“Feeling younger, walking faster”: subjective age and walking speed in older adults

Yannick Stephan · Angelina R. Sutin ·
Antonio Terracciano

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Abstract Walking speed is a key vital sign in older people. Given the implications of slower gait speed, a large literature has identified health-related, behavioral, cognitive, and biological factors that moderate age-related decline in mobility. The present study aims to contribute to existing knowledge by examining whether subjective age, how old or young individuals experience themselves to be relative to their chronological age, contributes to walking speed. Participants were drawn from the 2008 and 2012 waves of the Health and Retirement Study (HRS, $N = 2970$) and the 2011 and 2013 waves of the National Health and Aging Trends Study (NHATS, $N = 5423$). In both the HRS and the NHATS, linear regression analysis revealed that a younger subjective age was associated with faster walking speed at baseline and with less decline over time, controlling for age, sex, education, and race. These associations were partly accounted for by depressive symptoms, disease burden, physical activity, cognition, body mass index, and smoking. Additional analysis revealed

that feeling younger than one's age was associated with a reduced risk of walking slower than the frailty-related threshold of 0.6 m/s at follow-up in the HRS. The present study provides novel and consistent evidence across two large prospective studies for an association between the subjective experience of age and walking speed of older adults. Subjective age may help identify individuals at risk for mobility limitations in old age and may be a target for interventions designed to mitigate functional decline.

Keywords Subjective age · Walking speed · Mobility

Introduction

Walking speed is a key vital sign in older people, reflecting overall health status and function (Peel et al. 2013; Studenski et al. 2003; White et al. 2013). Slower walking speed is predictive of a range of adverse outcomes, including falls (Verghese et al. 2009) disability in activities of daily living (Rothman et al. 2008), hospitalization (Cesari et al. 2009), and mortality (Elbaz et al. 2013; Hardy et al. 2007; Studenski et al. 2011). In addition, slow gait is associated with cognitive decline and risk of dementia (Verghese et al. 2002, Verghese et al. 2007) as well as incident depressive symptoms over time (Sanders et al. 2012). Given these implications, a large literature has identified health-related, behavioral, cognitive, and biological factors that are related to walking speed and that moderate age-related decline in mobility (Gale et al. 2014; Rosso et al. 2015).

Y. Stephan (✉)
EA 4556 Dynamic of Human Abilities and Health Behaviors,
University of Montpellier, 700, avenue du Pic Saint Loup,
34090 Montpellier, France
e-mail: yannick.stephan@univ-montp1.fr

A. R. Sutin
Department of Behavioral Sciences and Social Medicine, Florida
State University College of Medicine, Tallahassee, FL, USA

A. Terracciano
Department of Geriatrics, Florida State University College of
Medicine, Tallahassee, FL, USA

The present study aims to contribute to existing knowledge by examining whether subjective age, how old or young individuals experience themselves to be relative to their chronological age, contributes to walking speed.

Existing studies mainly use chronological age as a key marker to track, describe, and explain changes in physical functioning (Forrest et al. 2006; White et al. 2013). However, subjective age is gaining popularity in gerontological research because of its links with a range of health-related outcomes in old age, independent of chronological age. In particular, a younger subjective age is related to higher well-being and lower depressive symptoms (Keyes and Westerhof 2012), better cognition (Stephan et al. 2014), better health (Demakakos et al. 2007), and survival (Kotter-Grühn et al. 2009) whereas an older subjective age is associated with increased mortality risk (Kotter-Grühn et al. 2009). To date, however, no study has examined whether subjective age is related to walking speed.

Observational and experimental research suggests that subjective age may have a motor signature in gait speed. For example, older individuals induced to feel younger show better physical functioning, including better performance on a grip strength task than controls (Stephan et al. 2013). Subjective age has also been related to a range of behavioral, health-related, and cognitive processes directly associated with physical function and mobility in old age. Specifically, a younger subjective age is related to a physically active lifestyle (Caudroit et al. 2012), a lower risk of obesity (Stephan et al. 2014), and less disease burden (Demakakos et al. 2007), which contribute to faster gait speed and slower decline (Haight et al. 2013; Ko et al. 2010). Individuals who feel younger than their age also have lower systemic inflammation (Stephan et al. 2015a) and better cognitive functioning (Stephan et al. 2014), which are also related to walking speed (Gale et al. 2014; Kuo et al. 2006).

Using longitudinal data from two large national samples of adults, the present study examined the association between subjective age and walking speed. Drawing upon existing evidence on its positive health-related outcomes (Demakakos et al. 2007; Keyes and Westerhof 2012; Stephan et al. 2013, Stephan et al. 2014), we hypothesized that a younger subjective age would be associated with faster concurrent walking speed and a slower decline in gait speed over time. Furthermore, we tested whether health-related (e.g. BMI, disease burden, depressive symptoms), behavioral (e.g. physical activity,

smoking), and cognitive factors accounted for the link between subjective age and gait speed.

Method

Participants

Participants were drawn from the Health and Retirement Study (HRS) and the National Health and Aging Trends Study (NHATS). The HRS is a nationally representative longitudinal study sponsored by the National Institute of Aging (Grant No. NIA U01AG009740) and conducted by the University of Michigan. The participants in HRS were Americans aged 50 and older and their spouses. The participants signed a consent form approved by the Institutional Review Board at the University of Michigan. A random one-half of the HRS sample was pre-selected for an enhanced face-to-face interview in 2006. The interview included the collection of physical measurements and a psychosocial questionnaire. The other half of the sample was tested in the 2008 wave, and the design is repeated in each subsequent wave. Walking speed was measured only among respondents aged 65 years or older (Crimmins et al. 2013). Given that subjective age was first assessed in the psychosocial questionnaire in 2008, the present study used the 2008 wave as the baseline measure of both subjective age and walking speed. The second walking measurement was obtained in 2012. With outliers removed, complete data on all measures of interest, including covariates, at baseline were obtained from 2970 participants (58 % women) who were, on average, 74 years old (range 65–107; SD = 6.70) and 88 % white. Of these participants, 2023 individuals completed the walking task again in 2012.

The NHATS is a nationally representative prospective cohort study of Medicare enrollees aged 65 years and older. NHATS is funded by the National Institute on Aging (Grant No. NIA U01AG032947) and conducted by the Johns Hopkins Bloomberg School of Public Health. Before beginning data collection, the participants signed a consent form approved by the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health. Study participants were first interviewed in 2011 and were re-interviewed annually (Kasper and Freedman 2014). Walking speed, subjective age, and data on covariates were assessed at each wave. We used data from 2011 as baseline assessment and the 2013 wave as follow-up. At baseline, 5423

participants (57 % women) were assessed for walking speed, subjective age, and covariates. They were on average 76 years old (range 65–102; SD = 7.47) and 77 % white. Of this sample, 3270 individuals completed the walking speed task again in 2013. Attrition analysis is presented in online resource 1.

Measures

Subjective age

In both samples, subjective age was assessed by asking participants to specify, in years, how old they felt. In line with existing research (Stephan et al. 2014), proportional discrepancy scores were calculated by subtracting participants' felt age from their chronological age, and these difference scores were divided by chronological age. A positive value reflected a youthful subjective age, whereas a negative value indicated an older subjective age. Consistent with prior studies (Stephan et al. 2014; Weiss and Lang 2012), responses 3 standard deviations above or below the mean were considered outliers, leading to the exclusion of 41 participants from analysis in the HRS and 83 participants in the NHATS.

Walking speed

Walking speed was measured using a timed walk of a 2.50-m span in the HRS (Crimmins et al. 2013) and of 3 m in the NHATS (Kasper et al. 2012). In both samples, respondents were asked to walk at their normal pace just past the end of the course. The interviewer started the stop watch once the respondent's foot was across the starting line and fully touching the floor and stopped the stop watch as soon as the respondent's foot was completely past the masking tape marking the finish line and fully touched the floor (Crimmins et al. 2013; Kasper et al. 2012). The participants were timed as they walked the course 2 times. The best of 2 times recorded was used in the analysis, and the participants with at least one performance were included. Walking speed was calculated by dividing the distance (in meters) by the time recorded (in seconds). The participants with speed values 3 standard deviations above the mean were excluded (HRS: $N = 5$; NHATS: $N = 7$).

Covariates

Age (in years), sex (coded as 1 for men and 0 for women), race (coded as 1 for white and 0 for other), and educational level were included as demographic covariates. Educational level was reported in years in the HRS, and using a scale from 1 "No schooling completed" to 9 "Master's, professional or doctoral degree" in the NHATS. Health-related covariates included body mass index (BMI), disease burden, and depressive symptoms. BMI, calculated as kg/m^2 , was based on measured height and weight by trained interviewers in the HRS, and on reported height and weight in the NHATS. In both samples, the sum of diagnosed conditions (i.e., high blood pressure, diabetes, cancer, lung disease, heart condition, stroke, osteoporosis, or arthritis) was computed to obtain a measure of disease burden. Depressive symptoms were assessed using an 8-item version of the Centers for Epidemiologic Research Depression (CES-D) scale in the HRS (Wallace et al. 2000). The participants were asked to report whether they had experienced (yes/no) eight specific symptoms for much of the past week. The items were summed to create a total depressive symptom score that ranged from 0 to 8 ($\alpha = 0.81$). Depressive symptoms were assessed using the Patient Health Questionnaire (PHQ)-2 in the NHATS (Kroenke et al. 2003). The participants were asked to report how often they had little interest or pleasure in doing things, and how often they felt down and depressed or hopeless during the last month, using a scale from 1 "not at all" to 4 "nearly every day." Behavioral covariates included physical activity and smoking. Participants in the HRS rated how frequently they participated in vigorous and moderate activities by answering 2 questions using a scale ranging from 1 (hardly ever or never) to 4 (more than once a week). In the NHATS, individuals were asked to report whether they ever go walking for exercise (yes/no) and ever spend time on vigorous activities in the last month (yes/no). Responses to the 2 items were summed. History of smoking was coded as 1 for current/former smokers and 0 for never smokers in both samples. Finally, we included a total cognition score in the HRS, computed from participants' answers to tests of memory, knowledge, language, and orientation (Ofstedal et al. 2005). Score ranged from 0 to 35, with higher scores indicating better cognition. In the NHATS, cognition was assessed using the clock drawing test (Shulman et al. 1993). Scores ranged from 0 to 5, with higher scores indicating better cognition.

Data analysis

In both the HRS and the NHATS, regression analyses were conducted with baseline walking speed as the dependent variable and baseline subjective age as the independent variable. The basic model was adjusted for age, sex, education, and race. Depressive symptoms, disease burden, BMI, physical activity, smoking, and cognition were added separately and together to this basic model to examine potential factors that could account for the association between subjective age and walking speed. The same analyses were conducted with follow-up walking speed as the outcome. The basic longitudinal model included subjective age, demographic factors, and baseline walking speed as predictors. Including baseline walking speed in the analysis as a control variable equalizes all participants with respect to their initial level, and is equivalent to examine change in this variable between baseline and follow-up. We are predicting what is left (the residual) of walking speed at follow-up after accounting for baseline level. Significant findings suggest that subjective age is associated with changes in the outcome variable over time (walking speed) because it is the residual effect of the predictor variable after controlling for earlier levels of the criterion variable. Depressive symptoms, disease burden, BMI, physical activity, smoking, and cognition were then added separately and together to the longitudinal model.

In complementary analysis, we tested whether subjective age is related to gait speed less than 0.6 m/s, a cutpoint indicative of frailty (Gray et al. 2013; Studenski et al. 2003) and thus increased risk of worse health outcomes, including falls, hospitalization, and dementia (Gray et al. 2013; Quach et al. 2011). Binary logistic regressions using an enter method were used to examine the association between subjective age and risk of walking speed below the clinical threshold of 0.6 m/s at follow-up. These analyses controlled for age, sex, education, race, and baseline walking speed.

Results

Descriptive statistics for the baseline samples are presented in Table 1. The correlations between the covariates and walking speed at baseline and follow-up in both the NHATS and the HRS are given in online resource 2.

Table 1 Baseline characteristics of the samples

Variables	M/%	SD
<i>HRS (N = 2970)</i>		
Sex (% female)	58 %	—
Age (years)	74	6.70
Education	12.48	3.02
Ethnicity (% white)	88 %	—
Depressive symptoms	1.19	1.75
Disease burden	2.30	1.27
BMI (kg/m ²)	28.94	5.70
Physical activity	2.35	1.06
Smoking (% current/former smokers)	52 %	—
Cognition	22.14	4.67
Subjective age ^a	0.15	0.14
Baseline walking speed (m/s)	0.81	0.28
<i>NHATS (N = 5423)</i>		
Sex (% female)	57 %	—
Age (years)	76	7.47
Education	5.22	2.19
Ethnicity (% white)	77 %	—
Depressive symptoms	1.43	0.64
Disease burden	2.47	1.54
BMI (kg/m ²)	27.57	5.48
Physical activity	1.03	0.77
Smoking (% current/former smokers)	52 %	—
Cognition	3.50	1.04
Subjective age ^a	0.16	0.16
Baseline walking speed (m/s)	0.79	0.27

Education, cognition, depression, physical activity, BMI, and walking speed were assessed using different methods in the two samples (See Method)

HRS Health and Retirement Study, *NHATS* National Health and Aging Trends Study, *BMI* body mass index

^a Subjective age = (chronological age-felt age)/chronological age

As expected, subjective age was positively related to baseline walking speed in the HRS and the NHATS, controlling for demographic factors (see Tables 2 and 3). Similar results were obtained without controlling for covariates. This result suggested that individuals who feel younger than their chronological age walk faster. The strength of the association between subjective age and walking speed was comparable to the effect size of demographic factors, such as sex and race. In line with recent research (Infurna and Gerstorf 2013; Infurna and Gerstorf 2014), we estimated the effect size of subjective age in terms of years of aging on walking speed.

Table 2 Summary of regression analysis explaining baseline walking speed in the HRS

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$
Age	-0.01(0.00) -0.29***	-0.01(0.00) -0.29***	-0.01(0.00) -0.27***	-0.01(0.00) -0.31***	-0.01(0.00) -0.26***	-0.01(0.00) -0.31***	-0.01(0.00) -0.25***	-0.01(0.00) -0.24***
Sex	0.06(0.01) 10***	0.05(0.01) 10***	0.06(0.01) 11***	0.06(0.01) 10***	0.04(0.01) 0.08***	0.06(0.01) 11***	0.07(0.01) 12***	0.05(0.01) 10***
Ethnicity	0.12 (0.01) 0.14***	0.12 (0.01) 0.14***	0.12 (0.01) 0.14***	0.11(0.01) 0.13***	0.12(0.01) 0.14***	0.12(0.01) 0.15***	0.10(0.01) 0.11***	0.09(0.01) 0.11***
Education	0.02(0.00) 0.18***	0.01(0.00) 0.16***	0.02(0.00) 0.17***	0.02(0.00) 0.18***	0.01(0.00) 0.15***	0.02(0.00) 0.18***	0.01(0.00) 0.12***	0.01(0.00) 0.09***
Subjective age	0.26(0.03) 0.13***	0.22(0.03) 0.11***	0.21(0.03) 0.11***	0.25(0.03) 0.13***	0.21(0.03) 0.11***	0.26(0.03) 0.13***	0.25(0.03) 0.12***	0.15(0.03) 0.07***
Depression	-	-0.02(0.00) -0.13***	-	-	-	-	-	-0.01(0.00) -0.07***
Disease burden	-	-	-0.04(0.00) -0.17***	-	-	-	-	-0.02(0.00) -0.11***
BMI	-	-	-	-0.00(0.00) -0.09***	-	-	-	-0.00(0.00) -0.05***
Physical activity	-	-	-	-	0.05(0.00) 0.18***	-	-	0.04(0.00) 0.14***
Smoking	-	-	-	-	-	-0.03(0.01) -0.05**	-	-0.01(0.01) -0.02
Cognition	-	-	-	-	-	-	0.01(0.00) 0.16***	0.01(0.00) 0.13***
Adjusted R^2	0.19	0.21	0.22	0.20	0.22	0.19	0.21	0.26

 $N = 2970$ b unstandardized regression coefficient, SE standard error, β standardized regression coefficient, BMI body mass index* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 Summary of regression analysis explaining baseline walking speed in the NHATS

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$	$B(SE) \beta$
Age	-0.01(0.00) -0.35***	-0.01(0.00) -0.35***	-0.01(0.00) -0.33***	-0.01(0.00) -0.38***	-0.01(0.00) -0.32***	-0.01(0.00) -0.35***	-0.01(0.00) -0.32***	-0.01(0.00) -0.32***
Sex	0.06(0.01) 0.10***	0.05(0.01) 0.10***	0.05(0.01) 0.09***	0.06(0.01) 0.10***	0.05(0.01) 0.08***	0.06(0.01) 0.11***	0.06(0.01) 0.11***	0.04(0.01) 0.07***
Ethnicity	0.11 (0.01) 0.17***	0.11 (0.01) 0.17***	0.11(0.01) 0.17***	0.11(0.01) 0.16***	0.11(0.01) 0.16***	0.11(0.01) 0.17***	0.10(0.01) 0.15***	0.08(0.01) 0.13***
Education	0.02(0.00) 0.19***	0.02(0.00) 0.17***	0.02(0.00) 0.18***	0.02(0.00) 0.18***	0.02(0.00) 0.16***	0.02(0.00) 0.19***	0.02(0.00) 0.17***	0.01(0.00) 0.12***
Subjective age	0.22(0.02) 0.13***	0.19(0.02) 0.11***	0.18(0.02) 0.11***	0.21(0.02) 0.12***	0.19(0.02) 0.11***	0.22(0.02) 0.13***	0.22(0.02) 0.13***	0.12(0.02) 0.07***
Depression	-	-0.06(0.00) -0.14***	-	-	-	-	-	-0.04(0.00) -0.09***
Disease burden	-	-	-0.03(0.00) -0.17***	-	-	-	-	-0.02(0.00) -0.11***
BMI	-	-	-	-0.01(0.00) -0.14***	-	-	-	-0.00(0.00) -0.11***
Physical activity	-	-	-	-	0.06(0.00) 0.18***	-	-	0.05(0.00) 0.14***
Smoking	-	-	-	-	-	-0.01(0.01) -0.01	-	0.00(0.01) 0.00
Cognition	-	-	-	-	-	-	0.03(0.00) 0.12***	0.03(0.00) 0.11***
Adjusted R^2	0.24	0.26	0.27	0.26	0.27	0.24	0.25	0.32

$N = 5423$

b unstandardized regression coefficient, SE standard error, β standardized regression coefficient, BMI body mass index

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

The unstandardized coefficient for subjective age was multiplied by its standard deviation and divided by the unstandardized coefficient for chronological age. Results suggested that for every SD increase in subjective age discrepancy score (i.e., feeling younger), the participants walked as if they were 3.64 and 3.52 younger in the HRS and in the NHATS, respectively. In additional analyses, depressive symptoms, disease burden, BMI, physical activity, and cognition were significantly associated with baseline walking speed; there was no significant association with smoking status. In both samples, the magnitude of the association between subjective age and gait speed was reduced by about 15 % with the inclusion of depression, disease burden, or physical activity, and by about 50 % in the fully adjusted model. Even adjusting for all of the covariates, subjective age remained significant in every model tested (see Tables 2 and 3).

In longitudinal analyses, subjective age was associated significantly with the rate of walking speed decline in both the HRS and the NHATS, controlling for demographic factors (Tables 4 and 5). This pattern was the same without the demographic covariates included. The results indicated that individuals who felt younger at baseline declined less in their walking speed over the follow-up period. The effect of subjective age was comparable to some demographic factors and a 1 SD higher subjective age discrepancy score (i.e., feeling younger) was associated with 2.38 and 1.12 fewer years of aging on change in walking speed in the HRS and the NHATS, respectively. In the HRS, the association was attenuated by about 15 % with the separate inclusion of each risk factor, and by about 50 % in the fully adjusted model (Table 4). However, subjective age remained significantly associated with changes in walking speed. Consistent with baseline analysis, depressive symptoms, disease burden, physical activity, BMI, and cognition were related to changes in walking speed, whereas smoking was not a significant correlate. In the NHATS, the subjective age-walking speed link was reduced by about 25 % with the separate inclusion of covariates, and it was reduced to non-significance in the fully adjusted model (Table 5). In contrast to the findings of HRS, history of smoking was significantly related to changes in walking speed.

Lastly, logistic regression revealed that a younger subjective age at baseline was related to a lower likelihood of walking slower than 0.6 m/s at follow-up in the HRS adjusting for age, sex, education, race, and baseline walking speed, but not in the NHATS (odds ratio

HRS = 1.21, 95 % CI 1.06–1.38, $p < 0.01$, odds ratio NHATS = 1.40, 95 % CI 0.73–2.71, $p = 0.31$).

Discussion

The present study adds to existing knowledge on the correlates of walking speed among older adults. In 2 large longitudinal surveys of adults aged 65 years and older, the results supported the hypothesis that a younger subjective age is associated with faster concurrent walking speed and less decline over a 2 and 4-year period. In addition, feeling younger than one's actual age at baseline was associated with a lower likelihood of walking slower than 0.60 m/s at follow-up in the HRS, which is indicative of frailty. This study thus indicates that beyond chronological age, the subjective experience of age is associated with gait speed.

The health, cognitive, and behavioral profiles of individuals who feel younger than their chronological age may explain partly why such individuals have slower decline in gait speed over time. Indeed, a younger subjective age is associated with fewer chronic conditions (Demakakos et al. 2007), lower risk of being overweight (Stephan et al. 2014), lower depressive symptoms (Keyes and Westerhof 2012), better cognition (Stephan et al. 2014), and a more physically active lifestyle (Caudroit et al. 2012), which are strong correlates of the maintenance of walking speed in old age (Bootsman-van der Wiel et al. 2002; Haight et al. 2013; Ko et al. 2010). Consistent with this literature, adjustment for these factors reduced the association between subjective age and gait speed, with most attenuation attributable to physical activity, depressive symptoms, and disease burden in both the HRS and the NHATS. This finding thus suggests that a younger subjective age is associated with faster gait and less decline over time, in part because it relates to lower disease burden, less depressive symptoms, and more frequent physical activity, and to a lesser extent through lower BMI and better cognition. Of note, these variables fully accounted for the association between subjective age and follow-up walking speed in the NHATS, whereas it accounted only partly for this relationship in the HRS. One explanation is related to the older age of the NHATS sample compared to the HRS sample. Thus, it is likely that worse health, cognition, and sedentary behavior may have stronger implications for mobility and functional limitations among older individuals of the NHATS sample

Table 4 Summary of regression analysis predicting follow-up walking speed in the HRS

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Variables ^a	B(SE) β	B(SE) β	B(SE) β	B(SE) β	B(SE) β	B(SE) β	B(SE) β	B(SE) β
Age	-0.01(0.00) -0.20***	-0.01(0.00) -0.20***	-0.01(0.00) -0.20***	-0.01(0.00) -0.22***	-0.01(0.00) -0.20***	-0.01(0.00) -0.20***	-0.01(0.00) -0.19***	-0.01(0.00) -0.20***
Sex	0.04(0.01) 0.06**	0.04(0.01) 0.06**	0.05(0.01) 0.07***	0.04(0.01) 0.07***	0.03(0.01) 0.05**	0.04(0.01) 0.06**	0.05(0.01) 0.07***	0.05(0.01) 0.07***
Ethnicity	0.12 (0.02) 0.12***	0.12 (0.02) 0.12***	0.12 (0.02) 0.12***	0.11 (0.02) 0.11***	0.12 (0.02) 0.12***	0.12 (0.02) 0.12***	0.10(0.02) 0.10***	0.10(0.02) 0.10***
Education	0.01(0.00) 0.08***	0.01(0.00) 0.07***	0.01(0.00) 0.08***	0.01(0.00) 0.08***	0.01(0.00) 0.07***	0.01(0.00) 0.08***	0.01(0.00) 0.05*	0.00(0.00) 0.04
Walking speed	0.34(0.02) 0.29***	0.33(0.02) 0.28***	0.31(0.02) 0.27***	0.32(0.02) 0.28***	0.32(0.02) 0.27***	0.34(0.02) 0.29***	0.33(0.02) 0.28***	0.28(0.02) 0.24***
Subjective age	0.17(0.05) 0.07***	0.14(0.05) 0.06**	0.14(0.05) 0.06**	0.16(0.05) 0.07***	0.15(0.05) 0.06**	0.17(0.05) 0.07***	0.17(0.05) 0.07***	0.11(0.05) 0.04*
Depression	-	-0.01(0.00) -0.07***	-	-	-	-	-	-0.01(0.00) -0.05*
Disease burden	-	-	-0.03(0.00) -0.12***	-	-	-	-	-0.02(0.00) -0.08***
BMI	-	-	-	-0.01(0.00) -0.11***	-	-	-	-0.01(0.00) -0.09***
Physical activity	-	-	-	-	0.02(0.01) 0.08***	-	-	0.02(0.01) 0.05**
Smoking	-	-	-	-	-	-0.00(0.01) -0.00	-	0.01(0.01) 0.01
Cognition	-	-	-	-	-	-	0.01(0.00) 0.08***	0.01(0.00) 0.07**
Adjusted R^2	0.21	0.22	0.23	0.23	0.22	0.21	0.22	0.24

$N = 2023$

b unstandardized regression coefficient, SE standard error, β standardized regression coefficient, BMI body mass index

^a Variables assessed at baseline

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 5 Summary of regression analysis predicting follow-up walking speed in the NHATS

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Variables ^a	B(SE) β	B(SE) β	B(SE) β	B(SE) β	B(SE) β	B(SE) β	B(SE) β	B(SE) β
Age	-0.01(0.00) -0.23***	-0.01(0.00) -0.24***	-0.01(0.00) -0.23***	-0.01(0.00) -0.26***	-0.01(0.00) -0.23***	-0.01(0.00) -0.24***	-0.01(0.00) -0.22***	-0.01(0.00) -0.25***
Sex	0.03(0.01) 0.07***	0.03(0.01) 0.06***	0.03(0.01) 0.06***	0.03(0.01) 0.07***	0.03(0.01) 0.06***	0.04(0.01) 0.08***	0.03(0.01) 0.07***	0.03(0.01) 0.07***
Ethnicity	0.04(0.01) 0.07***	0.04(0.01) 0.06***	0.04(0.01) 0.07***	0.04(0.01) 0.06***	0.04(0.01) 0.06***	0.04(0.01) 0.07***	0.04(0.01) 0.06***	0.03(0.01) 0.05***
Education	0.01(0.00) 0.11***	0.01(0.00) 0.11***	0.01(0.00) 0.11***	0.01(0.00) 0.11***	0.01(0.00) 0.10***	0.01(0.00) 0.11***	0.01(0.00) 0.10***	0.01(0.00) 0.08***
Walking speed	0.50(0.01) 0.52***	0.49(0.01) 0.51***	0.48(0.01) 0.50***	0.48(0.01) 0.50***	0.48(0.01) 0.50***	0.50(0.01) 0.52***	0.49(0.01) 0.51***	0.44(0.01) 0.46***
Subjective age	0.07(0.02) 0.04**	0.05(0.02) 0.03**	0.05(0.02) 0.03*	0.06(0.02) 0.03**	0.05(0.02) 0.03**	0.07(0.02) 0.04***	0.06(0.02) 0.04**	0.03(0.02) 0.02
Depression	-	-0.02(0.00) -0.06***	-	-	-	-	-	-0.02(0.00) -0.04**
Disease burden	-	-	-0.01(0.00) -0.09***	-	-	-	-	-0.01(0.00) -0.06***
BMI	-	-	-	-0.00(0.00) -0.11***	-	-	-	-0.00(0.00) -0.10***
Physical activity	-	-	-	-	0.03(0.00) 0.09***	-	-	0.02(0.00) 0.07***
Smoking	-	-	-	-	-	-0.02(0.01) -0.05***	-	-0.02(0.01) -0.04**
Cognition	-	-	-	-	-	-	0.02(0.00) 0.06***	0.02(0.00) 0.07***
Adjusted R^2	0.50	0.50	0.51	0.51	0.51	0.50	0.50	0.53

 $N = 3270$ b unstandardized regression coefficient, SE standard error, β standardized regression coefficient, BMI body mass index^a Variables assessed at baseline* $p < 0.05$; ** $p < 0.01$; *** $p < 0.00$.

compared to their counterparts of the HRS. In addition, the overall health, cognitive and behavioral profile associated with subjective age may be more important to explain short-term changes in walking speed (2 years in the NHATS) than over longer time periods (4 years in the HRS).

There may also be other pathways not assessed in the present study that explain this association. For example, a younger subjective age is associated with a reduced risk of systemic inflammation (Stephan et al. 2015a) and reflects slower biological aging, indexed by markers of better pulmonary and muscular function (Stephan et al. 2015b). In turn, this physiological profile is likely to convert over time into preserved mobility and lower risk of frailty (Kuo et al. 2006). Psychological processes may also contribute to the subjective age-walking speed relation. In particular, individuals who feel younger than their age remain more extraverted and open to new experiences over time than people with an older subjective age (Stephan et al. 2015c). The relative maintenance of a propensity to be open-minded, sociable, and energetic is likely to be reflected in better mobility, manifested though faster gait speed. Finally, decrements in physical functioning among older people may result in part from the harmful effects of negative aging stereotypes (Hausdorff et al. 1999; Levy 2009). Older adults are often stereotyped as having worse physical functioning (Löckenhoff et al. 2009) and as not being able to be physically active (Chalabaev et al. 2013). Individuals holding these negative views about aging are at greater risk for worse health-related outcomes and disability (Levy, 2009) because they are less likely to adopt the active lifestyle necessary to maintain fitness at older age (Chalabaev et al. 2013; Levy 2009). Individuals who feel relatively older are more susceptible to the influence of negative aging stereotypes (Eibach et al. 2010). Thus, they are more likely to adopt the behaviors stereotypically associated with older individuals, leading to less physical activity and slower gait speed.

These findings also contribute to the growing body of research on the implications of subjective age. Indeed, this study reveals that subjective age may be characterized by a motor signature. Faster walking and slower decline over time may be features of a younger subjective age, whereas a slower gait speed and steeper decline may be considered as signatures of an older subjective age. The present findings have clinical implications. Subjective age may be used as an early marker of individuals' risk of functional decline in old age and

may inform about an individual's risk of frailty and mobility limitations. Furthermore, subjective age has the potential to be changed through interventions (Stephan et al. 2013). Therefore, targeting subjective age may be one way to stimulate older people to adopt a physically active lifestyle and ultimately to mitigate functional decline.

The present study has several strengths. First, the findings were consistent across two large longitudinal samples of older adults. Second, we found consistent effects in cross-sectional and prospective analyses. Third, we accounted for several risk factors of walking speed decline. Despite these strengths, several limitations should be considered. The generalizability of our findings is limited to some extent by the positive selection of the longitudinal participants in both samples. It is likely that the association between subjective age and walking speed observed in the present study may be underestimated given that participants without follow-up gait measures were feeling older and less healthy, and thus could have experienced more mobility decline. In addition, the observational design limits our ability to determine causality in the association between subjective age and walking speed. Although we focused on walking speed as the dependent variable, it is likely that subjective age evaluations take into account walking speed. Therefore, experimental research is needed to test whether the manipulation of subjective age is associated with changes in gait speed. Finally, the size of the contribution of subjective age was relatively small. However, it is likely that subjective age acts as a distal factor that drives health-related, cognitive, and behavioral processes having a more proximal influence on walking speed. Taken as a whole, this study paves the way for future research interested in identifying the psychological markers of aging that contribute to mobility among older adults.

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