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ORIGINAL ARTICLE

Potentially Preventable Hospitalization Among Adults with Hearing, Vision, and Dual Sensory Loss: A Case and Control Study

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Abstract

Objective: To evaluate the risk of potentially preventable hospitalizations (PPHs) among adults with sensory loss. We hypothesized a greater PPH risk among people with a sensory loss (hearing, vision, and dual) compared with controls.

Patients and Methods: Using 2007-2016 Medicare fee-for-service claims, this retrospective, case-control study examined the risk of PPH among adults aged 65 years and older with hearing, vision, and dual sensory loss compared with their corresponding counterparts without sensory loss (between June 1, 2022, and February 1, 2023). We ran 3 step-in regression models for the 3 case and control cohorts examining PPH risk. Our generalized linear regression models controlled for age, sex, race, Elixhauser comorbidity count, rurality, neighborhood characteristics, and the number of primary care physicians and hospitals at the county level.

Results: People with vision (adjusted odds ratio [aOR], 1.21; 95% CI, 0.84-0.87) and dual sensory loss (aOR, 1.26; 95% CI, 1.14-1.40) showed a higher PPH risks than their corresponding controls. For people with hearing loss, our unadjusted models showed a higher PPH risk (OR, 1.40; 95% CI, 1.38-1.43) but after adjustment, hearing loss showed a protective association against PPH risk (OR, 0.85; 95% CI, 0.84-0.87). Moreover, in all models, annual wellness visits reduced the PPH risk by about half (eg, aOR, 0.54; 95% CI, 0.52-0.55), whereas living in disadvantaged neighborhood increased the PPH risk (eg, aOR, 1.13; 95% CI, 1.10-1.15) for cases and controls.

Conclusion: People with vision and dual sensory loss were at greater PPH risk. This study has important health policy implications in reducing PPH and is indicative of a need for more incentivized and systematic approaches to facilitating the use of preventive care, particularly among older adults living in a disadvantaged neighborhood.

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Potentially preventable hospitalizations (PPHs)—also known as ambulatory care-sensitive conditions or prevention quality indicators—can often be avoided if timely and effective outpatient care is provided.[1] PPHs are an expensive and largely inefficient use of health care services.[2-4] Moreover, PPHs are not value-added and may increase harm to vulnerable patient populations such as those with sensory disabilities.[5] In this study, we aimed to examine the risk of hearing, vision, and dual sensory loss for PPH.

In the United States, approximately 37.5 and 12 million adults aged 40 and older are reported to have hearing or vision loss, respectively.[6,7] Research indicates that people with sensory loss may have a heightened risk of PPH because of having more unmet needs, a higher risk of falls, and higher rates of comorbid conditions.[8,9] Unfortunately, hearing and vision care are not covered by traditional Medicare fee for service (FFS)—the primary health insurance for older adults in the United States. Thus, owing to higher out-of-pocket costs of care associated with uncovered hearing and vision care, patients may not be incentivized to address (or correct) their sensory loss(es). The National Poll on healthy aging—a national sample of adults over the age of 50—found that among people who

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had annual wellness visits, approximately 40% were asked about their vision, and less than 20% of them had their vision checked.[10] People with sensory loss are also less likely than those without sensory loss to have timely access to preventive care, while experiencing higher mortality rates, poorer mental and physical health, and longer hospitalization stays.[9,11] For example, Reed et al[12] found that individuals with untreated hearing loss, compared with those without hearing loss, accounted for 46% higher health care costs and 17% higher risk of emergency department visits. Moreover, Genther et al[13] observed that the hospitalization risks for those with mild and moderate hearing loss was 16% and 21% greater, respectively, when compared with hospitalizations among those without hearing loss. Furthermore, people with vision and dual sensory loss showed higher odds of hospital admission than those without sensory loss. However, no large-scale, national study has examined PPH risk among older people with different sensory loss as compared with their counterparts without sensory loss. There is also a gap in literature regarding the potential influence of preventive service use on PPH risk among individuals with sensory loss. Populations with sensory loss often do not receive the quality of care they should. Thus, it is imperative to examine PPH risk among patient populations with sensory loss.

In this study, we used 2007-2016 Medicare claims data to examine the risk of hearing, vision, and dual sensory loss in PPH—comparing each cohort with its respective control without sensory loss. Because unmet health care needs are higher among people with disabilities, we hypothesized that PPH risk is greater among the 3 cohorts of people with sensory loss compared with their controls. Our findings can inform health care policies and underscore the importance of timely access and use of preventive care for adults with sensory loss to prevent higher costs and medical harm for this at-risk population.

METHODS

Data Source

We used a 20% random sample of 2007-2016 Medicare FFS administrative claims data for this study. Data were extracted from the Medicare beneficiary summary file (MBSF), Medicare provider and analysis review (MedPAR) file, outpatient file, and carrier file (office visits). Medicare advantage (MA) enrollees were excluded because their health care encounters were not captured in the Medicare FFS claims. Moreover, we excluded enrollees who died or switched to MA during the year owing to lack of complete information on their use of services. For this study, we created pooled, cross-sectional data of older adults with at least 2-year continuous enrollments in Medicare parts A and B between 2007 and 2016, with the first year serving as the look-back period and the second year to measure PPH.

Because insurance claims data lack socioeconomic and access to care measures, we merged our claims data with the National Neighborhood Data Archive (NaNDA) and the area resource files (ARF).[2] NaNDA is publicly available data containing nationwide measures of the social environment at the census tract level. This dataset includes key variables from the US Census Bureau's American Community Survey, which defines each census tract's socioeconomic status and demographic characteristics. Using Medicare claims data, we could locate the zip code of the place of residence on an annual basis. Using publicly available crosswalk files, we first merged our unique patient-year zip codes with the corresponding zip code tabulation area (ZCTA).[14] We then merged each patient-year ZCTA with 2 composite measures available in NaNDA as follows: (1) disadvantage and (2) affluence.[15] Neighborhood disadvantage is described by high concentrations of poverty, unemployment, female-headed families, households receiving public assistance income, and a high proportion of Black individuals at the ZCTA level. Neighborhood affluence is described by high concentrations of adults with a college education, with incomes greater than 75,000, and people employed in managerial and professional occupations.[15]

Furthermore, we also merged our data with the ARF to include county-level information related to the number of primary care and general internal physicians, and the number of hospitals per capita. To do so, we used publicly available annual crosswalk files between

US zip codes, social security administration (SSA) county codes, and federal information processing standards (FIPS) codes, uniquely identifying all US counties.

Sample Selection

We used the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes to identify our patient cohorts of adults aged 65 years and older. People with a diagnosis of hearing, vision, or dual sensory loss were included as our cases (Supplemental Table 1, available online at http://www.mcpiqojournal.org). People without a diagnosis of hearing and vision loss were included as controls. People who enrolled in Medicare based on end-stage renal disease or cancer and those experiencing pregnancy were excluded. The same set of inclusion or exclusion criteria applied to our controls. Supplemental Figure 1, available online at http://www.mcpiqojournal.org, presents the schematic flow process of sample selection for cases and controls.

Outcomes

Using ICD-9 and ICD-10 codes, we used inpatient claims to identify any occurrence of PPH.[3,4,16] In accordance with the definition of the agency for healthcare research and quality, additional exclusion criteria were also considered to ensure an appropriate rate calculation (Supplementary Table 2, available online at http://www.mcpiqojournal.org). The patient-year composite PPH was estimated based on evidence of any PPH occurring each year.

Covariates

Our main exposure variables were as follows: (1) hearing loss, (2) vision loss, and (3) dual sensory loss, which were defined separately as dichotomous variables. Analytical models adjusted for a range of covariates, such as demographic, health, preventive service use, neighborhood characteristics, and number of primary care physicians and hospitals at the county level. Age, sex, race, enrollment year, and Elixhauser comorbidity count were extracted during each calendar year. We categorized age from 65 to 80 years and older than 80 years, with 65 to 80 years as the reference category. Because our sample size was not large enough to include all racial or ethnic groups, we categorized race into White, Black, and others or unknown, with White as the reference category. Elixhauser comorbidity count was calculated using diagnosis codes in claims data. An annual wellness visit was identified as a binary variable (yes=1 and no=0) using the health care common procedure coding system.[3,4] We used the distribution of zip codes in each of our 3 cohorts to categorize the continuous neighborhood variables of disadvantage and affluence into 3 groups of most, average, and least disadvantaged. In our analytic models, we categorized our continuous variables to enable easier interpretation (eg, comparing living in the most disadvantaged neighborhoods with the least disadvantaged neighborhoods regarding PPH risk).

Statistical Analyses

We examined bivariate analyses of baseline demographic and patient characteristics between older adults with and without hearing, vision, or dual sensory loss. For categorical variables, column percentages were compared between both groups using the χ^2 test. For continuous variables, means and standard deviations (SD) were used. Annual crude rates of any PPH between our cases and controls were compared over the study period.

For the composite measure of any PPH, we used 3 step-in multivariable generalized linear models. A binomial distribution and log link function with a compound symmetry covariance structure was used to minimize model fit statistics for dichotomous outcomes. Adjusted predicted rates and adjusted marginal odds ratios were calculated using the least square means (LSMEANS). All regression results are presented in Supplementary Tables 3-5, available online at http://www.mcpiqojournal.org.

This study was deemed exempt by the institutional review board for ethical approval. Because we used deidentified data, patient consent was not required. All analyses were conducted between June 1, 2022, and February 1, 2023, using SAS 9.4 (SAS Institute). Statistical testing was 2-tailed, with a significance level of $P<.05$.

Sensitivity Analysis

As a sensitivity analysis and to reduce a potential selection bias, we matched cases and

TABLE 1. Characteristics of Older Adults with Hearing, Vision, and Dual Sensory Loss (Cases) and Older Adults without (Controls)

Characteristic	Hearing			Vision			Dual Sensory Loss		
	Case	Control	*P*	Case	Control	*P*	Case	Control	*P*
n	92,623 (100%)	2,795,892 (100%)		4104 (100%)	2,051,254 (100%)	—	1655 (100%)	2,010,947 (100%)	
Age (y), mean ± SD	79.4±8.2	73.9±8.1	<.001	83.9±8.1	73.8±8.4	<.001	84.6±7.8	73.7±8.4	<.001
Sex									
Female	62,347 (67.3%)	1,789,664 (64.0%)	<.001	3033 (73.9%)	1,280,565 (62.4%)	<.001	1248 (75.4%)	1,255,493 (62.4%)	<.001
Male	30,276 (32.7%)	1,006,228 (36.0%)		1071 (26.1%)	770,689 (37.6%)		407 (24.6%)	755,454 (37.6%)	
Race									
White	80,571 (87.0%)	2,311,004 (82.7%)	<.001	3381 (82.4%)	1,684,762 (82.1%)	<.001	1421 (85.9%)	1,649,650 (82.0%)	<.001
Black	7411 (8.0%)	206,649 (7.4%)		589 (14.4%)	154,499 (7.5%)		179 (10.8%)	152,100 (7.6%)	
Other	4641 (5.0%)	278,239 (10.0%)		134 (3.3%)	211,993 (10.3%)		55 (3.3%)	209,197 (10.4%)	
Region									
Midwest	11,103 (12.0%)	702,432 (25.1%)	<.001	276 (6.7%)	521,727 (25.4%)	<.001	110 (6.6%)	513,098 (25.5%)	<.001
Northeast	26,922 (29.1%)	503,070 (18.0%)		1514 (36.9%)	373,205 (18.2%)		650 (39.3%)	363,481 (18.1%)	
South	46,277 (50.0%)	1,075,901 (38.5%)		2123 (51.7%)	770,241 (37.5%)		829 (50.1%)	753,716 (37.5%)	
West	8321 (9.0%)	514,489 (18.4%)		191 (4.7%)	386,081 (18.8%)		66 (4.0%)	380,652 (18.9%)	
Urban/Rural									
Urban	84,809 (91.6%)	2,441,029 (87.3%)	<.001	3782 (92.2%)	1,794,481 (87.5%)	<.001	1547 (93.5%)	1,758,497 (87.4%)	<.001
Rural	7814 (8.4%)	354,863 (12.7%)		322 (7.8%)	256,773 (12.5%)		108 (6.5%)	252,450 (12.6%)	
Elixhauser comorbidity count									
Mean ± SD	3.8±2.9	2.7±2.5	<.001	6.0±3.5	2.7±2.5	<.001	5.2±3.3	2.7±2.5	<.001
Annual wellness	11,790 (12.7%)	333,930 (11.9%)	<.001	254 (6.2%)	245,880 (12.0%)	<.001	98 (5.9%)	241,005 (12.0%)	<.001
Primary care physician (Per 1,000)									
Mean ± SD	0.9±0.5	0.8±0.4	<.001	0.9±0.5	0.8±0.4	<.001	0.9±0.5	0.8±0.4	<.001
Hospital (Per 100,000)									
Mean ± SD	2.0±2.3	2.5±3.2	<.001	1.9±1.8	2.5±3.2	<.001	1.9±1.6	2.5±3.2	<.001
Living in a disadvantage area									
Least	68,520 (74.0%)	2,127,254 (76.1%)	<.001	2800 (68.2%)	1,561,855 (76.1%)	<.001	1176 (71.1%)	1,530,812 (76.1%)	<.001
Middle	20,180 (21.8%)	561,850 (20.1%)		1051 (25.6%)	409,411 (20.0%)		394 (23.8%)	401,550 (20.0%)	
Most	3923 (4.2%)	106,788 (3.8%)		253 (6.2%)	79,988 (3.9%)		85 (5.1%)	78,585 (3.9%)	
Living in an affluence area									
Least	10,771 (11.6%)	410,035 (14.7%)	<.001	593 (14.4%)	300,266 (14.6%)	0.733	209 (12.6%)	295,738 (14.7%)	0.006
Middle	65,847 (71.1%)	1,988,086 (71.1%)		2927 (71.3%)	1,451,843 (70.8%)		1167 (70.5%)	1,422,983 (70.8%)	
Most	16,005 (17.3%)	397,771 (14.2%)		584 (14.2%)	299,145 (14.6%)		279 (16.9%)	292,226 (14.5%)	

Source: 2007-2016 Medicare claims data merged with the area resource files and National Neighborhood Data Archive based on the zip code of Medicare beneficiaries' place of residence.

controls based on all covariates in the model. We applied a 1-to-5 matching algorithm without replacement (hearing: cases=92,623; controls=463,115; vision: cases=4104; controls=20,520; dual: cases=1655; and controls=8275) (Supplementary Tables 6-8, available online at http://www.mcpiqojournal.org).

RESULTS

Table 1 presents the characteristics of adults aged 65 years and older with and without sensory loss during the 1-year lookback period. People compared with their controls (hearing loss [mean ± SD of 79±8.2 vs 74±8.1], vision loss [mean ± SD of 84±8.1 vs 74±8.4], and dual sensory loss [mean ± SD of 85±7.8 vs 74±8.4]; *P*<.001) were older. In all 3 cohorts (hearing, vision, and dual), the majority of the cases (67%, 74%, and 75%, respectively) vs controls (64%, 62%, and 62%, respectively) were females (*P*<.001). More than 80% of all participants were White and more than 85% resided in urban areas. The average Elixhauser counts showed higher comorbidity levels for people with sensory loss compared with their respective controls (hearing loss: 3.8 vs 2.7, *P*<.001; vision loss: 6.0 vs 2.7, *P*<.001; or dual loss: 5.2 vs 2.7, *P*<.001). Compared with their respective controls, rates of annual wellness visits were higher among people with hearing loss (12.7% vs 11.9%; *P*<.001) but substantially lower among people with vision loss (6.2% vs 12%; *P*<.001) or dual sensory loss (5.9% vs 12%; *P*<.001).

The Figure presents the unadjusted biannual PPH trends among Medicare beneficiaries with and without sensory loss between 2008 and 2016. Between 2008 and 2010, PPH rates slightly increased among Medicare beneficiaries with sensory loss but sharply decreased among their respective control groups. Between 2010 and 2016, trends in PPH remained almost flat among the cases (hearing: 4%; vision: 9%; or dual: 10%) and their respective controls (approximately 4%). Persistent gaps in PPH rates were observed between people with vision (4 percentage points; *P*<.001) and dual sensory (6 percentage points; *P*<.001) loss and their controls.

Table 2 presents the adjusted odds ratios (aORs) for PPH, comparing people with

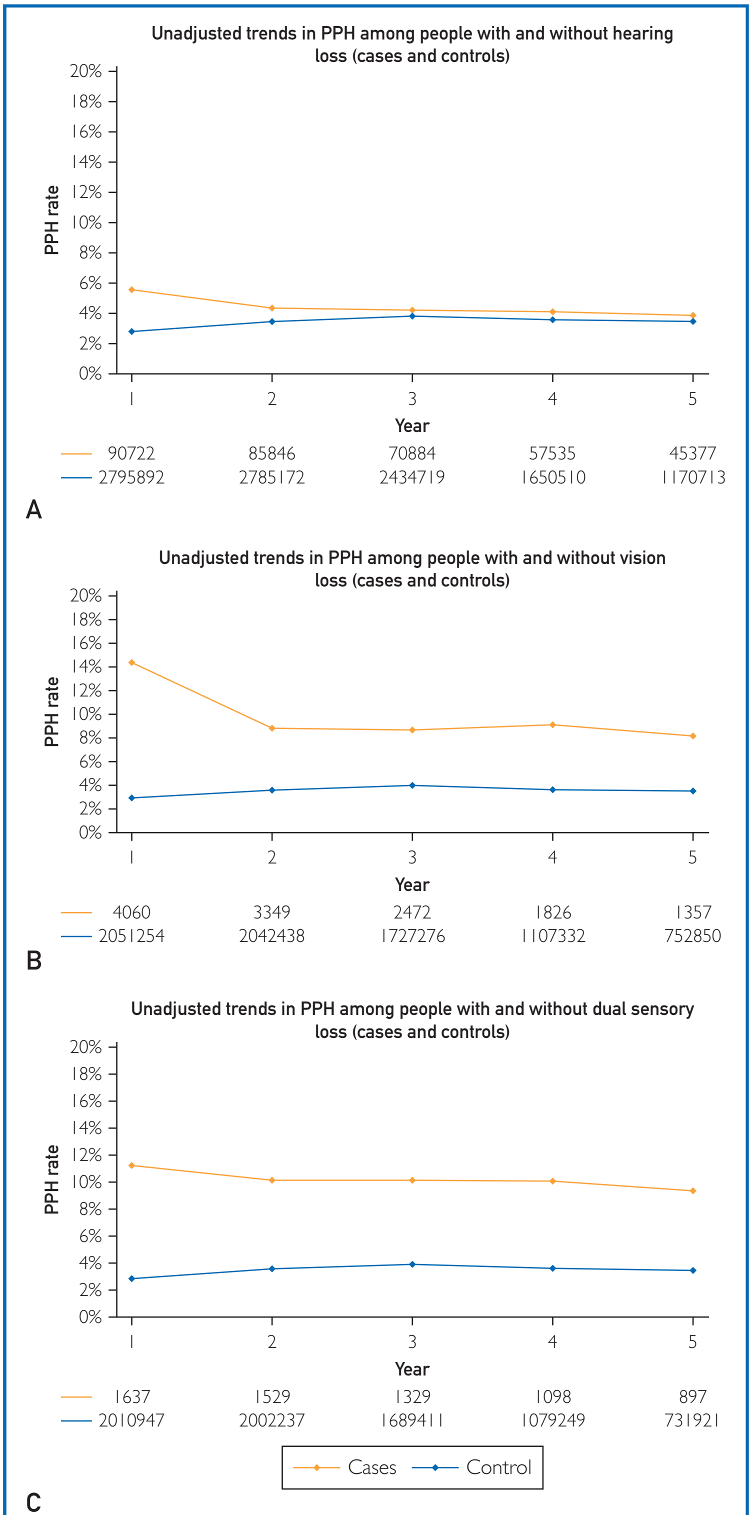

FIGURE. Unadjusted trends in PPH among people with (cases) and without (controls) (A) hearing loss, (B) vision loss, and (C) dual sensory loss. PPH, potentially preventable hospitalization.

TABLE 2. aORs for PPH Comparing Adults Aged 65 and Older with Hearing Loss (Cases) and Their Counterparts Without Sensory Loss (Controls)[a]

Model	Description	aORs for PPH Without Matching; (*P*)	aORs for PPH After Matching (Sensitivity Analysis); (*P*)
1	Cases/controls + year	1.40; 95% CI, 1.38-1.43; *P*<.001	0.79; 95% CI, 0.77-0.80; *P*<.001
2	Model 1 + age	1.09; 95% CI, 1.07-1.11; *P*<.001	0.80; 95% CI, 0.78-0.82; *P*<.001
3	Model 2 + Elixhauser comorbidity	0.83; 95% CI, 0.81-0.85; *P*<.001	0.81; 95% CI, 0.80-0.83; *P*<.001
4	Model 3 + all covariates	0.85; 95% CI, 0.84-0.87; *P*<.001	0.82; (95% CI, 0.80-0.84); *P*<.001

[a]Abbreviations: aOR, adjusted odds ratio; PPH, potentially preventable hospitalization.
Source: 2007-2016 Medicare fee-for-service claims data.
Note: All regression results are presented in Supplemental Tables 3 and 6, available online at http://www.mcpiqojournal.org.

hearing loss to their controls. Adjusting for the year in model 1 (OR, 1.40; 95% CI, 1.38-1.43) and then adding age in model 2 (OR, 1.09; 95% CI, 1.07-1.11), we observed a higher risk of PPH among people with hearing loss compared with controls. However, after adjusting for Elixhauser comorbidity count in model 3 (OR, 0.83; 95% CI, 0.81-0.85) and all other covariates in model 4 (OR, 0.85; 95% CI, 0.84-0.87), hearing loss showed a protective effect. Additionally, annual wellness visits reduced the PPH risk (OR, 0.54; 95% CI, 0.52-0.55); but living in the most disadvantaged neighborhoods compared with the least disadvantaged neighborhoods increased the PPH risk (OR, 1.13; 95% CI, 1.10-1.15) for everyone. After we matched the cases and controls, hearing loss showed a protective effect in all 4 models.

Table 3 presents the aORs of having a PPH, comparing people with vision loss to those without. The odds of having a PPH for people with vision loss were about 3 times higher in model 1 (OR, 3.38; 95% CI, 3.16-3.61). After adjusting for all other covariates in model 4, the odds of having a PPH was reduced but did not disappear (OR, 1.21; 95% CI, 1.13-1.29). Annual wellness visits reduced the PPH risk by half (OR, 0.51; 95% CI, 0.44-0.58); living in the most disadvantaged neighborhoods compared with the least disadvantaged neighborhoods; however, increased the PPH risk (OR, 1.14; 95% CI, 1.11-1.18) for cases and controls. After matching, the higher odds for PPH for people with vision loss diminished but did not disappear (eg, model 4: OR, 1.12; 95% CI, 1.04-1.21; *P*=.002).

Table 4 presents the aORs of having a PPH comparing people with dual loss to those without any sensory loss. The risk of dual loss for any PPH in model 1 (OR, 3.21; 95% CI, 2.90-3.54) was decreased after adding all covariates in model 4 (OR, 1.26; 95% CI, 1.14-1.40), but dual sensory loss remained a significant risk factor for PPH. Finally, annual wellness visits reduced the PPH risk (OR, 0.59; 95% CI, 0.48-0.71). However, living in the most disadvantaged neighborhoods compared with the least disadvantaged

TABLE 3. aORs for PPJH Comparing Adults Aged 65 and Older with Vision Loss (Cases) and Their Counterparts Without Sensory Loss (Controls)[a]

Model	Description	aORs for PPH Without Matching; (*P*)	aORs for PPH After Matching (Sensitivity Analysis); (*P*)
1	Cases/Controls + year	3.38; 95% CI, 3.16-3.61; *P*<.001	1.12; 95% CI, 1.04-1.20; *P*=.003
2	Model 1 + age	2.08; 95% CI, 1.94-2.23; *P*<.001	1.13; 95% CI, 1.05-1.22; *P*<.001
3	Model 2 + Elixhauser comorbidity	1.20; 95% CI, 1.12-1.29; *P*<.001	1.12; 95% CI, 1.04-1.21; *P*=.002
4	Model 3 + all covariates	1.21; 95% CI, 1.13-1.29; *P*<.001	1.12; 95% CI, 1.04-1.21; *P*=.002

[a]Abbreviations: aOR, adjusted odds ratio; PPH, potentially preventable hospitalization.
Interval source: 2007-2016 Medicare fee-for-service claims data.
Note: All regression results are presented in Supplemental Tables 4 and 7, available online at http://www.mcpiqojournal.org.

TABLE 4. aORs for PPH Comparing Adults Aged 65 and Older with Dual Sensory Loss (Cases) and Their Counterparts Without Sensory Loss (Controls)[a]

Model	Description	aORs for PPH Without Matching; (*P*)	aORs for PPH After Matching (Sensitivity Analysis); (*P*)
1	Cases/Controls + year	3.21; 95% CI, 2.90-3.54; *P*<.001	1.26; 95% CI, 1.13-1.41; *P*<.001
2	Model 1 + age	1.87; 95% CI, 1.69-2.07; *P*<.001	1.27; 95% CI, 1.13-1.42; *P*<.001
3	Model 2 + Elixhauser comorbidity	1.25; 95% CI, 1.13-1.39; *P*<.001	1.25; 95% CI, 1.12-1.39; *P*<.001
4	Model 3 + all covariates	1.26; 95% CI, 1.14-1.40; *P*<.001	1.25; 95% CI, 1.12-1.40; *P*<.001

[a]Abbreviations: aOR, adjusted odds ratio; PPH: potentially preventable hospitalization.
Source: 2007-2016 Medicare fee-for-service claims data.
Note: All regression results are presented in Supplemental Tables 5 and 8, available online at http://www.mcpiqojournal.org.

neighborhoods increased the PPH risk (OR, 1.13; 95% CI, 1.10-1.17) for everyone. Similar cases with vision loss, after matching, the odds for PPH for people with dual sensory loss reduced but did not disappear (eg, model 4: OR, 1.25 95% CI, 1.12-1.40; *P*<.001).

DISCUSSION

In this cross-sectional study, we used Medicare claims data to examine the risk of hearing, vision, and dual sensory loss for PPH—comparing each cohort with its respective control without sensory loss. Three primary findings emerged. First, our fully adjusted models revealed higher risks of experiencing a PPH for older adults with vision and dual sensory loss but not for adults with hearing loss. Second, our sensitivity analyses showed lower but still higher odds for PPH among cases with vision and dual sensory loss compared with matched controls. Third, the frequency of annual wellness visits and living in affluent neighborhoods substantially reduced the risk of PPH for both cases and controls.

Our study revealed a greater PPH risk for individuals with vision loss than those without vision loss. Vision loss increases the probability of encountering falls,[17] aspiration pneumonia,[18] lacerations, and collisions with objects,[19] which may be avoided with assistive devices and preventive measures. Moreover, research shows that hospitalized older adults with vision loss were more likely than their counterparts to be diagnosed with circulatory, nervous, or respiratory system disorders.[20] This underscores the need to improve annual wellness visits in this population to attempt to detect these disorders earlier and reduce the likelihood of PPH. Furthermore, older individuals—particularly those with sensory loss—may not be able to fully communicate their health issues at visits. This highlights the importance of providers' awareness of the barriers this population faces, which place them at a higher risk for PPH. For example, Morse et al[21] found that 15% of people with partial vision loss and 22% of those with severe vision loss had higher odds of readmission than controls with no vision loss. This study signifies the challenges with forms, preadmission protocols, instructions, and post-discharge routines.[21]

Contrary to our hypothesis, our models did not show a higher PPH risk among people with hearing loss compared with controls. Although our unadjusted data displayed a slightly higher PPH rates among people with hearing loss vs controls, our models revealed that after adjusting for comorbidities, people with hearing loss showed a protective effect compared with controls. People with hearing loss may be at lower PPH risk owing to protective factors such as the use of hearing aids.[22] Wells et al[23] found that older adults with severe hearing loss who used assistive devices were about 15% less likely to be hospitalized.[23] Because Medicare does not cover hearing aids, we could not identify people who used hearing devices. Moreover, our analyses could not account for the severity of hearing loss. More studies with increased granular data are needed to confirm our findings and explore plausible explanations.

Our findings show that people with dual sensory loss showed an increased risk for PPH compared with controls. Leveziel et al[24] found that European individuals with dual sensory loss have higher rates of chronic illnesses, depression, and social isolation. This vulnerable population may be at greater risk for PPH because of specialized needs associated with having multiple disabilities and comorbidities. For example, studies show that older adults with dual sensory loss have higher rates of hospitalization and functional dependence.[25,26] Additionally, these adults are prone to diabetes, impaired cognition, and cardiovascular events such as stroke and acute myocardial infarction.[27] Gopinath et al[27] reported that the 10-year mortality risk is 62% higher among people with dual sensory loss than in controls. Challenges in activities of daily living and timely access to care, as well as greater vulnerability to hazardous situations, are critical points to consider for preventive care management in this population.[28]

Our sensitivity analyses showed that despite matching for all included variables in the model, people with vision and dual sensory loss still had higher odds of PPH compared with their matched controls. As we discussed above, this is plausibly indicative of other barriers to timely access to quality care, which we did not match in our models.

Individuals living in disadvantaged communities showed an increased risk for PPH in all 3 groups. Lack of availability of trained professionals, practitioner supervision, practitioner resistance to innovation, and lack of access, trust, and service engagement are noted as existing problems in health care systems that operate within disadvantaged neighborhoods.[29] Individuals in low-resourced areas often need help utilizing regular primary care visits or face financial barriers. Similarly, understanding the social and medical needs of people with complex care needs highlights the importance of annual wellness visits for individuals with sensory loss. Our findings indicated that annual wellness visits reduced PPH risk by almost half. Annual wellness visits play a key role in the early detection of illnesses or situations that can be addressed in clinics vs hospitals.[30,31] Despite free coverage of annual wellness visits after the passage of the affordable care act, annual wellness visits and preventive care services are still underused by people.[32,33]

Our study had a few limitations. First and foremost, not all PPHs could have been avoided, even if patients had access to timely care. Using claims data, we did not have a mechanism to distinguish that factor among all PPHs. However, using large datasets, we assumed unavoidable PPHs were equally distributed among cases and controls. Second, since Medicare FFS does not cover most hearing and vision care, we may have missed many people with hearing or vision loss or those who used assistive devices to address their sensory loss. Moreover, if people in our cohort (cases or controls) did not use Medicare for the diagnosis or treatment of their sensory loss, we would have had no way of knowing whether they exhibited a sensory loss. For example, hearing aids are not covered by Medicare FFS. Therefore, we were unaware of whether our cases used hearing aids, particularly among the hearing loss group. Prior research shows that about 30% of adults with hearing loss use hearing aids.[22] Thus, it is plausible that PPHs were lower among these individuals owing to the use of corrective devices. We were also unable to define the severity of hearing or vision loss using claims data. We used ICD-9 and ICD-10 diagnosis codes to identify our cases of sensory loss. We acknowledge the existing discrepancies between ICD-9 and ICD-10 codes. However, since we did not aim to examine trends in incidents or prevalence of sensory loss, that limitation should have minimal effect on our study results.

The strength of our study is our use of large, nationally representative data of older adults in the United States, comparing PPHs between people with and without different sensory loss. We also used neighborhood characteristics and the availability of health care resources as salient predictors of PPH.

In conclusion, we used Medicare FFS claims data to examine the influence of sensory loss on PPH risk. Our results showed that vision and dual sensory loss increased the PPH risk compared with controls without sensory loss. Annual wellness visits and living in more affluent areas with more access to health care reduced the PPH risk for everyone. Findings from this study have important health policy implications for people with sensory loss, indicating the need for systematic

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and structural support to improve their use of preventive services, particularly annual wellness visits.

POTENTIAL COMPETING INTERESTS

There is no conflict of interest to report.

SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at http://www.mcpiqojournal.org. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

Abbreviations and Acronyms: **aOR,** adjusted odds ratio; **ARF,** area resource files; **FIPS,** Federal Information Processing Standards; **FFS,** fee for service; **ICD-9-CM,** International Classification of Diseases, Ninth Revision, Clinical Modification; **ICD-10-CM,** International Classification of Diseases, Tenth Revision, Clinical Modification; **LSMEANS,** the least square means; **MA,** Medicare advantage; **MBSF,** master beneficiary summary file; **MedPAR,** Medicare provider and analysis review; **NaNDA,** National Neighborhood Data Archive; **OR,** odds ratio; **PPH,** potentially preventable hospitalizations; **SD,** standard deviation; **SSA,** social security administration; **ZCTA,** ZIP code tabulation area

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