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Exploring How Peak Leg Power and Usual Gait Speed Are Linked to Late-Life Disability:

Data from the National Health and Nutrition Examination Survey (NHANES), 1999–2002

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Abstract

Objective—To investigate the relation of both peak leg power and usual gait speed in their association with varying domains of late-life disability.

Design—Participants (≥ 60 yrs of age, $n = 1753$) were from the National Health and Nutrition Examination Survey, 1999–2002. Disability in activities of daily living, instrumental activities of daily living, leisure and social activities, lower limb mobility, and general physical activities was obtained by self-report. Peak muscle power was the product of isokinetic peak leg torque and peak force velocity. Functional limitations were evaluated via usual gait speed, which was obtained from a 20-foot timed walk.

Results—Low usual gait speed was associated with disability independent of basic demographics, cognitive performance, co-morbidities, health behaviors, and inflammatory markers. The odds ratios for disabilities in activities of daily living, instrumental activities of daily living, leisure and social activities, lower limb mobility, and general physical activities for each standard-deviation increase in walking speed were 0.72 (95% confidence interval [CI], 0.59–0.87), 0.63 (95% CI, 0.52–0.77), 0.57 (95% CI, 0.45–0.72), 0.56 (95% CI, 0.47–0.67), and 0.74 (95% CI, 0.64–0.85), respectively. The odds ratios for disabilities in activities of daily living, instrumental activities of daily living, leisure and social activities, lower limb mobility, and general physical activities for each standard-deviation increase in leg power were 0.70 (95% CI, 0.55–0.89), 0.67 (95% CI, 0.53–0.86), 0.62 (95% CI, 0.47–0.83), 0.58 (95% CI, 0.47–0.72), and 0.73 (95% CI, 0.61–0.87), respectively. Supplementary adjustment for walking speed mildly attenuated the relation of leg power to disability.

Conclusion—Peak leg power and habitual gait speed were associated with varying domains of late-life disability. The association between peak leg power and disability seems to be partially mediated through usual gait speed.

Keywords

Muscle Power; Walking Speed; Gait; Disability; National Health and Nutrition Examination Survey

In considering the theoretical processes leading to late-life disability, Nagi¹ first characterized the disablement pathway. In considering this concept of disability, varying domains of disability exist, including activities of daily living (ADL), instrumental activities of daily living (IADL), social activities, and leisure activities.² Within this conceptual scheme of disablement, physical impairments represent dysfunction or abnormalities in an organ system and functional limitations as restrictions in basic physical actions. Both impairments and functional limitations are major pathway components in the causal relationship from active pathology to disability.^{2,3} Research directed toward the amelioration of late-life disability has focused primarily on identifying the modifiable impairments and functional limitations that are most closely related to the onset and progression of disability.⁴ Toward this end, muscle strength,^{5–8} a measure of physical impairment, and walking speed,^{7,9–14} a measure of functional limitation, have been identified as important indicators for disability in ADL,^{5,7–14} IADL,⁸ and mobility.^{6,10,11,14} In fact, usual gait speed has been particularly emphasized as a functional performance characteristic that is clinically predictive of subsequent disability.¹¹ Within one of the few investigations that attempted to understand the interrelationships between disablement outcomes, Jette et al.¹⁵ demonstrated that the influence of strength on disability was mediated by functional (mobility) limitations. This investigation, however, was among a relatively small, homogenous cohort and did not evaluate multiple domains of disability. In contrast to strength, muscle power is an impairment believed to have a greater influence on distal disablement outcomes.^{16,17} The influence of muscle power on disability has yet to be sufficiently evaluated within this context.

Peak limb muscle power represents the product of muscular force and velocity of movement. Leg power impairments have a greater influence on the functional performance of older adults than do impairments in leg strength.^{16,17} Moreover, power declines to an even greater degree than strength,^{16,18} suggesting that power is a major attribute in age-related functional decline. Although the association between muscle power and functional limitations is well established, only one small study has clearly linked muscle power to disability.¹⁹ Moreover, studies evaluating disability as an outcome, to a very large extent, have been limited to traditional measures of disability such as ADL or IADL.²⁰ It is important to clarify the relationship of muscle power to multiple domains of disability and to better understand the mediating effects of functional limitation. Therefore, the aims of this cross-sectional study were: (1) to test the hypotheses that muscle power and gait speed are related not only to traditional disability measures but also to disability as it pertains to leisure and social activities and (2) to evaluate if usual gait speed mediated or explained the association between muscle power within the separate domains of disability. We sought to investigate these aims by analyzing data from the National Health and Nutrition Examination Survey (NHANES), 1999–2002.

Method

Study Design and Population

NHANES is a national probability survey of Americans conducted by the National Center for Health Statistics. NHANES, a population-based survey, used a stratified, multistage, and cluster sampling design to obtain a representative sample of the noninstitutionalized United States population. Beginning in 1999, the NHANES became a continuous, annual survey rather than the periodic survey that it had been. Detailed survey operations manuals, consent documents, and brochures of the NHANES 1999–2002 are available on the NHANES Web site.^{21,22}

There were 3232 subjects aged ≥ 60 yrs who finished the Physical Functioning Questionnaire and attended the Mobile Examination Center for examination, which included an assessment of the right isokinetic quadriceps muscle strength and a 20-foot timed walk test. Of these, 457

were excluded from the muscle strength examination because of the following safety reasons: chest or abdominal surgery in the previous 3 wks ($n = 20$), heart attack in the previous 6 wks ($n = 10$), brain aneurysm or stroke ($n = 173$), current neck or back pain ($n = 90$), difficulty in bending or straightening the right knee ($n = 76$), or right knee or right hip replacement ($n = 88$). We further excluded 672 subjects with missing data in the muscle strength test or timed walk test because of the subjects' refusal, limited time to do the examinations, subjects' coming late or leaving early, examinations being interrupted, equipment or data capture failure, technician/software/supply error, communication problems, or other reasons. Those without missing values tended to be younger (70.6 vs. 73.4 yrs) and non-Hispanic white (58.0 vs. 45.5%).

The NHANES isokinetic muscle testing was designed to be measured at a fixed angular velocity of 60 degrees/sec. To have reliable measurements of peak leg power, subjects ($n = 350$) with peak force velocity that varied >5 degrees/sec from the chosen testing velocity were further excluded. Excluded subjects walked slower (0.887 vs. 0.979 m/sec); were more disabled in ADL (23.7 vs. 15.6%), IADL (29.1 vs. 19.6%), general physical activities (65.1 vs. 53.1%), lower limb mobility (41.1 vs. 28.3%), and leisure/social activities (24.9 vs. 13.0%) compared with included subjects. The final analytic sample was composed of 1753 subjects with reliable measures of knee extensor peak torque.

Disability

Subjects aged ≥ 60 were asked 19 questions of the Physical Functioning Questionnaire designed to measure their disability status (Table 1). These questions were phrased to assess the individual's level of difficulty in performing the task without using any special equipment. The authors reached consensus and classified the 19 questions into five major domains: ADL, IADL, leisure and social activities (LSA), lower limb mobility (LLM), and general physical activities (GPA). A subject's answer to a given question was coded as "no difficulty," "some difficulty," "much difficulty," or "unable to do." Difficulty in performing one or more activities within a given domain defined a disability.

Knee Extensor Power and Usual Gait Speed

Leg power was chosen as the measure of physical impairment for our investigation because of its previously stated relevance to more distal disablement outcomes.^{16,17} Right knee extensor force production was assessed using a Kinetic Communicator isokinetic dynamometer (Kin Com MP, Chattecx Corporation, Chattanooga, TN). Maximal voluntary concentric muscle force was measured in newtons in the right quadriceps at an angular velocity of 60 degrees/sec. Ideally, each subject would have a total of six trials during the strength test: three practice warm-ups and three trials for maximal voluntary effort. Highest peak force (PF) in newtons was obtained according to the following algorithm: for examinee who had four or more trials, one highest PF was selected from trials 4–6; for examinee with fewer than four trials, a highest PF was selected from the completed trials. Most subjects had the PF velocity (PFVel) around 60 degrees/sec. Subjects with extreme values of PFFVel (i.e., >65 degrees/sec or <55 degrees/sec) were excluded. Peak torque was calculated as $(PF \times \text{mechanical arm length in centimeters})/100$. The lever arm was set to the horizontal position, and the mechanical arm length represented the distance from ankle to knee joint. Knee extensor power was obtained from the following formula²³:

Peak leg power (watts) = peak torque (newton-meter) $\times$ PFFVel (radians/sec) = PF (newton) $\times$ lever arm length (meters) $\times$ PFFVel (degrees/sec) $\times (\pi/180)$

$$*\pi = 3.14$$

Habitual gait speed was selected as our measure of functional limitations because of its predictive relationship to subsequent adverse outcomes, including disability.^{7,9–14} The 20-foot timed walk test was performed at the subject's usual pace using a hand-held stopwatch. Timing was initiated as soon as the subject started to walk. Walk time was measured from the start time when the subject's first foot touched the floor across the start line to the stop time when the subject's foot touched the floor across the finish line. Subjects were allowed to use a walker or cane during the timed walk test if needed. Usual gait speed (meters/second) was calculated as walking distance (20 feet = 6.15 m) divided by time in seconds.

Adjusted Covariates

Age, sex, race/ethnicity, educational level, and smoking status were obtained by self-report. Diabetes was defined by self-report of a physician's diagnosis, the presence of a glucose level of >200 mg/dl, or the use of diabetic medications (including insulin injection or oral hypoglycemic agents). Three and sometimes four blood pressure determinations were taken using a mercury sphygmomanometer by a NHANES physician. Blood pressure was measured in the right arm unless specific conditions prohibited the use of the right arm. Averaged systolic and diastolic blood pressures were obtained. The presence of hypertension was defined by a self-reported doctor's diagnosis, the use of antihypertensive medications, or averaged blood pressure of >140/90 mm Hg. Body mass index was calculated as weight in kilograms divided by the square of height in meters. Medical histories of myocardial infarction (>6 wks), congestive heart failure, angina, chronic bronchitis, emphysema, and arthritis were ascertained by self-report. Anemia was defined according to World Health Organization guidelines as hemoglobin, obtained by the Beckman Coulter autoanalyzer, of <12 g/dl in women and <13 g/dl in men.²³ General health perception was ascertained by the question, "How would you say your health in general is?" and was categorized as excellent, very good, good, fair, or poor. Digit symbol substitution test was the cognitive performance test in the NHANES. Participants were asked to copy symbols that were paired with numbers in 2 mins. The correct numbers of coded symbols, ranging from 0 to 133, were recorded. Average level of daily physical activity was determined by self-report and categorized as "sit and not walk very much," "stand or walk a lot but do not have to carry or lift things very often," "lift light load or climb stairs/hills often," or "do heavy work or carry heavy loads." Alcohol intake was determined by the question, "In any 1 yr, have you had ≥ 12 drinks of any type of alcohol beverage?" and was dichotomized. During the muscle strength and timed walk examinations, use of walking devices and pain reported on walking were recorded. Chronic inflammation has been shown to be a significant predictor of disability in the elderly,²⁴ and we adjusted the levels of C-reactive protein, quantified by utilizing latex-enhanced nephelometry with a Behring Nephelometer Analyzer System, in the analysis.

Analysis

Usual gait speed and peak leg power in the study population were normally distributed. Therefore, individual standard deviation scores for both walking speed and leg power were obtained from the formula $(X_i - X_m) \div SD$, where X_i is the individual value of the measurement in the individual subject, X_m the mean values of the measurement in the study cohort, and SD the standard deviation of the measurement in the study cohort. The standard deviation scores of both performance-based measures were related to self-reported disability in ADL, IADL, GPA, LLM, or LSA by using a multiple logistic regression approach. The odds ratio (OR) for disability in a given domain was obtained for each increment of standard deviation score in the walking speed or leg power after multivariable adjustment.

We also categorized leg power and walking speed into quartiles. The ORs for disability in the individual domains were obtained by comparing subjects in the fourth, third, and second

quartiles of leg power, and of walking speed, to those in the lowest quartile. Trends of disability were assessed across different quartiles of leg power and walking speed.

To evaluate whether walking speed (measure of functional limitation) was intermediate in the association between leg power (measure of impairment) and disability, we adjusted for walking speed in the models for the association between leg power and self-reported disability to observe possible changes in the main effects. Because the NHANES population weights are only applicable to analyses that use the entire population and we limited our analyses to a special subset of subjects, we did not use the NHANES 1999–2002 population weights for the purposes of this study. Data management and analysis were performed using STATA 8.0 software (STATA Corporation, College Station, TX).

Results

Baseline Characteristics

Characteristics of the study sample are presented in Table 2. The mean age of the subjects was 70.2 yrs, and more than one half were men (53.8%) and non-Hispanic white (58.5%). Thirty-seven percent of subjects had an education higher than high school, 13.4% were current smokers, and 62.8% had >12 alcohol drinks per year. Mean body mass index was 27.9 kg/m², indicating a somewhat overweight population. Two thirds of subjects were hypertensive and 15.7% were diabetic. In terms of self-reported disability, more than one half (53.1%) reported any difficulty in GPA, and a corresponding percentage for disability in ADL, IADL, LSA, and LLM were 15.6, 19.6, 13.0, and 28.3%, respectively. A total of 34 individuals (1.97%) used assistive devices during the walk test and had a slower gait speed compared with those without assistive devices (0.987 m/sec vs. 0.585 m/sec). The cut-off values for individual quartiles of peak leg power (watts) were <79.3, 79.3–103.8, 103.9–136.6, and >136.6; for usual gait speed (meters/second), they were <0.830, 0.830–0.979, 0.980–1.124, and >1.124.

Knee Extensor Power and Disability

Peak leg power was independently related to various domains of late-life disability. After controlling for age, sex, race, educational levels, body mass index, cognitive performance, smoking status, alcohol intake, health perception, self-reported physical activity, devices used while walking, pain reported on walking, levels of C-reactive protein, and co-morbidities, the ORs for disabilities in ADL, IADL, LSA, LLM, and GPA for each standard deviation increase in leg power were 0.70 (95% CI, 0.55–0.89), 0.67 (95% CI, 0.53–0.86), 0.62 (95% CI, 0.47–0.83), 0.58 (95% CI, 0.47–0.72), and 0.73 (95% CI, 0.61–0.87), respectively (Table 3, model 1). In other words, each 1-SD increase in knee extensor power was associated with a 27–42% reduced likelihood of disability in five domains. By using a quartile-based approach, the ORs of disability in ADL, IADL, LSA, LLM, and GPA were 0.36 (95% CI, 0.19–0.67), 0.33 (95% CI, 0.17–0.63), 0.34 (95% CI, 0.16–0.72), 0.23 (95% CI, 0.13–0.40), and 0.34 (95% CI, 0.21–0.54), respectively, comparing subjects in the highest quartile of leg power with the lowest (*P* values for trend across quartiles were all statistically significant). We tested the interactive effect of sex and did not find any effect modification of sex in the association between power and disability.

Mediating Effects of Usual Gait Speed in the Leg Power-Disability Relationships

Additional adjustment of usual gait speed was made in the association between peak leg power and late-life disability to assess the mediating effects of usual gait speed (Table 3, model 2). The associations between leg power and disability had mildly attenuated after supplementary adjustment for usual gait speed. Despite modest changes in the ORs, relations of leg power to disability in five domains still remained statistically significant after additional adjustment for usual gait speed. The ORs for disability in ADL, IADL, LSA, LLM, and GPA were 0.75 (95%

CI, 0.59–0.97), 0.76 (95% CI, 0.59–0.98), 0.72 (95% CI, 0.54–0.96), 0.66 (95% CI, 0.53–0.83), and 0.77 (95% CI, 0.64–0.92), respectively, for each standard deviation increase in leg power. We had the same conclusions by using the quartile-based approach.

Usual Gait Speed and Disability

Walking speed was inversely associated with odds of self-report disabilities in various domains. The multivariable adjusted ORs for disabilities in ADL, IADL, LSA, LLM, and GPA for each standard deviation increase in walking speed were 0.72 (95% CI, 0.59–0.87), 0.63 (95% CI, 0.52–0.77), 0.57 (95% CI, 0.45–0.72), 0.56 (95% CI, 0.47–0.67), and 0.74 (95% CI, 0.64–0.85), respectively (Table 4). Each standard deviation increase in usual gait speed was associated with a 26–44% reduction in the likelihood of disability. We subsequently analyzed walking speed divided into quartiles and showed that the ORs of disabilities in ADL, IADL, LSA, LLM, and GPA, comparing subjects in the fastest quartile of walking speed with the lowest, were 0.40 (95% CI, 0.24–0.67), 0.41 (95% CI, 0.25–0.67), 0.31 (95% CI, 0.16–0.58), 0.24 (95% CI, 0.16–0.38), and 0.53 (95% CI, 0.36–0.76), respectively, with highly significant trends across the quartiles of walking speed (all $P \leq 0.001$). There seemed no effect modification of sex in the relationship between usual gait speed and disability.

Discussion

Among the noninstitutionalized older adults within the NHANES cohort, knee extensor leg power and usual gait speed were inversely associated with odds of disability in ADL, IADL, GPA, LLM, and LSA, independent of basic demographics, chronic co-morbidities, health-related behaviors, and marker of inflammation. This investigation is the first to directly link leg power generation to multiple domains of disability. In addition, it expands on our existing knowledge regarding the link between usual gait speed and varying domains of disability. Our results also suggest that the association between peak leg power and disability is in some cases mediated by changes in usual gait speed.

Based within disablement concepts advanced by Verbrugge and Jette,^{2,3} our study expands the current understanding of how leg power and mobility limitations interact to influence multiple domains of disability. Our findings provide a contrast to those of Jette et al.,¹⁵ who performed a similar analysis evaluating impairments in strength. They found that mobility limitations as measured by the timed up-and-go test mediated relationships between strength and both ADL and IADL disability. Our findings suggest that power impairments may in some way represent physiologic processes, for example, sarcopenia or neuromuscular changes, that contribute more to disability than that which is manifested through just strength or basic walking skills. This line of thinking would suggest that power impairments may be both on the mechanistic pathway to disability through mobility decline and perhaps a marker of other physiologic processes contributing to disability. These ideas warrant further investigation within mechanistic studies specifically designed around disablement concepts. It is also possible that these variations are only a manifestation of differences between our chosen measures of functional limitation (usual gait speed) and the timed up-and-go test used by Jette et al.,¹⁵ which evaluates more complex movements. Unfortunately, other suitable physical performance measures were not available with the NHANES dataset.

Our findings support and extend a previous cross-sectional study by Foldvari et al.,¹⁹ who examined 80 elderly women with preexisting impairments of functional status from the Boston-area community. They demonstrated that peak leg power was a strong predictor of combined outcomes in self-reported dependence in ADL or IADL. However, their findings had weakness in terms of generalizability because all participants had some disability at enrollment and because there were no men in the study. Moreover, their sample size was relatively small and their outcomes were confined to ADL and IADL. A strength of our investigation was the use

of a geographically dispersed and ethnically diverse representative sample of community-dwelling elderly people living in the United States. Moreover, the role of functional limitation (usual gait speed) was appropriately assessed in the context of the theoretical disablement process from low-leg muscle power to disability across multiple domains.

Beyond the mechanistic considerations mentioned above, our results have several clinical implications. The findings reinforce the importance of leg power impairments and walking speed limitations as potential clinical markers of individuals at risk for disability.^{17,25,26} Measurement of leg power and usual gait speed may be useful in identifying and targeting elderly individuals who may require intervention to prevent functional loss and disability. Second, these findings may inform the design of therapeutic approaches to those at risk for disability. Currently, the main therapeutic approach toward enhancing function and ameliorating disability includes some form of resistance training exercise.⁴ In acknowledging the independent effects of muscle power, a number of investigations have focused on augmenting muscle power through athletic-style training using exercise machines.^{27–29} Other investigations have attempted to emphasize the mediating effects of mobility performance, designing “functional” exercises that are similar to common mobility tasks.^{30,31} Given both the independent effects of muscle power and the mediating effects of walking speed, optimal therapies may involve exercise that emphasizes both attributes. The benefits of such an approach have been reported within pilot studies and are currently being evaluated within a larger randomized controlled trial.^{32,33} Lastly, it is also important to acknowledge the connection between leg power, usual gait speed, and disability associated with the performance of LSA factors. This broadens the perspective within which the detrimental effects of leg power impairments and gait speed limitations are viewed and, in turn, emphasizes the varied domains that may show improvements with new rehabilitation therapies.²⁰

Our study has potential limitations that deserve comments. First, due to the cross-sectional design of the study, causal relationship from leg muscle power to disability can not be established. The relationship should be studied prospectively. Second, usual gait speed is the only measure of functional limitation in the study. Other suitable physical performance measures (such as maximal gait speed or transfer ability) are not available in the NHANES and may mediate the leg power–disability association in a different way. Finally, although the data were drawn from a national population-based sample, 46% of the subjects (out of 3232) who finished the Physical Functioning Questionnaire and Mobile Examination Center examination were excluded due to technical, physical, administrative, or safety reasons. As a result, the analytic sample was limited to a subset of subjects aged ≥ 60 with reliable measures of leg power. Thus, our results were not generalizable to the entire United States population.

In conclusion, peak leg power and usual gait speed had independent associations with multiple domains of disability among the elderly. The association between peak leg power and disability was, to some extent, mediated by usual gait speed. Although there is a need to evaluate these relationships longitudinally, our study advances the knowledge regarding the relationships between leg power, usual gait speed, and late-life disability, having both mechanistic and clinical implications.

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Table 1**Self-reported disability^a****Domains**

Activities of daily living

Instrumental activities of daily living

General physical activities

Lower limb mobility

Leisure and social activities

Components

Difficulty in eating: using fork, knife, and drinking from a cup

Difficulty dressing yourself

Difficulty walking between rooms on the same floor

Difficulty getting in and out of bed

Difficulty managing money

Difficulty with house chores

Difficulty with preparing meals

Difficulty in stooping, crouching, kneeling

Difficulty in lifting or carrying

Difficulty in standing up from an armless chair

Difficulty in standing for long periods

Difficulty in sitting for long periods

Difficulty in reaching up over head

Difficulty grasping/holding small objects

Difficulty walking for a quarter mile

Difficulty walking up ten steps

Difficulty going out to movies and events

Difficulty attending social events

Difficulty with leisure activities at home

^aSubject was asked about the abilities to perform a series of activities without using any special equipment.

Table 2 Characteristics of study sample (aged ≥ 60 yrs, $n = 1753$)

Characteristics	Value	
Continuous variables ^a		
Age, yrs	70.2	(7.5)
Body mass index, kg/m ²	27.9	(5.0)
Blood pressure, mm Hg		
Systolic	138.7	(21.1)
Diastolic	69.8	(15.7)
Digit symbol substitution test, correct	44.3	(18.4)
Peak knee extensor force, N	333.2	(107.9)
Peak knee extensor power, W	110.2	(40.9)
Usual gait speed, m/sec	0.979	(0.236)
Categorical variables ^b		
Female sex	809	(46.2)
Race		
Non-Hispanic white	1026	(58.5)
Mexican American	340	(19.4)
Non-Hispanic Black	280	(16.0)
Other Hispanic	66	(3.8)
All others	41	(2.3)
Education more than high school	651	(37.1)
Current smoker	234	(13.4)
Alcohol consumption of ≥12 drinks/year	1101	(62.8)
Diabetes	275	(15.7)
Hypertension	1174	(67.0)
Disability		
Activities of daily living	274	(15.6)
Instrumental activities of daily living	343	(19.6)
General physical activities	931	(53.1)
Lower limb mobility	496	(28.3)
Leisure/social activities	228	(13.0)
Use of device during walking test	34	(1.94)

^aValues in the continuous variables were expressed as mean (standard deviation).^bValues in the categorical variables were expressed as number (percentage).

Association between peak knee extensor power and disability
Models with Knee Extensor Power as a Continuous Variable^a

Models ^a	ADL Disability		IADL Disability		LSA Disability		LLM Disability		GPA Disability	
	OR ^b (95% CI)	P Value	OR ^b (95% CI)	P Value	OR ^b (95% CI)	P Value	OR ^b (95% CI)	P Value	OR ^b (95% CI)	P Value
Model 1	0.70 (0.55–0.89)	0.004	0.67 (0.53–0.86)	0.002	0.62 (0.47–0.83)	0.001	0.58 (0.47–0.72)	<0.001	0.73 (0.61–0.87)	<0.001
Model 2	0.75 (0.59–0.97)	0.026	0.76 (0.59–0.98)	0.032	0.72 (0.54–0.96)	0.026	0.66 (0.53–0.83)	<0.001	0.77 (0.64–0.92)	0.004
Models with Knee Extensor Power by Increasing Quartiles ^a										
Quartile Comparison	ADL Disability		IADL Disability		LSA Disability		LLM Disability		GPA Disability	
	OR ^c (95% CI)	P for Trend	OR ^c (95% CI)	P for Trend	OR ^c (95% CI)	P for Trend	OR ^c (95% CI)	P for Trend	OR ^c (95% CI)	P for Trend
Model 1										
Q2 vs. Q1	0.91 (0.60–1.39)	0.001	0.95 (0.64–1.42)	0.002	1.06 (0.66–1.69)	0.003	0.66 (0.46–0.95)	<0.001	0.67 (0.48–0.94)	<0.001
Q3 vs. Q1	0.59 (0.36–0.96)		0.71 (0.45–1.14)		0.61 (0.35–1.05)		0.46 (0.31–0.70)		0.49 (0.33–0.72)	
Q4 vs. Q1	0.36 (0.19–0.67)		0.33 (0.17–0.63)		0.34 (0.16–0.72)		0.23 (0.13–0.40)		0.34 (0.21–0.54)	
Model 2										
Q2 vs. Q1	0.98 (0.64–1.51)	0.007	1.06 (0.71–1.59)	0.031	1.21 (0.75–1.95)	0.048	0.75 (0.52–1.09)	<0.001	0.72 (0.51–1.02)	<0.001
Q3 vs. Q1	0.67 (0.41–1.10)		0.87 (0.54–1.41)		0.77 (0.44–1.37)		0.59 (0.38–0.90)		0.55 (0.37–0.80)	
Q4 vs. Q1	0.42 (0.22–0.80)		0.43 (0.22–0.83)		0.47 (0.22–1.01)		0.31 (0.18–0.54)		0.39 (0.24–0.62)	

ADL, activities of daily living; IADL, instrumental activities of daily living; LSA, leisure and social activities; LLM, lower limb mobility; GPA, general physical activities; OR, odds ratio; CI, confidence interval; Q1–Q4, first through fourth quartiles.

^a Adjusted covariates. Model 1 = age, sex, race, educational levels, body mass index, cognitive performance, smoking status, alcohol intake, health perception, self-reported physical activity, devices used while walking, pain reported on walking, levels of C-reactive protein, and co-morbidities (diabetes, hypertension, myocardial infarction, congestive heart failure, angina, chronic bronchitis, emphysema, arthritis, and anemia). Model 2 = model 1 + usual gait speed.

^b ORs were per increment of 1 SD in the knee extensor power.

^c ORs can be interpreted as odds of disability comparing subjects in the second, third, or fourth quartiles of knee extensor power with those in the lowest quartile.

Association of usual gait speed and disability

Table 4

Models with Usual Gait Speed as a Continuous Variable^a

	ADL Disability		IADL Disability		LSA Disability		LLM Disability		GPA Disability	
	OR ^b (95% CI)	P Value	OR ^b (95% CI)	P Value	OR ^b (95% CI)	P Value	OR ^b (95% CI)	P Value	OR ^b (95% CI)	P Value
	0.72 (0.59–0.87)	0.001	0.63 (0.52–0.77)	<0.001	0.57 (0.45–0.72)	<0.001	0.56 (0.47–0.67)	<0.001	0.74 (0.64–0.85)	<0.001

Models with Usual Gait Speed by Increasing Quartiles^a

Quartile comparison	ADL Disability		IADL Disability		LSA Disability		LLM Disability		GPA Disability	
	OR ^c (95% CI)	P for Trend	OR ^c (95% CI)	P for Trend	OR ^c (95% CI)	P for Trend	OR ^c (95% CI)	P for Trend	OR ^c (95% CI)	P for Trend
Q2 vs. Q1	0.63 (0.42–0.94)	0.001	0.67 (0.46–0.99)	<0.001	0.63 (0.40–0.98)	<0.001	0.58 (0.41–0.82)	<0.001	0.81 (0.58–1.13)	<0.001
Q3 vs. Q1	0.56 (0.36–0.88)		0.48 (0.31–0.75)		0.55 (0.33–0.92)		0.48 (0.33–0.70)		0.68 (0.48–0.97)	
Q4 vs. Q1	0.40 (0.24–0.67)		0.41 (0.25–0.67)		0.31 (0.16–0.58)		0.24 (0.16–0.38)		0.53 (0.36–0.76)	

ADL, activities of daily living; IADL, instrumental activities of daily living; LSA, leisure and social activities; LLM, lower limb mobility; GPA, general physical activities; OR, odds ratio; CI, confidence interval; Q1–Q4, first through fourth quartiles.

^a All models were adjusted for age, sex, race, educational levels, body mass index, cognitive performance, smoking status, alcohol intake, health perception, self-reported physical activity, devices used while walking, pain reported on walking, levels of C-reactive protein, and co-morbidities (diabetes, hypertension, myocardial infarction, congestive heart failure, angina, chronic bronchitis, emphysema, arthritis, and anemia).

^b ORs were per increment of 1 SD in the usual gait speed.

^c ORs can be interpreted as odds of disability comparing subjects in the second, third, or fourth quartiles of usual gait speed with those in the lowest quartile.