Associations of Walking Impairment With Visual Impairment, Depression, And Cognitive Function In US Older Adults: NHANES 2013-2014

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Research Article

Keywords: Cross-sectional study, walking impairment, depression, visual impairment, cognitive function, older adults

Posted Date: November 15th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-1042843/v1

Abstract

Background: Walking impairment, a common health problem among older adults, has been linked to poor vision and mental health. This study aimed to investigate the associations of walking impairment with visual impairment, depression, and cognitive function in older adults.

Methods: A total of 1,489 adults aged 60 years and older who had participated in the National Health and Examination Survey (NHANES) 2013-2014 in the United States were included. Multivariate logistic regression models were used to examine the associations of walking impairment with visual impairment, depression, and four subdomains of cognitive function. Sample weights were used to ensure the generalizability of the results.

Results: Among all the participants (median age=68 years; 53.7% women), 17.5% reported walking impairment. Walking impairment was significantly associated with visual impairment (adjusted odds ratio [aOR] =2.76; 95% CI: 1.47-5.20) and depression (aOR=4.66; 95% CI: 3.11-6.99). Walking impairment was only associated with the Digit Symbol Substitution (DSST) subdomain of cognitive function in total participants (aOR=0.97; 95% CI: 0.95-0.99), and in non-Hispanic white adults (aOR=0.96; 95% CI: 0.94-0.98). Participants with more than 1 impairment indicators had higher OR of walking impairment (aOR = 3.64, 95% CI =2.46-5.38) than those with 0-1 (reference group) impairment indicator.

Conclusions: Walking impairment was associated with visual impairment, depression, and cognitive impairment in the American older adults and also positively associated with the number of impairment indicators. The association between walking impairment and cognitive impairment varied according to race. Evaluations of vision, cognition, and depression should be conducted among the elderly with walking impairment, and that needs of the older adults with biological aspect of their particular race should be provided in the evaluations.

Background

Older adults are the fastest growing percentage of the United States (U.S) population [1]. It has been estimated that the number of older adults with one or more disabilities will triple by 2050 [2]. Walking impairment affects millions of older adults worldwide and is a major cause of disability. It is associated with decreased quality of life, increased dependency on others and healthcare costs, and early mortality [3,4]. Since the physical body deteriorates with age, older adults are more likely to experience walking impairments than any other age group [5]. Walking is a fundamental motor task essential for healthy and active living. The health benefits of walking for older adults are well documented [6,7]. Moderate levels of walking have been shown to reduce the symptoms of depression and anxiety [8], protect older individuals from dementia and cognitive decline [9], and assist in the management of chronic diseases such as diabetes and uncontrolled hypertension [10,11]. Studies reported the gait parameters (unsteady gait and gait speed) were positively associated with visual acuity, depression, and cognitive function [12-14].

The burden of visual impairment, depression, and cognitive impairment will increase dramatically in the coming decades due to the aging of the U.S. population. Approximately 6.5 million Americans aged 65 years or older had severe visual impairment in 2000, and this number has been projected to double by 2030 [15,16]. Low visual acuity or visual field was associated with increased difficulties in walking and climbing steps [17]. Depression has a strong association with infrequent walking [18], which alone or in combination with other chronic diseases can lead to a shortened active life expectancy [19]. Older adults with visual impairment are two to three times more likely to be depressed than the general population [20,21]. Another common chronic condition is cognitive decline, which increases with age and imposes a heavy burden on older adults living in the community [22]. A previous study showed that ordinary, frequent walking had a protective effect in older individuals with dementia and cognitive decline [9]. While exercise, including walking, can improve cognitive function in older adults with mild cognitive impairment [23], older adults with relatively slower walking speeds are at a greater risk of developing dementia [24]. Meanwhile, cognitive impairment can influence walking ability [25].

The above studies showed that walking has effects on vision, depression, and cognitive function. However, studies about the associations of walking impairment with visual impairment, depression, and subdomains of cognition in older adults were limited, and few study has reported ethic differences. Therefore, our study investigated this association in a representative sample of older adults in the U.S. using data from the National Health and Nutrition Examination Survey (NHANES).

Methods

Study participants

The current study was a cross-sectional analysis of secondary data from the National Health and Nutrition Examination Survey (NHANES) 2013-2014. The NHANES is a nationally representative cross-sectional survey of the non-institutionalized US population aged 2 years or order with data collected in 2-year cycles. During each cycle, the NHANES was conducted based on a stratified multi-stage probability sampling design and included two components: a household interview and a health examination. Additional information on the design and procedures of the NHANES are available at the Centre for Disease Control and Prevention (CDC) website (https://wwwn.cdc.gov/nchs/nhanes/). For this study, we included individuals aged 60 years or older who had participated in the 2013-2014 NHANES. This included the most recent data on walking impairment, depressive symptoms, vision impairment, and cognitive function that were released for public use. We excluded participants who had declined to answer or had missing data including depressive symptoms, cognitive function, vision impairment, or walking impairment. The final sample size in the analysis was 1,489 (Figure 1). All participants have provided informed consent before study. This study was approved by the Research Ethics Review Board of the National Center for Health Statistics (NCHS) and was performed in accordance with the principles of the Declaration of Helsinki and all its amendments. The NHANES database was open to the public and did not require any ethical or administrative permission.

Assessment of Walking Impairment and Vision Impairment

Walking impairment was assessed using the data collected with the NHANES medical condition questionnaire. Participants were classified as having a walking impairment if they reported serious difficulty in walking or climbing stairs and as having vision impairment if they reported being blind or having serious difficulty seeing even when wearing glasses. The disability questionnaire was administered at home by trained interviewers using a computer-assisted personal interview (CAPI) system.

Depressive Symptoms and Cognitive Function

Depression was measured using the Patient Health Questionnaire (PHQ-9), which is a commonly used screening instrument for depression, with nine items that ask about the frequency of depression symptoms in the past two weeks. The total score of the PHQ-9 ranges from 0 to 27 with a higher score indicating a more likelihood of having major depression disorders. Based on literature, we used a score >10 as the cutoff for depression diagnosis in the current study [26,27].

Cognitive performance was evaluated across four cognitive subdomains, primarily related to working memory, language, processing speed, and executive function: (1) the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) test, a measure of immediate learning ability, that consisted of three consecutive tests where participants are instructed to read and recall ten words in each test (scores from all three test repetitions were summed and total score ranges from 0 to 30), (2) the animal fluency (AF) test ,a measure of verbal fluency which is a component of executive function, where participants were asked to name as many animals as possible in one minute , (3) the Digit Symbol Substitution Test (DSST), a measure of processing speed, sustained attention and working memory, in which participants have 2 min to match (pair) symbols to number, and (4) the CERAD delayed recall (CERAD–DR), which provides a measure of delayed memory, where participants were asked to recall the ten words used in the CERAD test after the Animal Fluency and DSST tests were completed (score ranges from 0 to 10). Higher scores reflect better cognitive functioning. DSST scores of $\leq$ 28 points indicated DSST impairment [28].

Covariates

Variables include age (years), sex (women vs. men), race/ethnicity (Hispanic American, non-Hispanic White, non-Hispanic Black, or other), education (less than high school, high school, or above), smoking status (current, former, or never), body mass index (BMI) (normal weight: BMI <25; overweight: BMI 25-29.9; obese: BMI$\geq$ 30 kg/m^2), drinking (having at least 12 alcohol drinks per year or not) [29], marital status (married or living with partner, widowed/separated/ divorced, or never married), and sleep disorder. The participant's history of diseases was recorded, including hypertension, diabetes, coronary heart disease and stroke.

BMI was calculated as the weight (kg) divided by the square of the height (m^2). Drinking was identified as whether the participant had at least 12 drinks of any type of alcoholic beverage in one year. A drink meant

a 12 oz. beer, a 5 oz. glass of wine, or one and half ounces of liquor. Sleep disorder and history of hypertension, coronary heart disease or stroke were obtained from the questionnaire and defined as “ever been told by a doctor or other health professional”. History of diabetes was based on participants’ self-reported diagnosis of diabetes, or those who did not report diabetes diagnosis but had a fasting HbA1c that was greater than 6.4 %.

Statistical Analysis

Descriptive analyses were conducted to summarize the participants’ characteristics. Continuous variables are described as medians with interquartile ranges (IQRs) or as means with standard deviations (SDs) if the variables had a normal distribution. Categorical variables are presented as numbers with percentages. One-way analysis of variance and chi-square tests were conducted to compare the continuous and categorical variables, respectively. The prevalence of walking impairment was estimated in all participants and by age group (60-69.9, 70-79.9, ≥80 years). Binary logistic regression analysis was used to investigate the associations of walking impairment with vision impairment, depression, and cognitive deficits. Depressive symptoms were analyzed both as categorical and continuous variables. All the binary logistic regression analyses were adjusted for age, sex, race/ethnicity, education, BMI, marital status, and sleep disorder (Model 1), and further adjusted for medical history which included diabetes, hypertension, and stroke (Model 2). Additionally, we performed stratified analyses according to race/ethnicity. Data were weighted to ensure that it were representative of the U.S. population using complex survey sampling analysis methods. All statistical analyses were performed using SAS software (version 9.4; SAS Institute, Cary, NC, USA). A two-tailed test was performed, and statistical significance was defined as $p < 0.05$.

Results

This study included 1,489 participants. The median age of the total group was 68 years (interquartile range, 63–74 years), and 53.7% of the participants were women. Of the 1,489 participants, 320 (17.5%) had a walking impairment, 103 (5.3%) had vision impairment, and 155 (8.9%) had depression. **Table 1** presents the characteristics of the study population stratified by their walking impairment status. Compared with those without a walking impairment, participants with a walking impairment were more likely to be widowed, separated, divorced, obese, had sleep disorders, hypertension, stroke, vision impairment, depression, and cognitive impairment, and were less likely to be educated. Older individual were more likely to have a walking impairment: the prevalence of walking impairment was 16.1%, 17.6 % and 22.9 in the 60-69.9 years old, 70-79.9 years old, and ≥80 years old age groups, respectively.

The weighted prevalence of vision impairment and depression was 11.9% and 25.9%, respectively in participants with a walking impairment compared to 3.9% and 5.2% respectively in those without a walking impairment (p =0.001). The median cognitive function score across the four cognitive domains was lower in participants with a walking impairment than in those without a walking impairment (p <0.05).

Table 2 shows the associations of walking impairment with cognitive function, depression, and vision impairment in all the participants stratified by race. Walking impairment was positively associated with the odds of having depression and vision impairment. In the multivariable model, the adjusted odds ratio (aOR) and 95% confidence interval (95% CI) for depression and vision were 4.66 (3.11-6.99) and 2.76 (1.47-5.20) , respectively. Cognitive score was inversely associated with a walking impairment only with the DSST subdomain (0.97: 0.95-0.99).

In addition, walking impairment was positively associated with depression and vision impairment across the three racial groups. The aORs for depression and vision impairment were 3.75 (1.37-10.24) and 3.80 (1.75-8.21) for Hispanics, 4.28 (2.42-7.58) and 2.59 (1.00-6.70) for Non-Hispanic Whites, and 4.23 (1.52-11.81) and 4.00 (1.16-13.85) for Non-Hispanic Blacks, respectively. The cognitive score was inversely associated with walking impairment only with regard to the CERAD-Total (0.83: 0.70-0.98) for Hispanics, DSST (0.96: 0.94-0.98) and Delayed Recall (0.94: 0.89-0.99) for Non-Hispanic Whites, and CERAD-DR (0.83: 0.73-0.93) for Non-Hispanic Blacks.

Table 3 shows the ORs for walking impairment according to the number of impairment indicators (vision impairment, depression, or cognitive impairment). Participants with more than 1 impairment indicators had higher aOR of walking impairment (aOR = 3.64, 95%CI =2.46-5.38) than those with 0-1 (reference group) impairment indicator.

Discussion

Using cross-sectional data from a nationally representative sample of older U.S. adults, this study found that walking impairment was associated with visual impairment, depression, and cognitive impairment. Positive associations were found for visual impairment and depression, and an inverse association was found for the DSST score of the cognitive subdomain with walking impairment. Positive associations were also found in all three racial groups, and the associations with cognitive impairment varied by race/ethnicity. In addition, there was also a positive association between the number of impairment indicators and walking impairment.

In our study, the prevalence of visual impairment and depression was higher in older adults with a walking impairment than in those without. The prevalence of walking impairment was 17.5%, the prevalence of vision impairment was 5.3% for all participants and 11.9% for participants with a walking impairment, and the prevalence of depression was 8.9% for all participants and 25.9% for participants with a walking impairment. A previous study estimated that there was a 25% prevalence of vision impairment in individuals aged over 70 [30]. Prevalence of psychological disorders are common among community-dwelling older adults and range from 15% to 25% [31]. A cross-sectional study conducted in four community clinics in Moscow among people aged 65 years and older showed that 58.3% of all participants reported visual or hearing impairment, 58.2% reported cognitive impairment, 46% reported mood disorder, and 42% reported difficulty walking [32]. The differences between these studies and ours may be due to the different populations or different definitions of older adults. In addition, depression,

vision impairment, and walking impairment were self-reported; therefore, the results may differ from those obtained with clinical data.

Our results differ from previous studies [33-35] as we investigate the cross-sectional associations of walking impairment with visual impairment, depression, and cognitive impairment in older adults. Vision impairment, cognitive decline, and depression were found co-occur and to be associated with walking impairments in older adults. Furthermore, the associations were stronger between walking impairment and depression than between walking impairment and visual or cognitive impairment in this study. A study explored the relationships between exercise capacity, depression, and cognition in patients with heart failure and found that depression, but not cognition, was independently associated with walking capacity [36]. Previous studies [33-35] found that visual impairment was significantly associated with both depression and cognitive impairment. Most visual impairments in older adults can be treated, and cataract surgery is effective at relieving depressive symptoms, highlighting the potential importance of vision screening and managing vision impairments to improve the well-being of older adults.

The present study found a positive association between walking impairment and vision, and an inverse association between walking impairment and cognitive score with DSST in older adults. In a previous study of a nationally representative sample of older US adults using the NHANES (1999-2002), self-reported distance vision dysfunction was associated with poor cognitive function, as reflected in the DSST scores [35]. In a population-based sample of older US adults, distance visual impairment was associated with declining cognitive function (assessed using the Mini-Mental State Examination, MMSE) both cross-sectionally and longitudinally over time, with worsening vision having a strong association with declining cognition [37]. However, few studies have examined this relationship by measuring multiple fields of cognition. We measured cognitive function across four cognitive domains and not only the DSST or MMSE scores. The cognitive assessments administered in the NHANES 2013–2014 covered four selected domains of cognitive function, and scores from these assessments were not combined to create a composite score with a cut-off that could be used to characterize cognitive impairment, as was done in other studies [22,38]. Furthermore, we found that the associations between walking impairment and cognitive subdomains varied by race, with Delayed Recall in Hispanics and Non-Hispanic Blacks, and DSST and CERAD Total in Non-Hispanic Whites. A study from the 2016-2017 Harmonized Cognitive Assessment Protocol showed that cognitive health varied by race and ethnicity, and cognitive health appraisals measured by MMSE were positively associated in non-Hispanic Whites, but not significantly associated in non-Hispanic Blacks [39]. Increased education and white race were independently associated with better performance in cognitive domains after adjusting for gender and health conditions [40]. These studies suggested that race/ethnicity contributes to individual differences in neural function, and related cognitive performance.

Thus far, studies assessing the association between walking impairment and the combined impairment indicators (vision, depression, and cognitive function) in older adults are sparse. We found a positive association between the number of impairment indicators and walking impairment. Approximately 28% of the participants with a walking impairment had two or three impairment comorbidities. Similar to a

previous study, the prevalence of comorbid depression in older adults with visual impairment was estimated to be approximately 30% [33,34]. Screening for impairment indicators or providing any vision and mental healthcare may be beneficial to older adults with walking impairments.

This study has several strengths. First, the NHANES data is representative of the US non-institutionalized population and includes a relatively large sample of older participants with a walking impairment. Therefore, the findings of this study can be generalized. Second, this study examined racial differences. We provide new information on the associations of walking impairment with visual impairment, depression, and cognitive impairment among older adults where data currently does not exist. In order to deliver the best possible care to older patients with a walking impairment, evaluations of vision, cognition, and depression could be conducted and needs of the older adults with different ethnicity and biological aspect of their particular race could be provided in the health policies to improve their quality of life.

There are some limitations to this study. First, visual impairment and depression were self-reported. Therefore, the results may be different from those obtained using clinical data. Second, this study had a cross-sectional design, so conclusions about the direction of causality could not be made. Given the high prevalence of walking impairment in older adults and the increasing proportion of older adults in the general population, further research is needed to investigate the basis of the observed association of walking impairment on vision, depression, and cognitive impairment. Additionally, research is needed to determine whether screening and therapies for visual impairment, depression, and cognitive impairment could help mitigate a decline in walking impairment.

Conclusion

In a nationally representative sample, we observed that walking impairment was significantly associated with visual impairment, depression, and cognitive impairment in older adults. An inverse association between walking impairment and cognitive score differed by race. There was also a positive association between walking impairment and the number of impairment indicators. The study suggests that an evaluation of vision, cognitive and psychological state is needed for older adults with walking impairments and the racial-specific should be considered in the evaluations.

Abbreviations

U.S: United States; NHANES: National Health and Nutrition Examination Survey; aOR: adjusted odds ratio; CERAD: Consortium to Establish a Registry for Alzheimer's Disease Word List Learning; AF: Animal Fluency; DSST: Digit Symbol Substitution; BMI: body mass index; NCHS: National Center for Health Statistics; CAPI: computer-assisted personal interview; IQRs: interquartile ranges; SDs: standard deviations.

Declarations

Acknowledgment

Not applicable.

Authors' contributions

WG designed this study, conducted the results analysis, and wrote the manuscript. PFD and YQW collected the data and participated in the results analysis. YRZ coordinated and supervised all stages of the project. All authors have read and approved the final version of the manuscript.

Funding

This work was supported by the clinical research award of the First Affiliated Hospital of Xi'an Jiaotong University (Grant No. XJTU1AF-CRF-2018-024) and by the the horizontal subject of the First Affiliated Hospital of Xi'an Jiaotong University (Grant No. HX201872).

Availability of data and materials

The original NHANES dataset to support this study is available from the National Center for Health Statistics: https://wwwn.cdc.gov/nchs/nhanes/

Ethics approval and consent to participate

This study included data from NHANES 2013-2014, which obtained ethics approval from the National Center for Health Statistics (Protocol #2011-17). All methods were performed in accordance with the relevant guidelines and regulations (Declaration of Helsinki), and all participants provided their informed consent.

Consent for publication

Not applicable.

Competing interest

The authors declare that they have no competing interests.

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Tables

Table 1. Characteristics of study participants by walking impairment status, NHANES 2013-2014

Characteristic	Total (n=1,489)	No walking impairment(n=1,169)	Walking impairment (n=320)	*p* value
Age, in years (median, IQR)[a]	68 (63-74)	68 (63-74)	69 (64-76)	0.363
Age, n (%)[b]				0.242
60-69 y	801 (56.3)	636 (57.3)	165 (51.8)	
70-79 y	448 (30.0)	353 (30.0)	95 (30.3)	
≥ 80 y	240 (13.7)	180 (12.8)	60 (17.9)	
Female, n (%)[b]	774 (53.7)	597 (52.4)	177 (59.9)	0.063
Race, n (%)[b]				0.248
Hispanic American	284 (7.3)	195 (6.1)	89 (12.8)	
Non-Hispanic White	760 (79.6)	611 (81.1)	149 (72.5)	
Non-Hispanic Black	306 (8.4)	245 (8.2)	61 (9.5)	
Other	139(4.8)	118 (4.7)	21 (5.2)	
H.S. Education, n (%)[b]	1151 (85.5)	934 (87.5)	217 (76.5)	0.003
Marital status, n (%)[b]				0.010
Married or living with partner	881 (65.0)	718 (67.5)	163 (53.1)	
Widowed/separated/divorced	527 (30.6)	391 (28.2)	136 (41.9)	
Never married	81 (4.4)	60 (4.3)	21 (5.0)	
Current smoking, n (%)[b]	183 (20.3)	140 (19.5)	43 (23.5)	0.361
Alcohol drinks/year, n (%)[b]				0.124
≥12	1021(73.4)	815(74.8)	206(61.0)	
<12	464(26.6)	354(25.2)	110(33.0)	
Sleep disorder, n (%)[b]	181 (12.5)	108 (9.8)	73 (25.1)	<0.001
BMI (kg/m^2) (median, IQR)[a]	28 (25-32)	28(25-32)	32 (27-38)	<0.001
BMI, n (%)[b]				<0.001
Normal weight (BMI<	394 (25.1)	339 (27.1)	55 (15.7)	

25kg/m^2)				
Overweight (BMI25-29.9kg/m^2)	546 (36.5)	454 (38.9)	92 (25.7)	
Obesity (BMI≥ 30 kg/m^2)	549 (38.4)	376 (34.1)	173 (58.7)	
Cardiovascular risk factors, n (%)[b]				
Diabetes	340 (19.6)	234 (17.5)	106 (29.3)	0.067
Hypertension	947 (60.9)	697 (57.0)	250 (79.0)	<0.001
Stroke	99 (6.5)	66 (5.6)	33 (10.5)	0.013
Coronary heart disease	150 (10.6)	104 (9.3)	46 (16.8)	0.804
Visual impairment, n (%)[b]	103 (5.3)	53 (3.9)	50 (11.9)	0.001
Depression, n (%)[b]	155 (8.9)	65 (5.2)	90 (25.9)	<0.001
Female, n (%)	92 (9.6)	37 (5.1)	55 (28.6)	
Male, n (%)	63 (7.9)	28 (5.5)	35 (21.8)	
Depressive symptoms (median, IQR)[a]	2 (0-4)	1 (0-4)	4 (1-10)	<0.001
Cognitive function (median, IQR)[a]				
CERAD Total	21 (18-24)	21 (18-24)	19 (17-23)	0.001
Delayed Recall	7 (5-8)	7 (5-8)	6 (5-8)	0.004
Animal Fluency	18 (14-21)	18 (15-22)	16 (12-20)	0.021
Digit-Symbol Substitution Test	53 (42-63)	54 (43-64)	46 (32-56)	<0.001

CERAD Consortium to Establish a Registry for Alzheimer's Disease Word List Learning, *BMI* body mass index.

[a] Mann-Whitney U-tests were employed to compare the study participants between no walking impairment and walking impairment

[b] Chi-squared tests were employed

Table 2. Adjusted associations of walking impairment with cognitive function, depression and visual impairment, NHANES 2013-2014

Variables	Model 1		Model 2		Model 3	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Total						
Cognitive function						
CERAD Total	0.93 (0.90-0.97)	0.002	1.00 (0.95-1.06)	0.883	1.00 (0.94-1.70)	0.885
Delayed Recall	0.87 (0.80-0.95)	0.003	0.95 (0.83-1.10)	0.479	0.95 (0.82-1.09)	0.428
Animal Fluency	0.94 (0.90-0.99)	0.016	0.99 (0.95-1.03)	0.627	1.00 (0.95-1.05)	0.927
Digit-Symbol Substitution Test	0.96 (0.95-0.98)	<0.001	0.97 (0.95-0.99)	0.002	0.97 (0.95-0.99)	0.002
Depression	5.00 (3.38-7.39)	<0.001	5.02 (3.36-7.52)	<0.001	4.66 (3.11-6.99)	<0.001
Visual impairment	3.24 (1.85-5.65)	<0.001	3.26 (1.81-5.88)	0.001	2.76 (1.47-5.20)	0.004
By race/ethnicity						
Hispanic American						
Cognitive function						
CERAD Total	0.92 (0.85-0.99)	0.031	0.93 (0.85-1.00)	0.061	0.95 (0.87-1.02)	0.147
Delayed Recall	0.82 (0.72-0.94)	0.007	0.84 (0.73-0.96)	0.015	0.83 (0.70-0.98)	0.031
Animal Fluency	0.91 (0.84-0.98)	0.019	0.91 (0.85-0.97)	0.005	0.92 (0.84-1.01)	0.062
Digit-Symbol Substitution Test	0.98 (0.96-1.01)	0.104	0.98 (0.96-1.01)	0.124	0.99 (0.97-1.01)	0.380
Depression	5.00 (1.95-12.83)	0.002	5.21 (2.01-13.51)	0.002	3.75 (1.37-10.24)	0.013
Visual impairment	6.02 (2.78-13.05)	<0.001	5.89 (2.49-13.90)	0.001	3.80 (1.75-8.21)	0.002
Non-Hispanic White						
Cognitive function						
CERAD Total	0.93 (0.88-	0.017	0.94 (0.89-	0.047	0.94 (0.89-	0.033

	0.99)		1.00)		0.99)	
Delayed Recall	0.88 (0.78-0.98)	0.023	0.89 (0.79-1.01)	0.068	0.90 (0.80-1.01)	0.062
Animal Fluency	0.94 (0.89-1.00)	0.055	0.95 (0.89-1.02)	0.118	0.96 (0.89-1.03)	0.185
Digit-Symbol Substitution Test	0.96 (0.94-0.98)	<0.001	0.96 (0.94-0.98)	0.001	0.96 (0.94-0.98)	0.001
Depression	4.37 (2.54-7.55)	<0.001	4.45 (2.51-7.87)	<0.001	4.28 (2.42-7.58)	<0.001
Visual impairment	2.85 (1.14-7.17)	0.028	2.82 (1.12-7.12)	0.031	2.59 (1.00-6.70)	0.050
Non-Hispanic Black						
Cognitive function						
CERAD Total	0.94 (0.86-1.02)	0.120	0.94 (0.85-1.03)	0.176	0.96 (0.88-1.03)	0.231
Delayed Recall	0.81 (0.70-0.95)	0.010	0.80 (0.68-0.94)	0.009	0.83 (0.73-0.93)	0.003
Animal Fluency	0.97 (0.91-1.03)	0.278	0.97 (0.91-1.04)	0.366	0.98 (0.92-1.05)	0.547
Digit-Symbol Substitution Test	0.97 (0.95-1.00)	0.071	0.98 (0.96-1.01)	0.147	0.99 (0.96-1.01)	0.281
Depression	6.45 (2.31-17.98)	0.002	4.90 (1.74-13.77)	0.005	4.23 (1.52-11.81)	0.009
Visual impairment	3.79 (1.55-9.26)	0.006	4.90 (1.53-15.72)	0.011	4.00 (1.16-13.85)	0.031

Binary logistic regression analysis is presented

Model 1: adjusted for age, sex, race, education, BMI, marital status, sleep disorder

Model 2: Model 1 plus comorbidity (diabetes, hypertension, and stroke)

Model 3: Model 2 plus depression and visual impairment (plus cognitive function for depression)

Table 3. ODD Ratios (ORs) of walking impairment according to number of impairments.

	Impairments, NO.		*p* value
Variables	0-1	>1	
Participants, No.	1313	176	
Incidence cases, No.	230	90	
Model 1, OR (95% CI)	1[Reference]	3.61 (2.45-5.30)	<0.001
Model 2, OR (95% CI)	1[Reference]	3.64 (2.46-5.38)	<0.001

Binary logistic regression analysis is presented

Model 1: adjusted for age, sex, race, education, BMI, material statue, sleep disorder

Model 2: Model 1 plus comorbidity (diabetes, hypertension and stroke)

Impairments: Digit Symbol Substitution Test (DSST), visual impairment, depression

DSST impairment: DSST score≤28

Figures

Figure 1.

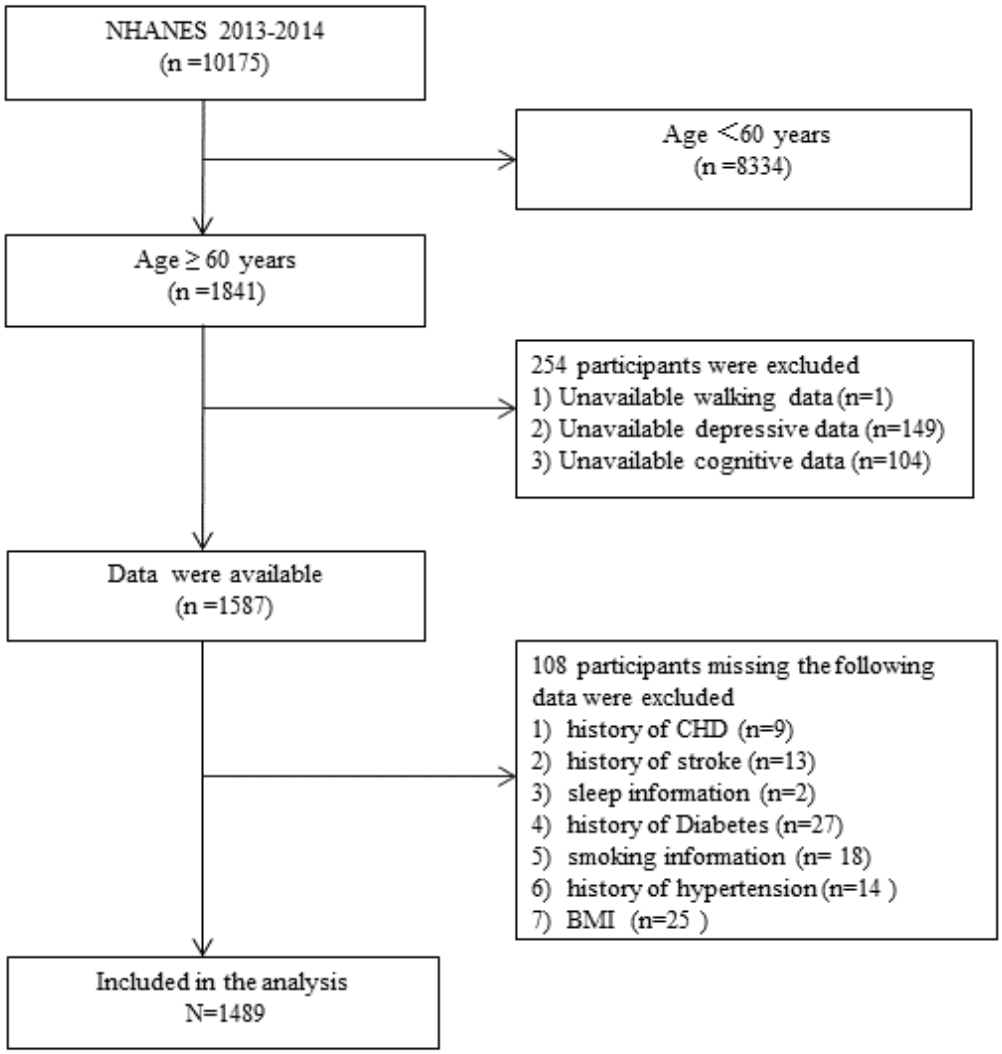

Figure 1

Flow chart of participant selection.