Uncorrected Hearing loss and Unmet Hearing Needs Among an Adult Homeless Population

Journal:	*CMAJ Open*
Manuscript ID	CMAJOpen-2019-0220
Manuscript Type:	Cross-sectional
Date Submitted by the Author:	05-Dec-2019
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More Detailed Keywords:	homeless persons, hearing loss, hearing impaired persons, health services accessibility, health services needs and demands
Keywords:	Ear, nose and throat/otolaryngology
Abstract:	Background: Though the link between homelessness and health is well established, the impact of chronic homelessness on our auditory system remains unknown. Given that hearing loss is associated with increased social isolation, reduced earning potential and neurocognitive disease, findings of uncorrected hearing loss in this population has important policy implications. As a result, we sought to estimate the prevalence of hearing impairment in an adult homeless population. Methods: One hundred adult homeless persons were recruited across ten homeless shelters in Toronto, Ontario utilizing a stratified random sampling technique. A survey, comprehensive head and neck exam and audiometric evaluation were performed on each patient by an otolaryngologist and an audiologist. Descriptive statistics were estimated. Audiometric data was directly age standardized to facilitate direct comparisons with the general Canadian population. Results: The median age was 46 years (IQR 37 – 58 years). The median

	duration of homelessness was 24 months (IQR 6 – 72 months). The majority of participants (78%) had some form of extended healthcare benefits through social assistance, though only 29% of these participants were aware that hearing tests and hearing aids were covered through these programs. After age standardization, the percentage of patients with a speech-frequency and high-frequency hearing loss was 40.7 (95% CI 31.1 – 50.3) and 50.6 (95% CI 40.8 – 60.4), respectively. Interpretation: These data suggest that homeless adults have a high prevalence of hearing impairment, even when living within a system of universal health insurance. Awareness of healthcare benefits through social assistance programs is poor.

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Short Title: Unmet Hearing Needs in the Adult Homeless

Conflicts of Interest: None
Funding: This work was supported through a Harry Barberian Scholarship Fund as well as a Head and Neck Cancer Alliance/American Head and Neck Society International Outreach Cancer Prevention Award

Authorship Statement: Each author contributed substantially to conception and design, or acquisition of data, or analysis and interpretation of data. They drafted the article or revised it critically for important intellectual content and gave final approval of the version to be published. Each author agrees to act as guarantor of the work.

ABSTRACT

Background: Although the link between homelessness and health is well established, the impact of chronic homelessness on the auditory system remains unknown. Given that hearing loss is associated with increased social isolation, reduced earning potential, and neurocognitive disease, findings of uncorrected hearing loss in this population has important policy implications. As a result, we sought to estimate the prevalence of hearing impairment in an adult homeless population.

Methods: One hundred adult homeless persons were recruited across ten homeless shelters in Toronto, Ontario utilizing a stratified random sampling technique. A survey, comprehensive head and neck exam and audiometric evaluation were performed on each patient by an otolaryngologist and an audiologist. Descriptive statistics were estimated. Audiometric data was directly age standardized to facilitate direct comparisons with the general Canadian population.

Results: The median age was 46 years (IQR 37 – 58 years). The median duration of homelessness was 24 months (IQR 6 – 72 months). The majority of participants (78%) had some form of extended healthcare benefits through social assistance, though only 29% of these participants were aware that hearing tests and hearing aids were covered through these programs. After age standardization, the percentage of patients with a speech-frequency and high-frequency hearing loss was 40.7 (95% CI 31.1 – 50.3) and 50.6 (95% CI 40.8 – 60.4), respectively.

Interpretation: These data suggest that homeless adults have a high prevalence of hearing impairment, even when living within a system of universal health insurance. Awareness of healthcare benefits through social assistance programs is poor.

Keywords: homeless persons, hearing loss, hearing impaired persons, health services accessibility, health services needs and demands

Level of Evidence: 4

INTRODUCTION

Homelessness is an important risk factor for poor health outcomes and represents a growing public health concern. Approximately a quarter of a million Canadians experience homelessness in any given year (1). The link between homelessness and health has been previously established and it is well known that the homeless population is at increased risk of a variety of medical comorbidities including cardiovascular disease, diabetes, hypertension, vision loss, and chronic obstructive pulmonary disease (2-9). There is also emerging evidence suggesting that the onset of chronic diseases in homeless individuals may be accelerated. Brown *et al.* observed that the self-reported rate of geriatric syndromes was higher in a homeless cohort than in a general United States population that was, on average, over 20 years older (10).

Despite the growing body of knowledge surrounding homelessness and health, the interplay between chronic homelessness and an individual's hearing status remains unknown. Although various national-level health surveys have shown a strong association between low socioeconomic status and hearing loss, these studies were geared towards individuals in private dwellings and fixed addresses, and inadvertently excluded homeless persons.

Findings of uncorrected hearing impairment in a homeless population could carry important implications. Hearing loss, like homelessness, has been shown to be strongly correlated with increased social isolation, reduced earning potential, and higher rates of neurocognitive disease (11-15). Hearing impairment, as an invisible disability, is often treatable, though under-recognized and often under-diagnosed. As a result, we aimed to investigate whether a significant proportion of the Canadian homeless population were afflicted with hearing loss and to what extent those with a hearing impairment were accessing aural rehabilitation.

METHODS

Ethics approval was obtained from St Michael's Hospital Research Ethics Board (#REB17-288). Written consent was obtained from shelter administrators and individual participants.

Participant Selection

We employed a stratified random sampling technique to establish the prevalence of hearing impairment among a representative sample of homeless persons. Participants from adult homeless shelters in Toronto, Ontario were recruited using a randomized two-stage sampling technique between April and June 2018. All adult homeless shelters with >20 beds in Toronto were identified. From this list, 10 shelters were randomly selected with the probability of selection being proportionate to each shelter's nightly housing capacity. Bed numbers within each shelter were then randomly selected using simple randomization via a random number generator (random.org) and individuals assigned to those beds were invited to participate in the study. This process continued until 10 participants had been recruited from each shelter.

Definitions

For this study, 'homelessness' was defined as any person residing in a homeless shelter for a minimum of 7 consecutive days. Participants were excluded if they were <18 years of age, non-English speakers, or lacked decisional capacity (16). Participants received a Canadian $10 gift card after completion of the study.

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 ("speech-frequency") and high-frequency PTA across 3, 4, 6, and 8 kHz ("high-frequency"). Hearing loss thresholds were based on the American Speech-Language Hearing Association guidelines (17). A normal tympanogram was defined as compliance between 0.2 cm^3 to 1.8 cm^3 with middle ear pressure between -150 and +150 daPa in an equivalent ear canal volume of between 0.75 cm^3 and 2.0 cm^3.

Survey

Demographic characteristics were collected for each participant. In order to facilitate comparisons with the general Canadian and US population, questions within the survey were identical to those posed in national household surveys (National Health and Examination Survey 1999-2004 and Canadian Health Measures Survey 2012-2013). For those with subjective hearing

loss, the Hearing Handicap Screening Inventory Questionnaire for Adults (HHISQA) was administered (18).

Audiological Assessment

All participants underwent an audiological evaluation conducted by a certified audiologist (MR and SS) using a portable audiometer (Grason-Stadler GSI 39 Auto Tymp). Patients were brought to a quiet room where air conduction thresholds were determined for each ear from 0.5 to 8 kHz across an intensity range of −10 to 120 dB. Middle ear bone conduction was also assessed through tympanometry.

Statistical Analysis

All statistical analyses were performed using SPSS version 25 (IBM Armonk, NY). Statistical significance was defined as $p<0.05$. Descriptive and inferential statistics were estimated. Audiometric data was directly age-standardized to facilitate direct comparisons with the general Canadian population. Chi-square analysis was used to assess significant differences between categorical variables. Cochran–Mantel–Haenszel tests were used in the analysis of stratified categorical data. Confidence intervals for proportions were calculated using the Wilson methods (19, 20).

RESULTS

Of the 132 homeless individuals approached, 100 agreed to participate in the study (76%). There were 64 male participants. The median age was 46 years (IQR 37-58 years). The median life duration of homelessness was 24 months (IQR 6-72 months). Further demographic characteristics are outlined in Table 1.

Participants had a wide range of medical comorbidities, with the most common self-reported health issues being: active smoker (67%), depression (36%), alcohol abuse (32%), other substance abuse (32%), hypertension (22%), and asthma (19%). Nine participants recalled having been assessed and treated by an otolaryngologist in the past: two underwent tonsillectomy, two had myringotomy and tube insertion, one had tympanoplasty, one had a

translabyrinthine excision of a cerebellopontine angle tumor, one underwent functional rhinoplasty, and one had a deep space neck infection requiring surgical drainage.

The majority of participants (78%) had some form of extended healthcare benefits through social assistance, though only 29% of these participants were aware that hearing tests and hearing aids were covered through these programs. Only 2% of participants currently owned hearing aids.

When asked about risk factors for noise exposure, 59% stated that they had worked or lived in an environment where their voice needed to be raised in order to be heard for a minimum of 3 consecutive months. The mean duration of exposure was 8.5 years (range 3 months – 50 years). Of the 59 participants who noted a history of noise exposure, only 22% stated that they wore hearing protection consistently.

On self-reporting, 32% of participants endorsed at least some difficulty with hearing. HHISQA scores for these participants suggested 37% experienced no handicap, 44% experienced a mild-moderate handicap, and 19% had a severe handicap. 22% of homeless persons in this study reported a hearing or ear-related problem in the past year but only 11 (50%) were able to access the required care.

Based on audiometric evaluation, 39% of participants had at least a mild speech-frequency hearing loss in one of their ears and 51% of participants had a mild high-frequency hearing loss. A direct age standardization was performed in order to accurately compare with the general Canadian population. After age standardization, the percentage of patients with a speech-frequency and high-frequency hearing loss were 40.7 (95% CI 31.1 – 50.3) and 50.6 (95% CI 40.8 – 60.4), respectively. There was a positive association between prevalence of hearing loss and advanced age. While only 16% of participants under the age of 39 had a four-tone frequency hearing loss, this number rose to 85% for those over the age of 60 (Table 2, $p<0.01$). Men were more likely to experience hearing loss as compared to women and a history of noise exposure was associated with high rates of high-frequency hearing loss, though the results did not reach statistical significance (Table 3). Nineteen participants were hearing aid candidates, of which 14 had benefits to offset the cost.

DISCUSSION

Our results suggest that large inequities exist in addressing Canadian hearing health needs. In this study, 40.7% (95% CI 31.1 – 50.3) of homeless persons met criteria for speech-frequency hearing loss in at least one ear, more than double the prevalence in the general Canadian population (19.2% [95% CI 16.9 – 21.7], p<0.001). For high-frequency hearing loss, the rate of 50.6% (95% CI 40.8 – 60.4) is similarly much higher than the 35.5% (95% CI 33.1 – 37.7) reported in the general Canadian population (p<0.001) (21).

Most of the limited information surrounding hearing needs of the homeless have been generated from studies conducted in the United States. One study focusing on geriatric syndromes in a group of homeless persons aged 40-59 indicated self-reported hearing impairment in 29.7% of the homeless population that was studied (10). While this work provides a glimpse into the problem, self-report methods are known to underestimate the problem (22). Another study of 132 homeless persons showed that 34.9% had speech-frequency hearing loss (23). However, this work was limited by its retrospective design and employed a convenience sampling technique. Our work builds upon these studies through the incorporation of a stratified random sampling technique and an assessment by an otolaryngologist in addition to audiometric evaluation.

While the link between homelessness and hearing impairment has not been adequately investigated, the correlation between hearing loss, income, and unemployment has been documented in multiple international studies (24-26). Data from the National Health and Nutrition Examination Survey demonstrates that individuals with hearing loss were 1.58 times more likely to be low income earners and 1.98 times more likely to be unemployed (27). Whether it is low socioeconomic status that drives hearing loss or vice versa continues to be a source of debate. On one hand, hearing impaired individuals have been shown to report significantly less control in the workplace, higher effort during listening and more frequent sick leave compared to normal hearing colleagues (28). Conversely, low socioeconomic status could drive the development of hearing loss as less educated individuals pursue work that increase their exposure to loud noise (29). Consistent with the latter theory, 59% of our homeless participants

reported prolonged noise exposure in the workplace. Due to the nature of this descriptive study, our ability to explore the former theory was limited.

A large proportion of our homeless participants were determined to derive benefit from hearing aid use. Of the 100 homeless persons in this study, 39 (39%) had speech-frequency hearing loss. Of these hearing-impaired participants, 19 were hearing aid candidates. Only 2 (10.5%) individuals actually owned hearing aids, and only 1 individual's hearing aids were functional. This figure is comparable to the 12% usage rate amongst hearing aid candidates in the general Canadian population. Furthermore, given the strong association between hearing loss and dementia, identification of at-risk groups and intervention with early amplification may help mitigate cognitive decline (30).

The small discrepancy in hearing aid use between homeless persons and the general population is interesting in light of our finding that homeless participants appear to possess overall greater awareness of their hearing impairment. While previous studies have suggested that self-report severely underestimates the prevalence of hearing loss in the general population, this trend appears to a lesser degree in our study of homeless individuals (22). In the Canadian Health Measures Survey, only 4% of Canadians reported subjective hearing loss. However, when measured objectively, there was five times increase, in which up to 19% had audiometrically-confirmed speech-frequency hearing loss (21). By contrast, the majority of our homeless population who met objective criteria (39%) for speech-frequency hearing loss did in fact notice their hearing loss subjectively (32%). Perhaps homeless persons suffer from a greater severity of hearing loss that renders their impairment more subjectively noticeable, the reasons for the phenomenon remain unclear. What is clear is that there is an underutilization of hearing aid resources in the homeless population.

The authors believe that underutilization of hearing aids in this population is multifactorial. One previously cited reason is the prohibitive cost of obtaining a hearing aid. Mizutari *et al* reported lower hearing aid ownership in countries where hearing aids are not covered by public health insurance (31). For patients with either Ontario Works or Ontario Disability Support Program, provincial social assistance programs, essential hearing aid technology costs are covered.

Though 14 of our 19 hearing aid candidates are eligible for free essential hearing aid technology, the majority were unaware of the availability of these benefits.

Although rates of hearing aid underutilization are similar among the homeless population and the general public, the authors believe that greater efforts should be provided to improve rehabilitation in homeless individuals who have hearing impairment. As noted, the homeless population experiences earlier onset of geriatric syndromes, are more aware of their hearing impairment, and may be negatively affected in terms of job security and employed due to hearing loss. We believe that homeless individuals with hearing loss may gain significant benefits from being aided.

This study has potential limitations. First, while Toronto shelters are known to represent the majority of the Toronto homeless population (72.2%) there is a significant cohort of patients that do not access shelter services that would have been missed (7). Second, the audiological assessment of the study participants was performed within a quiet area of the shelter with a portable audiometer instead of within a sound booth. Although this may have affected the accuracy of the audiometry results, for evaluation of hearing-loss >25dB, testing results generated within a quiet area has been shown to be not significantly different from a sound booth (32). Finally, this data was drawn from a urban homeless population in a large Canadian city and may not reflect the experience of other Canadian centres and may not be generalizable to homeless populations who live outside of systems of universal health insurance.

Results from this study have potential for creating an impetus for initiatives in the future surrounding homeless outreach and health screening. Currently there exist mobile screening programs for vision health in the homeless population in Toronto, and it may be possible to initiate hearing screening alongside these pre-existing programs. Information and education can also be provided to shelters and homeless individuals with hearing concerns, so as to increase knowledge, thereby decreasing the barriers in accessing healthcare resources such as hearing-aids.

CONCLUSION

Within the homeless population in Toronto, 40.7% and 50.6% of the surveyed participants met criteria for speech-frequency hearing loss and high-frequency hearing loss, respectively. These rates are significantly higher than the rates reported for the general Canadian population. Despite social assistance programs being in place to support aural rehabilitation of the patients, awareness and utilization of these healthcare benefits is low.

List of Abbreviations

CI – confidence interval
Gen Can – General Canadian population
HHISQA – Hearing Handicap Inventory Screening Questionnaire for Adults
IQ – inter-quartile range
PTA – pure-tone average

REFERENCES

1. Gaetz S, Gulliver T, Richter T. The state of homelessness in Canada 2014: Canadian Homelessness Research Network; 2014.
2. Noel CW, Fung H, Srivastava R, Lebovic G, Hwang SW, Berger A, et al. Visual impairment and unmet eye care needs among homeless adults in a Canadian city. JAMA Ophthalmol. 2015;133(4):455-60.
3. Noel CW, Srivastava R, Lo R, Berger A, Tehrani N, Lichter M. Unmet eye care needs among a homeless youth population. Can J Ophthalmol. 2016;51(3):180-4.
4. Jiang S, Mikhail M, Slomovic J, Pereira A, Lebovic G, Noel C, et al. Prevalence and impact of eye disease in an urban homeless and marginally housed population. Canadian Journal of Ophthalmology. 2019.
5. Hwang SW. Homelessness and health. CMAJ. 2001;164(2):229-33.
6. Hwang SW, Bugeja AL. Barriers to appropriate diabetes management among homeless people in Toronto. CMAJ. 2000;163(2):161-5.
7. Hwang SW, Martin RE, Tolomiczenko GS, Hulchanski JD. The relationship between housing conditions and health status of rooming house residents in Toronto. Can J Public Health. 2003;94(6):436-40.
8. Gelberg L, Linn LS. Assessing the physical health of homeless adults. JAMA. 1989;262(14):1973-9.
9. Kushel MB, Vittinghoff E, Haas JS. Factors associated with the health care utilization of homeless persons. JAMA. 2001;285(2):200-6.
10. Brown RT, Kiely DK, Bharel M, Mitchell SL. Geriatric syndromes in older homeless adults. J Gen Intern Med. 2012;27(1):16-22.
11. Dalton DS, Cruickshanks KJ, Klein BE, Klein R, Wiley TL, Nondahl DM. The impact of hearing loss on quality of life in older adults. Gerontologist. 2003;43(5):661-8.
12. Weinstein BE, Ventry IM. Hearing impairment and social isolation in the elderly. J Speech Hear Res. 1982;25(4):593-9.
13. (CDC) CfDCaP. Economic costs associated with mental retardation, cerebral palsy, hearing loss, and vision impairment--United States, 2003. MMWR Morb Mortal Wkly Rep. 2004;53(3):57-9.
14. Uhlmann RF, Larson EB, Rees TS, Koepsell TD, Duckert LG. Relationship of hearing impairment to dementia and cognitive dysfunction in older adults. JAMA. 1989;261(13):1916-9.
15. Mick P, Kawachi I, Lin FR. The association between hearing loss and social isolation in older adults. Otolaryngol Head Neck Surg. 2014;150(3):378-84.
16. Etchells E, Campus S. Aid to capacity evaluation (ACE).
17. Association AS-L-H. Guidelines for audiologic screening. 1997.
18. Newman CW, Weinstein BE, Jacobson GP, Hug GA. The Hearing Handicap Inventory for Adults: psychometric adequacy and audiometric correlates. Ear Hear. 1990;11(6):430-3.
19. Wilson EB. Probable inference, the law of succession, and statistical inference. Journal of the American Statistical Association. 1927;22(158):209-12.
20. Newcombe RG. Two-sided confidence intervals for the single proportion: comparison of seven methods. Statistics in medicine. 1998;17(8):857-72.
21. Feder K, Michaud D, Ramage-Morin P, McNamee J, Beauregard Y. Prevalence of hearing loss among Canadians aged 20 to 79: Audiometric results from the 2012/2013 Canadian Health Measures Survey. Health Rep. 2015;26(7):18-25.

22. Nondahl DM, Cruickshanks KJ, Wiley TL, Tweed TS, Klein R, Klein BE. Accuracy of self-reported hearing loss. Audiology. 1998;37(5):295-301.
23. Saccone PA, Steiger JR. Hearing handicap among adult residents of an urban homeless shelter. J Health Care Poor Underserved. 2007;18(1):161-72.
24. Helvik AS, Krokstad S, Tambs K. Socioeconomic inequalities in hearing loss in a healthy population sample: The HUNT Study. Am J Public Health. 2009;99(8):1376-8.
25. Hasson D, Theorell T, Westerlund H, Canlon B. Prevalence and characteristics of hearing problems in a working and non-working Swedish population. J Epidemiol Community Health. 2010;64(5):453-60.
26. Järvelin MR, Mäki-Torkko E, Sorri MJ, Rantakallio PT. Effect of hearing impairment on educational outcomes and employment up to the age of 25 years in northern Finland. Br J Audiol. 1997;31(3):165-75.
27. Brennan M, Bally SJ. Psychosocial adaptations to dual sensory loss in middle and late adulthood. Trends Amplif. 2007;11(4):281-300.
28. Kramer SE, Kapteyn TS, Houtgast T. Occupational performance: comparing normally-hearing and hearing-impaired employees using the Amsterdam Checklist for Hearing and Work. Int J Audiol. 2006;45(9):503-12.
29. Vogel I, Verschuure H, van der Ploeg CP, Brug J, Raat H. Adolescents and MP3 players: too many risks, too few precautions. Pediatrics. 2009;123(6):e953-8.
30. Lin FR, Yaffe K, Xia J, Xue Q-L, Harris TB, Purchase-Helzner E, et al. Hearing loss and cognitive decline in older adults. JAMA internal medicine. 2013;173(4):293-9.
31. Mizutari K, Michikawa T, Saito H, Okamoto Y, Enomoto C, Takebayashi T, et al. Age-related hearing loss and the factors determining continued usage of hearing aids among elderly community-dwelling residents. PloS one. 2013;8(9):e73622.
32. Maclennan-Smith F, Swanepoel DW, Hall III JW. Validity of diagnostic pure-tone audiometry without a sound-treated environment in older adults. International journal of audiology. 2013;52(2):66-73.

Table 1: *Demographic characteristics of 100 homeless participants surveyed*

Characteristic	***n=100***
Sex	
Male	64
Female	36
Age	
18-29	8
30-39	24
40-49	22
50-59	26
60+	20
Length of Time Spent Homeless	
<1 year	38
1-5 years	33
> 5 years	29
Ethnicity	
White	57
Black	35
Aboriginal	4
East Asian	2
South Asian	2
Marital status	
Single	66
Married or common-law marriage	9
Divorced, separated, or widowed	24
Refused	1
Highest level of education achieved	
Elementary school	1
Junior high school	8
High school (did not graduate)	19
High school graduate	37
Some college education	35
Monthly income, Can$	
<500	45
500-1000	23
>1000	22
Refused	10

Table 2: *Percentage distribution of homeless population by measured hearing status and by age group*

Pure tone average, age group (y)	Normal hearing (25dB and lower) n (%)	Mild loss (26-40dB) n (%)	Moderate or worse loss (41 dB or above) n (%)
Four-tone PTA frequency			
20-39	27 (84)	4 (13)	1 (3)
40-59	31 (64)	11 (23)	6 (13)
60+	3 (15)	7 (35)	10 (50)
High-tone PTA frequency			
20-39	25 (78)	4 (13)	3 (9)
40-59	21 (44)	17 (35)	10 (21)
60+	3 (15)	7 (35)	10 (50)

Table 3: *Prevalence of measured four-tone and high-tone PTA frequency loss in homeless persons and the general Canadian population by selected characteristics*

		Four-Tone PTA Frequency Loss (%)				**High-Tone PTA Frequency Loss (%)**			
Characteristic	n	Homeless	95% CI	Gen. Can*	95% CI	Homeless	95%	Gen Can*	95% CI
Sex									
Male	64	42	30-55	25	21-30	56	46-38	41	36-46
Female	36	28	14-45	13	11-16	31	16-48	30	24-35
Age									
20-39	32	15	04-28	7	04-12	21	8-35	8	5-12
40-59	48	35	22-50	15	10-22	56	41-70	35	28-45
60+	20	85	62-96	51	45-57	85	62-96	84	88-96
Noise Exposure									
No	41	36	21-50	--	--	46	31-61	--	--
Yes	59	41	28-54	--	--	57	44-70	--	--

Abbreviations: Gen. Can = General Canadian Population
*Feder *et al.* 2012

STROBE Statement— ***Noel et al. 2019***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p.1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p.2
Objectives	3	State specific objectives, including any prespecified hypotheses	p. 3, 23-35
Methods			
Study design	4	Present key elements of study design early in the paper	p.4, 1-10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p. 5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	p. 4, 13-16
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p. 4, 26-30 p. 5, 1-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p. 4/5
Bias	9	Describe any efforts to address potential sources of bias	p. 5, 14-18
Study size	10	Explain how the study size was arrived at	N/A - pilot study
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p.4, 18-24 p.5, 12-18
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p. 5, 12-18
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	p. 5, 14-16
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p. 5, 22-25
		(b) Give reasons for non-participation at each stage	This is a vulnerable population. Our REB won't allow up to report on reasons for

			refusal.
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p. 5, 22-31, p. 6 1-18
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	p. 6, 20-21; table
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	p. 6, 20-25
		(*b*) Report category boundaries when continuous variables were categorized	p. 4, 18-24
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	p. 6, 25-31
Discussion			
Key results	18	Summarise key results with reference to study objectives	p. 7, 3-8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p. 9, 12-19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p. 8, 1-2, p 9, 12-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	p. 9, 19-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 1, 35-36

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.