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Original Study

Modifiable Risk Factors for New-Onset Slow Gait in Older Adults

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A B S T R A C T

Objective: Despite the growing importance of slow gait as a universal screen of health, systematic investigation of risk factors for incident slow gait is lacking. Our objective was to identify potentially modifiable risk factors for incident slow gait.
Design: Prospective cohort study.
Setting: The Health and Retirement Study, a nationally representative US sample.
Participants: A total of 2306 individuals age 65 and older (56.5% women) from the 2008 wave with timed walks at baseline and 4 years later.
Measurements: Incident slow gait (walking speed 1 SD below age and sex means) was the outcome. Fifteen potentially modifiable medical and lifestyle risk factors were examined as predictors.
Results: Incident slow gait developed in 243 participants (11%) at 4 years. Physical inactivity (adjusted relative risk [aRR] 1.94), cognitive impairment (aRR 1.77), muscle weakness (aRR 1.48), pain (aRR 1.45), obesity (aRR 1.35), vision (aRR 1.36), and falls (aRR 1.32) predicted increased risk of developing incident slow gait. Together, these risk factors accounted for 77% (95% confidence interval 14–95) of the Population Attributable Risk for incident slow gait.
Conclusion: A limited set of potentially modifiable risk factors is associated with new-onset slow gait in older adults. These findings provide a foundation for developing clinical guidelines and preventive interventions for slow gait.

Gait speed is recommended by experts and professional societies for assessing risk of adverse events such as disability or falls,[1,2] defining frailty, determining fitness, and as a yardstick to judge efficacy of clinical interventions.[3,4] Slow gait is a not only a robust predictor of outcomes, such as dementia, falls, and mortality, but also gait speed is recommended as a primary endpoint for clinical trials.[1,4–7] Improving gait speed is clinically meaningful in terms of better function, reduced disability, increased community ambulation, and survival.[5,6]

Although many older adults in community and clinical settings walk slowly or have clinical gait abnormalities,[3,8–10] risk factors for slow gait are not well established. This knowledge gap is reflected in the lack of guidelines to help clinicians plan interventions in older patients to prevent mobility loss.[1,3] As done in previous studies that have identified risk factors for other medical conditions,[11,12] we selected 15 potentially modifiable medical as well as lifestyle variables based on reported and predicted associations with mobility as well as literature review.[2,4,8,13] We examined contributions of these variables to risk of developing incident slow gait in the Health and Retirement Study (HRS),[14] a nationally representative US sample. Information from our study can not only help clinicians in treating older patients with slow gait, but also guide design of public health interventions to maintain and improve mobility in aging.

Methods

Study Population

In 1992, the HRS enrolled a cohort of adults born between 1931 and 1941 (between ages 51 and 61) residing in households, and their spouses.[14] The HRS later merged with additional cohorts to become nationally representative of the community-dwelling US population aged 51 years and older in 1998.[15] The HRS is sponsored by the

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National Institute of Aging (U01AG009740) and conducted by the University of Michigan. Further details of HRS are available in previous publications[13–16] and study brochure ("Growing older in America." Available at: http://hrsonline.isr.umich.edu/sitedocs/brochure/HRS-brochure.pdf). The HRS conducts core interviews every 2 years using a mixed-mode design of telephone and in-person interviews. In 2004, HRS implemented in-home visits ("enhanced" face-to-face interviews) in 3300 participants.[17] This effort was expanded to include the entire sample in 2006 and 2008. One half of the HRS cohort selected for the enhanced interview was randomly selected to receive physical performance tests in 2006, and the other half in 2008. Timed walks were administered only to participants aged 65 and older. Although HRS follow-up was at 2-year intervals, timed walks were repeated only at 4-year intervals; the 2008 cohort had timed walks repeated in 2012. The Einstein institutional review board approved this analysis.

Gait

Timed walks were done as part of the Short Physical Performance Battery protocol at participants' homes.[18] Participants were timed as they walked unassisted at normal pace on a 98.5-inch course with start and stop points marked on the floor. The mean of 2 trials was calculated. Walking times were converted to gait speed (m/s) for consistency with other studies.[3,8] Timed walks have excellent test-retest reliability.[3,5] Our primary outcome was incident "slow gait" at the 2012 follow-up. Slow gait was defined as gait speeds 1 SD or more below age and sex means. Slow gait cut scores for women younger than 70 was 0.57 m/s, age 70–79 0.49 m/s, and age 80 and older 0.38 m/s. Cut scores in men were 0.62 m/s, 0.56 m/s, and 0.45 m/s, respectively. The same procedure has been used to define slow gait in other cohorts,[19] and is similar to how cut scores on cognitive tests are derived. Slow gait at baseline in our sample was associated at cross-section with difficulty performing daily activities, such as climbing stairs (relative risk adjusted for age, sex, and education [aRR] 2.28, 95% confidence interval [CI] 1.94–2.69), getting up from chair (aRR 1.92, 95% CI 1.67–2.20), and bathing (aRR 2.63, 95% CI 2.28–3.03), confirming the clinical relevance of this outcome.

An alternate approach to define slow gait is to use a single cut-score,[7] but there is no consensus on the value for the cutscore.[3,6] In secondary analysis, we examined incident slow gait defined by one of the recommended cut scores ($\leq$0.60 m/s)[7] to confirm reliability of findings.

Modifiable Exposures

We followed the approach used in previous studies that identified risk factors for myocardial infarction and stroke[11,12]; 15 potentially modifiable medical illnesses and lifestyle variables were selected based on reported or predicted associations with slow gait.[2,4,8,13] We reviewed HRS publications to identify additional variables.[14,18,20,21] HRS has standardized training and protocols.[13–16,18] The manual of procedures is available online (http://hrsonline.isr.umich.edu/sitedocs/userg/dr-011.pdf). Definitions of variables herein generally follow previous HRS publications.[13,14,16,22] All variables had no or very little missing data at baseline (<5%), and these cases were excluded. HRS lay interviewers asked participants about physician-diagnosed diseases and impairments.[13,14] Presence of hypertension, diabetes, strokes, heart conditions (angina, myocardial infarction, or cardiac failure), and arthritis were recorded.[13,15,22,23] Information on some low-prevalence diseases with gait impairment, such as Parkinson disease, was lacking.[19] If a respondent reported any disease, additional information was collected to determine if any treatment was received or if it impaired physical functions. Cognition was tested with the Telephone Interview for Cognitive Status adapted to be administered in-person and by telephone.[14] Cognitive impairment was defined as scores 1 SD or more below the mean, the same procedure used to define predementia syndromes.[19] Four or more depressive symptoms on the 8-item Center for Epidemiologic Studies Depression Scale was considered elevated.[16] Participants were asked, "How often do you feel really rested when you wake up in the morning? Would you say most of the time, sometimes, or rarely or never?" Poor sleep quality was defined as responses of "sometimes, rarely, or never"[24] Occurrence and number of falls over the previous 2 years was recorded.[13,25] Participants were asked how often they took part in sports or activities that were vigorous, such as running or jogging, swimming, cycling, aerobics or gym workout, tennis, or digging with a spade or shovel. Responses were every day, once weekly, more than once a week, 1 to 3 times per month, or hardly ever/never. Physical inactivity was defined as participating in any vigorous activity less than once weekly. This physical inactivity definition mirrors criterion used in HRS and other studies.[14,15,20,21] A 1-item physical activity question was very reliable compared with objective activity measurements.[26] Another HRS study linked the 1-item physical activity question responses to walking capacity.[21] Low vision was rated as self-reported "fair" or "poor" ability to see objects at far or near distances.[14,15] Obesity was defined as a body mass index of $\geq$30.[14] Grip strength (kg) in both hands was assessed using a Smedley spring-type hand dynamometer, and mean of 2 values computed. Muscle weakness was defined as handgrip 1 SD or more below age ($\geq$75 years or below) and sex means. Pain was considered to be significant if participants responded "yes" to the question, "Are you often troubled with pain?"[24] Current consumption of alcoholic beverages was asked, "Do you ever drink any alcoholic beverages, such as beer, wine, or liquor?"[4,24]

Variables such as chronic lung disease, hearing loss, smoking, and medications were not included, as they are either not established as slow gait risk factors or were not significant in our preliminary analyses. Although "not smoking" was correlated with self-reported walking ability in HRS,[20] past or current smoking was not associated with incident slow gait in preliminary analysis (aRR 1.20, 95% CI 0.93–1.55). Taking prescription medications for the selected chronic diseases was not associated with incident slow gait (aRR 1.94, 95% CI 0.96–2.33).

Analysis

SAS 9.3 (SAS Institute Inc, Cary, NC) and Stata 14 (StataCorp, College Station, TX) were used for all analyses. Descriptive statistics were used to summarize data. We examined associations of the risk factors with incident slow gait at 4 years in the 2008 wave database.[15] The 15 variables and covariates (age, sex, and education) were entered simultaneously in models. There were no collinearity issues among the risk factors (phi coefficients ranged from −0.12 between physical inactivity and alcohol consumption to 0.26 between pain and arthritis). Associations are reported as aRR with 95% CIs. RRs were obtained using Poisson regression with robust variance estimator.[27] Variance of RR was obtained using ultimate cluster variance estimate for complex designs method,[28] and implemented with Taylor series linearization technique.[28] Respondent-level sampling weights to account for the complex sampling design and nonresponse (http://hrsonline.isr.umich.edu/sitedocs/userg/dr-013.pdf) were applied.

Population Attributable Risk (PAR) represents the proportion of risk in slow gait in HRS that can be explained by the risk factor. Because no significant interaction was found among the risk factors and demographic variables, we calculated PAR for each individual risk factor (adjusting for age, gender, education, and all other selected risk factors) using Miettinen's formula[29]:

$$\mathrm{PAR} = \mathrm{P}_1 * (\mathrm{aRR} - 1)/\mathrm{aRR}.$$

P_1 is the prevalence of the modifiable risk factor among those who develop slow gait and aRR is the adjusted relative risk. This