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Prevalence and Impact of Bilateral Vestibular Hypofunction: Results from the 2008 United States National Health Interview Survey

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Abstract

Objective—Profound bilateral vestibular hypofunction (BVH) causes disabling oscillopsia, chronic disequilibrium and postural instability. Our aim was to assess prevalence and functional impact of BVH in the U.S. adult population.

Study Design—National cross-sectional survey and corollary validation study.

Setting—National database

Patients—Adult participants in the 2008 Balance and Dizziness Supplement to the United States National Health Interview Survey (NHIS), (n=21,782).

Intervention—Survey-based diagnosis of BVH, all of the following: presence of visual blurring with head movement, unsteadiness, difficulty walking in darkness/unsteady surfaces and in a straight path, symptoms being at least “a big problem” and present for at least 1 year, in the absence of other neurologic conditions or eye pathology affecting vision.

Main Outcome Measures—Prevalence of BVH, socioeconomic and quality-of-life impact of BVH, and fall risk.

Results—Adjusted national estimates from this survey indicate the prevalence of BVH in 2008 was 28/100,000 U.S. adults (64,046 Americans). 44% of participants with BVH reported changing their driving habits because of their symptoms, 56% reported reduced participation in social activities, and 58% reported difficulties with activities of daily living. Respondents with BVH had

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a 31-fold increase in the odds of falling in multivariate analyses compared to all respondents, with 25% reporting a recent fall-related injury.

Conclusions—BVH, as estimated by the presence of specific symptoms in a nationally representative survey, has considerable socioeconomic and quality-of-life impacts and significantly increases fall risk. These data support the need for new therapeutic strategies for BVH, including vestibular rehabilitation and implantable vestibular prostheses.

INTRODUCTION

Profound bilateral loss of vestibular sensation disables the vestibulo-ocular and vestibulo-spinal reflexes that normally maintain stable gaze and posture. Affected individuals suffer oscillopsia (illusory movement of the visible world during head movement), chronic disequilibrium and postural instability that interfere with otherwise routine activities such as walking or driving[1, 2]. Although the cause of bilateral vestibular hypofunction (BVH) is frequently unknown, ototoxicity due to gentamicin or other aminoglycosides is the most commonly identified cause of BVH; other causes include Ménière's disease, labyrinthitis, meningitis, autoimmune disease and iatrogenic damage due to cochlear implantation or other surgeries[3–5].

Incidence and prevalence data are available for a number of conditions affecting vestibular function[6–8]; however, few data exist regarding the prevalence of BVH. Accurate estimates have been difficult to generate due to the lack of detailed reporting mechanisms focusing on balance or vestibular dysfunction in large surveys. In 2008, the National Health Interview Survey (NHIS) included supplemental dizziness and balance questions intended to assess the prevalence and associated impairments of vestibular disorders. The objective of this study is to assess the prevalence and impact of severe-to-profound BVH from the results of this large, nationally representative sample of adults.

MATERIALS AND METHODS

Data Source

The NHIS is an annual nationwide survey of the non-institutionalized civilian population conducted by household interview[9, 10]. Interviews are conducted weekly on an ongoing basis by staff at the U.S. Census Bureau, using stratification, multi-stage sampling, and a probability cluster sampling technique with oversampling of minorities to improve statistical estimates. In 2008, additional information related to dizziness and balance problems was collected in a subsample of respondents as part of the annual survey. Respondents were asked if during the previous 12 months, they had problems with dizziness and balance or associated symptoms. They were then asked a series of questions to characterize the severity, duration, frequency, provoking or mitigating factors, and associated symptoms of their most bothersome problem with dizziness. Additional questions regarding the use of balance aids, healthcare utilization, use of pharmacologic treatments, and absenteeism from school or work were asked[11]. The frequency and severity of falls associated with dizziness or balance problems were also obtained. In 2008, 74,236 individuals were interviewed as part of the

NHIS with a response rate of 84.9%[12]. A subsample of 21,781 adults completed the 2008 NHIS balance supplement.

Definition of Bilateral Vestibular Hypofunction

Questions defining a constellation of symptom characteristics typical of BVH were intentionally incorporated into the 2008 NHIS balance supplement to allow accurate estimation of the prevalence of this disorder. 3,411 respondents (14.8%) answered, “yes” to one of the following questions defining a general problem with dizziness or balance in the past 12 months, excluding times when using alcohol: “problem with dizziness or balance?” “spinning or vertigo sensation?”, “floating, spacey, or tilting sensation?”, “feeling lightheaded, without a sense of motion?”, “feeling as if you are going to pass out or faint?”, “blurring of your vision when you move your head?”, or “feeling off-balance or unsteady?”. Of those who responded “yes”, the prevalence of bilateral vestibular hypofunction was estimated based on affirmative responses to all of the following questions: In the absence of alcohol consumption, do you “have blurred or fuzzy vision when moving your head?” “feel off-balance or unsteady?”, “drift to the side when trying to walk straight?”, “have difficulty walking in the dark?” or on “uneven ground or surfaces?”. Respondents had to additionally report their dizziness problem as at least a “big problem” and with duration of symptoms greater than 1 year. To exclude confounding neurologic or visual conditions with overlapping responses, respondents must have answered “no” to the diagnosis of “spinal cord injury”, “stroke”, “movement disorders such as Parkinson’s”, “muscular dystrophy” or “multiple sclerosis”, or a diagnosis “macular degeneration”, “glaucoma”, “diabetic retinopathy” or “cataracts” causing visual impairment.

Participants in the NHIS cannot be contacted after completing the interview study; therefore, a corollary study was performed to assess construct validity of our case definition of BVH. We surveyed three groups with a sample of questions from the NHIS balance supplement: 12 individuals with known BVH, 12 with known chronic unilateral vestibular hypofunction (UVH) of at least one year duration and 13 with no history of dizziness or inner ear pathology. For BVH and UVH groups, respondents must have had documented vestibular hypofunction based on history and physical examination and confirmed by supine and prone ice water caloric responses with peak eye slow phase velocity of 5 degrees per second or less bilaterally for BVH subjects or unilaterally for UVH subjects. Etiologies for BVH subjects included aminoglycoside ototoxicity (n=5), bilateral Ménière's disease (n=1), head and neck trauma (n=1) and unknown (n=5). UVH subjects had a history of unilateral Ménière's disease that had been treated by intratympanic gentamicin to ablate residual vestibular function. The proposed survey-based case definition of BVH completely differentiated BVH from chronic UVH respondents (Table 1). One subject with BVH had symptom duration less than 1 year and would not have met the case definition requirement. This requirement of disease duration of at least 1 year was maintained for application to the NHIS data as we wished to exclude temporary vestibular conditions with overlapping symptoms.

Measurement of Physical Dysfunction and Healthcare Utilization

Questions regarding activities of daily living and social limitations were asked of all NHIS respondents. Respondents were categorized as having none, one to three, or four or more

functional limitations by the frequency with which they responded “very difficult” or “can’t do at all” for 9 activities: walk a quarter mile, walk up ten steps without resting, stand for 2 hours, sit for 2 hours, stoop/bend/kneel, reach overhead, grasp small objects, lift/carry up to 10 pounds, and push/pull large objects. Respondents had at least one social limitation if they reported it was “very difficult” or that they “can’t do at all” any of three social/leisure activities: “go out to things like shopping, movies, or sporting events”; “participate in social activities such as visiting friends, attending clubs and meetings, or going to parties”; or “do things to relax at home or for leisure”. Their need for special equipment was determined by the questions “Do you now have any health problem that requires you to use special equipment, such as a cane, a wheelchair, a special bed, or a special telephone?”

The NHIS balance supplement included additional questions specifically pertaining to a problem with dizziness or balance in the prior 12 months. These items further defined symptom character, severity and timing; provoking and mitigating factors; physical and psychological problems as a result of their balance problem; medicine and drug use; health care utilization; diagnoses conferred; treatments offered; outcomes; limitations of activities; days of school or work missed; number of falls in the past 1 and 5 years; and injury sustained due to falls. Respondent answers to these questions were used to assess the impact of BVH relative to all those with dizziness or balance problems within the last 12 months.

Statistical Analyses

Statistical analyses were adjusted for the complex sample design to ensure that estimates accurately represent percentages of the U.S. population. Sample weights were used in all analyses to adjust for the probability of selection for participation. Overall proportions and odds ratios for adults with symptoms consistent with BVH were calculated. Multivariate logistic regression was performed to evaluate for association between BVH and the above listed covariates. Independent variables that have previously demonstrated an association with dizziness were included in the analysis. These included gender, age, and race/ethnicity (Hispanic, non-Hispanic, white, black, native American, and multiple races). Associations were considered statistically significant for 2-sided statistics with a p-value < 0.05. Stata 12.0 (StataCorp, College Station, TX, USA) was used for all prevalence estimates, confidence intervals, and odds ratios.

RESULTS

The 2008 NHIS Balance and Dizziness Supplement revealed that 14.8% of U.S. adults (33.4 million) report they had a problem with dizziness or balance during the past year. The prevalence was higher for women (18.3%; 21.3 million) than for men (11.1%; 12.1 million) and increased with age up to 27.7% of adults (4.8 million) aged 75 years and older. Symptoms designated as most bothersome were ‘unsteadiness’ (28.0%), ‘feeling lightheaded’ (18.4%), ‘feeling you are about to pass out’ (16.3%), ‘vertigo or spinning feeling’ (13.5%), and ‘blurred vision when moving head’ (5.2%). The least bothersome was a ‘floating or spacey feeling’ (3.7%), and a few subjects (1.1%) had multiple symptoms but could not choose which was most bothersome. Other respondents (13.8%) reported a

dizziness or balance problem but indicated their problem was not characterized by one of the specific symptoms listed.

Of 21,782 adults surveyed, 12 respondents reported a history consistent with chronic, disabling, severe-to-profound BVH (i.e., all of the following: dizzy in the past year, visual blurring during head movement, unsteadiness, difficulty walking in darkness, in a straight path, or on uneven surfaces, symptom duration > 1 year, and severity of problem “big” or “very big”, in the absence of neurologic or ophthalmic disease causing visual impairment). Table 2 shows the accumulated national prevalence with each ‘yes’ response to the questions that suggest a BVH case. In 2008, the approximate U.S. adult population was 225.2 million people. This yields an estimated adjusted national point prevalence of 28/100,000 U.S. adults with BVH, or 64,046 Americans affected.

Baseline demographic characteristics of BVH respondents, all respondents, and those with a dizziness or balance problem in the preceding 12 months are shown in table 3. BVH respondents were more likely to be female, to have been diagnosed with diabetes or depression, and to have functional, social, and physical impairments than all survey respondents taken as a group. They were also more likely to be unemployed and to report being disabled as the reason for their unemployment. Compared to those with dizziness or balance problems in the prior year, BVH respondents were more likely to be Hispanic, to have functional limitations, and to be on physical disability.

Of the 12 NHIS respondents who met the case definition, 7 were provided a diagnosis for their dizziness or balance problem. Reported diagnoses included benign paroxysmal positional vertigo (BPPV) (1), head and neck trauma (1), inner ear infection (1), Ménière's disease (1), or other health problems (3). Of the 9 who responded that they had taken or tried treatments to alleviate their symptoms, 5 (56%) had undergone physical therapy, 2 (22%) had tried “head rolling maneuvers”, 1 (11%) had undergone head and neck surgery, 3 (33%) adopted a “low-salt diet” or “avoidance of food triggers”, and 6 (66%) attempted alternative therapies including massage therapy (2), herbal remedies (2), chiropractic manipulation (1) or wearable magnets (1). The majority (75%) reported that their balance problem has stayed the same or worsened over the preceding 12 months. Despite seeing a mean of 5.6 (SD 2.9) health professionals for their dizziness or balance problems, only 25% feel that a health professional had helped with their primary dizziness complaint.

Specific functional limitations of NHIS respondents who meet the case definition of BVH compared to those with dizziness or balance problems are demonstrated in table 4. As a result of their balance problem, the majority of BVH respondents reported limitations in social activities and employment, at higher rates than those with dizziness or balance problems alone. Of those respondents reporting a symptom complex consistent with BVH, 44% reported that they had either changed or limited their driving habits due to their symptoms, while the majority had motion discomfort, particularly when traversing tunnels, navigating stairs, escalators or moving walkways, or riding as a passenger in car, bus, train, or plane. Additionally, 88% of respondents reported falling within the past 5 years. This equates to an age-adjusted 9.9-fold increase in fall risk (95% CI: 1.8–53.6) among those with BVH in comparison to those with dizziness/imbalance but not BVH, and a 31-fold

increase in fall risk (95% CI: 6.1–165.0) in comparison to the nationwide average. In the 12 months prior to the survey, 67% reported falling with a mean count of 1.75 (SD 1.8) falls. One-quarter (n=3) reported suffering bodily injury from a fall in the last 12 months and 1 respondent missed 3 months of work as a result of the injury.

DISCUSSION

The results of this study indicate that a constellation of symptoms and historical features consistent with severe to profound BVH affects approximately 28 out of every 100,000 U.S. adults. This equates to a prevalence of 64,046 cases of severe-to-profound bilateral vestibular hypofunction in the United States, and 1.8 million worldwide (by extrapolation of U.S. estimates to the 2008 world population). Prior studies on the prevalence of bilateral vestibular hypofunction have been restricted to subspecialty practices and to the etiology/prognosis of the condition[3–5, 13].

In applying the broad series of balance-related questions in the NHIS balance supplement to patients with known BVH by examination in our validation study, we identified a series of items to which patients with BVH consistently respond, distinguishing them from patients with chronic UVH. Some items such as presence of ‘unsteadiness’, ‘blurred vision with head motion’ and ‘difficulty walking in darkness’ have been reported previously[4, 14]; however, others such as difficulty walking on uneven surfaces, or difficulty walking in a straight path, may provide additional diagnostic power to clinicians and researchers attempting to distinguish BVH from chronic UVH patients. While all the patients with known BVH responded affirmative to the questions of the case definition, some questions better discriminated BVH from UVH. All subjects with BVH ranked their problem with dizziness or balance as a “big” or “very big” problem, whereas this was found in only one of the 12 subjects with chronic UVH (8%). The presence of symptoms ‘1 or more times a day’ or ‘almost always’ was found in no patients with chronic UVH and all patients with chronic BVH. The least discriminating questions included ‘feeling off-balance or unsteady’ (92% of patients with UVH), having ‘difficulty walking in the dark’ (67%), ‘drifting to the side when trying to walk straight’ (58%), having ‘difficulty walking on uneven ground’ (42%), and experiencing ‘blurred vision during head movements’ (42%). A combination of these questions may aid clinicians/researchers in establishing a history-based case definition of BVH.

While the ages of BVH subjects found in this study are consistent with prior reports[3, 5, 14], this study found a higher proportion of female respondents who met the case definition for BVH. The distribution of BVH by gender has varied across prior studies, with a recent study by Kim et al. reporting a slight female preponderance[14]; however, these studies investigated patients in subspecialty clinics. A higher prevalence of dizziness/balance symptoms among females has been noted more generally in a nationally representative sample[6]. Whether the higher proportion of women with BVH in this study represents selection bias or altered referral patterns to dizziness specialists warrants additional study.

Consistent with the perceived severity of their balance problem, many BVH respondents reported a negative impact of their dizziness or balance problem on daily activities:

approximately 44% either stopped driving due to these symptoms or changed driving habits as a result of their dizziness, and 55% reported missed work or school. Cohen et al. note a negative impact of vestibular deficiencies on driving habits, particularly in situations with limited visual feedback such as driving at night or in the rain[15]. While that study found no decrease in total distance driven between vestibular patients and controls, no subjects with BVH were included. Other studies also demonstrate the influence of dizziness symptoms on daily activities, including increased sick leave from work and lost productivity[6, 16]. This study found that three-quarters of BVH respondents were unemployed with a significantly greater percentage on disability than those with a dizziness/balance problem but not BVH by our case definition.

Data on the influence of BVH on quality of life have been limited, but recent evidence suggests social and physical limitations of patients with this condition[17]. In this study, 39% of BVH respondents reported at least one social activity as “very difficult” or “unable to do”, and 58% reported severe limitations in at least 4 of 9 activities of daily living. 42% of those who met the case definition, however, reported no functional limitations. This supports wide variation in reported disability due to bilateral vestibular deficiency and may depend on the degree of vestibular loss and age at onset. Those with congenital BVH or those who acquire it at a young age may suffer delays in reaching developmental milestones for sitting, standing and walking, delays which may depend on the degree of remaining otolith organ function[18]. Long-term data on functional impairments of congenital BVH are lacking. Patients who acquire BVH acutely as adults, however, may be dramatically affected by relentless disequilibrium, chronic oscillopsia and cognitive dysfunction due to the need for constant attention to normally automatic functions like walking[1]. Dizziness Handicap Inventory scores have recently been shown to vary in subjects with bilateral vestibulopathy depending on residual otolith function[19]. While BVH subjects as a group report profound impairments in quality of life, functional impairment may vary depending on age of onset and degree of vestibular loss.

BVH may impart additional risks of fall-related injury. An analysis of the National Health and Nutrition Examination Survey (NHANES) demonstrated that 35.4% of adults, aged 40+ years, fail a modified Romberg test, and that this finding increases the odds of falling by as much as 12 times in those who also self-report dizziness or balance problems[20]. The age-adjusted fall risk in the present study of those respondents who answered according to the case definition of BVH was over 9 times greater than that of other respondents reporting problems with dizziness/balance, and 31 times the national average. Furthermore, one-quarter of those who met the case definition reported a fall-related injury within the last 12 months. Results from this study and others support a need for effective treatments of patients with bilateral vestibular hypofunction.

Currently, the only widely available treatment of BVH is vestibular rehabilitation, which can enlist visual and proprioceptive cues to partly supplant missing vestibular sensation[21, 22]. Although rehabilitation is helpful for active or predictable head movements, the benefits are modest for rapid and unpredictable movements[23]. Furthermore, some BVH subjects never adequately recover performance, as can be demonstrated in the functional impairments seen in many respondents in this and other studies[17]. Attempts to replace vestibular sensation

with tactile stimulation of the torso, sound, and electrical stimulation of the tongue have identified postural effects, but are unlikely to improve VOR function[24]. In contrast, implantable vestibular prostheses may help patients with BVH recover VOR function (reviewed in references 34 and 35)[24, 25].

This study describes 12 respondents with symptoms consistent with BVH, but without confirmatory clinical examination or laboratory testing. The case definition for bilateral vestibular hypofunction used in this study was developed to include symptoms most commonly seen in patients with this condition who present to a dizziness clinic. We further excluded respondents who reported symptom duration less than one year, in addition to neurologic diagnosis with overlapping symptoms or ophthalmic disease causing vision loss. Though these restrictions may exclude individuals who also had bilateral vestibular hypofunction, we intended to provide a more conservative estimate, given the limitations of being unable to contact survey respondents. The prevalence estimate in this study may therefore underestimate the true disease prevalence. By using a less restrictive case definition that also distinguished BVH from UVH subjects in the corollary validity study (presence of dizziness or balance problem in the last 12 months, feeling off-balance or unsteady, difficulty walking in the dark, blurred vision with head motion, defined as at least a big problem and present for >1 year) the projected prevalence of BVH could extend to 85/100,000 or 193,369 U.S. adults.

There are several additional limitations associated with the use of cross-sectional survey data such as in the NHIS. Conclusions regarding causation for the associations with functional impairments noted in this study cannot be determined; however, respondents attributed functional limitations (shown in table 4) to their most troublesome problem with dizziness or balance. Since the data are also self-reported, recall bias or observational bias could lead to either an overestimation or underestimation of the true prevalence of bilateral vestibular hypofunction. Though we tried to exclude individuals who may have symptoms that confound our definition of BVH, we may also potentially include respondents with other causes of chronic, severely symptomatic disequilibrium and visual blurring during head movement. Of the 12 cases, however, the conferred etiology and treatments were consistent with what has previously been reported in the literature for patients with BVH[4]. Alternatively, BVH patients may be affected by a misclassification bias by underreporting the severity of their disability, therefore leading to underestimation of prevalence. Finally, there are limitations in generalizing these results, as aminoglycoside use is more common outside of the United States, and therefore the prevalence of BVH may vary geographically.

Future studies assessing BVH prevalence would benefit from physical examination and quantitative testing such as static and dynamic visual acuity assessments, which could be administered during a future round of the NHIS. Similar studies in countries outside the United States may additionally add greater insight into the global prevalence of this morbid condition. Additionally, a universal consensus regarding a case definition of bilateral vestibular hypofunction is needed.

Conclusions

As estimated from self-reported symptoms obtained during a comprehensive interview about balance/vestibular dysfunction in a nationally representative survey of U.S. adults, chronically symptomatic severe-to-profound bilateral loss of vestibular sensation affects many U.S. Adults, at prevalence estimates comparable to Ménière's disease[8]. Individuals reporting a constellation of symptoms consistent with BVH are at increased risk for falls and functional impairments.

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Data Source: CDC/NCHS, National Health Interview Survey Balance Supplement, 2008

Any analyses, interpretations, or conclusions reached by the authors are credited to the authors and not to the NCHS, which is responsible only for the initial data.

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Table 1

Corollary study to determine construct validity of the bilateral vestibular hypofunction case definition.

Must answer 'yes' to all of the following:	BVH (12)	UVH (12)	Control (13)
Dizziness or Balance problems in last 12 months?	12 (100%)	10 (83%)	3 (30%)
Feel off-balance or unsteady	12 (100%)	10 (83%)	2 (20%)
Have difficulty walking in the dark	12 (100%)	7 (58%)	0 (0%)
Have difficulty walking on uneven surfaces	12 (100%)	3 (25%)	0 (0%)
Blurred of fuzzy vision when moving your head	12 (100%)	1 (8%)	0 (0%)
Drifting to the side when trying to walk straight	12 (100%)	1 (8%)	0 (0%)
Problem defined as at least a 'big problem'	12 (100%)	0 (0%)	0 (0%)
Duration of symptoms of at least 1 year	11 (92%)	0 (0%)	0 (0%)

Results of a corollary validation of 37 subjects who were not enrolled in the 2008 NHIS Balance Supplement. Values are cumulative counts of remaining respondents that meet the case definition for confirmed bilateral vestibular hypofunction (BVH), unilateral vestibular hypofunction (UVH), and for those with no history of dizziness or balance complaints.

Table 2

NHIS 2008 Balance Supplement accumulated prevalence of case-defining responses.

Total NHIS Balance Supplement Respondents (21,782)	Sample size, n	Prevalence % [95% CI]	Per 100,000 US Adults
Dizziness or Balance problems in last 12 months?	3,411	14.84% (14.2–15.5)	14,841
Feel off-balance or unsteady	2,094	9.07% (8.6 – 9.6)	9,074
Have difficulty walking in the dark	691	2.94% (2.7 –3.2)	2,943
Have difficulty walking on uneven surfaces	572	2.38% (2.2 – 2.7)	2,880
Blurred of fuzzy vision when moving your head	301	1.28% (1.1 – 1.5)	2,112
Drifting to the side when trying to walk straight	264	1.13% (1.0 – 1.3)	1,990
Problem defined as at least a ‘big problem’	79	0.32% (0.2 – 0.4)	1,364
Duration of symptoms of at least 1 year	70	0.27% (0.2 – 0.4)	1,319
Exclusions			
Chronic neurologic conditions	16	0.05 (0.03 – 0.08)	947
Ophthalmic condition causing visual impairment	12	0.03% (0.02–0.05)	28

Sample numbers and prevalence (population-based %) values represent cumulative ‘yes’ responses, with each row representing a ‘yes’ response to that row and to each of the rows above it. Chronic neurologic conditions included “spinal cord injury”, “stroke”, “movement disorders such as Parkinson’s”, “muscular dystrophy” or “multiple sclerosis”. Ophthalmic conditions included a diagnosis “macular degeneration”, “glaucoma”, “diabetic retinopathy” or “cataracts”. Respondents with ophthalmic conditions must also have answered ‘yes’ to whether the condition causes visual impairment.

Table 3

Prevalence (population-weighted %[3]) of selected demographic characteristics, reported co-morbidity, and functional limitations of 2008 NHIS Balance Supplement respondents. Groups represent bilateral vestibular hypofunction status determined from case definition, all respondents, and those who reported a problem with dizziness or balance in the last twelve months.

	BVH (12)	All Respondents (21,770)	P value[1]	Dizziness/ Imbalance[2] (3,411)	P value[1]
Gender			0.03		0.13
Male	11.2%	48.3%		36.1%	
Female	88.8%	51.7%		63.9%	
Age Group			0.84		0.89
18–44 years	40.7%	49.1%		37.5%	
44–64 years	39.5%	34.3%		36.6%	
>65 years	19.8%	16.6%		26.0%	
Race			0.15		0.02
White	71.0%	81.1%		85.0%	
Black	16.2%	11.9%		11.2%	
Native American	0%	0.2%		1.0%	
Asian	12.9%	4.6%		2.4%	
Multiple Race	0%	1.2%		0.3%	
Ethnicity			0.07		0.02
Non-Hispanic	64.2%	86.4%		89.5%	
Hispanic	35.8%	13.6%		10.5%	
Medical Comorbidity					
Smoking Status			0.70		0.80
Current/Former Smoker	48.4%	42.2%		52.4%	
Never Smoked	51.6%	57.8%		47.6%	
Hypertension			0.68		0.49
Ever diagnosed	35.1%	29.5%		45.1%	
Never diagnosed	65.0%	70.6%		54.8%	
Diabetes			0.05		0.47
Ever diagnosed	24.5%	8.3%		16.5%	

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	BVH (12)	All Respondents (21,770)	P value[1]	Dizziness/ Imbalance[2] (3,411)	P value[1]
Never diagnosed	75.5%	91.7%		83.5%	
Depression			0.02		0.65
Ever had	63.8%	28.2%		55.6%	
Never had	36.3%	70.3%		43.8%	
Generalized Anxiety			0.15		0.84
Ever had	37.8%	19.2%		41.0%	
Never had	62.2%	80.7%		58.3%	
Social Limitations			<0.0001		0.10
0	60.8%	93.2%		86.7%	
≥1	39.2%	6.8%		13.3%	
Functional Limitations			<0.0001		0.02
0	42.0%	81.9%		57.8%	
1 – 3	0%	10.5%		37.4%	
≥4	58.0%	7.6%		18.7%	
Special Equipment Need			<0.0001		0.34
No	68.6%	93.6%		79.6%	
Yes	31.4%	6.4%		20.4%	
Employment Status			<0.01		0.14
Working	23.6%	64.1%		41.2%	
Not working	76.4%	35.9%		58.8%	
Disability	78.0%	17.1%	<0.001	34.3%	0.05
Retired	9.7%	43.2%		42.1%	
School/Caring for family	0%	27.6%		14.6%	
Other	12.3%	12.1%		9.1%	

[1] P value is the level of statistical significance for between group comparisons to the bilateral vestibular hypofunction (BVH) group.

[2] The Dizziness/Imbalance group includes all who reported a problem with dizziness or balance in the preceding 12 months.

[3] Percentages are adjusted to represent the U.S. population based on the weights supplied by NHIS to correct for the complex survey design.

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Table 4

Prevalence[1] (population-weighted %) and adjusted odds ratios[2] of functional impairments in patients with bilateral vestibular hypofunction compared to all respondents with a reported dizziness or balance problem in the preceding 12 months.

	BVH[3] (n = 12)	Dizziness (n = 3,411)	
As a result of a balance or dizziness problem…	**Prevalence % [95% CI]**	**Prevalence % [95% CI]**	**Adjusted Odds Ratio (95% CI)**
Prevented from doing things you could otherwise do.	73.6 (37.6 – 92.8)	23.8 (22.0 – 25.7)	8.7 (2.3 – 32.8)
Change or limited social activities like visiting friends.	56.4 (24.1 – 84.6)	9.8 (8.6 – 11.1)	11.5 (3.1 – 43.2)
Cut back at work or school.	44.0 (15.7 – 76.8)	5.6 (4.7 – 6.8)	19.0 (4.7 – 76.3)
Ever missed days from work or school.	55.7 (22.8 – 80.4)	12.8 (11.4 – 14.3)	5.3 (1.4 – 21.0)
Change or limit driving a motor vehicle.	44.0 (15.7 – 76.8)	10.2 (8.9 – 11.6)	6.5 (1.8 – 24.2)
Change or limit riding in car, bus, plane, or train.	40.8 (13.8 – 74.8)	5.6 (4.6 – 6.7)	10.1 (2.2 – 47.4)
Had difficulty riding on an escalator or moving walkway.	58.7 (25.4 – 85.6)	13.3 (12.1 – 14.7)	8.1 (2.2 – 29.8)
Had difficulty going through tunnels.	36.2 (13.0 – 68.2)	8.5 (7.5 – 9.6)	5.5 (1.6 – 18.8)
Had difficulty going up a flight of stairs.	90.6 (49.2 – 98.8)	28.0 (26.1 – 29.9)	27.2 (3.6 – 207.0)
Had difficulty walking down a flight of stairs.	90.6 (49.2 – 98.8)	25.6 (23.9 – 27.4)	29.2 (3.8 – 221.8)
Had difficulty walking through a doorway without bumping into one side.	75.0 (38.0 – 93.6)	25.2 (23.5 – 27.1)	8.2 (1.7 – 39.1)
Change or limit exercising/taking walks.	60.8 (26.9 – 86.7)	12.3 (11.0 – 14.0)	12.1 (3.1 – 47.3)
Fell within the last 5 years due to balance problem	87.8 (54.9 – 97.7)	41.8 (39.7 – 44.1)	10.2 (2.0 – 53.0)

[1] Prevalence values are weighted by NHIS according to the US 2008 Census projection.

[2] Odds ratios are adjusted for age group, gender, and race/ethnicity.

[3] BVH, bilateral vestibular hypofunction