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Gait speed reference values in community-dwelling older adults – Cross-sectional analysis from the Rotterdam Study

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ABSTRACT

Background: Gait speed is a simple, inexpensive and clinically useful marker of physical function in older adults. We aimed to establish gait speed reference values for community-dwelling older adults. To this end, we further explored the association of age, sex and height with gait speed.

Methods: This study included community-dwelling participants aged 50 years and over enrolled in the Rotterdam Study. Participants completed the gait protocol between 2009 and 2016. The mean gait speed was calculated for age and height groups, stratified by sex. Reference values for gait speed were calculated using a quantile regression model adjusted for sex, the non-linear effects of age and height, as well as the interaction between age and sex plus the interaction between age and height.

Results: The study population included 4656 Dutch participants with a mean (standard deviation) age of 67.7 (9.5) years, comprising 2569 (55.2%) women. The mean height of the participants was 1.69 (0.10) meters and the mean gait speed was 1.20 (0.20) m/s. Gait speed was lower with older age and greater with taller stature, but the effect of height disappeared above the age of 80 years. Sex did not affect gait speed after accounting for age and height. Age-, sex-, and height-specific reference values for gait speed are available for use at https://emcbiostatistics.shinyapps.io/GaitSpeedReferenceValues/.

Conclusions: We found that height explains the commonly noted difference in usual gait speed between sexes and that neither height nor sex impacts gait speed in the very oldest adults. We developed reference values for usual gait speed in Western European community-dwelling older adults.

1. Introduction

Gait speed is a simple, inexpensive and clinically useful measure of physical performance in older adults (Rydwik et al., 2012). In this demographic, gait speed is also a reliable predictor of adverse outcomes, including hospitalization (Abellan Van Kan et al., 2009), post-operative outcomes (Afilalo et al., 2016) and all-cause mortality (Studenski et al., 2011). In addition, gait speed is used as a specific diagnostic criterion for both sarcopenia (Cruz-Jentoft et al., 2019) and frailty (Lee et al., 2017). Gait speed is therefore an important part of the assessment of the older patient.

A fixed cut-off of 0.8 m/s is oftentimes used to define slow gait speed (Cruz-Jentoft et al., 2019; Castell et al., 2013a; Castell et al., 2013b). However, using this crude cut-off in the geriatric assessment is insufficient to determine how an older patient performs compared to their peers. More elaborate information on gait speed reference values is needed.

The majority of currently available reference values for gait speed are age- and sex-specific (Bohannon and Williams, 2011). Height, which is also a significant contributor to gait speed, is not considered in most reference values (Bohannon and Williams, 2011; Studenski, 2009). Taking into account height is necessary for the appropriate

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interpretation of gait speed reference values and improves generalizability to other populations (Moe-Nilssen and Helbostad, 2020). However, the current literature lacks general population height-adjusted gait speed reference values covering a broad age spectrum.

The objective of this study was to determine the influence of age, sex and height on gait speed in order to establish reference values for gait speed in a large Dutch population-based cohort study. To encourage the clinical use of the gait speed reference values, we built a simple interactive application that visually compares the gait speed of a patient to the established reference values.

2. Methods

2.1. Study population

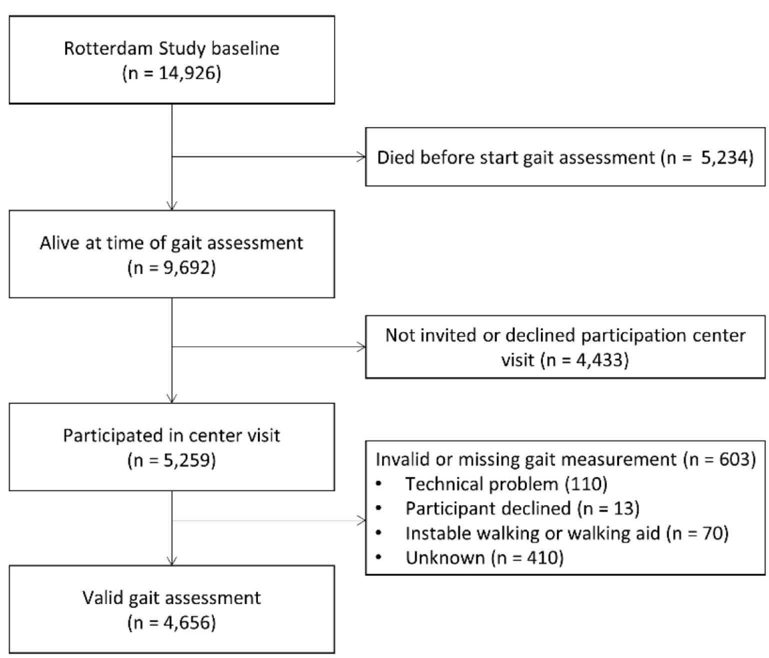
This cross-sectional descriptive study was embedded within the Rotterdam Study, a large, ongoing, population-based cohort study in the Netherlands. Details of the Rotterdam Study have been described previously (Ikram et al., 2020). The inclusion of participants started in 1990, when 7983 inhabitants of the district Ommoord aged 55 years and over were included. In 2000, the cohort was extended with 3011 inhabitants who had become 55 years and over or who moved into Ommoord. In 2006, the cohort was further extended with 3932 participants aged 45 years and over. The response rate over the three cohorts was 72%. At baseline and at the follow-up visits, participants underwent a home interview and examinations at the research center.

2.2. Inclusion criteria

Gait assessments have been included in the Rotterdam Study protocol as part of a third research center visit since March 2009. The current study includes gait speed assessments performed until November 2016. Fig. 1 shows the flow diagram of participants included in the current study. At the time of the gait measurement, 9692 participants of the baseline assessment of the Rotterdam Study were still alive. Participants who visited the research center for the first two regular visits were asked to participate in a third research center visit which included the gait assessment. All participants of the third research center visit who were willing to perform the walking protocol and could walk without use of a walking aid were eligible for gait assessment. In this study we included 4656 participants of 50 years and older who underwent a gait assessment. The 5036 participants of the Rotterdam Study who were alive but did not visit the research center during the third round were older at Rotterdam Study baseline (mean (standard deviation, SD) age 63.4 (8.0) years compared to 58.5 (5.9) years) and included relatively more women (64.1% versus 55.2%).

2.3. Demographic and clinical characteristics

Educational attainment and smoking status were assessed with questionnaires during the home interview. Education was categorized into four levels: primary education, lower/intermediate general education or lower vocational education, intermediate vocational education or higher general education, and higher vocational education or university. Smoking status was categorized into 'former', 'current' or 'never' cigarette smokers. Ethnicity was based on genome-wide association studies (GWAS) data and estimated using Admixture. Height and weight were obtained during a research center visit and body mass index (BMI) was calculated by dividing weight over height squared. Blood pressure was measured twice with a random-zero sphygmomanometer at the right brachial artery with the participant in sitting position, the mean of the two measurements was used. Hypertension was defined as a



Gait speed assessment

Fig. 1. Flow diagram.

resting blood pressure exceeding 140/90 mmHg or the use of blood pressure-lowering medication (Anatomical Therapeutic Chemical codes C02, C03, C07, C08 and C09). Diagnoses of diabetes, chronic obstructive pulmonary disease (COPD), heart failure, coronary heart disease, cancer, stroke and parkinsonism were based on repeated screening and review of medical records, which was previously described in more detail (Ikram et al., 2020). In addition to the review of medical records, diagnoses of diabetes and COPD involved fasting glucose levels and spirometry, respectively. Depression was defined as a Centre for Epidemiologic Studies Depression scale (CES-D) score above 16. Diagnoses of hip and knee osteoarthritis were based on radiological signs of arthritis and defined as a Kellgren and Lawrence grade of two or higher.

2.4. Gait speed assessment

Gait was assessed using a 5.8 m long walkway (GAITRite Platinum; CIR systems, Sparta, NJ: 4.9 m active area; 120-Hz sampling rate), a reliable and valid device for the evaluation of gait (intra-class correlation coefficients gait speed between 0.91 and 0.99) (Webster et al., 2005a; Menz et al., 2004a). A standardized gait protocol was used for the assessment of usual gait speed. Participants initiated walking about one meter in front of the walkway, walked across the walkway and ended the walk at the other side of the walkway. This first walk was considered a practice or initiation walk. Then, the participants turned outside of the walkway and walked back across the walkway to their starting position. This back and forth walk was repeated three more times. Because the walking protocol started and ended outside of the walkway, the initial and final steps were not included in the gait speed assessment. All recordings were visually inspected, after which the average gait speed of each of the seven walks, as well as the average gait speed over the seven walks was calculated.

2.5. Statistical analysis

R version 4.03 was used for all statistical analyses (R Development Core Team, 2020). Mean gait speed values by age, height, BMI and education were calculated, stratified for sex. Subsequently, quantile regression models were fitted for the association of age, sex and height with gait speed. First, we assessed the separate effects of age, sex and height. Second, we tested the interaction effects between age and sex and age and height. Third, we assessed whether natural cubic splines of the continuous predictors improved the model fit. Decisions regarding the inclusion of interactions and splines were based on the Akaike Information Criterion (AIC). The AIC's of the models can be found in Supplementary Table 1. The final model included a spline of age with two degrees of freedom, a spline of height with two degrees of freedom, sex, the interaction between age and sex and the interaction between age and height.

To determine effect modification by age in the association between sex and gait speed, we plotted the predicted sex-specific median values of gait speed over age for the population-median height. To determine effect modification by age in the association between height and gait speed, we plotted the predicted median values of gait speed over age for the 10th and 90th percentiles of height, stratified by sex. We visualized the final reference values of gait speed by plotting the 10th, 25th, 50th, 75th, and 90th percentile values of gait speed over age for the sex-specific median height. All figures include only the results for ages between 50 and 90 years because the current study sample included no participants below 50 years old and only a limited number of participants above 90 years old. The R Shiny package version 1.6.0 was used to visualize the reference values in an interactive application (Chang et al., 2021).

3. Results

Characteristics of the study population are presented in Table 1. The mean (SD) age of the participants was 67.7 (9.5) years and 55.2% were women. Almost all participants were of European ethnic origin (98.1% of men and 96.9% of women). Most men had an intermediate or higher education level (68.2%) and almost half of women had a lower education level (48.2%). The mean (SD) height of the participants was 1.77 (0.07) meters in men and 1.63 (0.07) in women. The most frequent comorbidity was hypertension (73.9% in men and 66.9% in women). Hypertension, diabetes, chronic obstructive pulmonary disease and coronary heart disease were more prevalent in men, whilst depression and knee osteoarthritis were more prevalent in women.

The mean (SD) gait speed of the study population during the seven walks was 1.20 (0.20) m/s. The gait speed increased over the seven walks from 1.15 (0.21) m/s at the first walk to 1.23 (0.20) m/s at the seventh walk. The average gait speed of all separate walks can be found in Table 2.

The average gait speed was higher in men than in women (mean (SD) 1.23 (0.20) m/s versus 1.17 (0.20) m/s). Table 3 shows the mean sex-specific gait speed for different age, height, BMI and education groups. Gait speed decreased with increasing age, from 1.31 (0.16) m/s in men and 1.26 (0.17) m/s in women aged 50 to 60 years to 0.91 (0.17) m/s in men and 0.76 (0.21) in women aged 90 years and over. Gait speed was greater with taller stature and was highest in the normal BMI group. In addition, gait speed increased with higher education. A comparison between our average age- and sex-specific gait speed and the 2017 study of Beauchet et al. (2017) can be found in Supplementary Table 2.

Fig. 2 shows the effect of sex and height on gait speed over age. Gait

Table 1
Characteristics of the study population.

Characteristic	Men (n = 2087)	Women (n = 2569)	P-value
Demographics			
Age, years	67.75 (±9.46)	67.63 (±9.54)	0.67
European[a]	1816 (98.1%)	2200 (96.9%)	<0.05
Education[a]			<0.05
Primary	143 (6.9%)	235 (9.3%)	
Lower	515 (24.9%)	1224 (48.2%)	
Intermediate	776 (37.5%)	637 (25.1%)	
Higher	635 (30.7%)	443 (17.4%)	
Smoking			<0.05
Current	252 (12.4%)	308 (12.4%)	
Former	1226 (60.4%)	1166 (46.9%)	
Never	551 (27.2%)	1012 (40.7%)	
Height, m	1.77 (±0.07)	1.63 (±0.07)	<0.05
BMI, kg/m^2	27.33 (±3.50)	27.28 (±4.59)	0.68
Comorbidities			
Hypertension	1490 (73.9%)	1642 (66.9%)	<0.05
Diabetes	347 (17.5%)	297 (12.5%)	<0.05
COPD	268 (13.2%)	201 (8.1%)	<0.05
Heart failure	43 (2.1%)	55 (2.2%)	0.91
CHD	199 (9.8%)	68 (2.7%)	<0.05
Cancer	221 (10.6%)	240 (9.3%)	0.17
Stroke	84 (4.0%)	71 (2.8%)	0.02
Parkinsonism	7 (0.4%)	7 (0.3%)	0.90
Depression	96 (4.7%)	295 (11.9%)	<0.05
Hip osteoarthritis	248 (15.5%)	289 (15.2%)	0.81
Knee osteoarthritis	275 (17.2%)	469 (24.5%)	<0.05

Note. Values are numbers (percentage) or mean (±standard deviation). m: meters, BMI: body mass index, kg: kilogram, COPD: chronic obstructive pulmonary disease, CHD: coronary heart disease. Data on population characteristics were incomplete for some variables, percentages represent those with complete information. [a]Education was categorized as follows: primary education, lower/ intermediate general education or lower vocational education, intermediate vocational education or higher general education, and higher vocational education or university. P-values were calculated using the Chi square test for categorical variables and the *t*-test for continuous variables.

Table 2
Average gait speed separated by walk.

Trial	N	Gait speed (m/s)
First walk	4656	1.15 (0.21)
Second walk	4651	1.17 (0.20)
Third walk	4649	1.20 (0.20)
Fourth walk	4625	1.20 (0.20)
Fifth walk	4599	1.22 (0.20)
Sixth walk	4506	1.22 (0.20)
Seventh walk	4116	1.23 (0.20)

Note. N: number of participants for each walk, m: meters, s: seconds. Mean (SD) gait speed values are presented.

Table 3
Mean gait speed by categories of age, height, BMI and education stratified by sex.

Group	Men		Women	
	N	Gait speed (m/s)	N	Gait speed (m/s)
Age (years)				
50–59	501	1.31 (0.16)	651	1.26 (0.17)
60–69	739	1.27 (0.17)	871	1.22 (0.16)
70–79	604	1.18 (0.20)	750	1.12 (0.20)
80–89	231	1.02 (0.20)	282	0.98 (0.21)
≥90	12	0.91 (0.17)	15	0.76 (0.21)
P-value		<0.05		<0.05
Height (m)				
<1.60	13	1.08 (0.13)	764	1.09 (0.20)
1.60–1.69	302	1.16 (0.21)	1401	1.19 (0.19)
1.70–1.79	1120	1.21 (0.19)	392	1.25 (0.17)
1.80–1.89	578	1.28 (0.18)	12	1.24 (0.25)
≥1.90	74	1.33 (0.18)	0	–
P-value		<0.05		<0.05
BMI				
Underweight	3	1.25 (0.14)	24	1.21 (0.25)
Normal	500	1.24 (0.21)	799	1.22 (0.21)
Overweight	1105	1.23 (0.20)	1026	1.18 (0.18)
Obese	341	1.20 (0.19)	436	1.11 (0.20)
Severely Obese	53	1.15 (0.18)	150	1.06 (0.20)
P-value		<0.05		<0.05
Education				
Primary	143	1.13 (0.18)	235	1.08 (0.22)
Lower	515	1.19 (0.20)	1224	1.16 (0.20)
Intermediate	776	1.23 (0.20)	637	1.17 (0.19)
Higher	635	1.27 (0.19)	443	1.26 (0.19)
P-value		<0.05		<0.05

Note. N = number of participants per group, m: meters, s: seconds, BMI: body mass index. Mean (SD) gait speed values averaged over the seven walks are presented. BMI was categorized as: Underweight (<18.5), Normal (18.5–24.9), Overweight (25–29.9), Obese (30–34.9), Severely Obese (≥35). P-values were calculated using the ANOVA test to compare the mean gait speed between the groups.

speed did not differ between men and women after correction for height (Fig. 2, panel A). The median gait speed differed significantly between the population's 10th (1.57 m) and 90th (1.82 m) percentile of height at the age of 50 years for both men (1.17 m/s (95% confidence interval 1.09–1.25) m/s versus 1.31 m/s (95% CI 1.28–1.34)) and women (1.20 m/s (95% CI 1.14–1.25) versus 1.34 m/s (95% CI 1.29–1.39)) (Fig. 2, panel B). This difference between the two height groups diminished with age. At the age of 70 years, the median gait speed was 1.18 m/s (95% CI 1.15–1.21) in men of 1.57 m versus 125.0 m/s (95% CI 1.24–1.27) in men of 1.82 m. In women this was 1.17 m/s (95% CI 1.15–1.18) versus 1.24 m/s (95% CI 1.21–1.26). At the age of 90 years, the median gait speed of the two height groups highly overlapped for both men (0.91 m/s (95% CI 0.82–0.99) versus 0.90 m/s (95% CI 0.82–0.99)) and women (0.89 m/s (95% CI 0.83–0.95) versus 0.89 m/s (95% CI 0.75–1.02)).

Age-, sex- and height-specific gait speed reference values averaged over the seven walks are shown in Fig. 3. This figure specifically shows the reference values for the sex-specific median height of our population (1.76 m for men and 1.63 m for women). For men of 50 years old and of median height, the median gait speed was 1.28 m/s (95% CI 1.24–1.32) and for women this was 1.24 m/s (95% CI 1.20–1.27). At 70 years old, the median gait speed for men was 1.25 m/s (95% CI 1.23–1.26) and for women this was 1.20 m/s (95% CI 1.19–1.21). At 90 years old, the median gait speed for men was 0.92 m/s (95% CI 0.87–0.98) and the median gait speed for women 0.91 m/s (95% CI 0.84–0.97).

The gait speed reference values shown in Fig. 3 and additional reference values for the first walk are available through: https://emcbiostatistics.shinyapps.io/GaitSpeedReferenceValues/, which allows numerical and visual comparison of the gait speed of an individual patient with these reference values.

4. Discussion

In this study, we have provided clinically valuable height-adjusted gait speed reference values for Western European community-dwelling adults between 50 and 90 years of age. Our study suggests that after accounting for age and height, sex does not have a significant impact on usual gait speed. Additionally, as age increases, height becomes a less significant contributor to gait speed, with the effect of height disappearing above the age of 80. These results indicate that gait speed is independent of height in the very oldest adults.

Gait speed reference values for older adults reported by previous studies are highly diverse because of differences in gait speed assessment methods, inclusion criteria, and anthropometrics between studies (Moe-Nilssen and Helbostad, 2020; Beauchet et al., 2017; Bergland and Strand, 2019; Samson et al., 2001; Hollman et al., 2011). We showed that the average gait speed increased over the seven walks: gait speed increased most over the first three walks and flattened afterwards. This increase in gait speed is in line with previous studies showing an association between walking distance and walking speed (Pasma et al., 2014; Salbach et al., 2015). The number of walks should thus be taken into account when comparing reference values for gait speed across studies. As expected, the age- and sex-specific mean gait speed in our study was lower than in most studies excluding individuals with comorbidities (Moe-Nilssen and Helbostad, 2020; Beauchet et al., 2017; Samson et al., 2001; Hollman et al., 2011). However, exclusion of all individuals with comorbidities leads to a highly selected and non-representative population of older individuals. We thus think that excluding individuals with comorbidities does not provide relevant reference values for general practitioners and geriatricians. Compared with the 2017 study of Beauchet et al. (2017), which utilized stricter exclusion criteria and therefore would be expected to represent a healthier population, our study demonstrated slightly slower gait speed values in the population aged 65 to 84, although slightly faster gait speed in the population above 85 years (Supplementary Table 3). Similarly, compared to the 2015 systematic review of Salbach et al. (2015), describing gait speed in disease-free individuals aged 50 to 79, our average gait speed was lower in adults aged 50 to 59 years, but largely comparable thereafter.

Locomotion is a complex multi-system activity which is influenced by physiological, psychological and environmental factors (Rosso et al., 2015; Verlinden et al., 2015). Age, sex, height, weight and education are all factors influencing gait speed which could be obtained in a clinical setting. These factors should thus be considered when creating reference values for gait speed.

Starting with age, the mechanism behind slowing of gait speed with age is multi-faceted, with studies suggesting musculoskeletal (Evans, 1997), aerobic capacity (Coen et al., 2012; Malatesta et al., 2004) and psychological factors (Brandler et al., 2012) all play a role. Our study confirms the well-established reduction in gait speed with increasing age. We show a relatively stable or slow decline in gait speed between the sixth and eighth decades and a subsequent more rapid decline in the ninth and tenth decades.

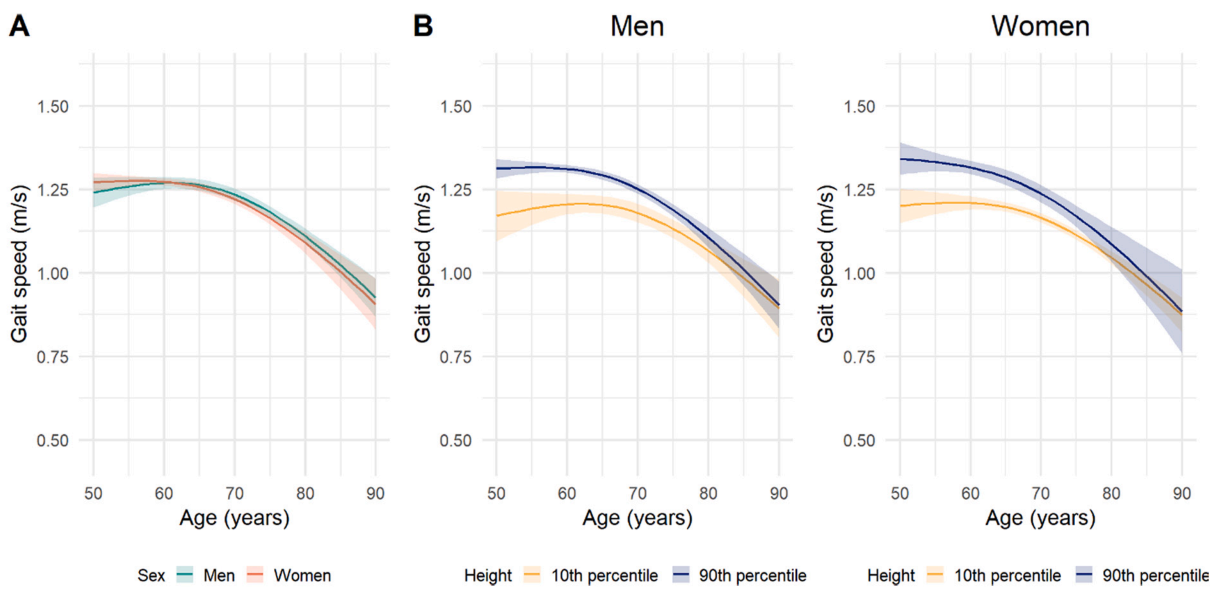


Fig. 2. The influence of sex and height on gait speed over age. Panel A. shows the influence of sex on gait speed over age. The green line shows the predicted gait speed for men and the red line the predicted gait speed for women with a height of 1.69 m (median height population). The shaded areas present the 95% confidence intervals. Panel B. shows the influence of height on gait speed over age. The yellow line shows the predicted gait speed for the 10th percentile of height (1.57 m) and the blue line the predicted gait speed for the 90th percentile of height (1.82 m). The shaded areas present the 95% confidence intervals. Confidence intervals were wider for the group of men with a height of 1.57 m and women with a height of 1.82 m because these groups included less individuals. The average gait speed of the seven walks is presented both in panels A and B.

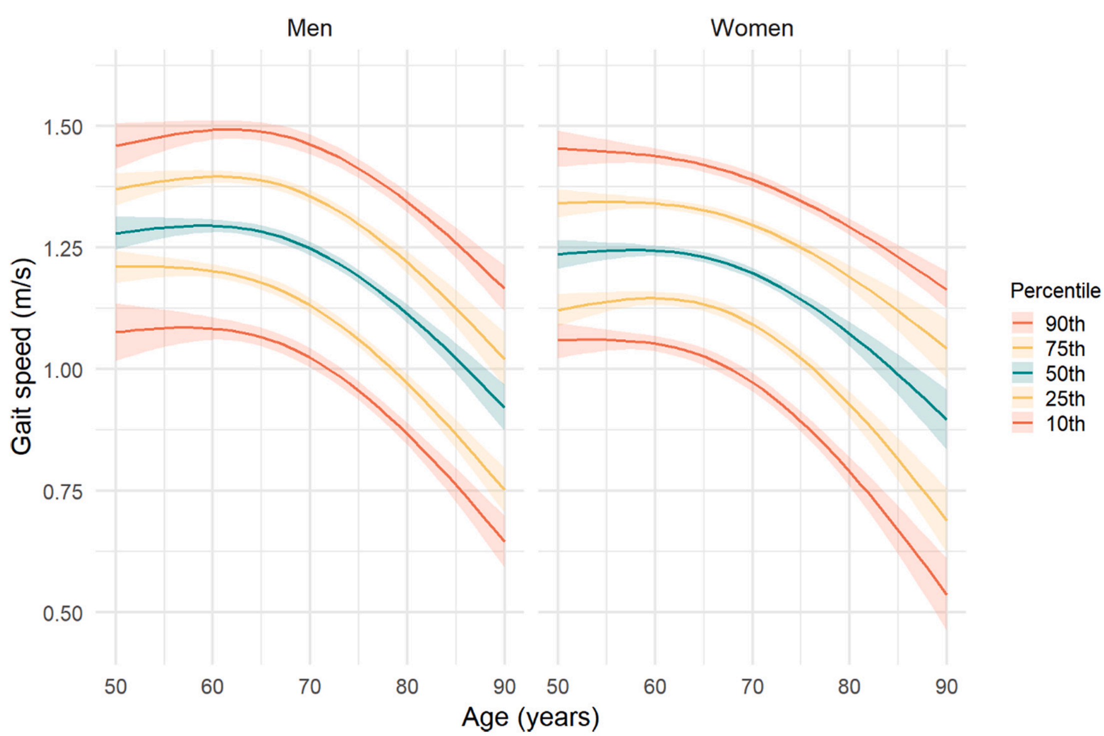


Fig. 3. Sex- and age- specific reference values for gait speed. The panels show the reference values for gait speed averaged over the seven walks for men of median height (1.76 m) and women of median height (1.63 m). The shaded areas present the 95% confidence intervals.

Our results indicate that height explains sex differences in gait speed, which is in line with several previous studies (Hollman et al., 2011; Ko et al., 2011). However, a recent Dutch study using repeated measurements of gait speed showed that men continued to have faster gait speed than women after adjustment for baseline height (Sialino et al., 2021). This difference in findings could possibly be explained by the non-linear effects of height and the interaction effect between age and height. There are two main disadvantages to categorizing gait speed reference values by sex. First, interpretation will be inaccurate for men and women who fall outside of 'normal' heights, i.e. taller women and shorter men. Second, comparison of gait speed between different populations becomes more complex if results are published in sex-specific form without data on height. We have presented our height-adjusted gait speed reference values stratified by sex to allow easier comparison with similar studies. Of note, we found comorbidities which are known to negatively impact gait speed to affect men and women unequally. This difference in prevalence of comorbidities, however, did not result in differences in the mean or median gait speed between men and women after adjustment for height.

Several studies have indicated that taller individuals walk faster than shorter individuals (Samson et al., 2001; Verlinden et al., 2013). However, a recent study showed that this height advantage is lost with age (Elbaz et al., 2018). Elbaz et al. demonstrated that gait speed of taller individuals declines faster with increasing age than gait speed of shorter individuals and that the advantage of taller statue is lost around the age of 80 (Elbaz et al., 2018). Our results support these previous observations. Height loss alone cannot explain the lesser advantage of taller stature with age (Elbaz et al., 2018). The advantage of height is expected to be caused by leg length, whereas height loss with aging is related to changes in bone, muscles, and joints and mainly affects truncal height (Weingarten, 2018; Asahi et al., 2020). Several studies have shown that slower gait speed in older adults may result from a higher energy expenditure of walking associated with aging (Schrack et al., 2012; Rowley et al., 2019). Subsequently, older individuals might develop their own 'basal' gait speed designed to minimize energy expenditure, as hypothesized by Elbaz et al. (2018).

Weight affects gait speed in an inverse U-shaped manner, with extremes of high and low weight or BMI being associated with a reduction in gait speed (Tabue-Teguo et al., 2020). Although our findings also show an association between BMI and gait speed, we decided not to create BMI-specific reference values for gait speed. By accounting for the lower gait speed values seen at the extremes of BMI, we may falsely find these patients' gait speed to be nearer to the median for their age than they actually are. Moreover, weight can vary with time and previous studies have shown that loss of weight in the severely obese leads to a proportional increase in gait speed (Vincent et al., 2012).

Higher levels of education are also known to be associated with faster gait speed at older age (Kyrönlahti et al., 2020). This association is likely to be multifactorial, with chronic medical conditions, lifestyle factors and physical demands whilst working all contributing (Kyrönlahti et al., 2020). We have not accounted for educational differences between individuals in our model as this information is less easy to standardize across time periods and nationalities than simple measures such as height.

Our study has a number of strengths. Firstly, the method we used to assess gait speed has been shown to be both valid and reproducible (Menz et al., 2004b; Webster et al., 2005b). The GAITRite walkway itself is not available in routine clinical practice, however, the measurement of gait speed correlates well with more widely available stopwatch methods (Youdas et al., 2006). Secondly, the number of participants in our study is much larger than most equivalent gait speed reference values studies, providing more reliable estimates of usual gait speed. Thirdly, our statistical models allowed for non-linear effects of age and height, as well as interactions between the variables, which represented the data better than often-used simple linear models. Fourthly, we developed an online application that facilitates the comparison of a patient's gait speed to the established reference values. A comparable gait calculator was previously created by Moe-Nilssen et al. (Moe-Nilssen and Helbostad, 2020). However, their calculator focused on a more holistic gait assessment, requiring measurements of stride length and stride time to calculate gait speed. In clinical practice, such an approach is not yet routinely applied and thus the simple calculation of gait speed as distance divided by time is of greater clinical relevance.

There are a number of limitations to our study. Firstly, the presented reference values were created in a Dutch population and the generalizability of our findings to populations with other demographic characteristics thus warrants further investigation. Previous studies have shown, for example, that ethnicity can impact on gait speed (Boulifard et al., 2019) and our population was predominantly of Western European origin. Therefore, despite the use of height-adjustment, our reference ranges may not be generalizable to other populations. Furthermore, our protocol excluded participants requiring walking aids or assistance with mobilizing, both groups who would be expected to have a slower gait speed. As a result of the absence of these groups in our sample, our reference values might provide an over-estimation of gait speed in this population. Finally, as can be observed in Table 2, not all participants completed the seven normal walks of our gait protocol. Reasons for a lower number of walks include technical and instructional errors, which were not systematically recorded.

Gait speed cut-off values, such as the 0.8 m/s as an indicator of sarcopenia and increased mortality risk (Studenski et al., 2011; Cruz-Jentoft et al., 2019), may be of benefit to identifying the most at-risk groups across a population. However, the use of a gait speed cut-off has two main limitations. Firstly, very few community-dwelling older adults will have gait speed values below 0.8 m/s, only 4% in our population, indicating that little information is gained from the use of this cut-off in clinical practice. Secondly, cut-off points are currently not age- and height-specific, which impedes their clinical value and their generalizability across populations. As an alternative, reference values can be used in a clinical setting to allow a more elaborate comparison of an individual's gait speed relative to their peers. As part of a holistic assessment, this would, for example, facilitate the identification of patients who are at higher risk of complications from an operation. Further work is needed to determine the predictive ability of gait speed percentiles or age- and height- specific gait speed cut-offs for clinical outcomes. Furthermore, more research is needed into gait speed in the over 90 year olds, as this group was under-represented in our study.

5. Conclusion

We present clinically valuable and easy-to-use reference values for usual gait speed in community-dwelling older Dutch adults. We show that height explains the commonly noted difference in usual gait speed between sexes. Additionally, our results suggest that in the very oldest adults, neither height nor sex impacts gait speed.

Sponsor's role

The funders had no role in the design or conduct of the study and the decision to submit the manuscript for publication.

Disclosures

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CRediT authorship contribution statement

L.J. Dommershuijsen: Data curation, Investigation, Conceptualisation, Methodology, Writing - Original draft preparation, Writing - Review and Editing, Visualization, Formal Analysis, Software.

J. Ragunathan: Conceptualisation, Writing - Original draft preparation, Writing - Review and Editing, Methodology, Visualization, Formal Analysis.

R. Ruiter: Conceptualisation, Writing - Review and Editing, Supervision.

D. Groothof: Methodology, Writing - Review and Editing.

F.U.S. Mattace-Raso: Conceptualisation, Writing - Review and Editing.

M.A. Ikram: Conceptualisation, Writing - Review and Editing.

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Declaration of competing interest

The authors have no conflicts.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.exger.2021.111646.

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