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Stance Time and Step Width Variability Have Unique Contributing Impairments in Older Persons

Jennifer S. Brach, PhD, PT, **Stephanie Studenski, MD, MPH**, **Subashan Perera, PhD**, **Jessie M. VanSwearingen, PhD, PT**, and **Anne B. Newman, MD, MPH**
Department of Physical Therapy, Division of Geriatric Medicine, Department of Epidemiology, University of Pittsburgh, Pittsburgh, PA

Abstract

Gait variability may have multiple causes. We hypothesized that central nervous system (CNS) impairments would affect motor control and be manifested as increased stance time and step length variability, while sensory impairments would affect balance and be manifested as increased step width variability. Older adults (mean ± standard deviation (sd) age = 79.4±4.1, n= 558) from the _____ site of the Cardiovascular Health Study participated. The sd across steps was the indicator of gait variability, determined for 3 gait measures, step length, stance time and step width, using a computerized walkway. Impairment measures included CNS function (modified mini-mental status test, Trails A & B, Digit Symbol Substitution, finger tapping), sensory function (lower extremity (LE) vibration, vision), strength (grip strength, repeated chair stands), mood, and LE pain. Linear regression models were fit for the 3 gait variability characteristics using impairment measures as independent variables, adjusted for age, race, gender, and height. Analyses were repeated stratified by gait speed. All measures of CNS impairment were directly related to stance time variability ($p<0.01$), with increased CNS impairment associated with increased stance time variability. CNS impairments were not related to step length or width variability. Both sensory impairments were inversely related to step width ($p<0.01$) but not step length or stance time variability. CNS impairments affected stance time variability especially in slow walkers while sensory impairments affected step width variability in fast walkers. Specific patterns of gait variability may imply different underlying causes. Types of gait variability should be specified. Interventions may be targeted at specific types of gait variability.

Keywords

Gait variability; Central nervous system impairment; sensory impairment; age

Introduction

Gait variability, defined as fluctuation in gait characteristics from one step to the next, is an important indicator of impaired mobility in older adults. Greater variability in stride or swing time is predictive of future falls[1;2] and greater stance time variability is an independent predictor of future mobility disability.[3] Understanding of the underlying mechanisms of variable gait could help develop appropriate treatment interventions.

Address correspondence to: Jennifer S. Brach, PhD, PT, University of Pittsburgh, Department of Physical Therapy, 6035 Forbes Tower, Pittsburgh, PA 15260, Telephone: (412)383-6533, Fax: (412) 648-5970, Email: jbrach@pitt.edu.

Little is known about what contributes to variable gait. Over twenty years ago, Gabell and Nayak hypothesized that gait characteristics, such as step length and stride time are representative of the automatic stepping mechanisms of gait (i.e. pattern generator for gait) and that step width and double support time are representative of balance control. Therefore, failure of the automatic stepping mechanism would lead to an increase in step length and/or stride time variability and a disruption in balance control would lead to an increase in step width or double support variability.[4]

The few studies that investigated factors influencing gait variability examined individuals with specific disorders or assessed variability of temporal gait characteristics. Gait variability is greater in individuals with disorders affecting the basal ganglia, such as Parkinson's and Huntington's disease, and in individuals with other central nervous system disorders such as leukoariosis (white matter disease) and Alzheimer's disease when compared to healthy older adults.[5–8] Individuals with Parkinson's disease demonstrated increased stride time variability that could not be explained by tremor, rigidity, or bradykinesia in the "off" state. In the "on" state, stride time variability was related to variability in upper extremity tapping, suggesting that gait variability was the result of a disruption of a central process. Levodopa, a treatment for Parkinson's disease, decreased stride time variability.[7] It is unknown whether step width or double support time variability are altered in individuals with CNS impairment since the variability of these parameters was not measured in these studies. In recent work, stride time variability was shown to be unrelated to finger tapping or tests of memory but was related to higher-level resources such as measures of executive functioning.[9]

Gait variability is also increased in individuals with peripheral nervous system abnormalities such as peripheral neuropathy (PN).[10] This affects sensation in the lower extremities and the deficit in proprioception has an effect on balance, leading to an increased risk of injury from falls.[11] Richardson et al[10] reported increased step time variability but not increased step width variability in women with peripheral neuropathy compared to controls, a finding that is contradictory to the Gabell and Nayak hypothesis.[4] Others have shown that individuals with peripheral neuropathy demonstrated increased gait variability compared to controls. However, these increases in gait variability were attributed to the slow walking speed rather than the peripheral sensory loss.[12]

Visual input is another important form of sensory information for maintaining balance. Visual impairments have been associated with decreased walking speed, a shift in the center of mass over the center of the base of support, and an increased variability in center of mass upon termination of walking.[13;14] However, the impact of impaired vision on variability of gait has not been assessed. Thies and colleagues showed increases in step width variability in individuals with peripheral neuropathy walking on an uneven surface with low light compared to walking on a flat surface with good light. This would suggest a contribution of vision to step width variability. However, two conditions were tested simultaneously and it difficult to determine the role of each one.[15]

Other than examining gait variability in specific patient populations, little work has been conducted to describe the underlying mechanisms of gait variability. Hausdorff and colleagues examined the etiology of gait variability in community-dwelling older adults.[16] Impairments of dynamic balance (tandem walk) and upper extremity flexibility were significantly related to stride time variability in multivariate analyses.[16] Variability of spatial gait characteristics was not assessed.

As part of the 1998–99 clinic visit at the _____ site of the Cardiovascular Health Study (CHS), gait characteristics (i.e. gait variability) were measured using an instrumented walkway. Measures of cognitive, sensory and motor function, health status, and numerous other

covariates were also collected at this clinic visit, thus providing an opportunity to begin to understand the underlying factors responsible for variable gait. The purpose of this study was to examine the contribution of central nervous system and sensory impairments to the variability of spatial and temporal gait characteristics. We hypothesized that central nervous system impairments, such as alterations in executive functioning and central processing, would affect motor control and thus stance time and step length variability, while sensory impairments, such as impaired vision and lower extremity vibration sense, would affect balance and thus step width variability.

Methods

Study Population

Ambulatory older adults from the _____ site of the Cardiovascular Health Study (CHS) had an assessment of gait characteristics at the 10th follow-up visit in 1998–1999. CHS is a population-based, ongoing longitudinal multi-center study of coronary heart disease and stroke risk in community-dwelling older adults age 65 years and older.[17;18] At the initiation of the CHS in 1989–90, individuals were identified from the Health Care Financing Administration sampling frame. Individuals who were 65 years or older, non-institutionalized, expected to remain in the area for 3 years and able to give informed consent were included in the study. Individuals who were wheelchair-bound in the home or were receiving hospice care, radiation therapy or chemotherapy for cancer were excluded.[17;18] In 1989–90 an original cohort of 5201 predominately white (> 95% white) men and women were enrolled, and in 1992–93 a cohort of 687 African Americans was added.

Participants in the current study included men and women who attended the 1998–99 clinic visit at the ___ site, who could walk without the assistance of another person, and who could follow directions to complete the gait assessment (n=558). Individuals who used an assistive device were included if they could ambulate without the assistance of another person.

Gait Characteristics

The GaitMat II™ system was used for the gait analysis.[19] The GaitMat II™ consists of a 4-meter long walkway and a computer system which controls the mat and analyzes the data. In addition to the 4-meter long walkway, there are initial and final one meter inactive sections to allow for acceleration and deceleration of the participant. The GaitMat II™ is an automated gait analysis system based on the opening and closing of pressure sensitive switches which are represented on the computer screen as footprints when the participant walks on the walkway. After two practice passes, each participant completed two passes at their self-selected walking speed for data collection.

We were primarily interested in gait speed and variability of step length, step width, and stance time. Step length and width represent spatial characteristics in two different planes. Stance time was selected as the temporal gait characteristic. Step length, step width and stance time were also specifically selected since they have been studied by other investigators.[1;2;20;21] Gait speed was determined by dividing the distance traversed by the time between the first and last step (eg switch closure). Step length was determined as the distance between two consecutive footprints, measured from the heel of one footprint to the heel of the next footprint. Step width was determined as the distance between the outer most borders of two consecutive footprints. Stance time was determined as the time one foot was in contact with the floor (i.e. from initial foot-floor contact until final foot-floor contact). The standard deviations of step length, step width, and stance time determined from all of the steps recorded over 2 passes were used as measures of variability.

Potential Contributors to Variable Gait

Central Nervous System Impairment—Central nervous system impairment was assessed using a Modified Mini-Mental State Examination, finger tapping, Trail making A and B, and the Digit Symbol Substitution Test. A modified Mini-Mental State Examination (3MS), a global measure of cognition including attention, memory, and language, incorporates four added test items, more graded scoring and is scored on a 0 to 100 scale.[22] The four added items include: recall of personal information, naming of four-legged animals as a measure of fluency of retrieval, identifying similarities of words to sample abstraction or conceptual thinking, and a second recall after a longer time period. Finger tapping, a measure of complex motor performance and processing speed,[23;24] was quantified as the number of taps the participant could complete with their right hand in fifteen seconds. The Trail Making test Part A and B was used to evaluate visual scanning and mental flexibility.[25] Digit Symbol Substitution Test (DSST), a subtest of the Wechsler Adult Intelligence Test, is a measure of information processing speed.[26] For the DSST the participants were given a coding key pairing a list of digits from 1–9 with nine symbols. Under the coding key were rows of randomly ordered numbers. Participants had 90 seconds to transcribe as many symbols as possible based on the digit-symbol associations specified in the coding key. The number correctly completed was recorded.

Sensory Impairment—Sensory impairment was assessed using a measure of lower extremity vibratory perception and self-reported visual impairment. Lower extremity vibratory perception was assessed at both medial malleoli using a tuning fork. Visual impairment was coded as present if the participant reported being unable to see in order to drive, to watch television or to recognize someone across a room with or without glasses.

Strength, Lower extremity pain, and Mood—Strength was assessed using grip strength and repeated chair stands. Grip strength of the dominant hand was assessed using a grip dynamometer. The average of three trials was recorded. Repeated chair stand time was used as a surrogate measure of lower extremity strength.[27] Participants were timed as they stood from a standard chair five times without using their upper extremities for assistance. The time to complete the 5 chair stands was recorded.

Self-reported lower extremity pain was recorded as being present if the participant reported having knee or foot pain for at least half of the days in a month; otherwise it was recorded as being absent. Depressed mood was assessed by the modified Center for Epidemiologic Studies Depression Scale (CES-D).[22;28;29] A validated 10-item version of the CES-D was used as a measure of mood. Scores range from 0–30 with a score of 10 or greater on this modified scale indicating significant depressive symptoms.[29]

Statistical Analysis

The associations between the different measures of gait variability and gait speed were examined using Pearson's product-moment correlations. The bi-variate association of gait variability and potential contributors were examined by comparing mean values of stance time, step length, and step width variability across the levels of potential contributing factors. Gait variability was compared across quartiles of finger tapping, DSST score, Trail Making A and B time, modified Mini-mental score, repeated chair stand time, grip strength, and depression score. Lower extremity vibratory perception was classified as being intact at both malleoli, diminished at either malleolus, or diminished/absent at both malleoli and vision was classified as being impaired or not impaired. A test for linear trend across categories of predictors defined by quartiles based on a statistical contrast using orthogonal polynomial coefficients for a linear trend was performed.[30]

A series of simple regression models with gait variability (stance time, step length, or step width) as the dependent variable and each of contributors as the only independent variable was used to quantify the unadjusted associations between gait variability and potential contributing factors. Age, gender, race, and height were added to the regression models as covariates to obtain adjusted associations between gait variability and other measures. All analyses were repeated after stratifying the sample by a gait speed 1.0 m/s, because the association between step width variability and fall history has been shown to be stronger in those walking at a near normal walking speed.[31] Since the association between step width variability and fall history was shown to be nonlinear in previous work,[31] the analyses were repeated removing a small group of individuals with extreme step width variability (step width SD > 70 mm, n=10). Analyses were also repeated controlling for assistive device use in the models and after removing the small number of individuals who used an assistive device.

A series of multiple regression analyses with gait variability as the dependent variable and independent variables representing each of the domains (central nervous system impairment, sensory impairment, strength, lower extremity pain, and mood) was used to further examine the association between the contributors and gait variability. After controlling for the potential confounding factors the contributor from each of the domains with the highest univariate association with the dependent variable was added to the model. Given the high correlations among the contributors within a domain, only one contributor from each domain was entered into the model. Only the independent variables representing each domain which were significantly related to the dependent variable were retained in the model.

Results

Participant characteristics are presented in Table 1. The mean age of the sample was 79.4 years (SD=4.1), 60% were female and 23% were African-American. The perceived health of the sample was good, with 28% reporting their health as very good or excellent and 49% reporting their health as good. The sample had good mobility with only 42 of the 558 participants (8%) using an assistive device. In addition, the mean gait speed for the group was 1.00 m/s (SD=0.23).

The three measures of gait variability were all significantly related to each other ($p < 0.001$ to 0.03). However, the associations were minimal at best with the r's ranging from −0.09 for stance time variability and step width variability to 0.35 for stance time variability and step length variability. Stance time variability was moderately related to gait speed ($r = -0.58$, $p<0.0001$) whereas step length variability and step width variability had weaker associations with gait speed ($r = -0.18$, $p<0.0001$ and $r = 0.24$, $p<0.0001$, respectively).

In unadjusted analyses, all measures of CNS impairment were related to stance time variability (trend $p< 0.05$), with greater CNS impairment related to greater amounts of stance time variability (Figure 1). The measures of CNS impairment were not related to step width variability, and only DSST was related to step length variability.

Sensory impairments were related to step width variability, but stance time and step length variability were not (Figure 2). The relationship between peripheral sensation and step width variability was in the opposite direction to initial expectation; individuals with intact vibratory perception had the highest amounts of step width variability and individuals with diminished vibratory sensation had the lowest amount (trend $p< 0.01$).

Both measures of strength were associated with stance time variability, with decreased strength leading to increased stance time variability (trend $p<0.05$). Neither strength measure was related to step length or step width variability. Depressed mood was positively related to stance

time and step length variability and negatively associated with step width variability (trend $p < 0.05$). Lower extremity pain was not associated with any of the measures of gait variability.

After adjusting for age, race, gender and height, central nervous system impairments and strength were primarily related to stance time variability; whereas sensory impairments were primarily related to step width variability (Table 2). Depressed mood was related to all three measures of variability; whereas lower extremity pain was not related to any of the measures.

After stratifying the sample by gait speed, the association between step width variability and sensory impairment remained only in individuals who walked at a near normal walking speed (≥ 1.0 m/s) (Table 3) and the associations between stance time variability and central nervous system impairment and strength remained only in individuals who walked slowly (< 1.0 m/s) (Table 4). When individuals with extreme step width variability (> 70 mm) were removed from the analyses, all relationships were stronger. Neither controlling for assistive device use nor removing individuals who used an assistive device from the analyses changed the findings.

Since the measures of CNS and sensory impairment were also related to mean stance time, mean step length, and mean step width (data not shown), we decided to adjust for mean gait characteristics in the models. Mean step length and step length variability and mean step width and step width variability were negatively correlated (step length $r = -0.19$ and step width $r = -0.32$). For the models examining step length and step width variability we controlled for the respective mean gait characteristic in the model and the results did not change significantly.

Mean stance time and stance time variability were positively correlated in that as mean stance time increased the variability of the measures of stance time variability increased ($r = 0.64$). Since larger mean values are naturally going to vary more we decided to control for this phenomenon by repeating the analyses using the coefficient of variation (CV) as the measure of stance time variability. The CV is a useful statistic for comparing the degree of variation from one data series to another, even if the means are drastically different from each other. The results did not change significantly when the coefficient of variation was used to quantify stance time variability.

In the multivariate analyses, DSST, chair stand time and depression all significantly contributed to the description of stance time variability (adj $R^2 = 0.15$, $P_{model} < 0.0001$). Similarly, DSST and depression added to the description of step length variability (adj $R^2 = 0.05$, $P_{model} < 0.0001$); whereas, lower extremity vibration and depression significantly added to the description of step width variability (adj $R^2 = 0.02$, $P_{model} < 0.01$).

Discussion

Central nervous system impairment, represented by impairments in cognitive function and central processing, is related to stance time variability, whereas sensory impairment is related to step width variability. Variable gait characteristics are not homogeneous and should not be considered equivalent or generically referred to as “variable gait.” Instead, the specific variable gait characteristic should be specified, since increases in variability of a specific gait characteristic could be an indication of potential underlying causes or mechanisms of the abnormal gait.

Our finding that stance time variability is related to central nervous system impairment is consistent with the work of others.[5–9] Although our finding that sensory impairment is related to step width variability is consistent with the theory proposed by Gabell and Nayak[4], the association we found was in the opposite direction to the expected and opposite to the findings of Dingwell and Cavanagh.[12] However, the finding that step width variability is lower with sensory impairment is consistent with our previous finding that low step width variability is

related to fall history.[31] Individuals with impaired vision and lower extremity vibration sense may not have the capacity to adjust step width. If such adaptation is important for maintaining balance during walking, decreased step width variability could increase risk for falls. Another potential explanation is that visually impaired persons or those with impaired vibratory sense exaggerate their step width to improve balance, thus overcoming any tendency to have greater step width variability. Individuals with intact sensation tend to walk with a smaller step width which allows them more opportunity to have changes or adjustments in their step width. These changes or adjustments in step width would be captured as greater step width variability.

Richardson et al (2004) failed to find an association between step width variability and peripheral neuropathy in a study of 24 older women (12 with peripheral neuropathy and 12 without peripheral neuropathy).[10] The discrepancy in our findings and those of Richardson could possibly be explained by differences in testing conditions (they tested subjects walking on an uneven surface), the differences in definitions of sensory impairment, the differences in sample size, and potential confounding factors such as visual or vestibular impairment. In fact, their group with peripheral neuropathy may have also had lower extremity muscle weakness which could possibly explain the findings of increased step time variability.

We did not find a consistent association between central nervous system impairments and step length variability. Many of the measures of CNS impairment in this study had a timing component, which may explain the stronger association with stance time variability (temporal measure) than with step length variability (spatial measure).

In the stratified analyses, we did not find an association between stance time variability and CNS impairment at slow walking speeds or between step width variability and sensory impairment at near normal walking speeds. These findings are explained by the association between the measures of gait variability and gait speed. From a statistical perspective, the range of stance time variability was limited in fast walkers and the range of step width variability was limited among slow walkers. This lack of range in the data limits the ability to assess associations. When walking speed is near normal, stepping usually occurs automatically, thus reducing stance time variability. Likewise, when walking speed is slow, step width is often increased. Individuals walking with a large step width may be more likely to maintain this position, thus limiting the variability in step width. Conversely, individuals who are walking at a near normal walking speed are more likely to have a narrower step width than those walking slowly.

This study has important strengths. The study included a relatively large sample of diverse community-dwelling older adults who were well characterized on a number of covariates. In addition, since gait was measured using a computerized walkway we were able to examine both spatial and temporal gait characteristics.

This study also has limitations. The measures of central nervous system impairment, sensory impairment, strength, mood, and lower extremity pain may not be ideal. This study was conducted using covariates obtained from the Cardiovascular Health Study; therefore, we could not control the specific measures used. However, the patterns of association are still striking despite the constraints imposed by the measures. It is possible that with more accurate and precise measures of central nervous system and sensory impairment, the associations would be even stronger. This study also failed to detect some associations. The lack of association between central nervous system impairment and step width variability is just as important as the consistent associations between all the measures of central nervous system impairment and stance time variability. Likewise, the lack of association between sensory impairment and stance time variability is just as interesting as the association between sensory impairment and step width variability. Given the large sample size available for these analyses compared to

other studies of gait variability, there is a reduced likelihood that the failure to find these associations is a false negative result

If underlying mechanisms of variable gait are better understood, then distinct interventions can be designed to address specific deficiencies. Preventive and therapeutic interventions could target the underlying impairments. Patients with increased stance time variability may respond to a different therapeutic exercise program than those with increased step width variability. It is possible that individually designed therapeutic exercise programs based on the type of gait variability could result in greater improvements in walking function and overall mobility.

Conclusion

Increased stance time variability is associated with increased CNS impairment while decreased step width variability is associated with increased sensory impairment. Further exploration of distinct patterns of gait variability and their underlying causes could lead to novel preventive and therapeutic interventions.

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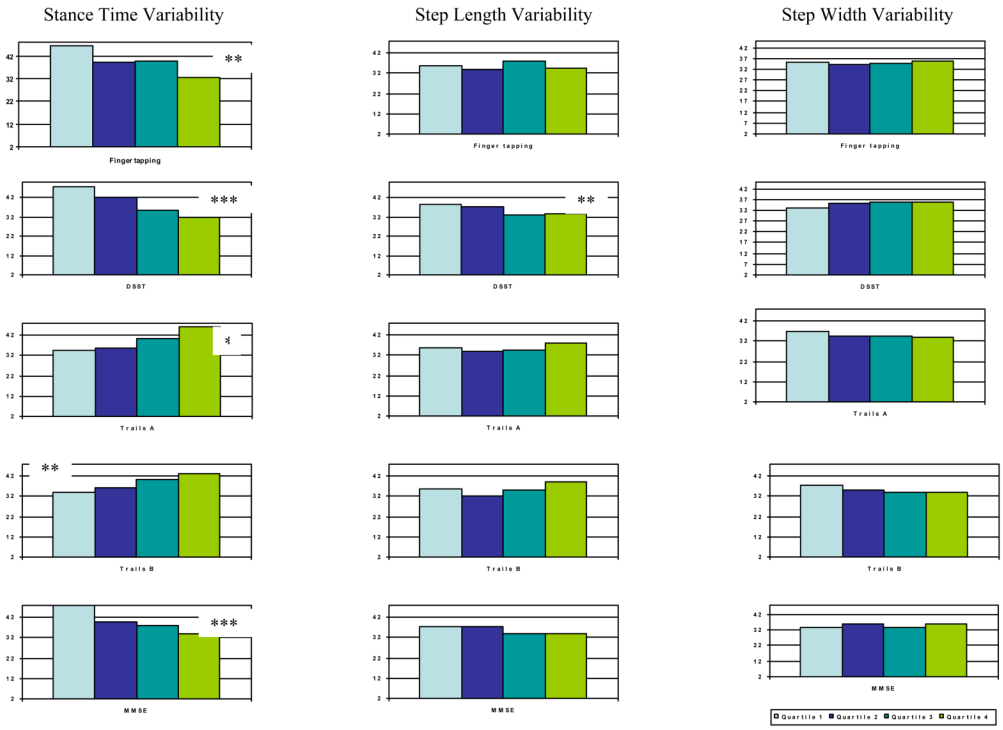

Test for linear trend: * p<0.05; ** p<0.01; *** p<0.001

Figure 1.
The association between measures of central nervous system function as quartiles of performance and types of gait variability.

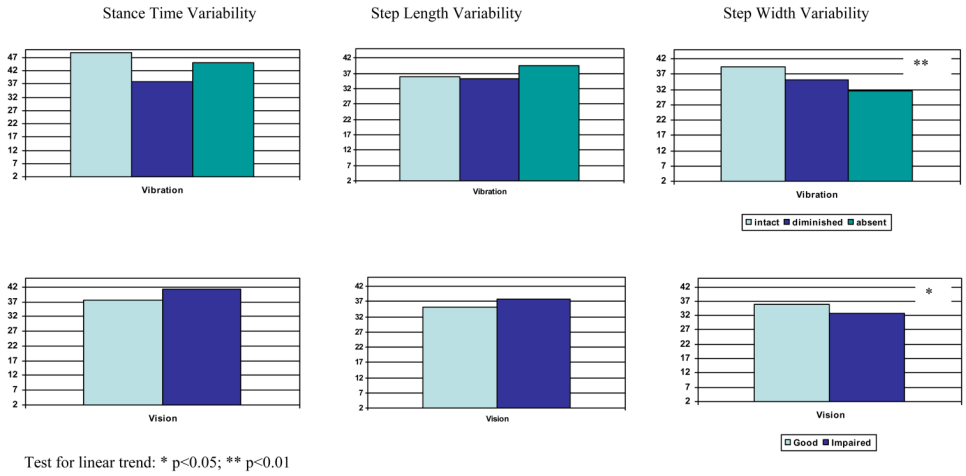

Figure 2.
The association between measures of sensory function and types of gait variability.

Table 1

Participant characteristics (n=558).

	Mean (SD)	Range
Demographics and Health Status		
Age, years	79.4 (4.1)	71–98
Women, n (%)	339 (60.5)	
Black, n (%)	127 (22.7)	
Number of chronic conditions	0.99 (1.03)	0–5
Number of prescription medications	3.3 (2.6)	0–14
Rate health as very good or excellent, n (%)	159 (28.4)	
Use assistive device, n(%)	42 (7.6)	
Central Nervous System Impairment		
3MS	92.6 (7.9)	39–100
Trails A, s	57.8 (30.3)	19–242
Trails B, s	142.9 (86.2)	50–978
DSST, number correct	42.3 (13.3)	1–79
Finger tapping, number of taps in 15s	59.1 (10.4)	22–95
Sensory Impairment		
Lower extremity vibratory perception		
Intact	64 (11.5)	
Diminished	451 (80.7)	
Absent	44 (7.9)	
Report vision problem, n (%)	163 (33.4)	
Strength		
Grip strength, kg	26.0 (9.4)	6–52
Timed chair stand, s	16.0 (4.9)	5–42
Other Factors		
Reported lower extremity pain, n (%)	189 (34.2)	
Modified Geriatric Depression Scale	5.1 (4.5)	0–23
Gait Characteristics		
Gait speed, m/s	1.00 (.23)	.22–1.64
Stance time variability, ms	39.5 (22.6)	7.36–241.1
Step length variability, mm	35.7 (16.8)	10.0–225.0
Step width variability, mm	35.0 (15.3)	7.0–146.0

Table 2

The relationship between specific impairments and types of variable gait in the sample as a whole*.

	Stance time variability		Step length variability		Step width variability	
	B	***p*-value**	**β**	***p*-value**	**β**	***p*-value**
Central Nervous System Impairment						
3MS	−0.70	<0.0001	−0.17	0.04	0.10	0.35
Finger taping	−0.53	<0.0001	−0.01	0.33	−0.03	0.64
Trails A	0.15	<0.0001	0.01	0.04	−0.02	0.30
Trails B	0.03	0.01	0.01	0.21	−0.01	0.16
DSST	−0.50	<0.0001	−0.21	0.002	0.07	0.17
Sensory Impairment						
Lower extremity vibratory perception	1.20	0.59	−1.75	0.29	3.80	0.01
Vision problem	2.51	0.25	2.85	0.08	−2.70	0.05
Strength						
Grip strength	−0.60	<0.0001	−0.22	0.03	−0.06	0.58
Chair stands	0.83	<0.0001	0.16	0.35	0.21	0.20
Self-reported leg pain	2.92	0.16	−1.32	0.41	−1.34	0.35
Mood (depression)	0.68	0.001	0.50	0.003	−0.35	0.02

β= Adjusted regression coefficient

*linear regressions adjusted for age, gender, race, and height

Table 3

The relationship between specific impairments and types of variable gait in fast walkers (n= 289)* **.

	Stance time variability		Step length variability		Step width variability	
	B	***p*-value**	**β**	***p*-value**	**β**	***p*-value**
Central Nervous System Impairment						
3MS	−.10	0.45	−0.04	0.84	0.03	0.85
Finger taping	−0.17	0.05	0.01	0.92	−0.21	0.05
Trails A	−0.005	0.89	−0.04	0.38	0.03	0.57
Trails B	0.007	0.61	−0.0006	0.97	−0.02	0.32
DSST	−0.08	0.16	−0.03	0.69	−0.01	0.91
Sensory Impairment						
Lower extremity vibration	0.73	0.69	−2.20	0.36	5.62	0.02
Vision problem	1.50	0.42	2.23	0.38	−6.22	0.005
Strength						
Grip strength	−0.18	0.10	−0.06	0.64	−0.12	0.44
Chair stands	0.15	0.42	−0.18	0.47	0.48	0.05
Self-reported leg pain	1.36	0.43	−1.26	0.58	−1.01	0.64
Mood (depression)	0.23	0.23	0.39	0.13	−0.34	0.17

β= Adjusted regression coefficient

* linear regressions adjusted for age, gender, race, and height

** fast walkers defined as gait speed > 1.0 meters/second

Table 4

The relationship between specific impairments and types of variable gait in slow walkers (n= 269)* **.

	Stance time variability		Step length variability		Step width variability	
	B	***p*-value**	**β**	***p*-value**	**β**	***p*-value**
Central Nervous System Impairment						
3MS	−0.68	0.0001	−0.19	0.08	−0.02	0.85
Finger taping	−0.51	0.001	−0.07	0.48	−0.01	0.88
Trails A	0.11	0.02	0.07	0.01	−0.004	0.87
Trails B	0.006	0.70	0.01	0.30	0.002	0.79
DSST	−0.48	0.0005	−0.19	0.02	0.005	0.94
Sensory Impairment						
Lower extremity vibration	4.82	0.17	−0.42	0.84	1.05	0.55
Vision problem	−0.50	0.89	2.44	0.27	1.76	0.25
Strength						
Grip strength	−0.57	0.03	−0.28	0.09	−0.20	0.14
Chair stands	0.86	0.0006	0.30	0.15	0.23	0.21
Self-reported leg pain	1.89	0.58	−1.69	0.40	−0.87	0.61
Mood (depression)	0.51	0.12	0.42	0.03	−0.17	0.28

β= Adjusted regression coefficient

* linear regressions adjusted for age, gender, race and height

** slow walkers defined as gait speed ≤ 1.0 meters/second