Catalogue no. 82-003-X
ISSN 1209-1367

Health Reports

Prevalence of hearing loss among Canadians aged 20 to 79: Audiometric results from the 2012/2013 Canadian Health Measures Survey

by Katya Feder, David Michaud, Pamela Ramage-Morin, James McNamee and Yves Beauregard

Release date: July 15, 2015

Statistics Canada Statistique Canada

Canada

How to obtain more information

For information about this product or the wide range of services and data available from Statistics Canada, visit our website, www.statcan.gc.ca.

You can also contact us by

email at infostats@statcan.gc.ca

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

- Statistical Information Service 1-800-263-1136
- National telecommunications device for the hearing impaired 1-800-363-7629
- Fax line 1-877-287-4369

Depository Services Program

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

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner. To this end, Statistics Canada has developed standards of service that its employees observe. To obtain a copy of these service standards, please contact Statistics Canada toll-free at 1-800-263-1136. The service standards are also published on www.statcan.gc.ca under "About us" > "The agency" > "Providing services to Canadians."

Note of appreciation

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

Standard table symbols

The following symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E}	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

Published by authority of the Minister responsible for Statistics Canada

An HTML version is also available.

Cette publication est aussi disponible en français.

Prevalence of hearing loss among Canadians aged 20 to 79: Audiometric results from the 2012/2013 Canadian Health Measures Survey

by Katya Feder, David Michaud, Pamela Ramage-Morin, James McNamee and Yves Beauregard

Abstract

Background: In Canada, population-level estimates of hearing loss have been based on self-reported data, yielding estimates of 4% or 5%. Self-reported hearing difficulties may result in underestimates of hearing loss, particularly among people with mild hearing loss and among older adults.

Data and methods: The 2012/2013 Canadian Health Measures Survey (cycle 3) collected audiometric and self-reported data to estimate the prevalence of hearing loss and limitations in a population-based sample of Canadians aged 20 to 79. Weighted frequencies and cross-tabulations were used to calculate measured and self-reported hearing levels by sociodemographic characteristics. All estimates were weighted at the person-level to represent the population.

Results: Based on a pure-tone average of four frequencies that are important in speech, 19.2% of Canadians aged 20 to 79 had measured hearing loss in at least one ear; 35.4% had high-frequency hearing loss. These levels exceeded the self-reported estimate of hearing difficulty—3.7%—derived from responses to questions from the Health Utilities Index Mark 3. The prevalence of measured hearing loss rose with age from no more than 10% among people younger than 50 to 65% at ages 70 to 79. Men were significantly more likely than women to have a hearing loss, a difference that emerged around age 60. Canadians with low household income and/or educational attainment were more likely than those in higher income/education households to have a hearing loss.

Interpretation: This analysis presents the first population-based audiometric data on the prevalence of hearing loss among the adult household population of Canada, and highlights the disparity between measured and self-reported outcomes.

Keywords: Audiometry, deafness, earwax, hearing aids, hearing-impaired persons, hearing loss

Hearing loss is an important public health concern with far-reaching implications. At the beginning of the twenty-first century, the World Health Organization reported adult-onset hearing loss to be one of the leading causes of years lived with disability (YLD); in 2000, hearing loss accounted for 4.7% of total YLD due to all causes, with the total global YLD for hearing loss estimated at 24.9 million.[1,2] As well, hearing loss has been associated with worse quality of life and functional outcomes.[3] The personal consequences may include social isolation, depression, safety issues, mobility limitations, and reduced income and employment opportunities.[4-6] Yet despite the importance of hearing for daily functioning, hearing loss is often unrecognized and undertreated.[3,7]

In Canada, the prevalence of hearing loss has typically been estimated through self-reports. For example, according to the Canada Community Health Survey and the Participation and Activity Limitations Survey, the self-reported prevalence of hearing impairment was 4% and 5% for the population aged 12 or older and 15 or older, respectively.[8,9] However, self-reports may result in underestimates, especially among older adults and among people with mild hearing loss.[10-13] Survey respondents may not self-identify as having a hearing disability and/or may not even be aware of it, particularly if it is mild or moderate.[14,15] Furthermore, hearing loss occurs gradually and represents lifetime cumulative insults to the auditory system,[16,17] initially affecting the high frequencies and later progressing to lower frequencies that can affect speech comprehension. Age of onset varies, depending on factors such as genetic susceptibility, the presence of diseases, and exposure to drugs that are toxic to hearing.[16,18,19]

Objective measurement of hearing acuity is necessary to determine the extent of the problem.[20] Clinical studies using audiometry have been carried out in specific populations and/or age groups, but no population-based audiometrically measured hearing data have been available for Canada.

The 2012/2013 Canadian Health Measures Survey (CHMS), a population-based survey designed to provide national estimates of health indicators, included both audiometric evaluations and self-reports. This study presents an analysis of CHMS audiometric and self-reported hearing data for adults aged 20 to 79. The study was approved by the Health Canada and Public Health Agency of Canada Review Ethics Board (Protocol #2005-0025).

Methods

Data source

The data are from the Canadian Health Measures Survey (CHMS), an ongoing survey that samples households in five regions across Canada (Atlantic, Quebec, Ontario, Prairies and British Columbia). The survey entails an in-person, computer-assisted household interview to gather demographic, socioeconomic, health and lifestyle information, and a subsequent visit to a mobile examination centre (MEC) for direct physical measures. The CHMS excludes full-time members of the Canadian Forces; residents of the three territories, First Nations Reserves and other Aboriginal settlements, and certain remote regions; and residents of institutions such as nursing homes. Together, these exclusions make up about 4% of the target population. Proxy interviews are accepted in cases of physical and/or intellectual impairment.

Authors: Katya Feder (Katya.Feder@hc-sc.gc.ca), David Michaud (David.Michaud@hc-sc.gc.ca) and James McNamee (James.McNamee@hc-sc.gc.ca) are with the Health Effects and Assessment Division at Health Canada, Ottawa, Ontario. Pamela Ramage-Morin (Pamela.Ramage-Morin@statcan.gc.ca) is with the Health Analysis Division at Statistics Canada, Ottawa, Ontario. Yves Beauregard is with the Audiology Department at the Children's Hospital of Eastern Ontario, Ottawa, Ontario.

Details about sampling design, data collection and calculation of responses rates are available elsewhere.[21]

Screening

To account for potential temporary threshold shift, CHMS respondents were asked if they had listened to loud noise/music in the previous 24 hours; 6.7% had done so, but no significant differences were found in four-frequency pure-tone average hearing loss between those who reported exposure to loud noise/music and those who did not.

Before testing, a *visual inspection* of the outer ear flap (pinna) and entrance to the ear canal was performed to identify signs of infection, obstruction and other conditions/circumstances that might interfere with testing.

Hearing evaluation

Otoscopy was performed using the Welch Allyn otoscope (Model 25020) 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 collapsible ear canal, or other occlusion. The criteria for exclusion were: obstructed ear canal, acute pain or infection, open wounds or bandages covering the ear(s), refusal to remove hearing aid, and chronic ear conditions including congenital atresa or microtia of the ear canal (one or both ears). No further testing was performed if the individual was excluded by otoscopy.

Tympanometry was conducted using the A GSI 39 Auto Tympanometer. A normal tympanogram was compliance between 0.2 cm^3 to 1.8 cm^3 with middle ear pressure between -150 and +50 daPa in an equivalent ear canal volume of between 0.75 cm^3 and 2.0 cm^3. The criteria for exclusion were: blood, pus or impacted wax, eardrum perforation, growth in the ear canal, and significant skin abnormality or discharge observed during otoscopy. In these cases, audiometry was performed using TDH-39 supra-aural headphones instead of insert earphones.

Audiometric evaluation was carried out by health measures specialists with training/supervision provided by a certified audiologist, which included on-site visits to ensure quality control. Testing was conducted in a portable audiometric booth (Eckel, AB-4230), using a computer-controlled CCA-100 mini audiometer with insert earphones (EAR 5A case) and disposable foam ear tips or supra-aural headphones (TDH-39). 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 or had very slow response times, or when difficulties were noted with automatic mode. Manual mode was carried out using the modified down-10 up-5 methodology.[22] The audiometer was calibrated daily using the Bio-Acoustic simulator BAS-200, which served as a baseline. To avoid interference with audiometric evaluation, subjects were asked to refrain from using chewing gum or candies. 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. Respondents who refused to sit in the audiometric booth with the door closed or who had cognitive deficits that interfered with testing were excluded from audiometric evaluation.

Self-reported hearing loss

To determine self-reported hearing loss, the Health Utilities Index Mark 3 (HUI3) hearing attribute was administered.[23,24] HUI3 is a generic preference-based measure of functional health. Respondents were asked: "Are you usually able to hear what is said in a group conversation with at least three other people without a hearing aid?" Those who responded "no" were asked follow-up questions: "Are you usually able to hear what is said in a group conversation with at least three other people with a hearing aid?," "Are you able to hear at all?," "Are you usually able to hear what is said in a conversation with one other person in a quiet room without a hearing aid?," and "Are you usually able to hear what is said in a conversation with one other person in a quiet room with a hearing aid?" Responses were scored according to an established algorithm and classified as level 1 (no hearing problems) to level 6 (unable to hear at all). A dichotomous variable identified individuals with hearing problems (levels 2 to 6) versus no hearing problems (level 1).

Definitions

Hearing loss was defined as a unilateral or bilateral hearing threshold above 25 dB in the worse ear, based on four-frequency pure-tone average (PTA) across 0.5, 1, 2 and 4 kHz (frequencies generally associated with normal speech), high-frequency PTA across 3, 4, 6, and 8 kHz, and low-frequency PTA across 0.5, 1 and 2 kHz. Unilateral and bilateral hearing loss were mutually exclusive. Hearing loss thresholds were based on the American Speech-Language Hearing Association guidelines[25] (Text table 1).

Occlusion of ear canal indicates excessive earwax or pus observed during otoscopic examination.

Household education was defined as the highest level attained by a household member, dichotomized as less than postsecondary graduation and postsecondary graduation or more.

Based on total annual income, three *household income* categories were defined: less than $50,000; $50,000 to less than $100,000; and $100,000 or more.

Respondents' *age* was as of the date of their MEC visit; *education* and *income*, as of the date of their household interview.

Text table 1
Hearing loss categories and thresholds for people aged 20 to 79

Hearing loss category	Hearing loss threshold (dB)
Normal hearing	25 or lower
Mild loss	26 to 40
Moderate loss	41 to 70
Severe loss	71 to 90
Profound loss	Above 90

Note: Based on American Speech-Language Hearing Association guidelines.[25]

Study sample

The overall response rate for cycle 3 was 51.7%, yielding 5,785 respondents aged 3 to 79 who completed the household questionnaire and MEC visit. The study sample was established by excluding 2,601 respondents aged 19 or younger, and a further 212 with the following conditions: a) ear infection, cochlear implant (56); b) collapsed ear canal or complete obstruction of ear canal, pain/trauma to ear, ear surgery within previous three months, refusal to remove hearing aid or participate in otoscopy (33); or c) incomplete or unacceptable audiometric testing, including audiometry results for only one ear (123). The final study sample comprised 2,972 respondents aged 20 to 79 (1,483 men and 1,489 women) with bilateral audiometric results, representing 23.7 million Canadians.

Analytical techniques

Weighted frequencies and cross-tabulations were used to estimate measured and self-reported hearing levels by sex, age group, total household income, and highest household educational attainment. All estimates were weighted at the person level to represent the population. Analyses were conducted using SAS 9.1.3 and SAS-Callable SUDAAN 11.0.0 software. To account for the complex survey design, p-values, 95% confidence intervals, and coefficients of variation (CV) were estimated using the bootstrap technique with 11 degrees of freedom.[26,27] In the tables and text, estimates with a CV of 16.6% to 33.3% are flagged with an E (interpret with caution); those with a CV that exceeds 33.3% are not releaseable and are designated F.

Results

In 2012/2013, an estimated 4.6 million Canadians aged 20 to 79 (19%) had hearing loss that affected their ability to hear normal speech (Table 1). That is, their audiometric tests revealed that their pure-tone average (PTA) across the four speech frequencies (0.5, 1, 2 and 4 kHz) was greater than 25 dB.

For 12% of Canadian adults, hearing loss was mild (26 dB to 40 dB) (Table 2). These people would be less likely to be aware of or self-report their hearing difficulty, and would cope by using adaptive measures such as moving closer to the source of the sound or increasing the volume. For 7% of adults, hearing loss was moderate or worse (41 dB or above); these individuals would be more likely to notice and self-report hearing impairment.

Table 1
Prevalence of measured four-frequency, low-frequency and high-frequency pure-tone average (PTA) hearing loss, by selected characteristics, household population aged 20 to 79, Canada excluding territories, 2012/2013

	Four-frequency PTA hearing loss				Low-frequency PTA hearing loss				High-frequency PTA hearing loss			
			95% confidence interval				95% confidence interval				95% confidence interval	
Characteristics	Number	%	from	to	Number	%	from	to	Number	%	from	to
	'000	100.0	. . .	. . .	'000	100.0	. . .	. . .	'000	100.0	. . .	. . .
Total	4,555	19.2	16.9	21.7	3,649	15.4‡	13.5	17.4	8,397	35.4‡	33.1	37.7
Sex												
Men†	2,986	25.3	20.9	30.4	2,158	18.3‡	15.5	21.5	4,849	41.2‡	36.5	46.0
Women	1,570	13.1**	11.0	15.6	1,491	12.5**	10.3	15.0	3,548	29.7*‡	24.9	35.0
Age group (years)												
20 to 39	632E	7.1E	4.2	11.7	689 E	7.7E	5.2	11.4	712E	8.0E	5.3	11.9
40 to 49	466E	10.1E	6.6	15.2	458 E	9.9E	6.5	14.8	1,007E	21.8E**‡	14.6	31.4
50 to 59	967	19.9*	14.1	27.3	592	12.2‡	9.0	16.2	2,387	49.1**‡	39.9	58.3
60 to 69	1,414	38.3**	34.4	42.3	1,091	29.5**‡	24.9	34.6	2,738	74.1**‡	70.1	77.7
70 to 79	1,076	65.0**	56.4	72.7	820	49.5**‡	41.3	57.7	1,553	93.8**‡	88.1	96.8
Household education												
Less than postsecondary graduation	1,551	30.1**	23.8	37.2	1,218	23.6*	17.1	31.7	2,459	47.7*‡	37.2	58.4
Postsecondary graduation or more†	2,919	15.9	13.4	18.9	2,397 E	13.1	10.9	15.6	5,734	31.3‡	27.6	35.3
Total household income												
Less than $50,000†	2,298	28.1	23.8	32.9	1,800	22.0‡	18.2	26.3	3,525	43.1‡	37.3	49.1
$50,000 to less than $100,000	1,316	16.5**	12.5	21.3	990	12.4**	9.3	16.3	2,609	32.6*‡	29.2	36.2
$100,000 or more	941	12.4E**	7.0	21.2	859	11.4E*	6.2	19.9	2,264	29.9*‡	23.1	37.8

† reference category
* significantly different from reference category/preceding age group ($p < 0.05$)
** significantly different from reference category/preceding age group ($p < 0.01$)
‡ significantly different from four-frequency hearing loss ($p < 0.05$)
E use with caution
. . . not applicable
Four-frequency hearing loss = unilateral or bilateral, pure-tone average > 25dB over frequencies 0.5, 1, 2, and 4kHz
Low-frequency hearing loss = unilateral or bilateral, pure-tone average > 25dB over frequencies 0.5, 1, and 2kHz
High-frequency hearing loss = unilateral or bilateral, pure-tone average > 25dB over frequencies 3, 4, 6 and 8kHz
Source: 2012/2013 Canadian Health Measures Survey.

Table 2
Percentage distribution of population, by measured hearing status in four-frequency and high-frequency pure-tone average ranges and age group, household population aged 20 to 79, Canada excluding territories, 2012/2013

	Normal hearing (25 dB or lower)			Mild hearing loss (26 to 40 dB)			Moderate or worse hearing loss (41 dB or above)		
		95% confidence interval			95% confidence interval			95% confidence interval	
Pure-tone average range, age group	%	from	to	%	from	to	%	from	to
Four-frequency	**80.8**	**78.3**	**83.1**	**12.1**	**10.2**	**14.2**	**7.1***	**6.1**	**8.4**
20 to 39	92.9	88.3	95.8	F	...	...	F	...	...
40 to 49	89.9	84.8	93.4	7.1[E]	4.0	12.3	3.0[E]*	1.8	5.0
50 to 59	80.1	72.7	85.9	14.6[E]	8.5	23.9	5.3[E]*	2.8	9.9
60 to 69	61.7	57.7	65.6	25.0	20.8	29.6	13.3*	9.2	18.8
70 to 79	35.0	27.3	43.6	31.4	22.1	42.4	33.6	26.1	41.9
High-frequency	**64.6**	**62.3**	**66.9**	**15.5**	**13.9**	**17.3**	**19.9***	**18.3**	**21.6**
20 to 39	92.0	88.1	94.7	F	...	...	F	...	...
40 to 49	78.2	68.6	85.4	13.4[E]	7.9	21.8	8.5[E]	5.2	13.5
50 to 59	50.9	41.7	60.1	25.0	19.6	31.4	24.0[E]	16.1	34.2
60 to 69	25.9	22.3	29.9	33.2	28.3	38.5	40.9*	34.8	47.3
70 to 79	6.2[E]	3.2	11.9	19.0	13.3	26.4	74.8*	69.7	79.2

* significantly different from estimate for mild hearing loss ($p < 0.05$)
[E] use with caution
F too unreliable to be published
... not applicable
Four-frequency hearing loss = unilateral or bilateral, pure tone average > 25dB over frequencies 0.5, 1, 2, and 4kHz
High-frequency hearing loss = unilateral or bilateral, pure-tone average > 25dB over frequencies 3, 4, 6 and 8kHz
Source: 2012/2013 Canadian Health Measures Survey.

Overall, a larger percentage of men than women had four-frequency hearing loss: 25% versus 13% (Table 1). However, the difference emerged only around age 60 (data not shown).

The prevalence of hearing loss rose with advancing age. While no more than 10% of people younger than 50 had four-frequency hearing loss, the percentage was 65% among 70- to 79-year-olds.

Income and education were associated with hearing loss. The likelihood of having four-frequency hearing loss was 28% among people in households where annual income was less than $50,000, compared with 12% among those in households where annual income was $100,000 or more. Adults in households with lower levels of education were almost twice as likely as those in households where one or more members was a postsecondary graduate to have a hearing loss: 30% versus 16%.

Hearing loss measured over low (0.5, 1 and 2 kHz) and high (3, 4, 6 and 8 kHz) frequencies generally followed the same patterns as four-frequency hearing loss. However, high-frequency hearing loss was more common than four-frequency hearing loss—35% (8.4 million) versus 19% (4.6 million) of adults.

As well, people with high-frequency hearing loss were more likely to have hearing loss in both ears than in one ear (data not shown). For those with four-frequency hearing loss, the percentages with bilateral and unilateral loss were almost equal, while among those with low-frequency hearing loss, unilateral loss was more common.

The prevalence of measured hearing loss (19%) far surpassed the percentage of adults who reported difficulties difficulties hearing, based on the HUI

Table 3
Prevalence of self-reported hearing difficulty, by selected characteristics, household population aged 20 to 79, Canada excluding territories, 2012/2013

			95% confidence interval	
Characteristics	Number	%	from	to
	'000			
Total	867[E]	3.7[E]	2.2	6.0
Sex				
Men[†]	484[E]	4.1[E]	2.4	7.0
Women	383[E]	3.2[E]	1.7	5.9
Household education				
Less than postsecondary graduation	357[E]	7.0[E]	3.5	13.5
Postsecondary graduation or more[†]	505[E]	2.8[E]	1.5	5.2
Total household income				
Less than $50,000[†]	592[E]	7.2[E]	4.2	12.2
$50,000 to less than $100,000	192[E]	2.4[E]**	1.5	3.7
$100,000 or more	84[E]	1.1[E]**	0.5	2.3

[†] reference category
** significantly different from reference category ($p < 0.01$)
[E] use with caution
Note: Hearing difficulty was defined as level 2 to 6 on Health Utilities Index - Mark 3 (HUI3).
Source: 2012/2013 Canadian Health Measures Survey.

(fewer than 4%) (Table 3). No difference between men and women was apparent in self-reported hearing difficulties, whereas the audiometric findings indicated that hearing loss was more prevalent among men.

Overall, 12%[E] of adults with measured hearing loss used a hearing aid (data not shown). At ages 60 to 69, 9%[E] of those with hearing loss wore hearing aids; at ages 70 to 79, the figure was 24%[E]. An estimated 25% of all moderately/severely impaired individuals used a hearing aid.

Otoscopy revealed that 13% of Canadian adults had occluding wax or pus (one or both ears), which likely affected their hearing acuity (data not shown). The prevalence of earwax rose from 11%[E] among 20- to 39-year-olds to 21% among people aged 70 to 79.

Discussion

This is the first population-based study to report audiometric data for Canadians. According to results of the 2012/2013 CHMS, 19% of people aged 20 to 79 (4.6 million) had at least mild hearing loss in frequencies that are important for understanding speech. This far exceeded the percentage who self-reported hearing difficulties—fewer than 4%.

This disparity between measured hearing loss and self-reported hearing difficulties was consistent with previous findings.[11-14] However, the discrepancy in the CHMS data was wider than what was observed in studies that used a single question ("Do you feel you have a hearing loss?"), the Hearing Handicap Inventory for the Elderly-Screening (HHIE-S) tool, or questions about increased television volume.[11,12,28,29] The wide disparities in the present study may be due to the hearing questions that comprise the HUI3 or to differing demographic distributions across studies. The low self-reported prevalence in all studies may reflect the insidious nature of hearing loss and the tendency for individuals to unknowingly compensate and/or blame background noise for hearing difficulties, especially in cases of mild or high-frequency hearing loss.

Comparisons of Canadian audiometric estimates with those of population-based studies conducted in the United States,[10,30] Great Britain[31] and Australia[32] reveal consistent trends (Text table 2). Discrepancies between CHMS estimates and those of other surveys that used audiometric measures may be due to participant characteristics such as the presence of earwax or the use of medications that affect hearing.

The male-female gap in the prevalence of hearing loss starting around age 60 in the CHMS data is fairly consistent with global patterns, except that in other populations, the disparity emerged at younger ages.[31-34] The differences may reflect the relatively small CHMS sample (2,972) compared with other population-based studies, some of which used several years of data. Additional audiometric data from future CHMS cycles may yield greater consistency with global trends. The higher prevalence of hearing loss among men has been partly attributed to their greater likelihood of being exposed to loud noise at work or during leisure-time activities.[35]

The present study shows increasing bilateral hearing loss at older ages—the percentage rose sharply in middle age, and nearly doubled by ages 70 to 79. The effect of aging on hearing acuity is indisputable, but many factors influence the degree and rate of deterioration, including genetic susceptibility, ototoxic medication exposure, otological disorders, smoking, and occupational and leisure noise exposure.[7,16,18,30,36-40] In addition, an interaction between early noise exposure and acceleration of hearing loss has been postulated, with evidence that the aging process is different in noise-damaged cochlea (inner ear), compared with unaffected cochlea.[41] Further studies are warranted to investigate factors related to hearing loss that were outside the scope of this analysis.

The elevated prevalence of high-frequency loss among older Canadians is in line with research showing that age-related hearing loss begins in the highest test frequencies.[17] High-frequency hearing loss impairs the ability to detect higher-pitched sounds (for example, doorbell, telephone ringing, kettle whistling in another room) and consonants such as s and f. This type of hearing loss affects understanding of speech in noisy or reverberant environments[17] and makes it difficult to distinguish between certain words (sun/fun, sight/fight). Progression

What is already known on this subject?

- In Canada, national estimates of the prevalence of hearing loss have typically been based on self-reported data.
- Self-reports may underestimate the prevalence of hearing impairment, especially among older adults and among people with mild or high-frequency hearing loss.
- Audiometric evaluation of hearing is important in understanding the extent of the problem at the population level.

What does this study add?

- The 2012/2013 Canadian Health Measures Survey collected audiometric data on a sample of respondents representative of the adult population in the 10 provinces.
- Fewer than 4% of adults aged 20 to 79 reported difficulties hearing, but 19% (4.6 million) had a measured hearing loss that affected their ability to comprehend speech; at ages 70 to 79, the figure was 65%.
- Canadian population-based estimates of the prevalence of hearing loss are similar to those reported in the United States, Great Britain and Australia.
- Overall, 12% of adults with a measured hearing loss used a hearing aid; at ages 70 to 79, the figure was 24%.
- An estimated 13% of Canadian adults had occluding earwax, and among older people, the percentage was 21%.

Text table 2
Population-based studies: Prevalence of hearing loss above 25 dB (averaged over 0.5, 1, 2, 4 kHz), by age group, Canada, United States, Great Britain and Austrialia, selected years

Country and data source	Years	Sample size	Age group	Ear	Prevalence (%)
United States (Agrawal et al., 2008)[30]	1999 to 2004	5,742	20 to 69	worse	16.1
				bilateral	7.8
				unilateral	7.9
				HFPTA†	31.0
Canada (Canadian Health Measures Survey)	2012/2013	2,651	20 to 69	worse	15.8
				HFPTA‡	31.0
Australia (Wilson et al., 1999)[32]	1997	9,027	16 or older	worse	22.2
				better	16.6
Great Britain (Davis et al., 1989)[31]	1980 to 1986 (3 phases)	2,708	17 to 80	worse	26.1
				better	16.1
Canada (Canadian Health Measures Survey)	2012/2013	2,972	20 to 79	worse	19.2
				bilateral	10.2
				unilateral	8.9
				HFPTA†	35.4
United States (Lin et al., 2011)[10]	2005/2006	717	70 or older	better	63.1
				bilateral	90.9
				unilateral	4.4
Canada (Canadian Health Measures Survey)	2012/2013	321	70 to 79	worse	65.0
				bilateral	49.5
				unilateral	15.5

† high-frequency pure tone average over 3, 4 and 6 kHz
‡ high-frequency pure tone average over 3, 4, 6 and 8 kHz
Sources: 2012/2013 Canadian Health Measures Survey; 1999 to 2004 National Health and Nutrition Examination Survey; 2005/2006 National Health and Nutrition Examination Survey; References 31 and 32.

toward lower speech frequencies (2 to 4 kHz) that are important for hearing voiceless consonants (t,p,k,s,ch) would affect hearing some words (fish, cat, sit tip) and the ability to understand speech in any situation.[17] Also noteworthy is the impact of hearing loss on individuals communicating in their non-native language, for whom even a mild loss is problematic.[42]

This analysis revealed a higher prevalence of hearing loss among adults with lower household income and education. These results are similar to Swedish[36] and Australian[32] findings, and are consistent with the association between lower socioeconomic status and poor health outcomes in general. Difficulties that lower socioeconomic groups encounter in accessing health care and treatment[43,44] may result in conditions that can affect hearing.

A minority—12%—of hearing-impaired Canadians used hearing aids. Even at older ages, the percentage was relatively small: 24%[E] of 70- to 79-year-olds with four-frequency hearing loss wore a hearing aid. This was similar to NHANES findings (19%) for Americans aged 70 or older.[10]

Reasons for the low rate of hearing aid use are beyond the scope of this study, but the health care systems in different nations may be a factor. Mizutari et al.[45] reported lower hearing aid ownership/use (7.3%) in Japan where hearing aids are not covered, compared with countries where hearing aids are available through public health insurance (United Kingdom, France, Denmark, Netherlands) or are provided with restrictions (Australia).[46,47] In Canada, hearing aid subsidies and eligibility vary by province.[48] According to Gopinath et al.,[38] the reasons most commonly cited by older adults for not obtaining a hearing aid were the cost and the belief that it was not needed. A smaller study in Norway (where hearing aids are covered by public health insurance) found "acknowledgement of need for hearing aids" and "checkups/accessibility to professionals" accounted for 25% and 24%, respectively, of the variance in hearing aid use. The findings of the present study would be enhanced by information on the frequency of hearing aid use, associations with income and cost, and whether hearing aids improved functional communication.

Occluding earwax, which may reduce hearing acuity, was found in 13% of adults—double to six times the rate reported in other population-based studies.[31,34] The prevalence of earwax was 21% among 70- to 79-year-old CHMS participants, somewhat below percentages reported in previous analyses of older adults.[49,50] Other research found that earwax removal improved audiometric hearing thresholds for 40% to 75% of older participants.[33,49]

Limitations

The results of this analysis should be interpreted in the context of several limitations.

The sample size is small, and the data are cross-sectional. The findings offer a snapshot of the hearing status of Canadians in 2012/2013, but no information about the progression of hearing loss over time is available.

Moreover, the prevalence of hearing loss may be underestimated. The CHMS data pertain to the population aged 20 to 79, and so exclude people aged 80 or older, ages at which hearing loss is common. As well, people with complete ear canal obstruction and those with incomplete audiometry or those among whom only one ear was tested were excluded.

In addition, the CHMS excludes residents of institutions such as nursing homes, a large percentage of whom would be affected by hearing loss. The other groups not covered by the survey—full-time member of the Canadian Forces, and residents of the three territories, First Nations Reserves or other Aboriginal settlements, and certain remote regions—would have less impact on the hearing loss estimates.

It was not possible to distinguish between conductive and sensorineural hearing loss in this study, as bone conduction testing was not performed.

Although validated for measuring functional health, the HUI3 tool (self-reported hearing difficulty questions) was not specifically validated in studies involving hearing-impaired respondents and controls.

Finally, analysis using both "worse ear" and "better ear" definitions of hearing loss would have yielded additional information and facilitated comparisons with more studies.

Conclusion

Results of the 2012/2013 CHMS show that about one in five Canadians aged 20 to 79, an estimated 4.6 million adults, had audiometrically measured hearing loss. The large disparity between measured and self-reported prevalence in this study suggests that hearing loss is often unrecognized. Measured hearing loss rose sharply after age 40, to reach 65% at ages 70 to 79. The numbers affected are likely to rise substantially in coming decades. The population aged 65 or older, the age range most likely to have hearing loss, is projected to double from 5 million in 2011 to 10.4 million by 2036.[51] ■

References

1. World Health Organization. *World Health Report: Mental Health: New Understanding*, New Hope. Geneva: World Health Organization, 2001. Available at: www.who.int/whr
2. Mathers C, Smith A, Concha M. *Global Burden of Hearing Loss in the Year 2000. Global Burden of Disease*. Geneva: World Health Organization, 2003: 1-30. Available at : http://www.who.int/healthinfo/statistics/bod_hearingloss.pdf
3. Dalton DS, Cruickshanks KJ, Klein BEK, et al. The impact of hearing loss on quality of life in older adults. *The Gerontologist* 2003; 43(5): 661-8.
4. Kramer SE, Kapteyn TS, Kuik DJ, Deeg J. The association of hearing impairment and chronic diseases with psychosocial health status in older age. *Journal of Aging and Health* 2002; 14(1): 122-37.
5. Woodcock K, Pole J. Health profile of deaf Canadians. *Canadian Family Physician* 2007; 53: 2140-1.
6. Woodcock K, Pole J. Educational attainment, labour force status and injury: a comparison of Canadians with and without deafness and hearing loss. *International Journal of Rehabilitation Research* 2008; 31(4): 297-304.
7. Mitchell P, Gopinath B, Wang JJ, et al. Five-year incidence of hearing impairment in an older population. *Ear and Hearing* 2011; 32(2): 251-7.
8. Statistics Canada. *Participation and Activity Limitation Survey 2006 Facts on Hearing Limitations* (Catalogue 89-628-X 2009012) Ottawa: Statistics Canada, 2009. Available at: http://www.statcan.gc.ca/pub/89-628-x/89-628-x2009012-eng.pdf
9. Statistics Canada. *Profile of Disability in 2001* (Catalogue 11-008) Ottawa: Statistics Canada, 2004. Available at: http://www.statcan.gc.ca/pub/11-008-x/2003004/article/6804-eng.pdf
10. Lin FR, Thorpe R , Gordon-Salant S, Ferrucci L. Hearing loss prevalence and risk factors among older adults in the United States. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* 2011; 66A(5): 582-90.
11. Sindhusake D, Mitchell P, Smith W, et al. Validation of self-reported hearing loss: The Blue Mountains Hearing Study. *International Journal of Epidemiology* 2001; 30(6): 1371-8.
12. Nondahl DM, Cruickshanks KJ, Wiley TL, et al. Accuracy of self-reported hearing loss. *Audiology* 1998; 37(5): 295-301.
13. Wiley TL, Cruickshank KJ, Nondahl DM, Tweed TS. Self-reported hearing handicap and audiometric measures in older adults. *Journal of the American Academy of Audiology* 2000; 11: 67-75.
14. Chou R, Dana T, Bougatsos C, et al. Screening adults aged 50 years or older for hearing loss: a review of the evidence for the U.S. Preventive Services Task Force. *Annals of Internal Medicine* 2011; 154(5): 347-55.
15. Walling AD, Dickson GM. Hearing loss in older adults. *American Family Physician* 2012; 85(12): 1150-6.
16. Huang Q, Tang J. Age-related hearing loss or presbycusis. *European Archives of Oto-Rhino-Laryngology* 2010; 267(8): 1179-91.
17. Gates GA, Mills JH. Presbycusis. *Lancet* 2005; 366(9491): 1111-20.
18. Liu XZ, Yan D. Ageing and hearing loss. *Journal of Pathology* 2007; 211: 188-97.
19. Cruickshanks KJ, Nondahl DM, Tweed TS, et al. Education, occupation, noise exposure history and the 10-yr cumulative incidence of hearing impairment in older adults. *Hearing Research* 2010; 264 (1-2): 3-9.
20. Olusanya BO, Neumann, KJ, Saunders JE. The global burden of disabling hearing impairment: A call to action. *Bulletin of the World Health Organization* 2014; 92: 367-73.
21. Statistics Canada. *CHMS User Guide* - cycle 3. Available at: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5071
22. Carhart R, Jerger JF. Preferred method for clinical determination of pure-tone thresholds. *Journal of Speech and Hearing Disorders* 1959; 24: 330-45.
23. Feeny D, Furlong W, Torrance GW, et al. Multiattribute and single-attribute utility functions for the Health Utilities Index Mark 3 System. *Medical Care* 2002; 40(2): 113-28.

24. Feng Y, Bernier J, McIntosh C, Orpana H. Validation of disability categories derived from Health Utilities Index Mark 3 scores. *Health Reports* 2009; 20(2): 43-50.

25. Clark JG. Uses and abuses of hearing loss classification. *ASHA: A Journal of the American Speech-Language Hearing Association* 1981; 23(7): 493-500.

26. Rao JNK, Wu CFJ, Yue K. Some recent work on resampling methods for complex surveys. *Survey Methodology* (Statistics Canada, Catalogue 12-001) 1992; 18(2): 209-17.

27. Rust KF, Rao JNK. Variance estimation for complex surveys using replication techniques. *Statistical Methods in Medical Research* 1996; 5: 281-310.

28. Gates GA, Cooper JC, Kannel WB, Miller NJ. Hearing in the elderly: the Framingham cohort, 1983-1985. Part I. Basic audiometric test results. *Ear and Hearing* 1990; 11: 247-56.

29. Ranganathan B, Counter P, Johnson I. Validation of self-reported hearing loss using television volume. *The Journal of Laryngology and Otology* 2011; 125: 18-21.

30. Agrawal Y, Platz E, Niparko JK. Prevalence of hearing loss and differences by demographic characteristics among US adults: data from the National Health and Nutrition Examination Survey, 1999-2004. *Archives of Internal Medicine* 2008; 168(14): 1522-30.

31. Davis AC. The prevalence of hearing impairment and reported hearing disability among adults in Great Britain. *International Journal of Epidemiology* 1989; 18(4): 911-7.

32. Wilson DH, Walsh PG, Sanchez L, et al. The epidemiology of hearing impairment in an Australian adult population. *International Journal of Epidemiology* 1999; 28(2): 247-52.

33. World Health Organization. *WHO Global Estimates on Prevalence of Hearing Loss: Mortality and Burden of Diseases and Prevention of Blindness and Deafness*. Geneva: World Health Organization, 2012. Available at: http://www.who.int/pbd/deafness/WHO_GE_HL.pdf

34. Karlsmose B, Lauritzen T, Engberg M, Parving A. A randomised controlled trial of screening for adult hearing loss during preventive health checks. *British Journal of General Practice* 2001; 51(466): 351-5.

35. Nelson DI, Nelson RY, Concha-Barrientos M, Fingerhut M. The global burden of occupational noise-induced hearing loss. *American Journal of Industrial Medicine* 2005; 48: 446-58.

36. Hasson D, Theorell T, Westerlund H, Canlon B. Prevalence and characteristics of hearing problems in a working and non-working Swedish population. *Journal of Epidemiology and Community Health* 2010; 64: 453-60.

37. Ferrite S, Santana V. Joint effects of smoking, noise exposure and age on hearing loss. *Occupational Medicine* 2005; 55: 48-53.

38. Gopinath B, Schneider J, Hartley D, et al. Incidence and predictors of hearing aid use and ownership among older adults with hearing loss. *Annals of Epidemiology* 2011; 21: 497-506.

39. Portnuff CD, Fligor BJ, Arehart KH. Teenage use of portable listening devices: a hazard to hearing? *Journal of the American Academy of Audiology* 2011; 22(10): 663-77.

40. Solheim J, Kvaerner KJ, Sandvik L, Falkenberg ES. Factors affecting older adults' hearing-aid use. *Scandinavian Journal of Disability Research* 2012; 14(4): 300-12.

41. Gates GA, Schmid P, Kujawa SG, et al. Longitudinal threshold changes in older men with audiometric notches. *Hearing Research* 2000; 141: 220-8.

42. Rabinowitz PM, Sircar KD, Tarabar S, et al. Hearing loss in migrant agricultural workers. *Journal of Agromedicine* 2005; 10(4): 9-17.

43. Adler NE, Newman K. Socioeconomic disparities in health: Pathways and policies. *Health Affairs* 2002; 21(2): 60-76.

44. Raphael D. Poverty, income inequality and health in Canada. In: Anderson J, ed. *Social Justice Series*. Toronto: CSJ Foundation for Research and Education, 2002.

45. Mizutari K, Michikawa T, Saito H, et al. Age-related hearing loss and the factors determining continued usage of hearing aids among the elderly community-dwelling residents. *PLoS ONE* 2013; 8(9): e73622. doi:10.1371/journal.pone.0073622

46. Smeeth L, Fletcher A, Ng ES, et al. Reduced hearing, ownership, and use of hearing aids in elderly people in the UK—The MRC Trial of the Assessment and Management of Older People in the Community: A cross-sectional survey. *Lancet* 2002; 359: 1466-70.

47. Chia EM, Wang JJ, Rochtchina E, et al. Hearing impairment and health-related quality of life: The Blue Mountains Hearing Study. *Ear and Hearing* 2007; 28: 187-95.

48. Canadian Hard of Hearing Association. *Canadian Hearing Aid Subsidies*, 1-13, Spring 2010. Available at: http://www.chha.ca/documents/Hearing_Aid_Subsidies_Across_Canada.pdf

49. Gleitman RM, Ballachanda BB, Goldstein DP. Incidence of cerumen impaction in the general adult population. *Hearing Journal* 1992; 45(5): 28-32

50. Lewis-Cullinan C, Janken JK. Effect of cerumen removal on the hearing ability of geriatric patients. *Journal of Advanced Nursing* 1990; 15(5): 594-600.

51. Statistics Canada. *Estimates of Population, by Age Group and Sex for July 1, Canada, Provinces and Territories, Annual* (CANSIM Table 051-0001) Ottawa: Statistics Canada, 2010.