.3 | 12.8 | 18.5 | | 822 | 5,764 | 30.5 | 1.7 | 26.9 | 34.4 | | 352 2 | | 12.8 | 1.0 | 10.7 | 15.3 | |
| Less than postsecondary | 219 | 1,560 | 28.4 | 2.9 | 22.5 | 35.2 | ++ | 354 | 2,446 | 44.5 | 4.6 | 34.7 | 54.8 | * | 169 1 | 1,229 | 22.4 | 3.2 | 16.2 | 30.1 | e * |
| Household income | | | | | | | | | | | | | | | | | | | | | |
| $< \$50,000^{\dagger}$ | 338 | 2,316 | 26.8 | 2.0 | 22.6 | 31.4 | | 565 | 3,544 | 41.0 | 2.5 | 35.6 | 46.6 | | 281 1 | | 21.0 | 1.8 | 17.4 | 25.3 | |
| \$50,000 to < \$100,000 | 204 | 1,344 | 15.7 | 1.8 | 12.1 | 20.0 | ** | 392 | 2,668 | 31.1 | 1.4 | 28.2 | 34.2 | * | 146 1 | 1,019 | 11.9 | 1.4 | 9.1 | 15.4 | |
| \$100,000 or more | 123 | 972 | 12.0 | 3.1 | 6.7 | 20.6 | ‡ е,Е | 257 | 2,308 | 28.6 | 3.1 | 22.2 | 36.0 | * | 108 | 906 | 11.2 | 2.9 | 6.2 | 19.4 | * е,Е |
| Any hearing loss: FFPTA and/or HFPTA. e, E use with caution (coefficient of variation 16.6–33.3%), population size and %, respectively. f, F too unreliable to be published (coefficient of variation greater than 33.3%), population size and %, respectively. DPORE, distribution product oto accurate missions; FFPTA, four-frequency pure tone average over frequencies (3, 4, 6, and 8kHz); LFPTA, low- frequency pure tone average over frequencies (0.5, 1, and 2 kHz). * ⁴ Significantly different from estimate for reference category (P < 0.05) and (P < 0.01), respectively. * ¹ Reference category. Source: 2012/2013 Canadian Health Measures Survey (Cycle 3). | and/or H fficient o ublished t otoacou ver frequ from esti | FPTA and of variation (coefficient stitc emiss encies (0 imate for 1 Measure | Vor LFP. 1 16.6–3 nt of vari ions; FFI 5, 1, and reference s Survey | TA. 3.3%), pol lation grea PTA, four- 2 kHz). 5 category 7 (Cycle 3) | pulation siz ter than 33 . frequency f ($P < 0.05$) i | e and %, 1 , population ($P < C$) and ($P < C$) | ize and %, respectively. 3.3%), population size and %, respectively. i pure tone average over frequencies (0.5, 1,) and ($P < 0.01$), respectively. | ly. e and %,∷ er frequer ectively. | respective ncies (0.5, | ly. 1, 2, and | 4 kHz); H | FPTA, hig | ţh-frequen. | cy pure to | one avera | ge over fi | equencie | :s (3, 4, 6, | and 8 kH | z); LFPTA | , low- |

| 95% cteristics N N SE $From$ tly working in a noisy environment 71 602 17.7 3.2 11.7 tly working in a noisy environment 71 602 17.7 3.2 11.7 row ded in a noisy environment 313 $2,305$ 21.6 2.0 17.5 orked in noisy environment 313 $2,305$ 21.6 2.0 17.5 worked in noisy environment 313 $2,305$ 21.6 2.0 17.5 months 337 25.4 1.466 45.8 4.4 36.4 months 337 25.1 18.4 36.4 ears to <10 years 32.1 4.4 36.4 earning protection at work 95 827 20.6 3.8 13.6 g sytoffent 95 827 20.6 3.8 13.6 of earnor 1.478 1.75 3.4 11.2 13.6 < | FFPTA $(n = 3, 431)$ | | | | HFPT | HFPTA $(n = 3, 431)$ | 431) | | | | Г | LFPTA $(n = 3, 431)$ | = 3,431) | | |
|---|---|--------------------------|----------------------------------|----------------|--------------|----------------------|--------------|--------------|------------------|---|--------------------|----------------------|---|--------------|-------------|
| N % SE % mment 602 17.7 3.2 602 17.7 3.2 3.2 4,030 18.4 1.0 3.2 12,305 21.6 2.0 2.3 254 8.3 2.1 2.2 254 8.3 2.1 3.3 1,466 45.8 4.4 3.3 1,478 22.1 1.8 3.3 1,478 22.1 1.8 3.3 1,478 22.1 1.8 3.3 1,478 22.1 1.8 3.3 1,478 22.1 1.8 3.3 1,478 22.1 1.8 3.3 1,210 21.2 21.1 1.8 1,353 17.5 3.4 3.3 1,952 22.5 3.33 7.3 353 17.6 4.2 3.3 1,952 23.5 3.3 3.3 353 17.6 | 95% CI | | | | | | 95 % CI | IC | | | | | 95% | é CI | |
| nument 3.2 602 17.7 3.2 4,030 18.4 1.0 1 2,335 21.6 2.0 2,335 21.6 2.0 3.9 2,337 15.9 1.2 3.9 2,351 12.6 3.9 3.9 264 8.2 3.9 3.9 1,466 45.8 4.4 3.3 1,478 22.1 1.8 3.4 514 17.5 3.4 3.4 1,210 21.2 2.1 1.8 1,396 10.7 1.1 612 1,395 19.2 3.3 3.4 2,049 23.5 2.5 3.3 2,049 23.5 2.5 3.5 | | | u | N | % | SE % | From | To | u | N | " " | SE % | From | To | |
| | | | | 0 | | | | | | | | | | | , |
| tt 2,305 21.6 2.0 2,327 15.9 1.2 264 8.3 2.1 251 14.4 3.3 1,466 45.8 4.4 514 17.5 3.4 1,478 22.1 1.8 1,396 10.7 1.1 612 19.2 3.3 1,306 10.7 1.1 612 19.2 3.3 2,049 23.5 2.5 353 17.6 4.2 353 2.5 2.5 354 2.5 2.5 355 2.5 2.5 356 2.5 2.5 356 2.5 2.5 356 2.5 2.5 356 2.5 2.5 2.5 2.5 356 2.5 2.5 2.5 2.5 356 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 | 11.7 $25.916.2$ 20.8 | e,E | 133 1,081 | 1,040 7,480 | 30.5 34.2 | 3.6 1.0 | 23.2 31.9 | 39.0 36.5 | 52 483 | 2 523 3 3,221 | 23 15.4 21 14.7 | 4 2.8 7 1.1 | 10.1 12.5 | 22.6 17.3 | e,E |
| 2,305 21.6 2.0 2,327 15.9 1.2 264 8.3 2.1 251 14.6 45.8 3.3 1,466 45.8 3.4 827 20.6 3.8 1,478 22.1 1.8 827 20.6 3.8 1,478 22.1 1.8 1,478 22.1 1.8 1,478 22.1 1.8 1,478 22.1 1.8 1,210 21.2 2.1 1,396 10.7 1.1 612 19.2 3.3 1,353 17.6 4.2 353 17.6 4.2 2,049 23.5 2.5 2,049 23.5 2.5 | | | | | | | | | | | | | | | + |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$ | 17.5 26.3 13.6 18.7 | * | 532 682 | 3,766 4.753 | 35.2 32.6 | 1.9 1.7 | 31.2 28.9 | 39.5 36.4 | 249 286 | $\begin{array}{ccc} 9 & 1,939 \\ 6 & 1.805 \end{array}$ | 39 18.1 05 12.4 | 1 1.4 4 0.9 | 15.2 10.5 | 21.5 14.5 | + |
| hs 126 3.9 (5 years 43 264 8.3 2.1 (5 years 37 251 14.4 3.3 2.1 (5 years 37 251 14.4 3.3 2.1 (5 years 37 251 14.4 3.3 2.1 (5 years 194 1,466 45.8 4.4 3 (5 years)) (5 years) (5 | | | | | | | | | 1 | | | | | | |
| | | | 99 | 375 | 14.7 | 3.4 | 8.6 | 23.9 ‡ | | | - | | 7.4 | 25.2 | † f,E |
| <pre>< <10 years</pre> | | ++ П | 91 | 781 | 24.5 | | 17.9 | 32.6 12 5 | | 36 2 | 275 8.6 | | 5.2 | 14.0 | ++ Ц |
| ten [†] 95 827 20.6 3.8 strately/never 218 1,478 22.1 1.8 ection required/used 514 17.5 3.4 ection required/used 2514 17.5 3.4 178 1,210 21.2 2.1 r^{+} 83 612 19.2 3.3 and work noise 33 612 19.2 3.3 ansport 261 1,952 22.5 2.5 r^{-} 52 353 17.6 4.2 end other unspecified 25.6 2.5 r^{-} 10.8 20.4 23.5 2.5 r^{-} 10.8 20.6 2.5 r^{-} 10.8 20.6 2.5 r^{-} 10.8 20.6 2.5 r^{-} 2.5 | 8.0 25.2 36.4 55.5 | ŀ | 80 294 | 2.031 | 55.1 63.5 | 4. 60 8. 80 | 54.7 54.7 | 4.05 4.17 | ⁺e 145 142 | | 1.112 34.8 | 2.6 2.6 | 0.2 29.2 | 18.0 40.7 | - Ч |
| ten ^T 95 827 20.6 3.8 Ararely/never 218 1,478 22.1 1.8 ection required/used 62 514 17.5 3.4 62 514 17.5 3.4 178 1,210 21.2 2.1 ar 177 1,396 10.7 1.1 r^{\dagger} 83 612 19.2 3.3 and work noise 612 19.2 3.3 ansport 261 1,952 22.5 2.5 52 353 17.6 4.2 277 2,049 23.5 2.5 ions and/or other unspecified) 2.5 2.5 52 353 17.6 4.2 277 2,049 23.5 2.5 2.5 353 17.6 4.2 2.7 2,049 23.5 2.5 2.7 2,049 23.5 2.5 2.7 2,049 23.5 2.5 2.7 2,049 23.5 2.5 2.5 353 17.6 4.2 2.7 2,049 23.5 2.5 2.7 2,049 23.5 2.5 2.5 353 17.6 4.2 2.7 2,049 23.5 2.5 2.5 354 10.5 2.7 2,049 23.5 2.5 2.5 354 10.5 2.7 2,049 23.5 2.5 | | | I | | | | | | | | | | | | |
| strately/never 218 1,478 22.1 1.8 ection required/used 62 514 17.5 3.4 178 1.210 21.2 2.1 at 177 1,396 10.7 1.1 r ⁴ 83 612 19.2 3.3 ad work noise 261 1,952 22.5 2.5 ansport 261 1,952 22.5 2.5 ions and/or other unspecified) 26.0 2.5 52 353 17.6 4.2 52 353 17.6 4.2 353 17.6 4.2 355 17.5 4.2 355 10.5 4.2 355 10.5 4.2 355 10.5 4.2 355 10.5 4.2 355 10.5 4.2 355 10.5 4.2 355 10.5 4.2 355 10.5 4.2 355 10.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4 | | e,E | 166 | 1,303 | 32.5 | 5.2 | 22.2 | 44.9 | е 7 | L 6L | 742 18.5 | 5 3.3 | 12.3 | 27.0 | е,Е |
| ection required/used 62 514 17.5 3.4 1 178 1.210 21.2 2.1 1 r^{+} 177 1.396 10.7 1.1 1 at $177 1.396 10.7 1.1 1$ ansport 261 1.952 22.5 2.5 1 261 1.952 22.5 2.5 1 261 1.952 22.5 2.5 1 277 2.049 23.5 2.5 1 ions and/or other unspecified) 277 2.049 23.5 2.5 1 | 18.4 26.4 | | 365 | 2,458 | 36.8 | 1.9 | 32.7 | 41.0 | 17 | | | | 14.5 | 21.9 | |
| ar 178 1,210 21.2 3.4 1 ar 178 1,210 21.2 2.1 1 r^{\dagger} 83 612 19.2 3.3 1 ansport 261 1,952 22.5 2.5 1 52 3.33 17.6 4.2 1 52 3.049 23.5 2.5 1 ions and/or other unspecified) | | | | | | 1 | | | | | | | | | ţ |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | 11.2 26.3 | - | 111 | 872 | 29.7 | 0.0 0 C | 19.2 21.0 | 42.8 65.7 | | 52 4 | 456 15.5 202 | 0.50 | 10.0 | 23.4 | а С |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | 16.0 173 | т, п н | 05 | C/C | 40.4 | 6.1 C 0 | 2.10 1.00 | 7.00 20 5 | ъц | | 0.75 O | | 13.51 | 0.00 2.91 | ц ц ц |
| ar 177 1,396 10.7 1.1 r ¹ 83 612 19.2 3.3 1 ad work noise 261 1,952 22.5 2.5 1 261 1,952 22.5 2.5 1 52 353 17.6 4.2 1 52 353 17.6 4.2 1 in 277 2,049 23.5 2.5 1 ions and/or other unspecified) | | | 296 296 | 2.043 | 35.8 | 1.9 | 31.8 | 40.1 | | 138 9 | 935 16.4 | 4 2.2 | 12.1 | 21.8 | ļ |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | | Ì | Ì | | | | | | | | | | | |
| 19.2 3.3 22.5 2.5 17.6 4.2 23.5 2.5 23.5 2.5 | 8.6 13.3 | | 381 | 2,993 | 23.0 | 2.1 | 18.7 | 28.0 | * 158 | 8 1,360 | 60 10.5 | 5 1.1 | 8.3 | 13.2 | |
| 22.5 2.5 17.6 4.2 23.5 2.5 23.6 4.2 | | e,E | 164 | 1,176 | 37.0 | 4.5 | 27.7 | 47.3 | e (| 61 4 | 493 15. | | 10.4 | 22.5 | e,E |
| 22.5 2.5 17.6 4.2 23.5 2.5 | | | | | | | | | | | | | | | |
| 22. 2 2. 2 2. 2 2. 2 2 2 2 2 2 2 2 2 2 | | | ¢77 | 2 112 | 0 20 | Ċ | 0.00 | c (| | | 01 567 1 | | 110 | <i>с с</i> с | |
| 23.5 2.5 | 10.1 28.8 | لل لل | 744 | 553 | 2.10 | 4 i 7 | 18.6 | 78.7 28.7 | е. Н. 4 | | 314 15.6 | 4.1 1.7 | 14.0 8.2 | C.C7 | لت ف |
| 23.5 2.5 23.6 4.3 | | | 5 | 2 | | | | | | | | | | i | 5 |
| 23.5 2.5 23.6 1.3 | | f,F | 67 | 432 | 21.9 | 4.5 | 13.6 | 33.4 * | e,E | | | | | | f,F |
| 22 6 13 | 18.4 29.5 | | 465 | 3,334 | 38.2 | 2.5 | 32.9 | 43.9 | 219 | 9 1,713 | 13 19.6 | 5 2.1 | 15.4 | 24.6 | |
| 21 220 22 13 | | | | | | | | | | | | | | | |
| C.4 0.07 707 1C | 15.6 34.2 | e,E | F | 415 | 36.4 | 5.5 | 25.3 | 49.2 | e 4 | | 199 17.5 | 5 4.6 | 9.6 | 29.8 | e,E |
| No ⁺ 262 2,036 21.3 2.2 16.9 | | | 455 | 3,351 | 35.1 | 2.0 | 30.9 | 39.5 | 209 | 9 1,740 | | | 15.1 | 21.8 | |
| Any hearing loss: FFPTA and/or HFPTA and/or LFPTA. | | | | | | | | | | | | | | | |
| e, E use with caution (coefficient of variation 16.6–33.3%), population size and %, respectively. f, F too unreliable to be published (coefficient of variation greater than 33.3%), population size and %, respectively. | opulation size and 9 ater than 33.3%), p | 6, respecti opulation | vely. size and % | , respectiv | ely. | | | | | | | | | | |
| DPOAE, distortion product otoacoustic emissions; FFPTA, four-frequency pu frequency numerov nume tone average over frequencies $(0.5 - 1)$ and $2 kH_2$. | r-frequency pure tor | ie average | over frequ | encies (0.5 | i, 1, 2, and | 1 4 kHz); H | FPTA, higl | -frequency | pure tone | average | over frequ | encies (3, 4 | pure tone average over frequencies (0.5, 1, 2, and 4 kHz); HFPTA, high-frequency pure tone average over frequencies (3, 4, 6, and 8 kHz); LFPTA, low- | Iz); LFPT | A, low- |
| y $(P < 0.05)$ | | < 0.01), re | and $(P < 0.01)$, respectively. | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

| TABLE 6. Prevalence of Audiometric Hearing Loss, Among Working Canadians, Aged 16 to 79 Years: Demographics | Audiometri | c Hearing I | -oss, Amo | ng Working | I Canadian | is, Aged 16 | 6 to 79 Y | ears: Den | nographics | | | | | |
|---|--------------------------------|------------------------------------|-----------------------------------|---|--------------------------|------------------|---------------|--------------|----------------|-----------------|---|-------------------|----------------|----------|
| | | | Any Hea | Any Hearing Loss $(n=3,431)$ | =3,431) | | | | ł | Absent DPO | Absent DPOAE $(n = 3,068/\text{newfaildp})$ | 8/newfaildp) | | |
| | | | | | 95% CI | cI | | | | | | 95% | CI | |
| Characteristics | u | N | % | SE % | from | to | | u | N | % | SE % | From | To | |
| Ē | | 000. | | | 0.00 | | | | 000. | | | 1 | | |
| Total Demographic characteristics | 1,271 | 8,951 | 35.4 | 1.0 | 33.2 | 37.6 | | 928 | 6,274 | 28.5 | 1.4 | 25.5 | 31.8 | |
| Men | 725 | 5.235 | 41.6 | 2.1 | 36.9 | 46.4 | ÷ | 586 | 4.182 | 38.9 | 2.3 | 33.9 | 44.1 | ÷ |
| \mathbf{Women}^{\dagger} | 546 | 3,716 | 29.2 | 2.2 | 24.6 | 34.4 | | 342 | 2,092 | 18.6 | 2.0 | 14.7 | 23.3 | |
| Age group | 2 | | | ć | c u | 0 7 1 | Ľ | 2 | 100 | 0 | - | 6 | ſ | Ę |
| 10-29 years | 00 | 100 | 9.0 | 7.1 | 5.C | 14.8 | е, т, | 5 | 407 | 4.8 | 1.0 | 3.0 | 1.1 | е, †, |
| 30–49 years | 229 | 1,650 | 18.7 | 2.1 | 14.5 | 23.7 | + - | 177 | 1,444 | 18.8 | 2.7 | 13.6 | 25.5 | + - |
| 50–79 years | 976 | 6,737 | 65.9 | 1.7 | 62.0 | 69.7 | H | 717 | 4,577 | 50.5 | 2.4 | 45.1 | 55.8 | ÷ |
| Education (highest level in household) | isehold) | | | | | | | | | | | | | |
| Postsecondary or more [†] | 866 | 6,068 | 32.1 | 1.6 | 28.7 | 35.7 | | 633 | 4,332 | 26.6 | 2.1 | 22.2 | 31.4 | |
| Less than postsecondary | 366 | 2,572 | 46.8 | 4.4 | 37.3 | 56.6 | * | 265 | 1,690 | 34.7 | 3.9 | 26.7 | 43.7 | |
| Household income | | | | | | | | | | | | | | |
| $<\!$ | 587 | 3,692 | 42.7 | 2.3 | 37.8 | 47.8 | | 419 | 2,777 | 36.8 | 3.2 | 30.1 | 44.1 | |
| \$50,000 to $<$100,000$ | 410 | 2,860 | 33.3 | 1.3 | 30.4 | 36.3 | * | 311 | 2,039 | 27.4 | 2.4 | 22.4 | 33.1 | * |
| \$100,000 or more | 274 | 2,399 | 29.7 | 3.4 | 22.9 | 37.6 | * | 198 | 1,458 | 20.8 | 3.5 | 14.1 | 29.6 | ‡e,E |
| Any hearing loss: FFPTA and/or HFPTA and/or LFPTA | or HFPTA and | or LFPTA. | in action | m pro co | | | | | | | | | | |
| e, E use with cautori (coefficient of variation 10.0-03.5%), population 3.28 and %, respectively. f, F too unreliable to be published (coefficient of variation greater than 33.3%), population size and %, respectively | hed (coefficien | t of variation g | population sur- reater than 33 | ze anu %, respe 3.3%), populatio | cuvery. n size and %, | respectively. | | | | | | | | |
| DPOAE, distortion product otoacoustic emissions; FFPTA, four-frequency | acoustic emissi | ons; FFPTA, fc | our-frequency | pure tone average over frequencies (0.5, 1, 2, and 4kHz); HFPTA, high-frequency pure tone average over frequencies (3, 4, 6, and 8kHz); LFPTA, low- | ge over frequei | ncies (0.5, 1, 2 | 2, and 4 kHz) | ; HFPTA, hig | h-frequency pu | ure tone averag | te over frequenc | ies (3, 4, 6, and | 1 8 kHz); LFPI | A, low- |
| frequency pure tone average over frequencies (0.5, 1, and 2 kHz). $\sum_{i=1}^{3} \frac{1}{i}$ significantly different from estimate for reference category ($P < 0.05$) | requencies (0.5 estimate for r | 5, 1, and 2 kHz eference catego |). $ry \ (P < 0.05)$ | and $(P < 0.01)$, respectively. | respectively. | | | | | | | | | |

, sugnincanuy unterent nu [†]Reference category.

| 95.6 CI 95.6 CI 95.6 CI 95.6 CI 95.6 CI Dimenticible N 95.6 CI N 95.6 CI 95.6 CI Currently writing in a wrise environment N N N 95.6 CI 95.7 CI 95.6 CI 95.6 CI 95.6 CI 95.7 CI 95. | n $\%$ SE % From ament N % SE % From ament 7,819 35.7 1.1 33.3 5.95% CI ament 7,819 35.7 1.1 33.3 5.95% From ament 7,819 35.7 1.1 33.3 5.97 5.97 13 4,893 33.5 1.8 2.97 3.3 5.97 77 526 20.5 3.8 1.9 33.9 5.97 77 526 20.5 3.8 1.2 3.3 5.97 5.97 77 526 20.5 3.3 3.3 1.3,4 3.3 77 526 3.7 3.7 5.61 3.4 77 526 3.7 3.1 5.61 3.4 78 1,495 37.3 4.8 2.74 4.0 78 1,495 37.3 1.6 3.4.8 5.1 5.1 | | | ł | ADSENT DPUAE (n | (n=3,068) | | |
|---|--|----------|-----|---|-----------------|-----------|-------------|------------------|
| N % EP.% Frunt To n N % S.P.% Frunt To To 1,132 33.2 1.1 33.3 84.2 44.5 5.302 31.3 44.4 22.5 41.6 7.819 35.7 1.1 33.3 88.2 41.7 5.92 31.3 44.4 22.5 41.6 4.883 33.3 1.3 33.2 42.3 33.2 5.302 23.1 1.4 22.5 41.6 4.883 33.7 1.3 33.7 32.6 5.02 21.1 1.3 33.3 31.5 2.662 36.8 37.7 1.6 37.7 1.6 27.3 20.3 31.5 2.663 37.3 1.6 37.7 1.6 37.7 20.6 30.1 21.3 20.7 21.1 20.8 41.7 41.7 41.6 45.9 65.8 41.7 41.7 41.6 45.9 65.8 41.7 41.7 | r N % SE % From amment 1,132 33.2 3.6 25.9 40 1,132 33.7 1.1 33.3 13 7,819 35.7 1.1 33.3 13 7,819 35.7 1.1 33.3 13 4,893 33.5 1.8 29.7 77 526 20.5 3.8 1.3 94 642 36.8 3.7 56.1 77 526 20.5 3.7 18.5 84 642 36.8 3.7 56.1 77 526 20.5 3.7 56.1 78 1,495 37.3 4.8 27.4 79 2,558 38.3 1.6 34.8 79 2,558 38.3 1.6 32.1 79 2,558 38.3 1.6 32.1 71 1,210 38.0 1.9 32.1 60 </th <th></th> <th></th> <th></th> <th></th> <th>95%</th> <th>6 CI</th> <th></th> | | | | | 95% | 6 CI | |
| 113 333 36 415 113 333 44 225 416 7.819 35.7 11 333 38.2 31.5 13.3 31.5 31.7 4 45.5 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 45.7 | mment 40 7,819 35.7 1.1 33.3 41 7,819 35.7 1.1 33.3 58 4,058 38.0 1.9 33.3 58 4,058 38.0 1.9 33.3 58 4,058 38.0 1.9 33.9 58 4,058 38.0 1.9 33.9 77 526 20.5 3.8 1.8 29.7 94 823 25.8 3.7 1.8 29.7 94 823 25.8 3.7 56.1 34.8 77 526 20.5 3.8 13.4 78 1,495 37.3 4.8 27.4 79 2,558 38.3 1.6 34.8 70 2,558 38.3 1.6 34.8 70 2,558 38.3 1.6 34.8 71 1,210 38.0 4.8 27.5 71 1,210 38.0 4.8 28.2 70 2,66 25.1 | | u | | SE | | To | |
| | 40 $1,132$ 33.2 3.6 25.9 131 $7,819$ 35.7 1.1 33.3 138 $4,058$ 38.0 1.9 33.3 133 $4,893$ 33.5 1.8 29.7 77 526 20.5 3.8 1.9 33.9 94 642 36.8 3.7 50.1 33.7 77 526 20.5 3.8 13.4 29.7 84 642 36.8 3.7 56.1 33.7 56.1 77 526 20.5 3.7 3.7 56.1 33.7 78 $1,495$ 37.3 4.8 27.4 40.8 79 $2,558$ 38.3 1.6 34.8 27.4 79 $2,566$ 5.0 27.4 40.8 56.1 79 $2,566$ 5.0 25.6 40.8 27.4 71 $1,200$ 35.1 1.9 22.5 27.4 86 | | | | | | | |
| 7,819 35.7 1.1 33.3 38.2 815 5.302 2.81 1.5 2.50 31.5 4,058 38.0 1.9 33.9 42.2 4.91 3.246 25.5 2.0 21.3 30.3 4,803 33.5 1.8 2.97 37.6 4.91 3.246 25.5 2.0 21.3 30.3 526 205 3.8 1.34 30.2 4eE 7 3.028 32.7 2.1 28.3 37.5 5205 561 3.77 1.85 3.47 4eE 73 3.03 5.1 2.03 30.1 4 561 546 3.77 561 7.27 561 4.0 37.3 30.3 42.7 1495 37.3 4.8 27.4 48.4 e 12.77 561 4.0 45.9 65.8 7.7 2558 38.3 1.6 34.8 1.777 56.1 4.0 45.9 | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | | | | 22.5 | 41.6 | e |
| | t t 134,80333.01.933.9134,89333.51.829.77752620.53.813.49464236.83.756.1781,49537.34.829.5792,55838.31.634.8792,55838.31.634.8792,55838.31.634.8792,55838.31.634.8792,55838.31.634.8702,55838.31.634.8711,49537.34.827.46044457.27.440.85141741.39.522.96036.11.932.1613,26625.11.721.5711,21038.04.828.2633,49140.22.335.49556728.24.719.19556728.24.719.1 | | | | | 25.0 | 31.5 | |
| $4,058$ 33.0 1.9 33.9 42.2 437 3.028 32.7 2.1 28.3 37.5 $4,893$ 33.5 1.8 297 37.6 491 3.246 2.55 2.0 213 303 31 823 2.58 3.7 1.8 3.47 $^{1}e_{t}$ 7 561 4.6 3.7 2.13 303 301 $^{1}2$ 642 3.68 3.7 56.1 7.12 56.1 4.6 4.59 65.8 4.73 4.7 2.558 38.3 1.6 3.48 4.19 e_{t} 2.46 1.727 56.1 4.6 4.59 65.8 4.73 2.558 38.3 1.6 3.48 e_{t} 2.46 3.1 2.9 2.37 4.7 2.558 38.3 1.6 3.48 e_{t} 3.10 2.93 5.1 2.93 3.7 1.048 35.6 5.0 2.5.6 1.09 | 58 4,058 38.0 1.9 33.9 77 526 20.5 3.8 13.4 94 823 25.8 3.7 18.5 94 823 25.8 3.7 18.5 84 642 36.8 3.7 56.1 73 1,495 37.3 4.8 29.5 78 1,495 37.3 4.8 27.4 79 2,558 38.3 1.6 34.8 79 2,558 38.3 1.6 34.8 79 2,558 38.3 1.6 34.8 70 2,558 38.3 1.6 34.8 71 1,495 37.2 7.4 40.8 60 444 57.2 7.4 40.8 610 3,266 25.1 1.9 32.1 63 3,491 40.2 2.3 35.4 65 567 28.2 4.7 19.1 65 567 28.2 4.7 19.1 65 567 28 | | | | | | | |
| 4.893 33.5 1.8 29.7 37.6 491 3.246 25.5 2.0 21.3 30.3 4.83 3.7 31.4 30.2 4.7 4.6 3.7 31.4 30.2 4.7 4.6 3.7 31.4 30.2 4.7 4.6 7.3 50.1 50.1 2.97 30.1 4.7 4.6 7.2 3.6 7.3 50.1 4.9 30.1 4.7 3.6 2.97 30.1 4.9 2.97 30.3 30.1 4.7 3.6 50.1 $2.9.3$ 50.1 $2.9.3$ 30.1 4.7 3.6 50.1 $2.9.3$ 30.1 4.7 3.6 4.7 3.6 1.727 30.3 30.1 4.7 3.6 50.1 50.3 50.3 30.1 4.7 30.2 30.3 30.1 4.7 30.2 30.1 4.7 30.2 30.1 4.7 30.2 30.1 4.7 30.2 30.1 4.7 30.2 30.1 4.7 30.2 < | 13 $4,893$ 33.5 1.8 29.7 77 526 20.5 3.8 13.4 94 823 25.8 3.7 18.5 84 642 3.7 56.1 13.4 78 $1,495$ 37.3 4.8 27.4 79 $2,558$ 38.3 1.6 34.8 79 $2,558$ 38.3 1.6 34.8 79 $2,558$ 38.3 1.6 34.8 79 $2,558$ 38.3 1.6 34.8 70 $2,558$ 38.3 1.6 34.8 71 417 41.3 9.5 22.9 60 36.1 1.9 32.1 21.5 71 $1,210$ 38.0 4.8 28.2 71 $1,210$ 38.0 4.8 28.2 63 $3,491$ 40.2 2.3 35.4 95 567 2.8 4.7 19.1 95 567 <td></td> <td></td> <td></td> <td></td> <td>28.3</td> <td>37.5</td> <td>*</td> | | | | | 28.3 | 37.5 | * |
| 22620538134302 ${}^{4}e_{\rm E}$ ${}^{7}a_{\rm E}$ 15.130.2 ${}^{4}e_{\rm E}$ 7350819.93.713.029.33.12.06764.63.756.172.224.81.72756.14.5019.93.713.029.34.17 ${}^{4}e_{\rm E}$ 732.06764.63.756.172.224.81.72756.14.64.5965.841.74.12.06756.63.731.63.4.827.224.81.01930.35.120.34.171.49537.31.63.4.827.226.647.1e9578229.365.717.345.22.55838.31.930.11.932.140.372.2e9578229.365.717.345.241741.741.39.72.0434.01.930.31.929.938.441741.39.52.140.332.145.325.716.5132.423.423.22.06635.11.721.52.91e9.818.7615.6132.938.957.257.43.26638.044.721.828.818.7616.6132.423.423.657.157.63.26625.11.721.828.818.7610.7538.957.255.757.43.26628 | 77 526 20.5 3.8 13.4 94 823 25.8 3.7 18.5 84 642 36.8 3.7 18.5 84 642 36.8 3.7 56.1 78 1,495 37.3 4.8 27.4 79 2,558 38.3 1.6 34.8 79 2,558 38.3 1.6 34.8 79 2,558 38.3 1.6 34.8 79 2,558 38.3 1.6 34.8 70 2,558 38.3 1.6 34.8 71 417 41.3 9.5 22.9 60 444 57.2 7.4 40.8 610 3,266 25.1 1.9 32.1 71 1,210 38.0 4.8 28.2 63 3,491 40.2 2.3 35.4 95 567 28.2 4.7 19.1 95 567 28.2 4.7 19.1 | | | | | 21.3 | 30.3 | |
| 2.26 2.03 3.3 13.4 9.04 $^{+}_{0.6}$ 73 561 9.02 9.3 9.01 | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | F +- | | Ţ | | 0 | 1.00 | ÷ |
| 623 523 537 126 747 $7e$ 75 501 517 1200 223 427 72 208 571 120 551 120 551 120 551 120 551 417 $7e$ 727 561 460 550 471 484 e 126 1010 303 511 203 425 655 173 427 293 551 203 517 427 427 427 427 618 722 610 303 511 203 532 453 452 4 | 94 823 23.8 3.7 18.5 84 642 36.8 3.7 18.5 302 2,067 64.6 3.7 56.1 178 1,495 37.3 4.8 27.4 379 2,558 38.3 1.6 34.8 379 2,558 38.3 1.6 34.8 379 2,558 38.3 1.6 34.8 379 2,558 38.3 1.6 34.8 51 417 41.3 9.5 22.9 305 2,060 36.1 1.9 32.1 410 3,266 25.1 1.9 32.1 410 3,266 25.1 1.7 21.5 171 1,210 38.0 4.8 28.2 95 567 28.2 4.7 19.1 95 567 28.2 4.7 19.1 | ц ÷ | Ċ | | | 8.0 | 30.1 202 | בן נ ב + י |
| 042 56.8 5.5 44.1 e 57.1 45.1 56.1 56.1 56.1 56.1 56.3 56.3 56.3 56.1 56.1 56.1 56.1 56.1 56.3 56.3 56.3 56.3 56.1 72.2 248 1,727 56.1 4.6 45.9 65.8 50.3 38.4 41.9 57.2 74.3 41.9 50.1 2.04 34.0 11.9 20.3 38.4 42.7 56.1 4.6 45.9 65.8 57.3 42.7 1,048 57.2 7.4 40.8 72.2 e 95 782 29.3 58.1 20.3 38.4 417 41.3 9.5 32.1 40.3 e 257 1651 32.4 45.2 53.1 2,060 36.1 1.9 32.1 6.5 1.33 8.2 29.9 70.5 3,266 25.1 1.9 32.4 2.8 2.8 2.66.5 33. | 84 042 56.8 5.5 2.967 56.46 3.7 56.1 178 1,495 37.3 4.8 27.4 379 2,558 38.3 1.6 34.8 27.4 379 2,558 38.3 1.6 34.8 27.4 122 1,048 35.6 5.0 25.6 34.8 51 417 41.3 9.5 22.9 32.1 410 3,266 25.1 1.9 32.1 21.5 171 1,210 38.0 4.8 28.2 35.4 463 3,491 40.2 2.3 35.4 19.1 95 567 28.2 4.7 19.1 19.1 | ຍ ⊦ + | ς [| | | 13.0 | 29.3 | בן נ י + |
| $2.00'$ $0+0$ 3.1 50.1 $1.2.2$ 2.48 $1.7.2'$ 50.1 4.0 $4.5.9$ 05.8 $1,495$ 37.3 4.8 27.4 48.4 e 126 $1,019$ 30.3 5.1 20.3 42.7 2.558 38.3 1.6 34.8 41.9 e 126 $1,019$ 30.3 5.1 20.3 42.7 $1,048$ 35.6 5.0 25.6 47.1 e 95 782 29.3 6.5 17.3 45.2 417 41.3 9.5 22.9 62.5 e^{1} 28 27.4 33.4 82 182 53.1 417 41.3 9.5 22.9 62.5 e^{1} 28 22.4 33.4 82 53.9 $2,060$ 36.1 1.9 22.9 62.5 e^{1} 28 1826 38.9 70.5 $3,266$ 25.1 1.7 21.5 29.1 $*$ 288 1.826 16.8 1.5 13.7 $3,266$ 25.1 1.7 21.6 38.9 1.826 32.4 32.4 23.4 23.4 $3,491$ 40.2 28.2 48.9 e^{1} 1.651 32.4 28.8 27.2 20.4 $3,491$ 40.2 28.1 45.3 82.8 1.826 1.68 1.5 13.7 20.4 $3,491$ 40.2 28.2 48.9 82.8 1.82 23.3 24.1 20.4 <t< td=""><td>502 $2,060$ $04,0$ 5.1 50.1 178 $1,495$ 37.3 4.8 27.4 379 $2,558$ 38.3 1.6 34.8 379 $2,558$ 38.3 1.6 34.8 122 $1,048$ 35.6 5.0 25.6 60 414 57.2 7.4 40.8 51 417 41.3 9.5 22.9 305 $2,060$ 36.1 1.9 32.1 410 $3,266$ 25.1 1.7 21.5 171 $1,210$ 38.0 4.8 28.2 463 $3,491$ 40.2 2.3 35.4 95 567 28.2 4.7 19.1 95 567 28.2 4.7 19.1</td><td>e ⊦</td><td>/0</td><td></td><td></td><td>19.8</td><td>41.7</td><td>+ е,Е</td></t<> | 502 $2,060$ $04,0$ 5.1 50.1 178 $1,495$ 37.3 4.8 27.4 379 $2,558$ 38.3 1.6 34.8 379 $2,558$ 38.3 1.6 34.8 122 $1,048$ 35.6 5.0 25.6 60 414 57.2 7.4 40.8 51 417 41.3 9.5 22.9 305 $2,060$ 36.1 1.9 32.1 410 $3,266$ 25.1 1.7 21.5 171 $1,210$ 38.0 4.8 28.2 463 $3,491$ 40.2 2.3 35.4 95 567 28.2 4.7 19.1 95 567 28.2 4.7 19.1 | e ⊦ | /0 | | | 19.8 | 41.7 | + е,Е |
| | 178 1,495 37.3 4.8 27.4 379 2,558 38.3 1.6 34.8 122 1,048 35.6 5.0 25.6 60 444 57.2 7.4 40.8 51 417 41.3 9.5 22.9 305 2,060 36.1 1.9 32.1 410 3,266 25.1 1.7 21.5 171 1,210 38.0 4.8 28.2 95 567 28.2 35.4 19.1 95 567 28.2 35.4 19.1 | | | | | 4.04 | 8.00 | |
| $1,4^{20}$ 37.3 4.6 2.74 4.64 6.71 6.7 2.03 34.7 2.558 38.3 1.6 3.48 41.9 6 37.0 2.03 34.7 45.2 4.44 57.2 7.4 40.8 72.2 6.5 17.3 45.2 38.4 4.17 41.3 9.5 22.9 6.5 17.3 45.2 53.3 44.7 70.5 53.3 45.2 53.3 45.2 53.3 45.2 53.3 45.2 53.3 45.2 53.3 45.2 53.3 45.2 53.3 45.2 53.3 45.2 53.3 45.2 53.3 45.2 53.3 53.4 52.3 53.3 $53.$ | 1.6 1.499 57.5 57.5 57.5 57.5 122 1.048 35.6 5.0 25.6 60 444 57.2 7.4 40.8 51 417 41.3 9.5 22.9 305 2.060 36.1 1.9 32.1 410 3.266 25.1 1.7 21.5 171 1.210 38.0 4.8 28.2 463 3.491 40.2 2.3 35.4 95 567 28.2 4.7 19.1 95 567 28.2 4.7 19.1 | , | | | | C 0C | | Ľ, |
| 2.538 38.3 1.0 54.8 41.9 510 2.004 54.0 1.9 2.99 58.4 $1,048$ 35.6 5.0 25.6 47.1 e 95 782 29.3 6.5 17.3 45.2 417 41.3 9.5 22.9 62.5 $e.E$ 28 224 33.4 822 182 53.1 $2,060$ 36.1 1.9 32.1 40.3 $*$ 257 $1,651$ 32.4 2.8 266 38.9 3.266 25.1 1.7 21.5 29.1 $*$ 257 $1,651$ 32.4 2.8 266 38.9 3.266 25.1 1.7 21.5 29.1 $*$ 257 $1,651$ 32.4 2.8 266 38.9 3.246 25.1 1.7 21.5 29.1 $*$ 288 $1,826$ 16.8 1.5 13.7 20.4 3.491 4.8 28.2 48.9 e 13.4 $1,075$ 38.9 5.8 27.2 52.0 3.491 40.2 2.3 35.4 45.3 35.4 45.3 35.4 35.3 27.1 55.7 20.4 3.491 40.2 2.3 35.4 45.3 35.4 45.3 25.35 34.1 2.8 28.1 40.6 3.41 2.82 44.3 27.1 35.6 27.2 27.2 27.2 27.2 27.2 27.4 3.61 41.4 $2.$ | 5/9 2,538 58.5 1.6 54.8 122 1,048 35.6 5.0 25.6 60 444 57.2 7.4 40.8 51 417 41.3 9.5 22.9 305 2,060 36.1 1.9 32.1 410 3,266 25.1 1.7 21.5 171 1,210 38.0 4.8 28.2 463 3,491 40.2 2.3 35.4 95 567 28.2 4.7 19.1 | υ | | | | C.U2 | 4 (| с, Ľ |
| | 122 1,048 35.6 5.0 25.6 60 444 57.2 7.4 40.8 51 417 41.3 9.5 22.9 305 2,060 36.1 1.9 32.1 410 3,266 25.1 1.7 21.5 171 1,210 38.0 4.8 28.2 463 3,491 40.2 2.3 35.4 95 567 28.2 4.7 19.1 | | | | | 29.9 | 38.4 | |
| 1,048 35.6 5.0 25.6 47.1 e 95 782 29.3 6.5 17.3 45.2 414 57.2 7.4 40.8 72.2 e 50.3 9.8 29.9 70.5 417 41.3 9.5 22.9 62.5 $e.E$ 28 23.4 28 29.9 70.5 $2,060$ 36.1 1.9 32.1 40.3 $*$ 257 $1,651$ 33.4 82.5 53.1 $3,266$ 35.1 1.7 21.5 29.1 $*$ 288 $1,826$ 58.1 23.4 23.2 25.5 55.1 27.2 52.0 $3,491$ 40.2 23.3 45.3 38.9 5.8 27.2 52.0 $3,491$ 40.2 23.3 45.3 38.9 5.8 27.2 52.0 $3,491$ 40.2 23.2 45.3 34.1 | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | 1 | | | | 1 | I |
| 444 57.2 7.4 40.8 72.2 e 50.3 9.8 29.9 70.5 $2,060$ 36.1 1.9 32.1 40.3 $*$ 257 1.651 32.4 82 182 53.1 $2,060$ 36.1 1.9 32.1 40.3 $*$ 257 1.651 32.4 82 182 53.1 $3,266$ 25.1 1.7 21.5 29.1 $*$ 288 1826 168 1.5 53.1 $3,201$ 38.0 4.8 28.2 48.9 e 134 1.075 38.9 53.2 55.1 52.0 38.9 $3,491$ 40.2 28.2 48.9 e 134 1.075 38.9 57.2 52.0 52.0 52.0 52.0 $3,491$ 40.2 28.2 45.3 26.6 38.9 57.2 52.3 57.2 52.0 40.7 52.0 40.6 56.6 58.1 40.6 52.6 | ar 60 444 57.2 7.4 40.8 51 417 41.3 9.5 22.9 305 2,060 36.1 1.9 32.1 7^{\dagger} 171 $1,210$ 38.0 4.8 28.2 ar 410 $3,266$ 25.1 1.7 21.5 ad work noise 171 $1,210$ 38.0 4.8 28.2 ansport 463 $3,491$ 40.2 2.3 35.4 95 567 28.2 4.7 19.1 | e | 95 | | | 17.3 | 45.2 | e,E |
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| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | ar 305 2,060 36.1 1.9 32.1 r [†] 171 3,266 25.1 1.7 21.5 ad work noise 463 3,491 40.2 2.3 35.4 ansport 463 3,491 40.2 2.3 35.4 95 567 28.2 4.7 19.1 | e,E | 28 | | | 18.2 | 53.1 | e,E |
| 3,266 25.1 1.7 21.5 29.1 $*$ 288 $1,826$ 16.8 1.5 13.7 20.4 $1,210$ 38.0 4.8 28.2 48.9 e 134 $1,075$ 38.9 5.8 27.2 52.0 $3,491$ 40.2 2.3 35.4 45.3 35.4 45.3 35.2 5353 34.1 2.8 27.1 $55.$ 16.8 567 28.2 4.7 19.1 39.6 e,E 82 493 27.1 5.5 16.8 40.7 444 22.5 4.6 14.0 34.1 $*e,E$ 61 386 22.2 5.2 12.9 35.6 3.614 41.4 2.4 36.2 46.9 $*e,E$ 61 386 22.2 5.2 12.9 35.6 3.614 41.4 2.7 26.3 51.0 e,E 60 311 30.7 5.6 19.9 44.1 $3,626$ 38.0 1.8 34.0 42.1 27.17 33.0 2.3 28.2 38.2 | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | * | 257 | | | 26.6 | 38.9 | |
| 3,266 25.1 1.7 21.5 29.1 $*$ 288 $1,826$ 16.8 1.5 13.7 20.4 $1,210$ 38.0 4.8 28.2 48.9 e 134 $1,075$ 38.9 5.8 27.2 52.0 $3,491$ 40.2 2.3 35.4 45.3 355 $2,535$ 34.1 2.8 20.1 40.6 567 28.2 4.7 19.1 39.6 e,E 82 493 27.1 5.5 16.8 40.7 444 22.5 4.6 14.0 34.1 $* e,E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $* e,E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $* e,E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $* e,E$ 376 $2,642$ 35.2 277 29.6 41.2 $3,626$ 38.0 1.8 34.0 42.1 377 $2,717$ 33.0 2.3 28.2 38.2 $3,626$ 38.0 1.8 34.0 42.1 377 $2,717$ 33.0 2.3 28.2 38.2 | 410 3,266 25,1 1.7 21,5 171 1,210 38,0 4.8 28,2 463 3,491 40,2 2.3 35,4 95 567 28,2 4.7 19,1 | | | | | | | 4 |
| 1,210 38.0 4.8 28.2 48.9 e 13.4 $1,075$ 38.9 5.8 27.2 52.0 $3,491$ 40.2 2.3 35.4 45.3 355 $2,535$ 34.1 2.8 20.1 40.6 567 28.2 4.7 19.1 39.6 e,E 82 493 27.1 5.5 16.8 40.7 444 22.5 4.6 14.0 34.1 $* e,E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $* e,E$ 61 386 22.2 5.7 29.6 41.2 $3,626$ 38.0 1.8 34.0 42.1 377 2.717 33.0 2.3 28.2 38.2 | 171 1,210 38.0 4.8 28.2 463 3,491 40.2 2.3 35.4 95 567 28.2 4.7 19.1 | * | | | | 13.7 | 20.4 | ÷ |
| 3.491 40.2 2.3 35.4 45.3 355 355 2.535 34.1 2.8 28.1 40.6 567 28.2 4.7 19.1 39.6 e,E 82 493 27.1 5.5 16.8 40.7 444 22.5 4.6 14.0 34.1 $*e,E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $*e,E$ 61 386 22.2 5.7 29.6 41.2 432 37.9 5.7 26.3 51.0 e 60 311 30.7 5.6 19.9 44.1 $3,626$ 38.0 1.8 34.0 42.1 377 $2,717$ 33.0 2.3 28.2 38.2 | 463 3,491 40.2 2.3 35.4 95 567 28.2 4.7 19.1 | e | | | | 27.2 | 52.0 | Ш |
| 3,491 40.2 2.3 35.4 45.3 355 2535 34.1 2.8 28.1 40.6 567 28.2 4.7 19.1 39.6 e,E 82 493 27.1 5.5 16.8 40.7 444 22.5 4.6 14.0 34.1 $*e,E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 34.1 $*e,E$ 61 386 22.2 5.7 29.6 41.2 $3,614$ 41.4 2.4 36.2 46.9 $*e,E$ 61 386 22.2 5.7 29.6 41.2 $3,626$ 38.0 1.8 34.0 42.1 e 60 311 30.7 5.6 19.9 44.1 $3,626$ 38.0 1.8 34.0 42.1 377 $2,717$ 33.0 2.3 28.2 38.2 | 463 3,491 40.2 2.3 35.4 95 567 28.2 4.7 19.1 | | | | | | | |
| 3,491 40.2 2.3 35.4 45.3 355 2.535 34.1 2.8 28.1 40.6 567 28.2 4.7 19.1 39.6 e,E 82 493 27.1 5.5 16.8 40.7 444 22.5 4.6 14.0 34.1 $*e,E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $*e,E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $*e,E$ 61 386 22.2 27.7 29.6 41.2 432 37.9 5.7 26.3 51.0 e 60 311 30.7 5.6 19.9 44.1 $3,626$ 38.0 1.8 34.0 42.1 377 2.717 33.0 2.3 28.2 38.2 | $\begin{array}{cccccccccccccccccccccccccccccccccccc$ | | | | | | | |
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| 44422.54.614.034.1 $* e, E$ 6138622.25.212.935.63,61441.42.436.246.9 $* e, E$ 6138622.25.212.935.643237.95.726.351.0e6031130.75.619.944.13,62638.01.834.042.1 377 $2,717$ 33.0 2.3 28.2 38.2 | | e,E | 82 | | | 16.8 | 40.7 | e,E |
| 444 22.5 4.6 14.0 34.1 $* e, E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $* e, E$ 61 386 22.2 5.2 12.9 35.6 $3,614$ 41.4 2.4 36.2 46.9 $* e, E$ 5642 35.2 2.7 29.6 41.2 432 37.9 5.7 26.3 51.0 e 60 311 30.7 5.6 19.9 44.1 $3,626$ 38.0 1.8 34.0 42.1 377 $2,717$ 33.0 2.3 28.2 38.2 | | | | | | | | |
| $\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$ | 71 444 22.5 4.6 14.0 34.1 | | | | | 12.9 | 35.6 | e,E |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$ | 487 3,614 41.4 2.4 36.2 | | | | | 29.6 | 41.2 | |
| 80 432 37.9 5.7 26.3 51.0 e 60 311 30.7 5.6 19.9 44.1 478 3,626 38.0 1.8 34.0 42.1 377 2,717 33.0 2.3 28.2 38.2 | | | | | | | | |
| 478 3,626 38.0 1.8 34.0 42.1 377 2,717 33.0 2.3 28.2 | 80 432 37.9 5.7 26.3 | e | | | | 19.9 | 44.1 | e,E |
| | 478 3,626 38.0 1.8 34.0 | | | | | 28.2 | 38.2 | |
| | e, E use with caution (coefficient of variation 16.6–33.3%), population size and %, respectively. F F too unrelishle to be unblished (coefficient of variation greater than 33.3%), nonulation size and % respectively | | | | | | | |
| e, E use with caution (coefficient of variation 16.6–33.3%), population size and %, respectively. f F too unreliable to be unbliched (coefficient of variation orester than 33.3%), nonulation size and %, respectively | DPOAE. distortion product of oacoustic emissions: FEPTA, four-frequency pure for a vertage over frequencies (0.5, 1, 2, 2). | | | | | | | |

| IABLE 8. Prevalence of Audiometric Notch Among Working Canadians, Aged 16 to 79 Years: Demographics | r Audiome | | | orking Cana | dians, Age | a 16 to 75 | Years: D | emograpi | nics | = | | | | |
|--|--|--|---|--|--|---|--|---|-------------------------------------|---|--|---|-----------------------------------|----------------------------------|
| | | | ¶ ⁸ | [§] Notch $(n = 3, 431)$ | 31) | | | | | L | Notch $(n = 3, 431)$ | 31) | | |
| | | | | | 95% | CI | | | | | | 95% | cI | |
| Characteristics | u | N | % | SE % | From | To | | u | N | % | SE % | From | To | |
| Total Demographic characteristics | 670 | °000 5,558 | 22.0 | 1.6 | 18.6 | 25.7 | | 394 | $^{\circ}000$ 3,118 | 12.3 | 1.1 | 10.1 | 14.9 | |
| Sex Men Women [†] | 414 256 | 3,468 2,090 | 27.5 16.4 | 2.6 2.0 | 22.2 12.6 | 33.6 21.2 | ++ | 304 90 | 2,400 717 | 19.1 5.6 | 1.9 0.8 | 15.2 4.1 | 23.7 7.8 | ++ |
| Age group 16-29 years [†] 30-49 50-79 | 103 297 270 | 933 2,024 2,602 | 14.9 22.9 25.5 | 2.8 7.8 7 | 10.0 17.4 20.6 | 21.7 29.6 31.0 | о Щ * * | 170 | 1,241 | 14.0 15 3 | 1.1 5 c | 11.7 | 16.7 | f,F |
| Education (highest level in household) Postsecondary or more [†] 504 Less than postsecondary 139 | 504 504 139 | 3,998 1,400 | 21.2 25.5 | 1.6 3.3 | 17.8 18.9 | 25.0 33.4 | ÷ | 299 84 | 2,212 851 | 11.7 15.5 | 2.1 | 9.4 10.8 | 21.5 21.7 21.7 |) v |
| Household income $< \$50,000^{\circ}$ \$50,000 to $$100,000$100,000$ or more | 232 235 203 | 1,746 1,799 2,013 | 20.2 21.0 24.9 | 2.8 2.5 2.5 | 14.8 16.9 19.8 | 26.9 25.7 30.9 | | 146 143 105 | 1,217 907 993 | 14.1 10.6 12.3 | 1.2 1.2 2.3 | 11.7 8.2 8.0 | 16.9 13.6 18.5 | e,E * |
| Any hearing loss: FFPTA and/or HFPTA and/or LFPTA. e, E use with caution (coefficient of variation 16.6–33.3%), population size and %, respectively. f, F too unreliable to be published (coefficient of variation greater than 33.3%), population size and %, respectively. DPOAE, distortion product otoacoustic emissions; FFPTA, four-frequency pure tone average over frequencies (3, 4, 6, and 8 kHz); LFPTA, low- frequency pure tone average over frequencies (0.5, 1, 2, and 4 kHz); HFPTA, high-frequency pure tone average over frequencies (3, 4, 6, and 8 kHz), LFPTA, low- frequency pure tone average over frequencies (0.5, 1, and 2 kHz). * [*] significantly different from estimate for reference category (<i>P</i> < 0.05) and (<i>P</i> < 0.01), respectively. * [*] significantly different from estimate for reference category (<i>P</i> < 0.05) and (<i>P</i> < 0.01), respectively. * [*] significantly different from estimate for reference category (<i>P</i> < 0.05) and (<i>P</i> < 0.01), respectively. * [*] significantly different from estimate for reference category (<i>P</i> < 0.05) and (<i>P</i> < 0.01), respectively. * [*] significantly different from estimate for reference category (<i>P</i> < 0.05) and (<i>P</i> < 0.05) and st kHz of ≤ 15 dB, (2) maximal threshold at 3, 4, or 6 kHz ≥ 15 dB higher than the highest threshold for 0.5 and 1 kHz, and (3) threshold at 8 kHz were both minimally at hearing levels 10 dB lower (better than) the maximal threshold for 3, 4, or 6 kHz. (Niskar et al ⁴⁶), ⁽¹ Criteria for audiometric notch 2: thresholds at 2 and 8 kHz were both minimally at hearing levels 10 dB lower (better than) than the threshold for 3, 4, or 6 kHz. (Niskar et al ⁴⁶), ⁽¹ Criteria for audiometric notch 2: thresholds at 2 and 8 kHz were both minimally at hearing levels 10 dB lower (better than) the maximal threshold for 3, 4, or 6 kHz. (Niskar et al ⁴⁶), ⁽¹ Criteria for audiometric notch 2: thresholds at 2 and 8 kHz were both minimally at hearing levels 10 dB lower (better than) the maximal threshold for 3, 4, or 6 kHz. (Niskar et al ⁴⁶), ⁽¹ Criteri | id/or HFPTA : icient of variat lished (coeffic toacoustic em r frequencies om estimate fc s: ⁸ Criteria for aximal thresho | and/or LFPTA. tion 16.6–33.3% ient of variation uissions; FFPTA, (0.5, 1, and 2kF or reference cate audiometric not addiometric not |), population 1 greater than four-frequenc [z], gory $(P < 0.05$ [z], 1: (1) thresh H.z. (Niskar et | size and %, respectively. 33.3%, population size and % y pure tone average over frequ) and ($P < 0.01$), respectively olds at 0.5 and 1 kHz of ≤ 15 d i al ⁴⁶); ^[] Criteria for audiometri | ectively. ion size and %, age over freque), respectively. or audiometrici | respectively. encies (0.5, 1, -, (2) maximal t | 2, and 4 kHz) threshold at 3, tolds at 2 and | ; HFPTA, hi{ 4, or 6 kHz ≥ 8 kHz were b | gh-frequency pu ≥15 dB higher tf | ire tone avera and the highes at hearing leve | ize and %, respectively. 3.3%), population size and %, respectively. y pure tone average over frequencies (0.5, 1, 2, and 4 kHz); HFPTA, high-frequency pure tone average over frequencies (3, 4, 6, and 8 kHz); LFPTA, low-) and ($P < 0.01$), respectively.) and ($P < 0.01$), respectively. olds at 0.5 and 1 kHz of ≤ 15 dB, (2) maximal threshold at 3, 4, or 6 kHz ≥ 15 dB higher than the highest threshold for 0.5 and 1 kHz, and (3) threshold at 8 kHz al ⁴⁶); ¹¹ Criteria for autiometric notch 2: thresholds at 2 and 8 kHz were both minimally at hearing levels 10 dB lower (better than) than the threshold at 4 kHz | cies (3, 4, 6, and 5 and 1 kHz, and better than) than | d 8 kHz); LFP' d (3) threshold | TA, low- at 8 kHz at 4 kHz |

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| 9. Prevalence of Audiometric Notch Among Working Canadians, Aged 16 to 79 Years: Occupational Noise E ion Usage |
|---|
|---|

| Jes CI A set CI is N js N N js N N js N | بب ۵ ۵ ۵ ۳ ۳ | <i>n</i> 88 305 305 169 169 135 89 89 89 | | 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 | % From 5 From 3 9.3 9.3 9 7.4 1 10.1 1 10.1 | 5 | о с, т, с, с, , т, |
|---|--|--|---|--|---|--|---|
| 6 16 70 70 70 70 70 3 12 247 432 'c 88 516 133 93 500 70 70 3 129 164 246 'c 88 516 153 93 516 114 4 18 73 238 'c 134 135 93 516 114 7 44 18 736 'c 88 736 114 <th></th> <th>n 88 305 224 169 104 89 89 89 62</th> <th></th> <th></th> <th>% vr 06</th> <th>To 24.7 15.0 21.5 21.5 28.4 28.4 29.5</th> <th>ಲ್ ಈ ಗ್ರೆಗ್ ಎಲ್ ವಿ ಕ್ರೇರ್ನೆ ವಿ</th> | | n 88 305 224 169 104 89 89 89 62 | | | % vr 06 | To 24.7 15.0 21.5 21.5 28.4 28.4 29.5 | ಲ್ ಈ ಗ್ರೆಗ್ ಎಲ್ ವಿ ಕ್ರೇರ್ನೆ ವಿ |
| 3 4.2 3.17 4.2 3.47 4.2 3.47 4.2 3.45 1.9 1.3 9.3 5.0 0 1.9 1.64 3.66 1.6 3.05 1.9 1.3 9.3 5.0 0 1.8 1.54 2.23 1.70 16.6 2.0 7.4 11.4 1 3.14 8.7 2.38 1.70 16.6 2.0 7.4 11.4 1 3.14 8.7 2.38 1.70 16.6 2.0 7.4 11.4 2 4.4 8.7 2.8 4.0 7.4 1.1 2.4 2 2.15 4.0 7.6 7.6 7.4 1.1 2.4 2 2.1 1.8 7.6 7.6 7.6 7.4 7.4 2 2.1 1.1 7.6 7.6 1.3 1.6 7.4 7.4 2 2.1 1.1 7.6 7.6 1 | ** •* | 88 305 224 169 89 89 89 62 | | | | 24.7 15.0 21.5 21.5 28.4 28.4 29.5 | о, ң, ң, е, н, н, н |
| 3 42 31 43 53 53 510 133 5 | ** •* | 88 305 224 169 89 89 62 62 | | | | 24.7 15.0 21.5 21.5 28.4 28.4 29.5 | с, , , , , , , , , , , , , , |
| 3 4.2 3.4 4.3 4.4 1.1.4 4.1 1.1.4 1.1.4 3 3.4 8.1 3.4 2.38 t^2 1.32 0.0 7.4 1.1.4 4 3.1 1.8 7.36 t^2 3.1 0.0 7.4 1.1.4 5 3.1 1.00 t^2 3.1 0.0 7.4 1.1.4 6 5.5 1.09 t^2 3.1 0.0 7.4 1.1.4 7 4.1 1.01 7.4 1.1.4 1.1.4 1.1.4 7 4.1 1.01 7.6 7.6 1.01 0.0 1.01 0.0 1.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 <td>** م م م بر بر</td> <td>88 305 224 169 104 89 89 62 62</td> <td></td> <td></td> <td></td> <td>24.7 15.0 21.5 21.5 28.4 28.4 29.5</td> <td>с, Е f, F f, F f, E e, E</td> | ** م م م بر بر | 88 305 224 169 104 89 89 62 62 | | | | 24.7 15.0 21.5 21.5 28.4 28.4 29.5 | с, Е f, F f, F f, E e, E |
| 2 19 164 246 305 2.595 11.9 1.3 9.3 15.0 0 18 154 232 24 1.70 16.6 20 12.6 21.5 7 34 8.7 238 2 e.E 57 58 17.4 41 10.1 28.4 7 4.2 219 403 e.E 57 58 17.4 41 10.1 28.4 2 4.2 219 403 e.E 133 100 151 166 10.3 133 10 2 24 133 100 151 166 19 133 16 2 27 18.1 298 69 700 151 166 19 133 2 24 133 113 832 146 111 16 13 134 2 24 13 832 146 111 16 <td< td=""><td>++</td><td>305 224 169 104 89 89 62</td><td></td><td></td><td></td><td>15.0 21.5 11.4 28.4 29.5</td><td>т, б, F е, F е, E</td></td<> | ++ | 305 224 169 104 89 89 62 | | | | 15.0 21.5 11.4 28.4 29.5 | т, б, F е, F е, E |
| 0 29 202 338 1 eE 29 174 114 114 7 34 87 238 1 eE 77 56 174 11 114 9 44 184 376 1 E 57 56 174 41 101 284 9 44 184 376 1 E 57 56 174 41 101 284 3 42 193 1 E 57 56 174 41 101 284 5 21 90 1 E 57 56 131 101 284 133 5 21 90 1 E 100 151 16 113 313 5 21 92 1 E 133 140 14 314 6 61 153 16 113 823 140 151 313 7 21 | 40 | 224 169 104 89 83 62 | | | | 21.5 11.4 28.4 29.5 | , т, ө, т, т, т, т |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | ++ | 224 169 104 89 83 62 | | | | 21.5 11.4 28.4 29.5 | , , , , , , , , , , , , , , , , , , , |
| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$ | ++ | 169 57 104 89 135 62 | ~ ~ ~ | | | 11.4 28.4 29.5 | f, f f, f . E . E . E . E . E . E . E . E . E . E |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | ** | 57 104 89 62 | | | | 28.4 29.5 | f, F, F е, E, E |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | ** | 57 104 89 62 62 | | | | 28.4 29.5 | f, f, f, f, f, f, f, f, f, f, f, f, f, f |
| 9 44 184 376 E 57 556 17.4 4.1 10.1 28.4 3 5 2 213 469 e.E 104 706 22.1 31.1 16.1 29.5 2 4.9 203 420 e 89 760 19.0 4.7 10.7 31.3 2 4.9 203 420 e 89 760 19.0 4.7 10.7 31.3 9 6.7 211 9.97 e 8 760 19.0 6.1 10.4 37.4 2 2.7 18.1 2.93 6.1 11.4 16 19.9 19.0 2 6.4 8.8 36.9 16 11.3 82.2 14.4 17.4 37.4 2 2.1 173 82.3 14.4 11.1 16.1 13.4 2 2.4 17.6 2.4 4 17.6 13.4 <td></td> <td>57 104 89 62 62</td> <td></td> <td></td> <td></td> <td>28.4 29.5</td> <td>е, f, e, E, e, E</td> | | 57 104 89 62 62 | | | | 28.4 29.5 | е, f, e, E, e, E |
| 0 5.9 21.5 6.0 c.E 3 4.2 21.9 40.3 c.E 31 161 295 5 2.7 18.1 29.8 4.0 760 19.0 4.7 10.7 31.3 5 2.7 18.1 29.8 c.E 61 10.0 15.1 16.0 19.0 9 6.7 21.1 49.7 e.E 62 613 20.9 6.1 10.4 37.4 2 6.4 8.8 36.0 f.E 113 832 14.6 19 19.4 37.4 2 7 172 29.2 45.4 e 97 74.6 14.4 17.8 32.5 2 4.4 26.2 45.4 1.6 1.8 32.4 17.7 3 3.1 9.4 1.7 34 17.8 33.5 2 4.4 26.2 45.4 1.6 1.6 1.7 < | | 104 89 62 62 | | | | 29.5 | f,F е,Е |
| 3 4.2 21.9 40.3 104 706 22.1 3.1 16.1 29.5 5 2.7 18.1 29.8 - 135 1,010 15.1 16.6 11.9 19.0 5 2.7 18.1 29.8 - 6.6 30.0 6.7 11.9 19.0 9 6.7 21.1 49.7 6.8 6.1 10.6 15.1 10.4 37.4 2 6.4 8.8 36.9 f.E 11.3 832 14.6 10.8 19.4 2 17.1 29.7 11.3 832 14.4 3.4 17.8 32.5 2 4.4 36.5 6.1 1.6 10.4 37.4 3 2.5 17.9 2.87 * 17.8 32.5 4 3.3 2.14 3.4 17.8 32.5 32.5 3 3.1 3.5 6.8 1.64 1.6 10.7 | ۍ بې نې د. ۱ | 104 89 62 | | | | 29.5 | е, Е |
| 2 4.9 20.5 4.20 e 89 760 190 4.7 107 31.3 30.3 9 6.7 21.1 49.7 e.E 6.3 100 15.1 10.4 31.3 30.3 9 6.7 21.1 49.7 e.E 6.3 61.3 20.9 6.1 10.4 37.4 7 2.7 17.2 29.2 f.E 11.3 83.2 14.6 1.9 10.8 19.4 7 2.7 17.2 29.2 f.E 11.3 83.2 14.4 1.6 10.4 37.4 8 2.5 17.9 28.7 4 7.4 3.4 1.4 3.5.7 1.4 1.4 3.5.7 1.5.4 1.7 1.7 1.7 1.7 1.7 1.7 1.5 2.4 1.6 1.9 1.7 1.7 1.7 1.5 1.5 1.4 1.8 2.5 1.4 1.7 1.7 1.7 | بې ب ې ش | 89 135 62 | | | | | e,E |
| 2 4.9 20.5 4.2.0 e 89 760 19.0 4.7 10.7 31.3 5 2.7 18.1 29.8 1335 1,010 15.1 16 11.9 19.0 9 6.7 21.1 49.7 e.E 6.6 61.3 20.9 6.1 10.4 37.4 9 10.9 14.2 39.2 f.E 6 9.1 16 19.9 19.4 7 2.4 14.2 10.2 28.7 * 175 14.4 16.4 17.8 19.4 8 2.5 17.9 28.7 * 175 24.4 3.4 17.8 32.5 2 4.4 26.5 6.5 1.51 1.51 35.7 23.7 2 3.1 1.51 1.53 1.53 2.4 3.4 17.8 3.7 8 3.1 1.51 1.53 2.4 3.4 17.8 2.3 | , t, t, | 89 135 62 | | | | | е,Е |
| 5 2.7 18.1 2.08 135 1.010 15.1 1.6 11.9 19.0 9 6.7 21.1 49.7 $e.E$ 6.2 6.13 20.9 6.1 10.4 37.4 2 6.4 8.8 56.9 f.E 113 832 14.6 1.9 10.8 19.4 2 6.4 8.8 56.9 f.E 113 832 14.6 1.9 10.8 19.4 2 2.5 179 29.2 4.4 26.2 4.5 3.4 17.8 3.2.5 2 3.3 2.12 35.6 $e.F$ 9.7 776 2.4 3.4 17.8 3.2.5 2 3.3 11.1 28.5 $e.F$ 9.4 2.8 4.7 17.7 2 3.1 11.7 34.1 1.65 2.3 1.3 3.2.5 1.4 2 3.4 1.87 9.4 2.8 4.7 17.7 2 3.1 1.65 2.0 1.65 2.0 3.6 | | 135 62 | | | | 31.3 | |
| 0 6.7 21.1 49.7 c.E 6.2 613 209 6.1 10.4 37.4 2 6.4 8.8 36.9 f.E 113 832 14.6 19 10.4 37.4 2 6.4 8.8 36.9 f.E 113 832 14.6 19 10.8 19.4 2 2.7 17.2 29.2 4.54 * 175 14.9 11.1 16 19.4 34 15.1 2 3.3 21.2 35.6 e.E 97 7.449 11.1 16 15.3 32.5 3 3.3 21.2 35.6 e.E 20.4 16.8 3.4 17.8 32.7 7 5.1 11.1 2.85 e.E 20.4 1.634 18.7 2.5 13.9 17.7 7 5.1 11.7 34.4 1.634 18.7 2.5 3.4 3.7 17.7 | | 62 | | | | 19.0 | |
| 9 6.7 21.1 49.7 $e.E$ 62 613 20.9 6.1 10.4 37.4 7 6.7 21.1 49.7 $e.E$ 6.2 613 20.9 6.1 10.4 37.4 7 6.7 17.2 39.2 $f.E$ 11.3 83.2 14.6 1.9 10.8 19.4 8 2.5 179 28.7 $*$ 175 1449 11.1 16 8.1 15.1 8 3.3 21.2 35.6 $e.E$ 97 776 244 3.4 178 32.5 8 3.3 21.2 35.6 $e.E$ 94 2.8 4.7 17.7 7 5.1 11.7 24.6 1.634 18.7 2.5 13.9 24.8 7 5.1 11.7 34.1 1.574 16.5 2.0 3.6 2.9 $3.13.6$ 2.9 3.7 2.14 7 3.17 3.57 | | 62 | | | | | |
| 9 109 14.2 59.2 f.E 2 6.4 8.8 36.9 f.E 113 832 14.6 1.9 108 19.4 2 2.7 17.2 29.2 * 175 1,449 11.1 1.6 8.1 15.1 2 4.4 26.2 45.4 e 97 776 24.4 3.4 17.8 3.25 3 3.3 21.2 35.6 e.E 191 1.581 18.2 2.2 13.8 23.7 7 5.1 11.1 28.5 e.E 191 1.581 9.4 2.8 4.7 17.7 7 5.1 11.7 34.1 6.8 2.4 18.7 2.5 13.9 2.48 7 5.1 11.7 34.6 1.6 1.65 2.6 2.4 17.7 17.7 6 5.1 10.4 1.6.7 1.6.7 2.6 2.9 2.9 2.9 2.48 6 5.2 11.7 34.6 1.57 1.57 | | | | | | 37.4 | е,Е |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | | | | | | f,F |
| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$ | 2.62 | | | | | | f,F |
| 82517928.7*1751,44911.11.68115.124.426.245.4e9777624.43.417.832.583.321.235.6e.E1911.58118.22.213.823.775.111.128.5e.E1911.58118.22.213.823.775.111.734.1e.E2041.63418.72.513.924.875.211.734.5f.E2041.63418.72.513.924.895.211.734.6f.E1981.57416.52.03.631.295.211.734.6f.E1981.57416.52.012.931.263.120.43.391.57416.52.012.521.495.211.734.6f.E1981.57416.52.012.521.495.211.734.6f.E1981.57416.52.012.521.495.211.734.6f.E1981.57416.52.012.521.495.211.734.6f.E1981.57416.52.012.521.495.211.734.6f.E1981.57416.52.012.521.495.2 <td< td=""><td>1</td><td>113</td><td></td><td></td><td></td><td>19.4</td><td></td></td<> | 1 | 113 | | | | 19.4 | |
| 8 2.5 17.9 28.7 * 17.5 1,449 11.1 1.6 8.1 15.1 2 4.4 26.2 45.4 e 97 776 24.4 3.4 17.8 3.5.5 2 3.9 11.1 28.5 e.E 191 1,581 18.2 2.2 13.8 23.7 2 3.9 11.1 28.5 e.E 204 1,634 18.7 2.5 13.9 24.8 7 17.7 2 3.6 20.1 35.7 2.04 1,634 18.7 2.5 13.9 24.8 7 31.2 9 5.2 11.7 34.6 f.E 204 1,654 18.7 2.5 13.9 24.8 6 3.1 20.4 33.9 1,574 16.5 2.0 12.5 21.4 6 3.1 20.4 16.5 2.0 16.5 2.0 12.5 21.4 16 5.3 poldation size and %, respectively. 17.2 5.0 8.7 31.2 <t< td=""><td>-</td><td></td><td></td><td></td><td></td><td></td><td>+</td></t<> | - | | | | | | + |
| 2 4.4 26.2 45.4 e 97 776 24.4 3.4 17.8 32.5 8 3.3 21.2 35.6 e.E 191 1.581 18.2 2.2 13.8 23.7 2 3.9 11.1 28.5 e.E 9.4 1.631 18.2 2.8 4.7 17.7 7 5.1 11.7 34.1 e.E 20 136 6.9 2.0 3.6 12.9 $^{+1}$ 9 5.2 11.7 34.6 f.E 173 2.4 16.5 2.1 3.9 24.8 $^{+1}$ 9 5.2 11.7 34.6 f.E 172 5.0 8.7 31.2 $^{+1}$ 9 5.2 11.7 34.6 f.E 198 1.574 16.5 2.0 12.5 21.4 $^{-1}$ 9 1.574 16.5 $^{-1}$ 2.0 12.5 21.4 $^{-1}$ 9 1.574 16.5 2.0 12.5 21.4 $^{-1}$ 9 1.574 16.5 2.0 12.5 2.14 $^{-1}$ 9 1.575 1.74 16.5 $^{-1}$ 9 1.575 1.74 16.5 $^{-1}$ 9 1.575 1.74 16.5 $^{-1}$ 1.5 and 4.8 kH_2; HFPTA, high-frequency pure tone average over frequencies (0.5, 1, 2, and 4.8 kH_2; HFPTA, high-frequency pure tone average over frequencies (0.5, 1, 2, and 4.8 kH_2; HFPTA, high-frequency pure tone average over frequencies (0.5, 1, 5, and 4.8 kH_2; HFPTA, high-frequency pure tone average over frequencies (0.5, 1, 5, and 4.8 kH_2; HFPTA, high-frequency pure tone average over frequencies (0.5, 1, 5, and 4.8 kH_2; HFPTA, high-frequency pure tone average over frequencies (0.5, 1, 5, and 4.8 kH_2; HFPTA, high-frequency pure tone average o | | 175 | | | | 15.1 | |
| 8 3.3 21.2 35.6 191 1,581 18.2 2.2 13.8 23.7 2 3.9 11.1 28.5 e.E 9.4 2.8 4.7 17.7 7 5.1 11.7 24.1 e.E 204 1,634 18.7 2.5 13.9 24.8 9 5.1 11.7 34.1 e.E 204 1,634 18.7 2.5 13.9 24.8 9 5.2 11.7 34.6 f.E 204 1,634 18.7 2.5 13.9 24.8 9 5.2 11.7 34.6 f.E 172 5.0 8.7 31.2 6 5.2 11.7 34.6 f.E 157.4 16.5 2.0 12.5 21.4 6 5.1 20.4 1.574 16.5 2.0 12.5 21.4 7 31.3%), population size and %, respectively. 133.3%), population size and %, respectively. 1574 16.5 2.0 12.5 21.4 6 6.0.051 su d (P < 0.01), respectively. | | 91 | | | | 32.5 | e |
| 8 3.3 21.2 35.6 191 1,581 18.2 2.2 13.8 23.7 7 5.1 11.1 28.5 $e.E$ 9.4 2.8 4.7 17.7 7 5.1 11.7 34.1 $e.E$ 204 1,634 18.7 2.5 13.9 24.8 7 5.1 11.7 34.1 $e.E$ 204 1,634 18.7 2.5 13.9 24.8 9 5.2 11.7 34.6 $f.E$ 204 1,634 18.7 2.5 13.9 24.8 9 5.2 11.7 34.6 $f.E$ 198 1,574 16.5 2.0 12.5 21.4 6 5.1 20.4 33.9% 198 1,574 16.5 2.0 12.5 21.4 1.33.3% poulation size and $\%$, respectively. 1.36 1.574 16.5 2.0 12.5 21.4 1.frequency pure tone average over frequencies (0.5, 1, 2, and 4.kH2); HFPTA, high- | | | | | | | |
| 8 3.3 21.2 35.6 191 $1,581$ 18.2 2.2 13.8 23.7 7 5.1 11.1 28.5 $e.E$ 20 156 6.9 2.0 3.6 12.9 4 7 5.1 11.7 34.1 $e.E$ 204 $1,634$ 18.7 2.5 13.9 24.8 2 3.6 20.1 35.7 2.04 $1,634$ 18.7 2.5 13.9 24.8 9 5.2 11.7 34.6 $F.E$ 204 $1,574$ 16.5 2.0 12.5 21.4 9 5.2 11.7 34.6 $F.E$ 198 $1,574$ 16.5 2.0 12.5 21.4 6 3.1 20.4 15.74 16.5 2.0 12.5 21.4 6 3.1 20.4 $1,574$ 16.5 2.0 12.5 21.4 6 $3.3.3\%$ 9.0 9.6 1.53 2.0 | | | | | | | |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | 191 | | | | 23.7 | * |
| 7 5.1 11.7 34.1 e.E 20 136 6.9 2.0 3.6 12.9 4 2 3.6 20.1 35.7 2.04 1,634 18.7 2.5 13.9 24.8 9 5.2 11.7 34.6 f.E 17.2 5.0 8.7 31.2 6 3.1 20.4 198 1,574 16.5 2.0 12.5 21.4 opulation size and %, respectively. ter than 33.3%), population size and %, respectively. ter quencise (0.5, 1, 2, and 4.kH2); HFPTA, high-frequency pure tone average over frequencies (0.5, 4, 6, and 8.kH2); LFPTA, 1 (<i>P</i> < 0.05) and (<i>P</i> < 0.01), respectively. | | | | | | 17.7 | ť,E |
| 7 5.1 11.7 34.1 e,E 20 136 6.9 2.0 3.6 12.9 * 2 3.6 20.1 35.7 2.04 $1,634$ 18.7 2.5 13.9 24.8 9 5.2 11.7 34.6 f,E 204 $1,634$ 18.7 2.5 13.9 24.8 .6 3.1 20.4 33.9 f,E 198 $1,574$ 16.5 2.0 8.7 31.2 .6 3.1 20.4 33.9 198 $1,574$ 16.5 2.0 12.5 21.4 .9 33.3% , population size and $\%$, respectively. 198 $1,574$ 16.5 2.0 12.5 21.4 .1 16.5 2.0 12.5 21.4 31.2 21.4 .1 20.4 33.3% , population size and $\%$, respectively. 1.574 16.5 2.0 12.5 21.4 .1 .1 20.3 10.6 1.7 20.0 12.5 21 | | | | | | | + |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | 20 | | | | 12.9 | ⁺ е,Е |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | 1.65 | 204 | | | | 24.8 | |
| 9 5.2 11.7 34.0 1.5 $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.2$ $5.1.4$ $5.1.4$ $5.1.4$ $5.1.2$ $5.1.4$ | | | - | | | 6 | ļ |
| .6 opulation siz 2ater than 33 r-frequency / (P < 0.05) | | | | | | 31.2 | 1,E |
| opulation sizater than 33 r-frequency ($P < 0.05$) | 33.9 | 198 | | | | 21.4 | |
| | espectively. cies (0.5, 1, 2, and 4kH | (z); HFPTA, high- | frequency pure to | one average over | frequencies (3, 4, 6 | 6, and 8kHz); LFP | TA, low- |
| Reference category. Nucliometric notch definitions: ⁸ Criteria for audiometric notch 1: (1) thresholds at 0.5 and 1 kHz of $\leq 15 \text{dB}$, | | 35.6 e,E 28.5 e,E 34.1 e,E 35.7 e,E 34.6 f,E 33.9 f,E 33.9 f,E 33.9 (0.5, 1, 2, and 4kH icies (0.5, 1, 2, and 4kH | 35.6 e.E 191 28.5 e.E 20 34.1 e.E 20 35.7 e.E 204 34.6 f.E 198 33.9 f.E 198 33.9 and 4kHz); HFPTA, high- teise (0.5, 1, 2, and 4kHz); HFPTA, high- | 35.6 $e.E$ 191 1,581 1 28.5 $e.E$ 136 1 34.1 $e.E$ 204 1,634 1 34.6 $f.E$ 204 1,634 1 34.6 $f.E$ 198 1,574 1 33.9 $f.E$ 198 1,574 1 espectively. 198 1,574 1 ciss (0.5, 1, 2, and 4kHz); HFPTA, high-frequency pure to the second at 3, 4, or 6 kHz \ge 15 dB higher than to to the second at 3, 4, or 6 kHz \ge 15 dB higher than to notch 2: thresholds at 2 and 8 kHz were both minimally at the second seco | 35.6 $c.E$ 191 1,581 18.2 2 28.5 $c.E$ 9.4 2 34.1 9.4 2 34.1 $c.E$ 20 136 6.9 2 35.7 2.04 1,634 18.7 2 34.6 $f.E$ 204 1,634 18.7 2 34.6 $f.E$ 198 1,574 16.5 2 33.9 $1,574$ 16.5 2 2 33.9 $1,574$ 16.5 2 2 respectively. 198 $1,574$ 16.5 2 ciss (0.5, 1, 2, and 4,kHz); HFPTA, high-frequency pure tone average over these over these over the second at 3, 4, or 6, kHz ≥ 15 dB higher than the highest thresh over the over the second at 2 and 8, kHz were both minimally at hearing levels 1 | 35.6 $e.E$ 191 1,581 18.2 2.2 13.8 28.5 $e.E$ 9.4 2.8 4.7 34.1 $e.E$ 20 136 6.9 2.0 3.6 35.7 2.04 1,634 18.7 2.5 13.9 34.6 F.E 204 1,634 18.7 2.5 13.9 34.6 F.E 198 1,574 16.5 2.0 8.7 33.9 I.B 1,574 16.5 2.0 12.5 aspectively. 1,23 16.5 2.0 12.5 cise (0.5, 1, 2, and 4kHz); HFPTA, high-frequency pure tone average over frequencies (3, 4, 6 cise (0.5, 1, 2, and 4kHz); HFPTA, high-frequency pure tone average over frequencies (3, 4, 6 cise (0.5, 1, 2, and 4kHz); HFPTA, high-frequency pure tone average over frequencies (3, 4, 6 cise (0.5, 1, 2, and 4kHz); HFPTA, high-frequency pure tone average over frequencies (3, 4, 6 cise (0.5, 1, 2, and 8kHz were both minimally at hearing levels 10-dB lower (better tone tone 2 and 8 kHz were both minimally at hearing levels 10-dB lower (better tone tone 2 and 8 kHz were both minimally at hearing levels 10-dB lower (better tone tone average over 1 and | tie of load work noise the of load work load work noise the of load work load load work load work load load work load work load work load work load load work load load work load wor |

| TABLE 10. Prevalence of Self-Reported Occupational | of Self | -Repo | rted | Occu | patior | | se Ex | oosure | i by Sc | ource | of No | ise A | nong | Noise Exposure by Source of Noise Among Canadians, Aged 16 to 79 Years | ians, . | Aged | 16 to | γ 62 (| ears | | | | | | |
|--|---|--|---|--|--|------------------------------------|----------------------|--------------|-------------------------|------------------|-----------------------|----------------------|---------------------------|--|----------------------|------------|-------|----------------|-------------------|--------|---------------------|--------------------|-------------------|----------------------|------|
| | | | N | 1 achin | Machine/Transport [§] | sport [§] | | | | | | M | Music/People [§] | ple [§] | | | | | | | Otl | Other [§] | | | |
| | | | | | | 95 % | % CI | | | | | | | 95 | 95% CI | 1 | | | | | | | 95% CI | CI | |
| Characteristics | и | Ν | CV | % | SE % | From | 1 To | CV | <i>u</i> * | Ν | CV | 1 % | SE % | 6 From | a To | CV | * | и | N (| CV | % S | SE % | From | To | CV * |
| Total | 1,166 | °000 1,166 9,129 | | 81.2 | 1.6 | 77.3 | 84.6 | <u>,</u> | 279 | ,000° 2,056 | <u>5</u> 6 | 18.3 | 3 1.4 | 15.5 | 21.5 | 2 | | 190 1 | °000 1,171 | E 1 | 10.4 | 1.6 | 7.4 | 14.5 | |
| Men Women [†] | 913 253 | 7,179 1,950 | Щ | 88.9 61.7 | 1.7 3.6 | 84.6 53.6 | 92.0 69.2 | | [‡] 128 151 | 8 1,081 1 974 | 81 74 | 13.4 30.8 | t 1.1 3 3.2 | 11.1 24.3 | 16.1 38.3 | 3 1 | + | 119 71 | 763 407 | нц | 9.4 12.9 | 1.5 3.2 | 6.6 7.3 | $13.3 \\ 21.8$ | ш |
| Age group 16-29 years 30-49 years 50-79 years | 210 472 484 | 1,934 3,564 3,631 | | 73.9 82.3 84.7 | 5.8 3.0 3.0 | 59.5 74.6 76.9 | 84.5 88.0 90.1 | <u> </u> | 83 121 75 | | 854 737 E 465 E | 32.6 17.0 10.8 | 5 5.0 0 3.1 3 1.7 | 22.6 11.2 7.6 | 44.5 25.0 15.2 | 5 0 S | * ++ | 36 71 83 | 300 416 454 | ппп | 11.5 9.6 10.6 | 2.7 2.4 2.0 | 6.7 5.5 7.0 | 18.9 16.4 15.8 | шшш |
| Postsecondary or more [†] 829 6, Less than postsecondary 304 2, | 1001seno 829 304 | asenoid) 829 6,432 304 2,447 | | 79.5 86.5 | $1.8 \\ 3.9$ | 75.3 75.3 | 83.1 93.1 | | 208 60 | 8 1,517 0 501 | 17 01 E | 18.8 17.7 | 8 1.8 7 5.1 | 15.1 9.1 | 23.1 31.6 | 1 6 E | | 144 | 888 | Е Г | 11.0 | 2.2 | 7.0 | 16.7 | ы г |
| Household income $< $50,000^{\dagger}$ \$50,000 to $< $100,000$100,000$ or more | 461 392 313 | 3,282 2,847 3,000 | | 79.6 78.2 86.4 | 2.1 3.0 2.1 | 74.5 70.9 81.1 | 83.9 84.0 90.3 | ~ ~ ~ | 133 85 61 | | 869 795 392 E | 21.1 21.8 11.3 | 3.2 | 14.9 16.3 7.4 | 28.9 28.6 16.8 | ш 8 0 0 | | 78 71 41 | 460 396 314 | ппп | 11.2 10.9 9.0 | 2.4 2.3 | 6.9 6.0 5.1 | 17.5 18.8 15.5 | шшш |
| E use with caution (coefficient of variation 16.6–33.3%). F too unreliable to be published (coefficient of variation greater than 33.3%) *Significantly different from estimate for reference category ($P < 0.05$). ^t Reference category. ^t Significantly different from estimate for reference category ($P < 0.01$). ^s Among individuals who have ever worked in a noisy environment. Source: 2012/2013 Canadian Health Measures Survey (Cycle 3). | ent of va shed (coc 1 estimate 1 estimate we ever v n Health | e for refi sfricient e for refi vorked j Measure | 16.6–3 of var ference erence in a no es Surv | 3.3%). iation g catego catego isy env 'ey (Cy | reater th ry $(P < ($ y $(P < ($ ironmen cle 3). | an 33.3% 1.05). 1.01). t. | (| | | | | | | | | | | | | | | | | | |

| | | | Ever | Experi | enced T | innitus [§] | | | | Т | innitus | When | Quiet | (Always | s, Often, | Somet | imes) | 1 |
|--|---------------|------------|------|---------------|---------|----------------------|------|----|--------|-----|---------|------|--------------|------------|---------------------|--------------|-------|---|
| | | | | | | 95% | CI | | _ | | | | | | 95% | CI | | |
| Characteristics | n | N | CV | % | SE % | From | То | CV | * | n | N | CV | % | SE % | From | То | CV | * |
| | | ,000 | | | | | | | | | ,000 | | | | | | | |
| Total | 1,654 | 11,539 | | 43.2 | 1.8 | 39.3 | 47.2 | | | 568 | 3,881 | | 72.0 | 3.1 | 64.7 | 78.3 | | |
| Demographic characteristic | es | | | | | | | | | | | | | | | | | |
| Sex | | | | | | | | | ÷ | | | | | | | | | |
| Men | 857 | 6,319 | | 47.6 | 2.7 | 41.8 | 53.5 | | ŧ | 287 | 1,951 | | 67.6 | 4.8 | 56.3 | 77.2 | | |
| Women [†] | 797 | 5,220 | | 38.8 | 1.8 | 35.0 | 42.8 | | | 281 | 1,930 | | 77.0 | 3.1 | 69.5 | 83.1 | | |
| Age group | 1.00 | | | | | 14.0 | | | | | | - | <0. 7 | | 5 2 2 | 00 <i>(</i> | | |
| 16–29 years [†] | 468 | 3,398 | | 52.9 | 2.7 | 46.9 | 58.8 | | ţ | 117 | 1,044 | E | 68.5 | 6.4 | 53.2 | 80.6 | | |
| 30-49 | 589 | 3,747 | | 39.6 | 2.4 | 34.4 | 45.1 | | + ‡ | 147 | 726 | Е | 53.5 | 6.1 | 40.2 | 66.3 | | |
| 50-79 | 597 | 4,394 | | 40.6 | 2.6 | 35.0 | 46.4 | | ÷ | 304 | 2,111 | | 84.1 | 2.6 | 77.4 | 89.1 | | ~ |
| Education (highest level in | | | | | | 20.4 | | | | 100 | | | | | | | | |
| Postsecondary or more [†] | 1,221 | 8,218 | | 41.4 | 1.5 | 38.1 | 44.7 | | * | 409 | 2,722 | - | 73.5 | 3.9 | 64.2 | 81.1 | | |
| Less than postsecondary | 375 | 2,855 | | 48.6 | 3.5 | 41.1 | 56.2 | | | 141 | 998 | Е | 66.5 | 5.6 | 53.3 | 77.5 | | |
| Household income | (11 | 2 0 2 5 | | 41.0 | | 26.0 | 16.0 | | | 246 | 1 41 4 | Б | 72.0 | 4.7 | (1.4 | 00.1 | | |
| <\$50,000 [†] | 641 | 3,835 | | 41.0 | 2.3 | 36.0 | 46.3 | | | 246 | 1,414 | Е | 73.0 | 4.7 | 61.4 | 82.1 | | |
| \$50,000 to <\$100,000 | 553 | 4,376 | | 48.4 | 3.1 | 41.6 | 55.3 | | | 191 | 1,681 | | 79.3 | 4.3 | 68.1 | 87.2 | | |
| \$100,000 or more | 460 | 3,328 | | 39.9 | 2.7 | 34.2 | 45.9 | | | 131 | 787 | | 58.9 | 6.3 | 44.6 | 71.8 | | |
| Occupational characteristic | | | | | | | | | | | | | | | | | | |
| Currently working in a noi | | | | 55 A | 5.2 | 12 (| | | * | | 420 | Б | 55.0 | 0.0 | 25.0 | 72 7 | Е | |
| Yes No [†] | 250 | 2,029 | | 55.4 | 5.3 | 43.6 | 66.6 | | | 77 | 430 | E | 55.2 | 9.2 | 35.2 | 73.7 | E | |
| | .1,404 | 9,510 | | 41.3 | 2.0 | 37.0 | 45.7 | | | 491 | 3,451 | | 74.8 | 3.5 | 66.3 | 81.8 | | |
| Ever worked in a noisy en Yes | 791 vironinei | n 5,744 | | 51.1 | 2.9 | 44.8 | 57.4 | | ţ | 291 | 1,959 | | 75.1 | 4.5 | 64.0 | 83.7 | | |
| No [†] | 863 | 5,744 | | 37.4 | 2.9 | 44.8 32.5 | 42.7 | | | 291 | 1,939 | | 69.0 | 4.5 5.1 | 56.8 | 85.7 79.0 | | |
| Time worked in noisy envi | | , | | 57.4 | 2.5 | 52.5 | 42.7 | | | 211 | 1,922 | | 09.0 | 5.1 | 50.8 | 79.0 | | |
| <12 months | 202 | 1,259 | Е | 47.0 | 5.0 | 36.2 | 58.1 | | | 54 | 278 | Е | 70.1 | 8.0 | 50.3 | 84.4 | | |
| 1 year to <5 years | 202 | 1,239 | Ľ | 53.8 | 5.5 | 41.6 | 65.5 | | | 65 | 635 | E | 75.3 | 11.6 | 43.6 | 92.3 | | |
| 5 years to <10 years | 114 | 970 | | 53.8 | 7.0 | 38.4 | 68.4 | | | 40 | 261 | E | 68.1 | 13.1 | 43.0 36.1 | 92.5 89.0 | Е | |
| 10 years or more ^{\dagger} | 266 | 1,774 | | 50.5 | 3.7 | 42.4 | 58.7 | | | 132 | 785 | E | 79.8 | 5.9 | 63.8 | 89.0 | Ľ | |
| Used hearing protection at | | 1,774 | | 50.5 | 5.7 | 42.4 | 56.7 | | | 132 | 785 | Б | 79.0 | 5.9 | 05.8 | 09.0 | | |
| Always/often [†] | 268 | 2,274 | | 53.7 | 4.1 | 44.6 | 62.6 | | | 90 | 653 | Е | 70.2 | 6.3 | 54.8 | 82.1 | | |
| Sometimes/rarely/never | 523 | 3,470 | | 49.6 | 3.7 | 44.0 | 57.6 | | | 201 | 1,306 | Б | 77.9 | 3.9 | 68.2 | 85.2 | | |
| Hearing protection required | | 5,770 | | ч <i>у</i> .0 | 5.7 | 71.0 | 57.0 | | | 201 | 1,500 | | 11.9 | 5.7 | 00.2 | 0.5.2 | | |
| Yes/yes | 191 | 1,675 | Е | 53.2 | 4.8 | 42.7 | 63.5 | | | 60 | 525 | Е | 69.0 | 7.4 | 50.9 | 82.7 | | |
| Yes/no [†] | 64 | 449 | E | 55.8 | 11.6 | 31.0 | 78.0 | Е | | 24 | 208 | E | 83.7 | 10.8 | 47.2 | 96.7 | | |
| No/yes | 71 | 576 | E | 56.0 | 9.0 | 36.4 | 73.9 | 1 | | 27 | 200 | F | 73.9 | 9.5 | 49.0 | 89.3 | | |
| No/no | 437 | 2,853 | 1 | 47.8 | 3.3 | 40.6 | 55.1 | | | 166 | 1,051 | 1 | 76.3 | 5.3 | 62.7 | 86.1 | | |
| Job category | -57 | 2,000 | | 77.0 | 5.5 | 40.0 | 55.1 | | | 100 | 1,051 | | 70.5 | 5.5 | 02.7 | 00.1 | | |
| White collar | 791 | 5,836 | | 43.2 | 1.8 | 39.2 | 47.4 | | | 230 | 1,865 | | 73.3 | 2.8 | 66.8 | 78.9 | | |
| Blue collar ^{\dagger} | 210 | 1,472 | Е | 42.4 | 5.7 | 30.7 | 55.1 | | | 60 | 244 | Е | 48.9 | 13.1 | 23.3 | 75.1 | Е | |
| | 210 | 1,772 | Ц | 12.7 | 5.7 | 55.7 | 55.1 | | | 00 | 277 | - | 10.7 | 1.5.1 | 20.0 | , 5.1 | г | |

TABLE 11. Prevalence of Self-Reported Tinnitus Among Canadians Aged 16 to 79 Years: Demographics, Duration of Occupational Noise Exposure, Hearing Protection Usage, "Blue Collar," "White Collar" Workers

E use with caution (coefficient of variation 16.6-33.3%).

F too unreliable to be published (coefficient of variation greater than 33.3%).

Significantly different from estimate for reference category (P < 0.05).

Reference category.

[‡]Significantly different from estimate for reference category (P < 0.01).

[§]Universe: all respondents aged 16-79 years.

Universe: respondents who had tinnitus within the past month; "current tinnitus."

Source: 2012/2013 Canadian Health Measures Survey (Cycle 3).

In the present study, the odds of having a measured HL for FFPTA and LFPTA was twice as high for workers who worked in a noisy workplace for 10 years or more compared with those who had never worked in such an environment, even after adjusting for age and sex. Although we would have expected the same finding for HFPTA HL, this was not the case. There may be several explanations for this finding, one of which may be related to the use of HP in those exposed to a noisy work environment for 10 years or more. It is possible that HP usage in these workers protected them from developing HFPTA HL; however, further research examining this specific issue would be needed. Another explanation may be related to sample size. The addition of Cycle 4 hearing data, and analyses of the combined dataset (approximately 7000 respondents), may show higher odds for high-frequency HFPTA HL.

"Blue collar" workers in the present study had a significantly higher prevalence of any PTA HL than "white collar" workers, with the rate of FFPTA HL being nearly double, which is consistent with the findings reported by Rubak et al.⁵² This Danish populationbased study found 30% of industrial trade workers, aged 20 to 45 years, had HL at twice the prevalence of the reference population (office workers and residents exposed to traffic noise) with a fourfold increase among construction workers, despite the restricted age group and more stringent HL threshold (20 dB threshold, PTA: 2, 3, 4 kHz) than used in the present study.⁵² The exclusion of individuals

| FPTAI | FFPTAHFPTA95%95%95%95%Solution in the value of the confidenceAdjusted Interval OddsAdjusted IntervalAdjusted IntervalAdjusted ConfidenceAdjusted IntervalSolutionSexAdjusted IntervalOddMen2.21.33.8*2.1Men2.21.1Men2.21.1Men2.21.1Men2.21.1Men2.21.1Men2.21.1Men2.21.1Men2.21.1Men1.11.1Men1.1Men2.21.1Men1.1Men1.1Men1.11.11.11.11.1Note: relation (highest level in household)1.1Note: relation (highest level in household) <th col<="" th=""><th></th><th></th><th></th><th></th><th></th><th>H</th><th>earing Lo</th><th>oss, Note</th><th>Hearing Loss, Notch, and DPOAE</th><th>OAE</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th> | <th></th> <th></th> <th></th> <th></th> <th></th> <th>H</th> <th>earing Lo</th> <th>oss, Note</th> <th>Hearing Loss, Notch, and DPOAE</th> <th>OAE</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> | | | | | | H | earing Lo | oss, Note | Hearing Loss, Notch, and DPOAE | OAE | | | | | | | |
|---|---|---|---------------------|--------------------------|-------------------|-------------|------------------|----------------|-------------|------------------|--------------------------------|-------------|------------------|-----------------|-------------|------------------|------------------------|------------------|-----|
| $ \frac{95\%}{1000000000000000000000000000000000000$ | 95% 95%95% 95%Adjusted Interval95% ConfidenceAdjusted Interval55% OddsAdjusted IntervalAdjusted Interval60dds AdjustAdjusted OddsFrom ToTOAdjusted IntervalAdjusted OddsAdjust AdjustSex Men2.21.33.8* I.1.2.11.0OddAdjusted AdjustAdjust AdjustAdjustAdjusted OddsAdjust AdjustSex Men2.21.33.8* I.1.2.1Adjusted AdjustAdjustAdjust AdjustAdjust AdjustAdjust2.21.11.1Noment1.11.1Adjust2.21.1Adjust2.21.33.8* I.1.1Men2.11.0Adjust2.11.1Adjust2.11.1NewerfI.1.1.1 <th c<="" th=""><th>FFPTA</th><th>1</th><th>IH</th><th>FPTA</th><th></th><th>L.I</th><th>PTA</th><th></th><th>An</th><th>y HL</th><th></th><th>Audiome</th><th>etric Note</th><th>ch‡</th><th>Absen</th><th>Absent DPOAE</th><th>F</th></th> | <th>FFPTA</th> <th>1</th> <th>IH</th> <th>FPTA</th> <th></th> <th>L.I</th> <th>PTA</th> <th></th> <th>An</th> <th>y HL</th> <th></th> <th>Audiome</th> <th>etric Note</th> <th>ch‡</th> <th>Absen</th> <th>Absent DPOAE</th> <th>F</th> | FFPTA | 1 | IH | FPTA | | L.I | PTA | | An | y HL | | Audiome | etric Note | ch‡ | Absen | Absent DPOAE | F |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | Adjusted IntervalConfidence IntervalAdjusted IntervalConfidence Adjust Adjust RatioAdjusted IntervalAdjust Adjust Adjust AdjustSex MenRatioFromToRatioFromToAdjust AdjustSex MenMen2.21.33.8*2.11.33.8*Sex Men1.11.11.11.11.11.1Sex Men1.01.0Age (continuous)1.11.11.11.11.1Age (continuous)1.11.11.11.11.1Age (continuous)1.11.11.11.11.1Postsecondary or more†1.01.01.0Dotty contract1.01.0-1.0Less than postsecondary1.81.22.7*1.80.93.71.7Neverf1.01.01.01.0Up to 10 years0.70.41.50.73.02.2Any HL: FFPTA and/or LFPTA1.13.7*1.50.73.02.2Any HL: FFPTA and/or HFPTA1.13.7*1.50.73.02.2Any HL: FFPTA and/or HFPTA1.13.7*1.50.73.02.2Any HL: FFPTA and/or HFPTA1.13.7*1.50.73.02.2Any HL: FFPTA and/or HFPTA1.0 | | 95% | | 956 | 2 | | 956 | .0 | | 626 | .0 | | 656 | 20 | | 95% | 20 | |
| Ratio From To Ratio Factor Factor Factor Factor <th>RatioFromToRatioFromToRatioSexMen2.21.33.8*2.11.04.2*1.3Women†1.01.01.0Age (continuous)1.11.11.11.11.1*1.1Education (highest level in household)1.01.0Postsecondary1.81.2$2.7^*$1.80.9$3.7$1.7Time worked in a noisy environment1.01.0Up to 10 years0.70.41.50.73.02.2Any HL: FFPTA and/or LFPTA.Any HL: FFPTA and/or HFPTA and/or LFPTA.Any HL: FFPTA and/or HFPTA and/or LFPTA.Any HL: FFPTA four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kH2); LFPTA, low-frequence25.6 fl (adut 19-79 years).>25.6 fl (adut 19-79 years).>25.6 fl (adut 19-79 years).*25.6 fl (adut 19-79 years).FFPTA, high frequency pure tone average over frequencies (0.5, 1, 2, and 4kH2); LFPTA, low-frequence*17.7 if Reference category ($P < 0.05$).*26.6 fl (adut 19-79 years).*25.6 fl (adut 19-79 years).*25.6 fl (adut 19-79 years).*26.7 is unificiantly different from extrage over frequencies (0.5, 1, 2, and 4kH2); LFPTA, low-frequence*17.7 if Reference category ($P < 0.05$).*28.1 if frequency pure tone average over frequencies (0.5, 1, 2, and 4kH2).*28.1 if frequency pure tone average over frequencies (0.5, 1, 2, and 4kH2).<!--</th--><th></th><th>nfidence nterval</th><th>Adjusted Odds</th><th>Confid Inter</th><th>ence val</th><th>Adjusted Odds</th><th>Confid</th><th>ence val</th><th>Adjusted Odds</th><th>Confid</th><th>ence val</th><th>Adjusted Odds</th><th>Confid Inter</th><th>ence val</th><th>Adjusted Odds</th><th>Confidence Interval</th><th>ence val</th></th> | RatioFromToRatioFromToRatioSexMen2.21.33.8*2.11.04.2*1.3Women†1.01.01.0Age (continuous)1.11.11.11.11.1*1.1Education (highest level in household)1.01.0Postsecondary1.81.2 2.7^* 1.80.9 3.7 1.7Time worked in a noisy environment1.01.0Up to 10 years0.70.41.50.73.02.2Any HL: FFPTA and/or LFPTA.Any HL: FFPTA and/or HFPTA and/or LFPTA.Any HL: FFPTA and/or HFPTA and/or LFPTA.Any HL: FFPTA four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kH2); LFPTA, low-frequence25.6 fl (adut 19-79 years).>25.6 fl (adut 19-79 years).>25.6 fl (adut 19-79 years).*25.6 fl (adut 19-79 years).FFPTA, high frequency pure tone average over frequencies (0.5, 1, 2, and 4kH2); LFPTA, low-frequence*17.7 if Reference category ($P < 0.05$).*26.6 fl (adut 19-79 years).*25.6 fl (adut 19-79 years).*25.6 fl (adut 19-79 years).*26.7 is unificiantly different from extrage over frequencies (0.5, 1, 2, and 4kH2); LFPTA, low-frequence*17.7 if Reference category ($P < 0.05$).*28.1 if frequency pure tone average over frequencies (0.5, 1, 2, and 4kH2).*28.1 if frequency pure tone average over frequencies (0.5, 1, 2, and 4kH2). </th <th></th> <th>nfidence nterval</th> <th>Adjusted Odds</th> <th>Confid Inter</th> <th>ence val</th> <th>Adjusted Odds</th> <th>Confid</th> <th>ence val</th> <th>Adjusted Odds</th> <th>Confid</th> <th>ence val</th> <th>Adjusted Odds</th> <th>Confid Inter</th> <th>ence val</th> <th>Adjusted Odds</th> <th>Confidence Interval</th> <th>ence val</th> | | nfidence nterval | Adjusted Odds | Confid Inter | ence val | Adjusted Odds | Confid | ence val | Adjusted Odds | Confid | ence val | Adjusted Odds | Confid Inter | ence val | Adjusted Odds | Confidence Interval | ence val | |
| Sex Men 2.2 1.3 3.8* 2.1 1.0 4.2* 1.3 0.9 1.8 2.2 1.1 4.2* 1.8 1.1 2.9* 3.7 Wo may serve the function (highest level in household) 1.1 1.1 1.1* 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.1 1.1 | Sex Men Men Women [†] 2.2 1.3 3.8 [*] 2.1 1.0 4.2 [*] 1.3 Women [†] 1.0 $ -$ 1.0 $ -$ 1.0 Age (continuous) 1.1 1.1 [*] 1.1 1.1 [*] 1.1 1.1 [*] 1.1 Education (highest level in household) Postsecondary or more [†] 1.0 $ -$ 1.0 $ -$ 1.0 Postsecondary or more [†] 1.0 $ -$ 1.0 $ -$ 1.0 Newer [†] 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 Up to 10 years 1.8 1.2 2.7^* 1.8 0.9 3.7 1.7 Never [†] 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 Up to 10 years or more 2.0 1.1 3.7^* 1.5 0.7 3.0 2.2 Any HL: FFPTA and/or HFPTA and/or LFPTA. Any HL: FFPTA and/or HFPT | | | Ratio | From | To | Ratio | From | To | Ratio | From | To | Ratio | From | To | Ratio | From | \mathbf{T}_{0} | |
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| Women [†] 1.0 - - 1.0 - - 1.0 - - 1.0 - - 1.0 - - 1.0 - - 1.0 - - 1.0 - - 1.0 - - 1.0 - - 1.0 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.0 - - 1.0 - - 1.0 - - 1.0 1.1 | Women [†] 1.0 — 1.0 — 1.1 1.1* 1.1 1.1* 1.1 1.1* 1.1 Education (highest level in household) Education (highest level in household) Postsecondary or more [†] 1.0 — 1.0 — 1.0 1.1 1.1* 1.1 Time worked in a noisy environment 1.0 — 1.0 — 1.0 1.0 1.1 1.1 1.1* 1.1 Never [†] 1.2 2.7* 1.8 0.9 3.7 1.7 1.7 1.7 1.6 1.1 1.0 1.0 1.0 1.0 0.0 1.0 0.7 3.0 2.2 1.0 0.0 0.7 0.4 1.3 0.8 0.4 1.6 1.1 1.0 0.9 ears 0.7 0.7 0.4 1.3 0.8 0.4 1.6 1.1 1.0 0.0 0.9 ears 0.7 1.7 1.7 1.0 9 ears 0.7 3.0 2.2 1.1 1.0 9 ears 0.7 0.4 1.3 0.8 0.4 1.5 0.7 3.0 2.2 1.1 1.0 9 ears 0.7 0.4 1.3 0.8 0.4 1.5 1.0 0.7 3.0 2.2 Any HL: FFPTA and/or HFPTA and/or LFPTA. Any HL: FFPTA and/or HFPTA and/or LFPTA. Any HL: FFPTA and/or HFPTA and/or LFPTA. Any HL: FFPTA for the equency or the one average over frequencies (0.5, 1, 2, and 4kHz); LFPTA, low-frequent HFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz); LFPTA, low-frequent terme eategory ($P < 0.05$). Reference category. *Criteria for autionetric from estimate for reference category ($P < 0.05$). *Criteria for autionetric for a 4 ⁴⁶ . (Niskar et al ⁴⁶). | 2.2 1.3 | 3 3.8* | 2.1 | 1.0 | 4.2* | 1.3 | 0.9 | 1.8 | 2.2 | 1.1 | 4.2* | 1.8 | 1.1 | 2.9^{*} | 3.7 | 2.1 | 6.8^{*} | |
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| Less than postsecondary 1.8 1.2 2.7^{*} 1.8 0.9 3.7 1.7 1.0 2.9 1.8 0.9 3.7 1.1 0.8 1.6 1.1 Time worked in a noisy environment 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.1 $-$ 1.0 $ -$ | Less than postsecondary 1.8 1.2 2.7* 1.8 0.9 3.7 1.7 Time worked in a noisy environment 1.0 $ -$ 1.0 $ -$ 1.0 Never ⁴ 1.0 $ -$ 1.0 $ -$ 1.0 Up to 10 years 0.7 0.4 1.3 0.8 0.4 1.6 1.1 10 years 0.7 0.7 0.1 1.3 7^* 1.5 0.7 3.0 2.2 Any HL: FFPTA and/or HFPTA and/or LFPTA. Hearing loss thresholds: >20 dB (childyouth 16–18 years). >25 dB (adult 19–79 years). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz); LFPTA, low-frequent. HFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tome average over frequencies (0.5, 1, 2, and 4kHz). * Criteria for autioneric noteh 1: (1) thresholds at 0.5 and 1 kHz of ≤ 15 dB, (2) maximal threshold for 3, 4, or 6 kHz. (Niskar et al ⁴⁶). | st level in household) | | 10 | I | I | 1 0 | I | I | 10 | I | l | 10 | I | I | 1 0 | I | I | |
| Time worked in a noisy environment Never ¹ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ 1.0 $ -$ | Time worked in a noisy environment Never [†] 1.0 $-$ 1.0 $-$ 1.0 $-$ 1.0 Up to 10 years 0.7 0.4 1.3 0.8 0.4 1.6 1.1 10 years 0 more 2.0 1.1 3.7* 1.5 0.7 3.0 2.2 Any HL: FFPTA and/or HFPTA and/or LFPTA. Hearing loss thresholds: >20 dB (childyouth 16–18 years). >24 (adutt 19–79 years). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz); LFPTA, low-frequent HFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). FFPTA, four-frequency pure tone average over frequencies (0.5, 1, 2, and 4kHz). | 1.8 | | 1.8 | 0.9 | 3.7 | 1.7 | 1.0 | 2.9 | 1.8 | 0.9 | 3.7 | 1.1 | 0.8 | 1.6 | 1.1 | 0.6 | 1.9 | |
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over age 45 in the Danish study⁵² likely underestimated HL prevalence in that study. A German study (n = 4958) reported that male construction workers, aged 40 to 64 years, had a 1.5-fold increased prevalence of HL (sum of HL at 2, 3, 4 kHz greater than 105 dB in at least 1 ear) compared with "white collar workers" classified as office workers, architects, and engineers.⁵³ The high HL threshold, the exclusion of subjects under 40 and over 64 years of age, and the testing of only three audiometric frequencies (2, 3, 4 kHz averaged) likely reduced the HL prevalence findings reported by Arndt et al.⁵³

The present study results support previous research showing that males are more likely to be exposed to hazardous workplace noise and have a higher prevalence of HL than female workers,^{5,7,10} which is likely due to the traditional employment of men in high noise occupational industries such as construction, mining, lumber, and manufacturing. Interestingly, there were no significant differences in the proportion of men and women who worked in hazardous workplace noise environments for less than 10 years. This may be an indication of more women beginning to enter male-dominated, high-noise occupations; however, more research would be needed to corroborate these findings. Furthermore, the present study finding that individuals from households with an annual income of less than \$50,000 per year had a significantly higher prevalence of any one or more PTA HL than individuals from higher income households supports previous research in this area^{37,54} and may be related to the difficulty that low-income groups experience in accessing health care and treatment.55,56

Occupational NIHL

Occupational NIHL develops insidiously over time and is the result of continuous or intermittent noise exposure and duration. The time lag that occurs between work-related hearing damage and the presentation of symptoms can be several years, depending on the duration and intensity of the noise exposure. However, some studies have reported surprisingly high NIHL prevalence rates among young workers suggesting that NIHL may already be present even before employment.^{58,59} A Dutch survey of construction workers found that 7.6% of workers under age 25 were diagnosed with NIHL, while other studies reported prevalence rates ranging from 14.4% to 16.0%.^{58,59} In a large scale retrospective study (n=29,644) of Dutch construction workers in which hearing thresholds of workers (noise-exposed and nonexposed) were compared with ISO-1999 predictions, the authors found that NIHL was present at the start of employment and increased at the same rate as predicted for longer exposure durations.⁶⁰ It may be that leisure noise exposure is a contributing factor to NIHL in young workers as well as in workers of all ages. As Rabinowitz³ notes, most estimates of occupational noise exposure used to determine the prevalence of HL "fail to approximate meaningfully the size of the population exposed to potentially damaging noise outside of work." However, in two studies that considered nonoccupational exposure, there were no substantial overall differences in noise exposure reported, except in a subset of workers. Neitzel et al⁶¹ considered nonoccupational activities in a longitudinal study involving 266 construction workers, using dosimetry measurements and activity cards over 530 subject days. The researchers found minimal additional exposure for most workers compared with occupational noise found in construction; however, for a subset who frequently participated in noisy activities, nonoccupational noise may have contributed significantly to overall noise exposure levels.⁶¹ In a population-based study involving 788 workers from high noise exposure trades, using data from portable dosimeters, it was found that average leisure time noise levels had no effect on HL estimates-levels were comparable for the noise-exposed and reference populations (below $70 \, d\text{BA}$).⁵² However, the composition of different tradeworkers in the aforementioned study⁵² may have been associated with lower

occupational noise levels compared to the study by Neitzel et al,⁶¹ which comprised only construction workers.

There is some evidence that having NIHL can lead to a greater number of workplace accidents.² In a large retrospective Quebec study of blue-collar workers (n = 52,982), which examined audiograms and accident claims, even the slightest degree of NIHL, leading to not hearing a warning signal or being confounded by its masking effect, accounted for up to 15.6% of "passive" accidents, defined as the worker "becoming the involuntary recipient of some mechanical energy" with no direct or full participation in the accident.² Communication difficulties, cognitive failure, and worker fatigue are some of the factors associated with the risk of accidents for workers, with and without HL, exposed to high occupational noise conditions.^{57,62–64}

Audiometric Notch

One well-documented characteristic of occupational NIHL is not only a "notch" in the audiogram typically at 4 kHz but may also be observed at 3 kHz and more variably at 6 kHz depending on the frequency range of the noise exposure.⁶⁵ A notch can broaden and affect adjacent frequencies with continued noise exposure that has given rise to different audiometric notch definitions.57,65 The present study found that although a higher prevalence of noiseexposed individuals for both current and past workplaces showed the Niskar audiometric notch configuration⁴⁶ than the Wilson notch,45 the latter was more sensitive in differentiating between individuals who reported "ever being exposed" to hazardous workplace noise and those who did not. A significantly higher prevalence of workers who responded affirmatively to this question showed the Wilson audiometric notch configuration⁴⁵ than those who did not report this exposure (Table 9). Similarly, a higher prevalence of individuals reporting exposure to "machinery" and "people/music noise" in the workplace than those not exposed to these sources showed the Wilson audiometric notch⁴⁵; this notch also yielded a stronger association (P < 0.01) between "blue collar" versus "white collar" workers than the Niskar notch definition⁴⁶ (P < 0.05). These findings support the conclusion by McBride et al⁶⁵ that in conjunction with an accurate noise exposure history, the 4-kHz notch is a well-established clinical sign that is valuable in confirming a NIHL diagnosis. Our study findings indicate that the Wilson audiometric notch definition⁴⁵ may be a more sensitive parameter; however, further research is needed to corroborate these results.

DPOAE

The use of DPOAE testing has shown promise in early identification of NIHL in that low-level or absent DPOAEs could be indicative of NIHL susceptibility.⁶⁶ Cochlear status in individuals exposed to industrial workplace noise compared with nonexposed workers has increasingly been the subject of research. There have been studies showing the vulnerability of the cochlea to long-term noise exposure and increased susceptibility of outer hair cell damage compared with inner hair cells, likely due to their location, structure, and specific metabolism.^{67–69} Some studies have shown DPOAEs to be more sensitive than audiometry in determining subclinical cochlear damage, specifically in high-frequency outer hair cells, manifested by decreased amplitudes or absent DPOAEs.^{28,70–72}

In the present study, individuals with 10 years or more of hazardous workplace noise exposure were significantly more likely to have absent DPOAEs than those with shorter duration exposures, which is consistent with audiometric results. Likewise, "blue collar" workers had a significantly higher prevalence of absent DPOAEs than "white collar" workers. In general, our findings that DPOAEs can identify cochlear damage and are consistent with audiometric results are congruent with studies involving noise-exposed workers compared with controls²⁹; however, no significant differences were observed between the prevalence of absent DPOAEs and audiometric HL for any PTA.

Several studies have found reduced emissions in DPOAEs, including notches at 4 to 6 kHz, associated with chronic noise exposure, showing a greater sensitivity of DPOAEs in identifying cochlear damage than the audiogram.^{26,27,73,74} However, as the present study did not include data for specific frequency and amplitude emission levels during DPOAE testing, it was not possible to identify early subclinical damage and compare with audiometric results for differing durations of occupational noise exposure. However, it is clear that research in this area would be beneficial. As Forshaw²⁷ and the American College of Occupational and Environmental Medicine (ACOEM) statement on NIHL have indicated,⁷⁵ the use of OAE emissions is an emerging audiologic technology, identified as one of the research priorities for shedding light on current knowledge gaps.

Hazardous Workplace Exposure

In the present study, individuals who reported hazardous workplace noise exposure for 10 years or more had higher odds of having HL than those who were exposed for shorter durations with the odds of HL doubled when compared with those who had never worked in such an environment, regardless of age, sex, or education level. This demarcation of 10 years or more is consistent with population-based study findings by Palmer et al,⁵ where the risk of HL rose for men as a function of duration with the greatest risk observed at 10 or more years of noisy workplace exposure (where one had to shout to be heard at arm's length). However, Palmer et al⁵ reported a higher prevalence ratio for severe hearing difficulty (3.8) and for persistent tinnitus, such that noise-exposed men over the age of 35 had a prevalence ratio of 2.6 compared with those who were never exposed to loud occupational noise. One explanation for the high prevalence ratio may be the much larger sample size (n=21,201) in the study by Palmer et al⁵ than the present study sample, and their inclusion of members of the armed services (n = 993). In addition, as HL in the study by Palmer et al⁵ was self-reported, the high tinnitus prevalence may have been an indication of HL not realized by the individual. Lastly, the mail-in questionnaire used in the study by Palmer et al⁵ may have led to a potential bias in that more individuals with hearing impairment may have returned the questionnaire. Overall, it is likely that the HL prevalence ratio reported by Palmer et al⁵ represents an underestimate given previous findings showing a large disparity between self-reported HL and audiometric results,⁵¹ their exclusion of retired individuals over age 64, and those with mild to moderate HL.

In examining the prevalence of self-reported exposure to occupational noise, a NHANES study reported that 17% of U.S. workers were exposed to hazardous noise in their current job," which is somewhat higher than the 14% reported in the present study. The larger sample size included in the NHANES weighted analysis (n = 9275) may account for this difference as well as the slightly different hazardous noise exposure definition. The NHANES hazardous workplace noise exposure definition of "by loud noise I mean noise so loud that you have to speak in a raised voice to be heard" 7 was similar to the present study, with the exception of the distance condition used in the current study question, "so loud that one had to speak in a raised voice to communicate with co-workers standing within an arm's length." The NHANES definition may have led to a greater number of participants answering affirmatively to this question compared with the present study, which stipulated "within an arm's length."

The present study found that just over one-third of men (35.5%) and under a quarter of women (20.4%) had worked in a noisy job for 10 years or more, which is nearly double the percentage for men (16%) and six-fold more for women (3%) reported

in a British population-based study, using a similar definition of hazardous workplace noise (where there was a need to shout to be heard at arm's length).⁵ This may reflect differences in workplace occupations between Canada and Britain or may signify a change in the numbers of individuals working in high noise occupations. When comparing those *currently* exposed to hazardous workplace noise with the NHANES study,⁷ the present study findings are fairly consistent (21.7% compared with 26.3% NHANES for men; 5.9% compared with 6.7% NHANES for women).

Hearing Protection Usage

The current study found that nearly twice as many participants reported they "sometimes," "rarely," or "never" used HP compared with their American counterparts reported by NHANES (60% vs 34%).⁷ However, an important difference that may partially account for the higher percentage found in the present study are the response categories and the question itself. The NHANES study used a dichotomous "Yes/No" response for the question, "In this (current) job, do you ever wear protective hearing devices?" whereas the present study had five response categories (always, often, sometimes, rarely, never) for the question "How often do/did you use hearing protection at work when in a noisy area?" with the latter three categories collapsed to indicate routine nonuse of HP. In terms of workers who were required to use HP in their workplace, the present study found that 20% indicated they "sometimes," "rarely," or "never" wore HP, representing an estimated 809,000 Canadians. This is similar to findings by study by Hessel¹⁸ in which 24% to 27% of Albertan electricians, plumbers, and pipefitters (n = 198) reported "never, seldom or sometimes" wearing HP, while only 12% of boilermakers (n = 101) reported this. The higher noise exposure for boilermakers may explain the higher HP compliance rate of 70.5% who reported "always" wearing HP. A high HP compliance rate of nearly 100% was also observed in Canadian lumber mill workers; however, compliance dropped to 84% when noise exposure was at or above 95 dBA, and to 60% in those exposed under 85 dBA.²⁰ This pattern was also observed in a Danish population-based study wherein 75% of workers exposed to more than 85 dBA and 42% of workers exposed to 80 to 84 dBA, respectively, reported using HP.52 As the current study relied on selfreported workplace noise exposure, associations with specific noise levels cannot be made. However, this phenomenon along with other reasons for nonuse of HP may be worth exploring. Studies that have probed reasons for nonusage have cited improper fitting of HP, sizing problems, and comfort as factors, 76-78 many of which can also lower HP effectiveness due to suboptimal attenuation ^{19,57} such that even with high compliance, workers may not be completely protected from NIHL.

There are only a few population-based studies examining HP usage.^{7,52} Two industry-specific U.S. surveys were conducted, primarily involving male tradeworkers (n = 98) and firefighters (n = 425). The average HP usage was marginally above 50%, even though 98% indicated they were supposed to wear HP.⁷⁶ Similarly, for firefighters, respondents only used HP 34% of the time it was required.⁷⁹ Although the present population-based study encompassed a larger age range (16 to 79 years) of both genders working in various noisy occupations, it appears that the present study findings are consistent with many previous studies showing that HP is often not worn consistently, even when occupationally required.

For construction workers, there are many unique factors affecting HP usage such as high variability of noise exposure as workers move in and out of noisy areas, exposure to complex combinations of noise sources, employment at multiple job sites each day, and the likelihood of being self-employed, placing the onus on the worker to take greater responsibility for their own health and safety^{19,80,81}; other causes of irregular HP usage include hindrance to communication and discomfort.^{82,83} Studies have

found an array of factors associated with HP usage such as risk perception, perceived susceptibility to HL, noise annoyance, perceived self-efficacy, and perceived benefits or barriers.^{77,78,84} The insidious nature of HL and the fact that it is often not noticed until the loss is significant render the risk as "invisible"⁸⁵; this may have the effect of limiting perceived risk, thereby weakening the motivation of the individual to use HP.

Tinnitus

Tinnitus can be a debilitating chronic condition for some individuals, negatively impacting sleep and quality of life, while for others it is a minor annoyance.⁸⁶ The necessity of evaluating tinnitus using self-report and the various definitions of tinnitus used in surveys leads to challenges in estimating the prevalence of this condition.⁸⁶ According to Moller,⁸⁶ "the greatest challenge lies in defining the tinnitus," as this condition has many forms in terms of strength and character and is changeable within the same individual over the course of one day and across several days.^{86–88} Nonetheless, the National Center for Health Statistics⁸⁹ estimated that tinnitus affected up to 30% of the adult U.S. population at some time in their lives, while other studies in Britain, Sweden, Italy, Scotland, Japan, and Norway have reported prevalence estimates ranging from 10% to 20%.^{68,90–95} In a cohort of Australians (n = 1300; aged 11 to 35 years), a higher tinnitus prevalence of 64% was reported.⁹⁶ The present study finding of 43.2% of Canadians "ever having experienced" tinnitus is somewhat higher than found in previous population-based studies but lower than the Australian study,⁹⁶ which assessed a younger age cohort. The differing tinnitus definitions, the use of mail-in questionnaires versus face-to-face interviews, and the age groups involved are all factors to consider when examining tinnitus prevalence rates across studies.

Approximately one-third of Canadians, aged 16 to 79 years, reported tinnitus within the previous year, which is somewhat higher than estimates by NHANES⁹⁷ (25.3%) of 20 to 69 year olds and a Korean population-based study 98 (21.4%) of 20 to 97 year olds, both of which used the same question: "In the past 12 months, have you ever had ringing, roaring, or buzzing in your ears?" This may be due to the differing age groups and/or the tinnitus question itself. The current study presented a preamble definition before the question ("Tinnitus is the presence of hissing, buzzing, ringing, rushing or roaring sounds in your ears when there is no other sound around you") following which participants were asked if they experienced it. Concurrent with both aforementioned studies,^{97,98} the current study findings indicate that while tinnitus is generally higher in older age groups, it is also frequently reported by young adults; just over half of 16 to 29 year olds in the present study and approximately 20% of 21 to 30 year olds in the NHANES study⁹⁷ and 20 to 29 year olds in the Korean study⁹⁸ (14.6% men; 19.6% women) reported tinnitus. It has been speculated that this may be due to the increased participation in noisy leisure activities and the use of personal listening devices by adolescent and young adult populations.99

Masterson et al⁵⁰ found that among U.S. workers who had ever or currently worked in a noisy environment (defined as needing to speak in a raised voice to be heard), 19% and 15%, respectively, reported tinnitus in the previous 12 months. This is much lower than the present study findings wherein among participants who were exposed to hazardous workplace noise within the past 12 months, 55% reported tinnitus. This wide discrepancy is likely due to the use of "bothered" and the time reference of "5 minutes or more" in the definition used by Masterson et al⁵⁰: "In the past 12 months, have you been bothered by ringing, roaring, or buzzing in your ears or head that lasts for 5 minutes or more?" These results are more consistent with the present study findings wherein "bothersome" tinnitus, defined as tinnitus affecting sleep, concentration, or mood, was found in 19% of participants (who reported tinnitus within the past year), but without considering occupational noise exposure.

In fact, "bothersome" tinnitus prevalence in a population may be of the most importance due its association with lower quality of life and work capacity as well as negative mental health outcomes.⁹⁹⁻¹⁰¹ The prevalence of "troubling," "bothersome," or "moderately annoying" tinnitus in other population-based studies ranges from 4.4% to 17.4%, $^{90,95,100-107}$ with the wide variation likely due to the differing definitions and age groups studied. Nonetheless, a review of tinnitus studies found that despite variable prevalence rates, approximately 20% of tinnitus sufferers reported their condition as a "severe" annoyance,⁸⁶ which can translate to a significant proportion of a population. Bothersome tinnitus often includes sleep disturbance that is a common complaint affecting between 25% and 70% of tinnitus sufferers.^{108–111} The present study found that among those who had tinnitus within the previous year, 19% of participants, representing 1,752,000 Canadians, indicated that it affected their sleep, concentration, or mood. Although this is a small subset of those who have tinnitus, it is nonetheless a significant proportion of individuals reporting a serious form of tinnitus.

Contrary to expectations, the present study findings were similar for "blue collar" and "white collar" workers who had ever experienced tinnitus, 42.4% and 43.2%, respectively. This may be compared with a Swedish population-based study³⁷ wherein a similar prevalence of tinnitus in workers versus nonworkers was reported, 26% and 30%, respectively, using the question: "Have you during the most recent time experienced sound in any of the ears, without there being an external source (so-called tinnitus) lasting more than 5 minutes? (no, yes sometimes, yes often, yes all the time)." Also, in the aforementioned study, there was little difference between workers and nonworkers with regard to moderately or severely "bothersome" tinnitus prevalence, 30% and 37%, respectively, using the question: "How much do you feel that the tinnitus sounds worry, bother or upset you? (not at all, a little, moderately, severely)."³⁷ This may be an indication that nonoccupational exposures play a role in the pervasiveness of tinnitus.⁹⁰

One of the risk factors for developing tinnitus is exposure to loud noise, in addition to HL and aging97 with other risk factors being sex, personality type, work stress, head injury, exposure to toxins, and otological diseases.⁸⁶ A population-based Korean study found that the odds of tinnitus was approximately 1.5 times higher in those exposed to occupational noise than those who were not. Similarly, a U.S. NHIS (2007) found that among workers who had ever been exposed to occupational noise, the prevalence of hearing difficulty was 23% (compared with 7% nonexposed), the prevalence of tinnitus was 15% while 9% had both.⁵⁰ Furthermore, occupation was reported to have a marked effect on bothersome tinnitus in a population-based Norwegian study.⁹³ In the present study, among those who reported current exposure to hazardous workplace noise, just over half had tinnitus, while one-third had some measured HL. This may be an indication of compromised hearing in a higher percentage of workers than found using audiometric evaluation. Although tinnitus is not as well understood as HL, these two conditions share many risk factors and some causal etiologies.¹¹² One tinnitus progression theory suggests that cochlear changes may trigger central auditory system changes with speculation that those who report tinnitus but not hearing difficulty have subclinical auditory damage.^{112,113}

Indeed, tinnitus often coexists with HL and in isolation is seen as a warning sign of potential HL. Shargorodsky et al⁹⁷ reported that participants with hearing impairment were two to three times more likely to report frequent tinnitus than those with no hearing impairment. Furthermore, the presence of tinnitus and/or NIHL has implications for worker safety, as they are often associated with impaired speech discrimination and a higher risk of accidents in the workplace.^{2,22,114,115}

Limitations

One limitation of the present study is the absence of a nonoccupational noise exposure estimate and its contribution to the overall noise exposure of workers. Second, noise exposure in this study was not directly measured but recalled by participants that may have led to inaccuracies with regard to noise exposure levels and durations. Third, the lack of data for individual DPOAE test frequencies did not allow analysis of emission strength that may have shown changes in cochlear function compared with audiometry. Fourth, an estimate of conductive HL was not possible which may have affected the overall prevalence of HL in this study. Lastly, the relatively small sample size for the CHMS Cycle 3 resulted in a more limited analysis in certain cases where cell sizes were small. The release of CHMS Cycle 4 data will allow a comparison between datasets and provide a larger sample size when Cycle 3 and 4 are combined.

CONCLUSION

These study findings address a knowledge gap by providing national estimates of hazardous workplace noise exposure, and a snapshot of hearing health, acuity, and HP usage in the Canadian working population. An estimated 42% of respondents, representing 11.2 million Canadians, are exposed to hazardous workplace noise defined as so loud that workers had to speak in a raised voice to communicate with someone standing an arm's length away. An estimated one-third of workers, substantially more men than women, had some degree of measured HL, with a similar proportion showing cochlear hair cell damage evidenced by absent DPOAEs.

A strong effect was observed for 10 years or more of hazardous workplace noise exposure where the odds of having HL were doubled compared with never having worked in such an environment, regardless of age, sex, or education level. A significantly higher prevalence of "blue collar" workers had HL, absent DPOAEs, and a 4-kHz audiometric notch than "white collar" workers. Although the reasons were outside the scope of this study, just over half of Canadians overall reported not using HP while exposed to hazardous workplace noise, while for those required to use HP at work, 80% reported doing so. Beyond the impact on NIHL, there are potential health and safety implications for workers for whom HP is not mandatory, which may be worth exploring in future studies.

The Wilson audiometric notch⁴⁵ was found to be more sensitive than the Niskar audiometric notch⁴⁶ in that a clear differentiation was observed between "blue collar" and "white collar" workers and between those ever having been exposed to hazardous occupational noise and those who were not. Tinnitus, which is often associated with HL and also serves as a warning sign of potential hearing damage, was reported by over one-third of Canadians as having experienced it at some point in their lives and by over onehalf currently working in a noisy workplace. In addition, just under a quarter of tinnitus sufferers indicated that it affected their sleep, concentration, or mood. Despite the limitations highlighted, foremost being the unknown contribution of leisure noise exposure, these study findings provide a scientific knowledge base on the status of hearing health and acuity in the Canadian working population.

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