ORIGINAL RESEARCH

Dual Sensory Impairment and Functional Status in a Prospective Cohort Study*

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ABSTRACT

Objective

To examine the impact of visual impairment, hearing impairment, and dual sensory impairment (DSI) on functional status in older adults.

Methods

Secondary analysis of the Manitoba Health and Aging Study, a population-based cohort study of 1751 adults age 65+. Data were collected from 1991 to 1992 (Time 1), with follow-up five years later (Time 2). Vision and hearing were self-reported. Functional status was measured using the Older Americans Resource and Services (OARS). Logistic regression models were constructed to assess functional status at both Time 1 and Time 2.

Results

Dual sensory impairment (DSI) at Time 1 predicted poor functional status at both Time 1 and Time 2. The adjusted odds ratios (OR; 95% confidence interval [CI]) for poor functional status at Time 1 for those with only hearing impairment was 1.74 (1.25, 2.44) for visual impairment was 2.95 (2.19, 3.98), and for DSI was 3.58 (2.58, 4.95). At Time 2, the adjusted ORs for poor functional status for those with only hearing impairment was 1.32 (0.86, 2.03), for visual impairment was 1.63 (1.05, 2.52), and for DSI was 2.61 (1.54, 4.40).

Conclusions

DSI is associated with lower functional status, but the effect of visual impairment is more pronounced than hearing impairment.

Key words: visual impairment, hearing impairment, functional status, disability, cohort study

INTRODUCTION

Impairments in hearing and vision are common, and become more common with advancing age.(1-7) Hearing impairment has been associated with a reduction in quality of life,(8) depressive symptoms,(9) smaller social networks,(10) and social isolation and cognitive impairment.(11,12) Visual impairment has also been associated with lower quality of life,(13) depressive symptoms,(14) smaller social networks,(10), cognitive impairment,(11,12) falls,(15) and motor vehicle crashes.(16) Importantly, both are potentially modifiable, often with simple and straightforward interventions. Furthermore, the duration of life lived with DSI may be long, and interventions may therefore have considerable benefits.(17) For some time, there has been interest in the joint effect of hearing and visual impairment on the health and well-being of older adults. More recently, the term dual sensory impairment (DSI) has been used to describe the cumulative or interactive effect of hearing and visual impairment on adverse outcomes. Previously, the term deaf-blind had been used in clinical settings, with dual sensory impairment becoming more common amongst researchers. Formal definitions have not been universally agreed upon.(18)

Previous studies have shown that visual impairment was strongly associated with depressive symptoms, but that DSI was not associated with a higher risk of depression than isolated visual impairment.(19-21) There are fewer studies of the effect of DSI upon functional status. Reuben *et al*. reported on the effect of sensory impairment, and found that both impaired vision and impaired hearing predicted functional decline over a long time frame. However, they did not consider the interaction between the two deficits.(22) Brennan *et al*. report that DSI was associated with IADL and ADL impairment in cross-sectional analyses.(23) However, in other prospective analyses, the effect of visual impairment alone was comparable to the effect of DSI.(24) In a clinic-based sample, both hearing and vision deficits were associated with impaired functional status, and the effect of DSI was more than the effect of either deficit considered alone.[25] In cross-sectional analyses, self-reported DSI was associated with functional limitations.[26] Subsequently, Armstrong *et al*. report findings from the ABC study and show that visual impairment and hearing impairment predict incident mobility limitations and ADL limitations in a prospective cohort study.[27] From previous studies, there is clear evidence that hearing impairment and visual impairment are both associated with functional impairment, but there is less consensus if there is an interaction between these two deficits whereby the joint effect is stronger—or weaker—than the individual effect of each sensory deficit.

We have, therefore, conducted an analysis of a prospective cohort study in order to determine if visual impairment and/or hearing impairment are associated with functional decline, and if the joint effect is greater than the individual effect. Specifically, the objectives are to:

1. Determine the effect of self-reported visual impairment on functional status in a cross-sectional analysis;
2. Determine the effect of self-reported hearing impairment on functional status in a cross-sectional analysis;
3. Determine the effect of these impairments on functional decline over a five year time frame; and
4. Determine if there are interactions in these effects.

METHODS

Sample

Data used in this study are from the *Manitoba Study of Health and Aging* (MSHA), a prospective cohort study of aging and cognition conducted in conjunction with the *Canadian Study of Health and Aging*.[28] The MSHA included additional measures and expanded the sampling frame to include rural regions of the province. The primary objectives of the MSHA were to estimate the prevalence and incidence of dementia in Manitoba, and to examine issues related to informal caregiving. The MSHA received ethics approval from the Research Ethics Committee of the University of Manitoba and adhered to the Helsinki Declaration. Informed consent was obtained from the participants or from the appropriate proxy.

Community-dwelling persons aged 65 and over were randomly selected according to health region and age group from a list provided by Manitoba Health, one of the most complete listings of residents available. There was an over-sampling of the oldest old (>85 years), in order to increase the likelihood of obtaining adequate numbers of individuals with cognitive impairment. All health regions were represented, including rural areas. Initially 2,890 persons were selected. Of these, 443 refused to participate, 480 were not eligible (had died, entered a nursing home or were too ill), 162 could not be located, and 54 did not complete the screening questionnaire. This resulted in a sample of 1,751 participants. Interviews were conducted in person by trained interviewers.

In 1996/7, the participants were reassessed, and there were 1,024 participants still alive and living in the community; 400 had died and 111 were residing in nursing homes. Those living in nursing homes did not receive the screening questionnaire, but participated in the clinical examination, which we did not consider. The same process and measures were used for both phases of the study. The flow of participants is shown in Figure 1.

Measures

Vision and hearing were self-reported on five-point Likert-like scales, and rated as: "Excellent/good/fair/poor/unable [*sic* to hear/see]." We considered these five-point scales, and we also constructed categories: "no impairment" – those with excellent/good hearing and vision; "only visual impairment"—those with excellent/good hearing, but fair/poor/unable vision; "only hearing impairment"—those with excellent/good vision, but fair/poor/unable hearing; and *"*DSI*"*—those with fair/poor/unable hearing and vision. Participants were also asked to report "Yes/no" to the presence of any eye problems or ear problems as a part of an array of self-reported illness and complaints. Age was reported in years, and sex was self-reported. Education was reported as the number of years spent in school or post-secondary education. Diseases were self-reported. We considered diabetes and stroke since these are potential confounding factors in any association between sensory impairment and functional impairment.

Functional status was measured by asking participants about their ability to perform basic activities of daily living (ADL; eating, dressing, grooming, getting in and out of bed, taking a bath or shower, and ability to use the bathroom),

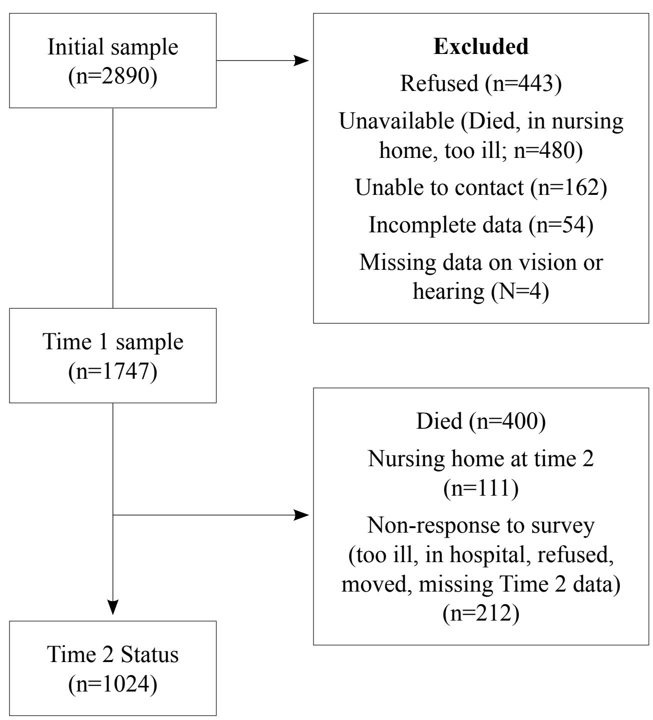

FIGURE 1. Flow of participants

instrumental activities of daily living (IADL; using the telephone, getting to places out of walking distance, going shopping, preparing meals, doing housework, taking medication[s], managing money), and ambulation. A disability was defined as needing help with, or an inability to perform, one or more of the activities listed above. For ambulation, walking independently with a cane was not defined as a disability. These questions were derived from the ADL and IADL portions of the Older Americans Resources and Services (OARS) Multidimensional Functional Assessment Questionnaire.[29,30]

For the primary analysis, we considered the OARS as a categorical variable, using the methodology from the original OARS to categorize subjects by function into the following groups: excellent/good function, mild disability, or moderate/severe/total disability. Briefly, those with excellent/good functional status could perform all ADLs without assistance; those with mild disability could perform all but one to three ADLs and could get through any single day without help. Those with moderate disability or greater needed regular assistance with at least four ADLs, and may have difficulty getting though a single day unassisted. In logistic regression models, we considered excellent/good vs. mild/moderate/severe/total disability.

Analyses

We conducted both a cross-sectional and a prospective analysis. For the cross-sectional (N=1,751) analysis, we used the entire sample from Time 1. For the prospective (N=1,024) analysis, we considered those who were alive and living in the community at Time 2, who were able to be located and who had complete data at Time 2. Categorical variables were compared using chi-square tests, and continuous variables were compared using Student's *t*-tests (assuming unequal variance) or ANOVA. We used a Mantel-Haentzel chi-square test for trend to determine if gradients were present in the association between vision or hearing, and functional impairment. We then constructed logistic regression models with the outcome of the OARS scale. We considered the OARS as a dichotomous outcome, categorized as excellent/good versus mild/moderate/severe/total disability.

For the cross-sectional analyses, we determined the association between sensory impairment and the OARS score at Time 1, adjusting for potential confounding factors. For the prospective analyses, our outcome variable was the Time 2 OARS score. In these prospective models, we included all the Time 1 factors, and also the baseline Time 1 OARS score. We constructed models sequentially, by adding potential confounding factors into subsequent models in blocks. We began with unadjusted models, then models adjusted for demographic factors, and finally models also adjusting for medical factors. For the prospective analyses, we also adjusted for baseline functional status. We chose variables which could reasonably confound potential associations. Since we wanted to keep the factors in the cross-sectional model consistent with the prospective model, we included all factors regardless of whether they were statistically significantly associated with both sensory status and disability. We considered interactions in the other predictor variables. A priori, we sought interactions between hearing and vision impairment on functional status. To do this, we constructed logistic regression models with the main effects of hearing impairment and visual impairment as well as an interaction term. Since there was a statistically significant interaction term, we stratified the results. For presentation, we constructed four categories noted above. We conducted standard regression diagnostics, including examining for collinearity of predictor factors, the linearity of continuous factors, and examining for other potential interacting factors. STROBE guidelines for reporting cohort studies were followed.[31]

RESULTS

At Time 1, 12% of the participants had excellent vision, 54% had good vision, 25% had fair vision, 7% had poor vision, and 1% were unable to see. Hearing impairment was common: 15% had excellent hearing, 55% had good hearing, 25% had fair hearing, and 5% had poor hearing. DSI was also fairly common at Time 1: 16% had DSI, 18% had only visual impairment, 14% had only hearing impairment, and 52% had no impairment. There were 0.2% of the sample who were missing data on sensory impairment.

Baseline characteristics are shown in Table 1. Those with impaired hearing, vision, and DSI were older, had fewer years of education, and were more likely to have diabetes or a previous stroke than those who had no impairment. Males were more likely to have isolated hearing impairment, while females were more likely to have isolated visual impairment. The flow of the participants over the course of the study is shown in Figure 1. Over the five year period, a substantial proportion of the sample died, or had moved to a nursing home. Per protocol, these participants who entered a nursing home did not receive the screening questionnaire at Time 2. This loss to follow-up was differential, and those with sensory impairment were more likely to have missing data at Time 2 (Table 1).

We noted a gradient in the association between visual impairment and functional status in cross-sectional analyses ($p<.001$, Mantel-Haentzel chi square test for trend), and this gradient effect was also present five years later ($p<.001$, Mantel-Haentzel chi-square test for trend; Figure 2), with those with no visual impairment having the least disability, and those with complete visual impairment having the most disability. A similar association was noted for hearing impairment, which was also a gradient effect at both Time 1 and Time 2 ($p<.001$, Mantel-Haentzel chi-square test for trend for both Time 1 and Time 2; Figure 3).

In logistic regression models, we noted a significant interaction term between the main effects of visual impairment and hearing impairment, with the effect of hearing impairment being less amongst those who also had visual impairment. This was true for Time 1 (interaction term $p<.001$) and Time 2 (interaction term $p<.001$) in separate regression models. We therefore categorized the participants into four sensory categories: “no impairment;” “only visual impairment;” “only hearing impairment;” and “DSI.” The association between DSI and functional status is shown in Figure 4. Both hearing impairment and visual impairment are associated with functional status at Time 1 and five years later. In logistic regression models at Time 1 (Table 2), we noted the association between sensory status and functional status. Both visual and hearing impairment were associated with disability in these cross-sectional analyses. The effect diminishes with consideration of other factors. Increasing age, female sex, diabetes, and previous stroke were also associated with disability. Note that we considered age per year of age as a continuous variable. In unadjusted logistic regressions at Time 2 (Table 3), we noted an association between visual impairment only, hearing impairment only, and DSI, and functional status. However, after adjustment for potential confounding factors, impairment in hearing alone was not associated with disability five years later, whereas DSI and visual impairment alone were associated with disability five years later. In these models, older age, female sex, and stroke were all associated with disability five years later. Unsurprisingly, there was a strong association between disability and Time 1 and disability at Time 2.

TABLE 1.
Baseline characteristics of the sample

	No Impairment (N=907)	*Only Hearing Impairment (N=247)*	*Only Visual Impairment (N=312)*	*Dual Sensory Impairment (N=281)*	*Total Sample (N=1747)*
Age (mean years, SD)[a]	75.5 (6.7)	78.5 (6.7)	79.5 (6.5)	81.2 (7.3)	77.5 (7.1)
Sex (percent women)[b]	54.5%	42.5%	69.6%	60.3%	58.5%
Education (mean years, SD)[a]	9.9 (3.4)	9.3 (3.6)	9.1 (3.4)	8.0 (3.9)	9.3 (3.6)
Self-reported eye trouble (percent)[b]	14.4%	17.8%	65.4%	61.2%	31.5%
Self-reported ear trouble (percent)[b]	15.3%	73.2%	21.2%	70.1%	33.4%
Diabetes (percent with diabetes)[b]	6.6%	8.1%	14.8%	8.9%	8.7%
Stroke (percent with stoke)[b]	4.5%	8.1%	10.9%	9.0%	6.9%
Mortality (percent who died)[b]	14.8%	22.7%	25.6%	35.6%	21.2%
Missing (percent missing at Time 2, including deaths)[b]	33.6%	40.9%	48.4%	58.7%	41.3%

[a]denotes $p<.05$, ANOVA.
[b]denotes $p<.05$, chi square test.
N = sample size of the group.

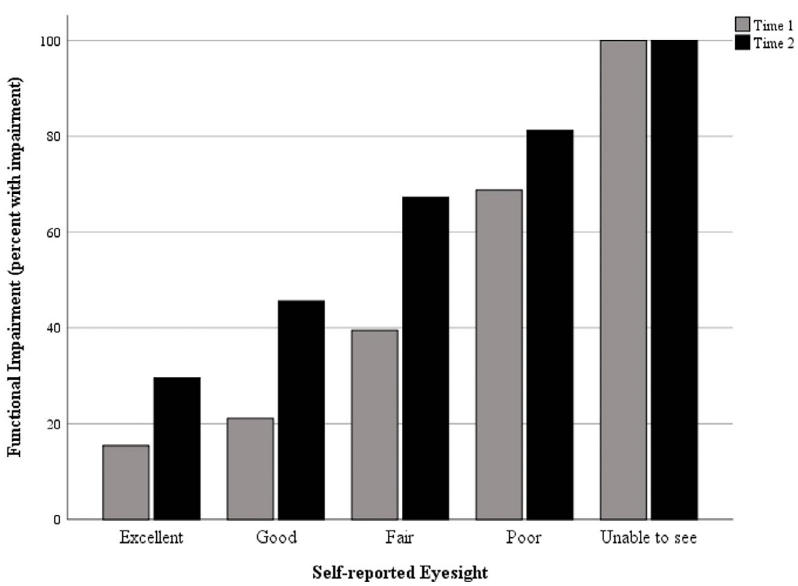

FIGURE 2. Self-reported eyesight and functional status at baseline, and five years later

DISCUSSION

We have conducted an analysis of an existing population-based cohort study and found that isolated hearing impairment, isolated visual impairment, and DSI were associated with functional status in cross-sectional analyses. We also found that visual impairment and DSI were associated with functional status five years later, even after accounting for a number of potential confounding factors. Moreover, we found that the effect of hearing impairment was diminished in those who also had visual impairment.

Our results are generally consistent with previous literature, which shows that sensory impairment is associated with poor outcomes, particularly functional decline. In cross-sectional analyses of administrative samples, and in prospective analyses of population based cohort studies and administrative studies, impairments in vision and hearing are associated with prevalent functional impairment,[26] and incident mobility and functional impairment.[27] Our results add to the existing literature by examining for the main effects, as well as the interaction effects of visual impairment and sensory impairment. We also considered a long time frame of five years.

There are important limitations to our approach. First, the data set we used was old. However, it is unlikely that the associations we noted have changed since the MSHA and CSHA were conducted. Second, we considered self-reports

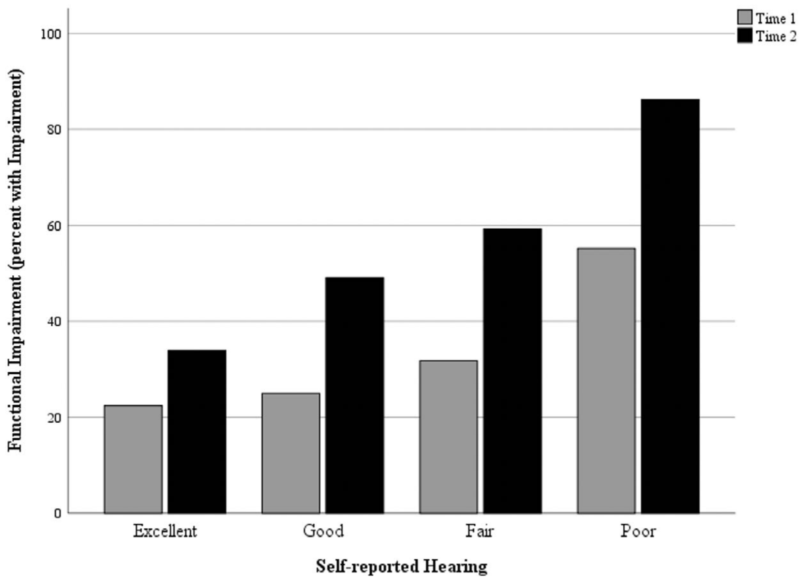

FIGURE 3. Self-reported hearing and functional status at baseline, and five years later

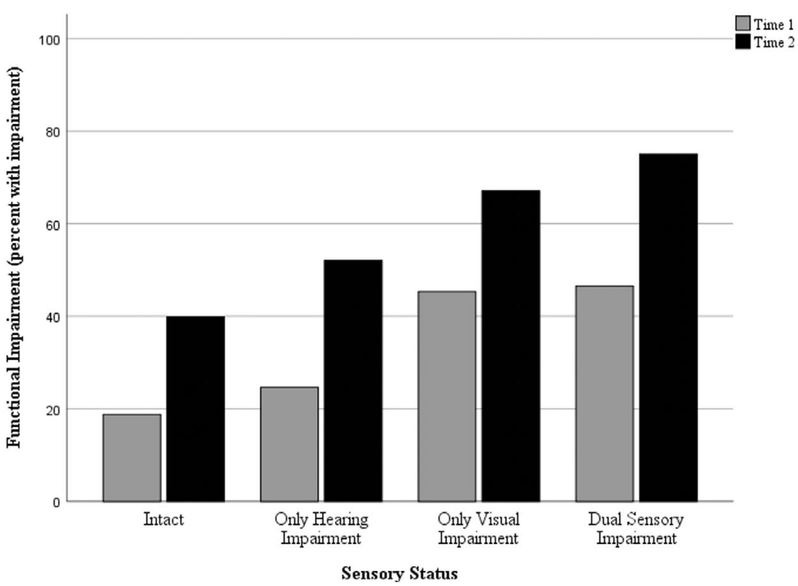

FIGURE 4. Sensory status and functional status at baseline, and five years later

TABLE 2.
Results of logistic regression models of the effect of dual sensory impairment on functional status at Time 1; the unadjusted and adjusted odds ratio (OR) and 95% confidence (95% CI) interval are displayed

	OR (95%CI)	*OR (95%CI)*	*OR (95%CI)*
	Model 1 - unadjusted	*Model 2 – adjusted for demographic factors*	*Model 3 – adjusted for demographic and health factors*
Sensory Status (ref= no impairment)			
Only Hearing	1.90 (1.41, 2.56)	1.79 (1.29, 2.48)	1.74 (1.25, 2.44)
Only Vision	4.42 (3.37, 5.80)	3.29 (2.46, 4.40)	2.95 (2.19, 3.98)
DSI	5.05 (3.80, 6.71)	3.64 (2.65, 4.99)	3.58 (2.58, 4.95)
Age (per year)	-	1.09 (1.07, 1.11)	1.10 (1.08, 1.12)
Sex (ref=men)	-	2.39 (1.89, 3.01)	2.65 (2.08, 3.37)
Education (per year)	-	0.97 (0.94, 1.00)	0.98 (0.95, 1.02)
Diabetes (ref=no diabetes)	-	-	2.39 (1.61, 3.54)
Stroke (ref=no stroke)	-	-	5.52 (3.42, 8.91)

TABLE 3.
Results of logistic regression models of the effect of dual sensory impairment on functional status at Time 2; the unadjusted odds ratio (OR) and 95% confidence (95% CI) interval are displayed

	OR (95%CI)	*OR (95%CI)*	*OR (95%CI)*	*OR (95%CI)*
	Model 1 - unadjusted	*Model 2 – adjusted for demographic factors*	*Model 3 – adjusted for demographic and health factors*	*Model 4 – adjusted for demographic and health factors, and baseline functional status*
Sensory Status (ref= no impairment)				
Only Hearing	1.64 (1.14, 2.46)	1.45 (0.98, 2.16)	1.39 (0.93, 2.08)	1.32 (0.86, 2.03)
Only Vision	3.07 (2.13, 4.44)	2.31 (1.56, 3.41)	2.19 (1.47, 3.26)	1.63 (1.05, 2.52)
DSI	4.52 (2.88, 7.10)	3.59 (2.20, 5.85)	3.62 (2.22, 5.93)	2.61 (1.54, 4.40)
Age (per year)		1.12 (1.10, 1.15)	1.13 (1.10, 1.15)	1.12 (1.09, 1.16)
Sex (ref=men)		1.75 (1.31, 2.32)	1.79 (1.35, 2.39)	1.20 (0.88, 1.64)
Education (per year)		0.99 (0.95, 1.03)	0.99 (0.95, 1.03)	0.99 (0.95, 1.04)
Diabetes (ref=no diabetes)			2.24 (1.29, 3.91)	1.49 (0.81, 2.74)
Stroke (ref=no stroke)			3.90 (1.86, 8.16)	2.54 (1.14, 5.67)
Baseline Functional Impairment (ref=mild or no impairment)				8.26 (5.47, 12.48)

of visual impairment and hearing impairment which may correlate imperfectly with objective measures of hearing and vision. Analyses of the *Canadian Longitudinal Study on Aging* have shown that self-reported sensory impairment may not detect early declines in vision or hearing.[32] However, the effect of this mismeasurement of exposure would likely result in noting weaker association between sensory impairment and functional status than the true association. Furthermore, subjective interpretation of sensory loss may be more relevant to the individual experiencing the loss than objective measures. Third, there was considerable attrition in the sample over the five year time frame, mostly through death and nursing home admission. However, the presence of sensory impairment was also associated with missing data at Time 2, so this would likely result in a stronger association between sensory impairment and functional decline than the association which we actually observed. Finally, there are some potential confounding and mediating factors which we could not consider. Depressive symptoms, cognitive impairment, physical activity, and physical performance measures could all be associated with both DSI and functional impairment, and we did not consider these.

There are also some strengths to our analyses. First, the sample is drawn from a representative sampling frame which was broadly reflective of Manitoba's population. Second, the measures of functional status are widely used, reliable and valid.[29,30] Third, the sample size was large, and we were able to detect differences in functional status as well as to detect relevant interactions.

Despite the limitations, we feel our findings are important for a number of reasons. First, hearing and visual impairment are common in older populations. These impairments are often not noted in clinical encounters.[33] Hearing and vision are relatively easily assessed in routine clinical encounters, and these assessments should be encouraged. Our association of functional status with subjective sensory loss suggests that simply asking people about vision and hearing may be a very straightforward and easy approach—although clearly further research is needed. Second, many of the interventions (such as hearing aids and eye glasses) are straightforward. However, many of these services and aids are not covered under many provincial health-care plans, and private coverage is variable.[34] Broadening universal coverage to include these services merits attention. Finally, the effect of interventions on adverse outcomes, including functional status and quality of life, merits ongoing research.

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood the *Canadian Geriatrics Journal*'s policy on conflicts of interest disclosure and declare the following interests: Dr. St John is a unremunerated board member of Age and Opportunity.

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REFERENCES

1. Fuller SD, Mudie LI, Siordia C, Swenor BK, Friedman DS. Nationwide prevalence of self-reported serious sensory impairments and their associations with self-reported cognitive and functional difficulties. *Ophthalmology.* 2018 Apr 1;125(4):476–85.
2. Gadkaree SK, Sun DQ, Li C, Lin FR, Ferrucci L, Simonsick EM, *et al*. Does sensory function decline independently or concomitantly with age? Data from the Baltimore Longitudinal Study of Aging. *J Aging Res*. 2016 Oct;2016:1865038.
3. Guthrie DM, Declercq A, Finne-Soveri H, Fries BE, Hirdes JP. The health and well-being of older adults with dual sensory impairment (DSI) in four countries. *PloS one*. 2016 May 5; 11(5):e0155073.
4. Schneider J, Gopinath B, McMahon C, Teber E, Leeder SR, Wang JJ, *et al*. Prevalence and 5-year incidence of dual sensory impairment in an older Australian population. *Ann Epidemiol*. 2012 Apr 1;22(4):295–301.
5. Vreeken HL, van Rens GH, Knol DL, van Reijen NA, Kramer SE, Festen JM, *et al*. Dual sensory loss: a major age-related increase of comorbid hearing loss and hearing aid ownership in visually impaired adults. *Geriatr Gerontol Int*. 2014 Jul;14(3):570–76.
6. Guthrie DM, Williams N, Jaiswal A, Mick P, O'Rourke HM, Pichora-Fuller MK, *et al*. Prevalence of sensory impairments in home care and long-term care using interRAI data from across Canada. *BMC Geriatr*. 2022 Dec 8;22(1):944. doi: 10.1186/s12877-022-03671-7.
7. Mick PT, Hämäläinen A, Kolisang L, Pichora-Fuller MK, Phillips N, Guthrie D, *et al*. The prevalence of hearing, vision, and dual sensory loss in older canadians: an analysis of data from the Canadian Longitudinal Study on Aging. *Can J Aging*. 2021 Mar;40(1):1–22. doi: 10.1017/S0714980820000070. Epub 2020 Jun 17.
8. Carabellese C, Appollonio I, Rozzini R, Bianchetti A, Frisoni GB, Frattola L, *et al*. Sensory impairment and quality of life in a community elderly population. *J Am Geriatr Soc*. 1993 Apr; 41(4):401–07.
9. Kim SY, Kim HJ, Park EK, Joe J, Sim S, Choi HG. Severe hearing impairment and risk of depression: a national cohort study. *PloS one*. 2017 Jun 22;12(6):e0179973.
10. Mick P, Parfyonov M, Wittich W, Phillips N, Kathleen Pichora-Fuller M. Associations between sensory loss and social networks, participation, support, and loneliness: analysis of the Canadian Longitudinal Study on Aging. *Can Fam Physician*. 2018 Jan 1;64(1):e33–e41.
11. Lin MY, Gutierrez PR, Stone KL, Yaffe K, Ensrud KE, Fink HA, *et al*. Vision impairment and combined vision and hearing impairment predict cognitive and functional decline in older women. *J Am Geriatr Soc*. 2004 Dec;52(12):1996–2002.
12. Phillips NA, Isler L, Kabir R, Hämäläinen A, Wittich W, Pichora-Fuller MK, *et al*. Hearing and visual acuity predict cognitive function in adults aged 45-85 years: findings from the baseline wave of the Canadian Longitudinal Study on Aging (CLSA). *Psychol Aging*. 2022 Nov 10;37(8):891–912. doi: 10.1037/pag0000716. Epub 2022 Nov 10.
13. Hollands H, Brox AC, Chang A, Adilman S, Chakraborti B, Kliever G, *et al*. Correctable visual impairment and its impact on quality of life in a marginalized Canadian neighbourhood. *Can J Ophthalmol*. 2009 Feb 1;44(1):42–48.
14. Cosh S, von Hanno T, Helmer C, Bertelsen G, Delcourt C, Schirmer H. The association amongst visual, hearing, and dual sensory loss with depression and anxiety over 6 years: The Tromso Study. *Int J Geriatr Psychiatry*. 2018 Apr;33(4):598–605.
15. Gopinath B, McMahon CM, Burlutsky G, Mitchell P. Hearing and vision impairment and the 5-year incidence of falls in older adults. *Age Ageing*. 2016 May 1;45(3):409–14.
16. Green KA, McGwin G, Jr., Owsley C. Associations between visual, hearing, and dual sensory impairments and history of motor vehicle collision involvement of older drivers. *J Am Geriatr Soc*. 2013 Feb;61(2):252–57.
17. Kiely KM, Mitchell P, Gopinath B, Luszcz MA, Jagger C, Anstey KJ. Estimating the years lived with and without age-related sensory impairment. *J Gerontol Series A*. 2016 May;71(5):637–42.
18. Wittich W, Southall K, Sikora L, Watanabe DH, Gagné JP. What's in a name: Dual sensory impairment or deafblindness? *Br J Visual Impair*. 2013 Sep;31(3):198–207.
19. Capella-McDonnall ME. The effects of single and dual sensory loss on symptoms of depression in the elderly. Int J Geriatr Psychiatry. 2005 Sep;20(9):855–61.
20. Chou KL, Chi I. Combined effect of vision and hearing impairment on depression in elderly Chinese. *Int J Geriatr Psychiatry*. 2004 Sep;19(9):825–32.

21. Chou KL. Combined effect of vision and hearing impairment on depression in older adults: evidence from the English Longitudinal Study of Ageing. *J Affect Disorders*. 2008 Feb 1;106(1-2): 191–96.
22. Reuben DB, Mui S, Damesyn M, Moore AA, Greendale GA. The prognostic value of sensory impairment in older persons. *J Am Geriatr Soc*. 1999 Aug;47(8):930–35.
23. Brennan M, Horowitz A, Su YP. Dual sensory loss and its impact on everyday competence. *The Gerontologist*. 2005 Jun 1; 45(3):337–46.
24. Brennan M, Su YP, Horowitz A. Longitudinal associations between dual sensory impairment and everyday competence among older adults. *J Rehabil Res Develop*. 2006 Sep 1;43(6):777–92.
25. Keller BK, Morton JL, Thomas VS, Potter JF. The effect of visual and hearing impairments on functional status. *J Am Geriatr Soc*. 1999 Nov;47(11):1319–25.
26. Assi L, Ehrlich JR, Zhou Y, Huang A, Kasper J, Lin FR, *et al*. Self-reported dual sensory impairment, dementia, and functional limitations in Medicare beneficiaries. *J Am Geriatr Soc*. 2021 Dec;69(12):3557–67. doi: 10.1111/jgs.17448. Epub 2021 Sep 3.
27. Armstrong NM, Vieira Ligo Teixeira C, Gendron C, Brenowitz WD, Lin FR, *et al*. Associations of dual sensory impairment with incident mobility and ADL difficulty. J *Am Geriatr Soc*. 2022 Jul;70(7):1997–2007.
28. Canadian Study of Health And Aging: study methods and prevalence of dementia. *CMAJ*. 1994;150(6):899–913.
29. Fillenbaum GG. Multidimensional functional assessment of older adults: the Duke Older Americans Resources and Services Procedures. Hillsdale, New Jersey: Lawrence Erlbaum Associates; 1988.
30. Fillenbaum GG, Smyer MA. The development, validity, and reliability of the OARS multidimensional functional assessment questionnaire. *J Gerontol*. 1981 Jul 1;36(4):428–34.
31. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet*. 2007 Oct 20;370(9596):1453–57. doi: 10.1016/S0140-6736(07)61602-X.
32. Hämäläinen A, Pichora-Fuller MK, Wittich W, Phillips NA, Mick P. Self-report measures of hearing and vision in older adults participating in the Canadian Longitudinal Study of Aging are explained by behavioral sensory measures, demographic, and social factors. *Ear Hear*. 2021 July 1;42(4):814–31.
33. Dullard B, Saunders GH. Documentation of dual sensory impairment in electronic medical records. *The Gerontologist*. 2016 Apr 1;56(2):313–17.
34. Ostevik AV, Westover L, Gynane H, Herst J, Cummine J, Hodgetts WE. Comparison of health insurance coverage for hearing aids and other services in Alberta. *Healthcare Policy*. 2019 Nov;15(2):72–84.

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