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Research Article

Correlates of Gait Speed Among Older Adults From 6 Countries: Findings From the COSMIC Collaboration

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Abstract

Background: Few studies have compared gait speed and its correlates among different ethnogeographic regions. The goals of this study were to describe usual and rapid gait speed, and identify their correlates across Australian, Asian, and African countries.

Methods: We used data from 6 population-based cohorts of adults aged 65+ from 6 countries and 3 continents (N = 6 472), with samples ranging from 231 to 1 913. All cohorts are members of the Cohort Studies of Memory in an International Consortium collaboration. We investigated whether clinical (body mass index [BMI], hypertension, stroke, apolipoprotein status), psychological (cognition, mood, general health), and behavioral factors (smoking, drinking, physical activity) correlated with usual (N = 4 cohorts) and rapid gait speed (N = 3 cohorts) similarly across cohorts. Regression models were controlled for age, sex, and education, and were sex-stratified.

Results: Age- and sex-standardized usual gait speed means ranged from 0.61 to 1.06 m/s and rapid gait speed means ranged from 1.16 to 1.64 m/s. Lower BMI and better cognitive function consistently correlated with faster gait speed in all cohorts. Less consistently, not having hypertension and greater physical activity engagement were associated with faster gait speed. Associations with mood, smoking, and drinking

were largely nonsignificant. These patterns were not attenuated by demographics. There was limited evidence that the associations differed by sex, except physical activity, where the greater intensity was associated with usual gait among men but not women.
Conclusions: This study is among the first to describe the usual and rapid gait speeds across older adults in Africa, Asia, and Australia.

Keywords: Cognition, Mobility, Physical activity, Psychological health, Risk factors

Older age is marked by a wide heterogeneity in terms of disability, cognitive impairment, falls, and mortality risk (1,2). Screening tools that can be applied quickly, safely, reliably, and sensitively (but not necessarily specifically) predicting adverse health outcomes in the clinic and research settings alike are of great interest (2). Many tools have been developed with varying degrees of adoption for such settings (3). Gait speed, typically assessed as one's preferred walking pace over a particular distance (eg, 6 m), is a mobility instrument that is a particularly useful measure of multisystemic well-being among older adults (3). Previous research has confirmed its utility as a predictor of adverse health, including future dementia, falls, and mortality risk (4). Additionally, gait speed is recognized as among the mobility tools most appropriate for clinical and research settings due to its ease of administration and predictive validity (3,5,6). Correlates of gait speed have been examined in large cohorts of healthy older adults, but epidemiologic evidence has not examined whether these correlates are similar across different ethnogeographic contexts. Such correlates could be targeted for future intervention, with the possibility that the interventions may need to be tailored to the needs of specific ethnogeographic populations.

Although a growing body of literature has established the importance of gait in older adulthood, most evidence is from samples living in Western, educated, industrialized, rich, and democratic (WEIRD) countries (7). Accordingly, there are some limitations to the generalizability of these findings to non-WEIRD samples. For example, the quantification of "slow gait" has proven difficult as there is marked heterogeneity across settings, collection methods, and testing protocols (8–10); furthermore, this work is generally based on cohort studies from high-income countries (11). Additionally, normalizing gait speed data based on 1 racial/ethnic group limits its generalizability as there are documented racial disparities in gait speed (12–14). Emerging evidence from low- and middle-income countries suggests the average gait speeds of community-dwelling older adults vary more across countries than would be expected based on the data from high-income countries. For instance, the average gait speed of community-dwelling older adults ranged from 0.61 m/s in Russia to 0.88 m/s in China (11). These estimates are similar to those previously reported among Cohort Studies of Memory in an International Consortium (COSMIC) collaboration sites such as Nigeria (15) and thus comparable to what we should expect for the current study. When using a conservative cutoff for slow gait, for example, 0.6 m/s, a sizeable proportion of older adults in these countries would, therefore, be considered as having impaired gait and being at increased risk of falls, dementia, or mortality. Although it is possible that the majority of older adults in these contexts actually experience mobility limitations that impede everyday life, it is likely that their slower gait speed performance does not necessarily reflect their performance in the context of their living environment. For example, sex- and ethnicity-based cutpoints outperformed standardized cutpoints in predicting 4-year mortality among older adults in the Health and Retirement Study cohort (16). When establishing population-specific cutoffs for slow gait, it is critical to carefully characterize gait speeds among community-dwelling older adults across different ethnogeographic contexts. By first quantifying gait speed among underrepresented regions, researchers can identify whether current and/or universal cutoffs for slow gait are reasonable across different ethnogeographic regions.

In addition to quantifying gait speed averages among community-dwelling older adults across different ethnogeographic regions, it is important to examine whether locomotor risk and protective correlates are similarly related to gait speed across regions. Many factors contribute to mobility in older adulthood, including demographic characteristics, health behaviors, genetics, and central and peripheral nervous system integrity and function (17). These factors may, however, not correlate with mobility to the same degree across different ethnogeographic contexts. For example, there is substantial variability in the prevalence and incidence of falling across countries that may be attributable to a complex interaction of intrinsic (person-specific) and external (environmental) factors (18) https://sciwheel.com/work/citation?ids=9498178&pre=&suf=&sa=0&dbf=0. Thus, it is possible that correlates of mobility in 1 sample may not replicate in a different ethnogeographic region. Insight into correlates of (slow) gait speed can better inform international policy-makers about which mobility promotion strategies may be more appropriate for worldwide use. Additionally, sample-specific correlates could be used to further tailor country-specific health priorities to promote older adult mobility. To address these limitations, the aims of the current study were to (a) describe the gait speed of community-dwelling older adults across different ethnogeographic regions and (b) identify correlates of gait speed among the different regions. Finally, we discuss which correlates are consistent across cohorts. As there were too few studies to conduct formal meta-regressions (19), this was a narrative rather than quantitative evaluation for cross-cohort comparisons.

Method

Contributing Studies and Participants

This study was conducted on cross-sectional data from 6 participating members of COSMIC, covering 6 countries from 3 continents (Table 1). Participants were excluded from analysis if they were (a) younger than 65, (b) had a self-reported diagnosis of Parkinson's disease, (c) or were missing gait speed. Table 2 shows the demographic characteristics of the samples used in our analyses, and Supplementary Figure 1 illustrates how the analytic sample for each cohort was derived. Supplementary Table 1 provides information on the recruitment, eligibility, and abbreviated data collection protocol for each contributing study. Each of the cohorts contributing data to the present study had previously obtained ethics approval from their respective institutional review boards, and all participants within the studies provided consent. The use of these data for the present study did not warrant further participant consent as all data were de-identified prior to their release from COSMIC.

Measures and Harmonization

Of the 6 contributing studies, 4 provided usual and 3 provided rapid gait speed (Korean Longitudinal Study on Cognitive Aging and

Table 1. Contributing Studies (in alphabetical order).

Study	Abbreviation	Country	Gait Outcome	Year of Gait Data Collection	Length of Walkway (m)
Identification and Intervention for Dementia in Elderly Africans (20) (*N* = 231)	IDEA	Tanzania	Usual gait speed	2014	10 meters
Ibadan Study of Aging (21) (*N* = 1 122)	ISA	Nigeria	Usual gait speed	2007	3 or 4
Korean Longitudinal Study on Cognitive Aging and Dementia (22) (*N* = 491)	KLOSCAD	South Korea	Usual gait speed; rapid gait speed	2010–2012	10
Sasaguri Genkimon Study (23) (*N* = 1 913)	SGS	Japan	Rapid gait speed	2011	5
Singapore Longitudinal Study of Aging-II (24) (*N* = 1 698)	SLAS-II	Singapore	Rapid gait speed	2009–2011	6
Sydney Memory and Ageing Study (25) (*N* = 995)	Sydney MAS	Australia	Usual gait speed	2005	6

Dementia [KLOSCAD] provided both). Table 1 shows these details, as well as the year of data collection.

Gait speed was presented in meters per second. Walkway lengths ranged from 3 to 10 m (Table 1). If necessary, the total time to complete the walkway was converted to gait speed in meters per second. In the usual gait conditions, participants were instructed to walk at their normal speed across a path. In the rapid gait conditions, participants were instructed to walk as quickly as possible. Age- and sex-normalized gait speeds were also calculated to reflect what the gait speed would be if the cohort had an average age of 75 and 50% women.

Demographic information included age, sex, and education. There was substantial overlap between the cohorts with regard to age; participants between the ages of 70 and 90 were well represented in these samples, and there were a number of young–old adults between 65 and 69 as well. Cohorts reporting centenarians or older tended to be from Africa and may reflect their more expansive inclusion criteria allowing for home-based assessments or age estimation error due to the lack of formal birth documentation for age verification. Education data for most studies were harmonized by forming a 3-category variable: (0) less than 7 years of education; (1) between 7 and 12 years of education; or (3) 13+ years. No participants from the Identification and Intervention for Dementia in Elderly Africans (IDEA) sample reported education greater than primary school, and we divided their data into tertiles reflecting (0) no formal education, (1) did not complete primary school, or (2) completed primary school. All contributing studies provided detail on these covariates. Details on how education data were harmonized are provided in Supplementary Table 2.

Data for several *clinical correlates* of gait speed included *body mass index* (BMI; calculated from height and weight if BMI was not provided in data set), as well as *hypertension* and *stroke* (both self-reported). Data for these covariates were available in all cohorts except BMI (not assessed in Tanzania) and stroke (not assessed in South Korea). Information on how these variables were harmonized across studies is provided in Supplementary Tables 3–5. We also included the *apolipoprotein (APOE) ε4 polymorphism*, which has been previously associated with poor performance-based mobility (26). Participants were coded as either having no (0) or at least 1 ε4 allele (1). APOE data were obtained in the South Korean, Singaporean, and Australian studies; cohort-specific details of the APOE protocol can be found in Supplementary Table 6.

Psychological correlates of gait speed included measures of cognition, mood, and subjective health. Cognitive tests included the *Mini-Mental State Examination* (MMSE) (27), *categorical fluency* (28), and *Trail-Making Tasks A and B* (TMT) (29). For the MMSE and categorical fluency tests, higher scores reflect better test performance. Conversely, higher TMT values reflect a slower time to complete (ie, worse performance). We reported TMT-B results in both their raw form as well as adjusted for TMT-A performance (TMT-B speed minus TMT-A speed). MMSE was assessed in all cohorts except Tanzania and Nigeria. Categorical fluency was assessed in all cohorts, except Japan. The TMT-A and TMT-B were assessed only in the South Korean, Singaporean, and Australian cohorts. Details on the cognitive assessment protocol can be found in Supplementary Table 7. *Depressive symptoms* were assessed using either the 15- or 30-item Geriatric Depression Scale (GDS); higher scores reflected greater depressive symptomatology (30). Depressive symptoms using either version of the GDS were assessed in the South Korean, Singaporean, and Australian cohorts; further information can be found in Supplementary Table 8. *General health* was assessed using a single-item question about one's perceptions of their general health; this measure reflects both self-perceptions of mental and physical health (31) and thus was considered a psychological correlate in this study. Because all studies did not include the same set of response options, scores were converted into a binary variable. Those who reported "excellent," "very good," or "good" health were coded as having "good" health, and those reporting either "fair" or "poor" health were coded as having "poor" health. General health was assessed in all cohorts. Information on data harmonization for general health can be found in Supplementary Table 9.

Finally, multiple *behavioral correlates* of gait speed were considered. Self-reported current *smoking* and *drinking* were coded as current use (1), regardless of quantity, or abstention (0). Data for these behaviors were available for all cohorts. Information on data harmonization for smoking and drinking can be found in Supplementary Tables 10 and 11. Self-reported *physical activity* participation was harmonized across studies into tertiles. Participants reporting no engagement in physical activities of any intensity were "minimally active"; those who reported engaging in moderate activity at least once a week were coded as "moderately active"; those reporting frequent (>1 time/wk) engagement in active sports (eg, swimming) were reported as "vigorously active." Additional detail for how physical activity data were harmonized can be found in

Table 2. Demographic, Clinical, Psychological, and Behavioral Characteristics of the Contributing COSMIC Studies.

	Tanzania (IDEA; *N* = 231)	Nigeria (ISA; *N* = 1 122)	South Korea (KLOSCAD; *N* = 491)	Japan (SGS; *N* = 1 913)	Singapore (SLAS-II; *N* = 1 698)	Australia (Sydney MAS; *N* = 995)
Age (years)	80.47 (8.30)	76.85 (7.87)	73.25 (5.27)	73.59 (6.09)	72.41 (5.84)	78.78 (4.79)
Sex (% Women)	162 (69.8%)	577 (51.4%)	272 (55.4%)	1 112 (58.1%)	1 004 (59.1%)	549 (55.2%)
Education (years)						
0–6	None: 130 (58.6%)	893 (79.6%)	60 (12.2%)	40 (2.1%)	1 247 (74.8%)	21 (2.1%)
7–12	Did not complete primary: 81 (36.5%)	153 (13.6%)	177 (36.0%)	1 550 (81.2%)	381 (22.8%)	622 (62.5%)
13+	At least primary: 11 (4.9%)	76 (6.8%)	255 (51.8%)	319 (16.7%)	40 (2.4%)	352 (35.4%)
BMI (kg/m^2)	NA	22.38 (4.42)	24.01 (2.62)	23.21 (3.20)	23.98 (4.02)	27.09 (4.47)
Hypertension (% yes)	75 (38.1%)	171 (15.3%)	281 (57.1%)	744 (38.9%)	989 (58.3%)	600 (60.4%)
Stroke	11 (4.8%)	52 (4.7%)	NA	72 (3.8%)	87 (5.1%)	38 (3.9%)
APOE e4 status (% with at least 1 allele)	NA	NA	99 (20.2%)	NA	273 (18.9%)	214 (22.6%)
MMSE (total score)	NA	NA	27.59 (2.29)	27.45 (2.40)	27.08 (3.35)	28.0 (1.51)
Categorical fluency (raw score)	5.28 (3.52)	12.51 (4.12)	18.13 (5.32)	NA	19.26 (4.93)	15.60 (4.37)
Trail-Making Test A (total time)	NA	NA	49.38 (31.03)	NA	98.24 (51.00)	46.71 (16.19)
Trail-Making Test B (total time)	NA	NA	149.31 (79.04)	NA	155.62 (57.65)	119.72 (53.125)
Trail-Making Test B – A (total time)	NA	NA	101.04 (65.47)	NA	67.62 (43.32)	73.82 (46.36)
Depressive symptoms: Geriatric Depression Scale	NA	NA	8.26 (5.94) (30-item)	NA	0.83 (1.57) (30-item)	2.27 (2.09) (15-item)
General health						
Poor	159 (68.5%)	31 (2.8%)	245 (49.8%)	405 (21.3%)	535 (32.1%)	158 (16.0%)
Good	73 (31.5%)	1 079 (96.2%)	247 (50.2%)	1 500 (78.7%)	1 131 (67.9%)	834 (84.1%)
Current smoker (% yes)	73 (32.4%)	466 (41.8%)	23 (4.7%)	154 (8.1%)	58 (3.7%)	31 (3.1%)
Current drinker (% yes)	94 (42.73%)	644 (58.4%)	144 (29.3%)	1 285 (67.3%)	36 (2.4%)	870 (87.4%)
Physical activity						
Minimally active	111 (49.6%)	NA	83 (16.9%)	NA	275 (16.2%)	136 (14.1%)
Moderately active	97 (43.3%)		250 (50.9%)		1 141 (67.4%)	505 (52.2%)
Vigorously active	16 (7.1%)		158 (32.2%)		276 (16.3%)	326 (33.7%)
Raw usual gait speed (m/s)	0.52 (0.24)	0.77 (0.23)	1.09 (0.25)	NA	NA	0.70 (0.17)
Adjusted usual gait speed (m/s)	0.61 (0.21)	0.78 (0.22)	1.06 (0.24)	NA	NA	0.74 (0.16)
Raw rapid gait speed (m/s)	NA	NA	1.34 (0.32)	1.68 (0.44)	1.20 (0.34)	NA
Adjusted rapid gait speed (m/s)	NA	NA	1.31 (0.30)	1.65 (0.38)	1.16 (0.33)	NA

Notes: APOE = apolipoprotein; BMI = body mass index; COSMIC = Cohort Studies of Memory in an International Consortium; IDEA = Intervention for Dementia in Elderly Africans; ISA = Ibadan Study of Aging; KLOSCAD = Korean Longitudinal Study on Cognitive Aging and Dementia; NA = not applicable; SGS = Sasaguri Genkimon Study; SLAS-II = Singapore Longitudinal Study of Aging-II; Sydney MAS = Sydney Memory and Ageing Study.

Supplementary Table 12. Self-reported physical activity data were available in the South Korean, Singaporean, and Australian cohorts.

Statistical Analysis

For all analyses, cohorts were analyzed separately. Bivariate associations between gait speed and demographic, health, and cognitive variables were calculated using Spearman's rho, independent samples' *t* tests, or chi-square tests as appropriate. We then examined the associations between health, cognition, and gait speed after controlling for demographic characteristics in a series of multiple regressions. The general form for these equations were as follows:

$$Gait\ speed = Intercept + Age + Sex + Education + Predictor\ of\ interest$$

Data were analyzed using SAS, version 9.4 (SAS Institute, Cary, NC). The significance for all tests was set at $p < .05$.

Results

Sample Description

Sample sizes across cohorts ranged from 231 (IDEA) to 1 913 (Sasaguri Genkimon Study [SGS]). Participant characteristics are reported in Table 2. The cohorts had an average age between 73.2 (South Korea) and 80.5 (Tanzania) years old. In all cohorts, more than 50% of the analytic sample were women.

Usual Gait Speed

Across the 4 studies with data, the average (raw) usual gait speed ranged from 0.52 (Tanzania) to 1.09 (South Korea) m/s, and age-/gender-normalized usual gait speed ranged from 0.61 (Tanzania) to 1.06 (South Korea) m/s. Demographic, clinical, and cognitive factors were generally associated with usual gait speed, and this pattern was largely consistent across data sets. In unadjusted analyses, age, depressive symptoms, BMI, and cognition showed the largest standardized association with usual gait speed (in the small-to-medium range in terms of relationship magnitude), whereas current smoking and having an APOE ε4 allele showed no association (small relationship magnitude range; Supplementary Figures 2–4 and Supplementary Table 12).

Controlling for demographics somewhat attenuated the associations with usual gait speed. As shown in Table 3, having a lower BMI, better cognitive function, and reporting at least moderate physical activity were significantly associated with faster usual gait speed after adjusting for demographics. The significant associations were small (ie, standardized $\beta < 0.30$) but consistent across studies. For example, the demographic-adjusted association between categorical fluency and usual gait speed ranged from $\beta = 0.10$–0.16 across the 3 studies with data. Finally, demographics-adjusted current health conditions, smoking status, alcohol use, and APOE ε4 status were not significantly associated with usual gait speed across studies. These relationships were not only statistically nonsignificant, but their standardized magnitudes were also small. Results were largely consistent in sex-stratified analyses between men and women and across cohorts (Table 3). One notable exception was in physical activity, whereby men reporting vigorous physical activity were significantly faster than minimally active men. Among women, however, this association was less consistent across cohorts.

Rapid Gait Speed

Across the 3 studies with data, the average (raw) rapid gait speed ranged from 1.20 (Singapore) to 1.68 (Japan) m/s, and age-/gender-normalized rapid gait speed ranged from 1.16 (Singapore) to 1.65 (Japan) m/s. Unadjusted analyses found that demographic, clinical, and psychological factors were generally associated with rapid gait speed, and this pattern was largely consistent across data sets. Age, depressive symptoms, and cognition tended to have the largest standardized association with rapid gait speed (Supplementary Figures 2–4 and Supplementary Table 14). Similar to that of usual gait speed, the magnitude of these associations was in the small-to-medium range. The presence of at least 1 APOE ε4 allele was not associated with rapid gait speed in any cohort ($p > .05$), and the magnitude of the association was small.

Controlling for demographics somewhat attenuated the associations with rapid gait speed. Lower BMI, better cognitive function, and having at least "good" health were significantly associated with a faster usual gait speed after adjusting for demographics (Table 4). As seen for usual gait speed, associations were statistically significant, yet small (ie, standardized $\beta < 0.30$) but consistent across studies. For example, the demographic-adjusted association between general health and rapid gait speed ranged from $\beta = 0.08$–0.14 across 3 studies (see Table 4). Finally, demographics-adjusted presence of hypertension, the presence of at least 1 APOE ε4 allele, current alcohol use, and engagement in moderate (but not vigorous) physical activity were not associated with rapid gait speed in any cohort ($p > .05$). Not only were these relationships statistically nonsignificant, but the standardized magnitude of the relationships was small as well. Results were largely consistent in sex-stratified analyses (Table 4).

Discussion

In this study of gait speed among older adults from Asia, Africa, and Australia, we found that age- and gender-standardized usual gait speed ranged from 0.60 to 1.06 m/s, and rapid gait speed ranged from 1.16 to 1.65 m/s. Furthermore, BMI, cognition, and physical activity factors were the most robust correlates of gait speed across cohorts; other locomotor risk factors were either not associated with gait speed or associations were less consistent across cohorts. Although the strength of association was small, these patterns of association were not attenuated by cohort-specific demographic characteristics.

Compared to U.S.-based cohort studies of older adults living in the community, the average age-/gender-standardized gait speeds of the cohorts in the present study were substantially slower. The average usual gait speed in all cohorts except South Korea, for example, was well below the 0.95–1.2 m/s speed previously cited as "average" gait speed among community-dwelling older adults seen elsewhere (32,33); the average gait speed among our cohorts would be classified as having limited community ambulation (34). Although gait speed statistics from samples outside the United States, Europe, and Australia are less common, the range of gait speed values reflected across the COSMIC cohorts is similar to community-dwelling older adults in countries underrepresented in mobility research such as South Africa, Brazil, India, Russia, and Ghana (11,35,36). Despite the slow gait speed, these cohorts largely reported at least "good' general health and were able to undergo the walking protocol, suggesting that these samples reflect ambulatory, community-dwelling older adults. These descriptive

findings highlight the importance of ensuring the appropriateness of cutpoints developed on selected samples in high-income and western countries to other geographic cohorts. Environmental factors can affect one's gait, including cross-country differences in height (37,38), cultural differences in healthful activity engagement (eg, physical activity) (39), and the environmental context (eg, rural vs urban-based cohort) (40). For example, Tanzanian older adults were assessed in their homes in the rural Hai District. Although efforts were made to ensure a flat walkway, the Hai District is situated at the foothills of Mount Kilimanjaro; such elevation changes may have contributed to this cohort's slower gait speed compared to the other sites. Additionally, participants in this cohort tended to perform the gait speed task with open-toed shoes, possibly contributing to their gait speed differences. As such, it is critical that future research reflects ethnogeographically diverse regions to examine whether the factors that are associated with gait are context-specific or reflect similar associations across various populations.

These results support previous literature that clinical, psychological, and health behavior measures such as BMI, cognitive performance, depressive symptoms, and physical activity are related to older adult mobility (41). The magnitude of the effect was largely consistent across different ethnogeographic regions as well as in gender-stratified analyses. This suggests that although there is marked variability in gait speed across different regions, the associations between psychological and clinical factors with gait were remarkably consistent. Behavioral interventions to improve gait speed should be developed to address the unique experiences and contexts of the population, but the same types of interventions may confer similar benefits regardless of region of origin. For example, physical activity levels varied across samples, but the strength of the association was significant and similar across cohorts. Notably, physical activity tended to be associated with usual gait speed among women but not men. In comparison, there was some evidence to suggest that physical activity—especially at greater —may be a stronger correlate of usual gait speed among men. Sex differences in gait speed are well documented, and recent work suggests that sex moderates the gait/health outcomes association (42). Taken together, this suggests that men and women may have differential susceptibility to modifiable determinants of gait, particularly regarding physical activity. Future observational studies and intervention programs that target physical health should account for gender and sex differences in the determinants of physical aging and gait itself. There is less evidence, however, that sex-stratified behavioral interventions outside of physical activity will provide additional benefits. These results are consistent with non-U.S. population-based studies that found psychological, physical, and cognitive health are associated with older adult mobility (36). As these are cross-sectional relationships, however, we cannot ascertain the directionality of these associations.

Negative findings are also of interest. There was limited evidence that health conditions were associated with gait speed. Slower gait speed is often seen in the presence of chronic health conditions (43,44), including stroke (45) and hypertension— both untreated and treated alike (46,47). Chronic health conditions and slower gait speed are hypothesized to be linked through pathways such as systemic inflammation, physical inactivity, and depleted nutrition (48,49). Although we were able to account for some of these hypothesized mechanistic pathways, limitations in the data collected within cohorts may help explain the lack of significant association. The types of health conditions measured were not standardized across studies, limiting the number of conditions we could evaluate across multiple cohorts. Additionally, few studies among the COSMIC cohorts included inflammatory markers. It is possible that increased general inflammation with age, rather than the presence of specific diseases, contributes to slow gait (50,51). Future work is warranted and should incorporate both chronic health conditions and inflammatory biomarkers believed to influence gait such as interleukin-6 or C-reactive protein (49,52,53). This is especially warranted in developing countries, as most existing work reflects populations from high-income countries (54).

In contrast to previous studies (55,56), we found inconsistent evidence that smoking or drinking behaviors were significantly associated with gait speed. Although significance was not consistent across cohorts, the associations were in the expected direction such that abstinence from tobacco and/or any alcohol use was associated with faster gait. It is possible that our summary indicator of these behaviors was too imprecise to identify associations among these cohorts. For instance, alcohol consumption questions among the COSMIC cohorts spanned from how frequently one consumes alcohol in a typical week to whether the individual had ever consumed alcohol. Previous work suggests an inverted-U association between alcohol use and gait (57), which we were unable to model with our dichotomized measure. Future work should incorporate more sensitive measures of consumptive behaviors to explore potential dose-dependent associations with gait speed.

We also found a consistently nonsignificant association between APOE and gait speed across studies. Although contrary to our hypothesis, this partially replicates work that found e4 carrier status may not affect certain gait outcomes such as speed (58). APOE may exert a more complex influence on gait than we modeled in this study. For example, the association between APOE and cognitive function is not consistent across all populations and is moderated by factors such as Hispanic/Latino region of origin (59), physical activity engagement (60), or stress (61). APOE may exhibit a similarly complex association with gait speed such that their association depends on other sociodemographic or health characteristics. The potential interactive effect of APOE on gait outcomes warrants future research, as it may help explain inconsistent findings in the literature.

Limitations and Strengths

The COSMIC consortium offers a unique opportunity to examine gait and mobility among older adults across many ethnogeographic regions, but there are limitations to consider. Differences in gait speed among the cohorts may be attributed to differing gait speed protocols such as varying walk distances (62). Walkway distances ranged between 3 and 10 m, and half of the walkways were either 5 or 6 m; evidence suggests that walkways of this length may not meaningfully contribute to differences in gait speed (63). A related limitation was that not all studies assessed both types of gait speed, limiting our ability to understand how the pattern of associations within cohorts differs by usual versus rapid gait speed. Emerging evidence suggests that correlates of usual gait speed may differ from correlates of rapid gait speed (41,64–66). By including both usual and rapid gait speed assessments in future studies, we will gain novel insights into the unique and common correlates of different older adult gait parameters. Potential covariates were also not assessed in all cohort studies, thereby reducing the number of studies that were able to contribute to our analyses. This limitation may be due to the purpose of the original cohorts contributing to COSMIC, as these cohorts were primarily designed to examine correlates and predictors of cognitive decline and dementia rather than physical function. As data consortia such as

Table 3. Correlates of Usual Gait Speed Adjusted for Demographics

	Tanzania (N = 231)		Nigeria (N = 1 122)		South Korea (N = 491)		Australia (N = 995)	
	Unstandardized B (SE), p Value	β	Unstandardized B (SE), p Value	β	Unstandardized B (SE), p Value	β	Unstandardized B (SE), p Value	β
BMI			−0.003 (0.001), p = .05	−0.06	−0.02 (.004), p <.001♂,♀	−.18	−0.007 (0.001), p < .001♂,♀	−0.19
Hypertension	−0.04 (0.03), p = .22	−0.08	−0.04 (0.02), p = .04	−0.06	−0.04 (0.02), p = .04	−.06	−0.03 (0.01), p = .001♀	−0.10
Stroke	−0.12 (0.07), p = .07♀	−0.11	0.04 (0.03), p = .19♂	0.04			−0.09 (0.03), p < .001 ♂,♀	−0.11
≥1 APOE ε4 allele					−0.01 (0.03), p = .63	−0.02	−0.01 (0.01), p = .29	−0.03
MMSE					0.01 (0.005), p = .02♀	0.11	0.008 (0.003), p = .02♂,♀	0.07
Categorical Fluency	(0.004), p = .01♂	0.15	0.01 (0.002), p < .001♂,♀	0.16	0.005 (0.0002), p = .04	0.10	0.005 (0.001), p <.001♂,♀	0.13
Trail-Making Task A					−0.001 (<0.001), p = .04	−0.10	−0.002 (<0.001), p < .001♂,♀	−0.22
Trail-Making Task B					−0.004 (<0.001), p = .01	−0.13	−0.005 (<0.001), p < .001♂,♀	−0.17
Trail-Making Task B – A					−0.0003 (<0.001), p = .06	−0.09	−0.0004 (<0.001), p < .001♀	−0.12
Depressive symptoms					−0.003 (0.002), p = .08	−0.07	−0.01 (0.002), p < .001♀	−0.13
General health = Good	0.02 (0.03), p = .43	0.11	0.14 (0.04), p < .001♀	0.11	0.04 (0.02), p = .05	0.09	0.06 (0.01), p < .001♀	0.12
Current smoker	0.02 (0.04), p = .55	0.05	0.003 (0.01), p = .86	.006	−0.01 (0.05), p = .77	−0.01	0.002 (0.03), p = .95	0.002
Current drinker	0.06 (0.03), p = .06♀	0.12	−0.003 (0.01), p = .98	−.001	0.04 (0.03), p = .12	0.08	0.03 (0.01), p = .06	0.06
Moderate physical activity (vs minimal)	0.10 (0.03), p < .001♂,♀	0.22			0.06 (0.03), p = .04♂	0.12	0.05 (0.02), p = .001♀	0.10
Vigorous physical activity (vs minimal)	.01 (0.04), p = .01♂	0.24			0.05 (0.03), p = .12♂	0.10	0.07 (0.02), p < .001♂,♀	0.13

Notes: Rows represent separate regression analyses adjusting for the sample-specific demographics (age, sex, and education). For sex-stratified results, ♂ indicates instances where the predictor was significant among men; ♀ indicates instances where the predictor was significant among women (p < .05). No symbols indicate that the variable was not significant in either sex-stratified analysis. Shaded areas denote when a variable was not available for this cohort. β reflects the standardized beta coefficient. APOE = apolipoprotein; BMI = body mass index; MMSE = Mini-Mental State Examination; *SE* = standard error.

Table 4. Correlates of Rapid Gait Speed Adjusted for Demographics

	South Korea (N = 242)		Japan (N = 1 913)		Singapore (N = 1 698)	
	Unstandardized B (SE), p Value	β	Unstandardized B (SE), p Value	β	Unstandardized B (SE), p Value	β
BMI	−0.02 (0.005), p = .001♂, ♀	−0.14	−0.03 (0.01), p < .001♂	−0.08	−0.05 (0.01), p < .001♂, ♀	−0.14
Hypertension	−0.05 (0.03), p = .05	−0.08	−0.02 (0.02), p = .24	−0.02	−.055 (0.02), p = .001♀	−0.08
Stroke			−0.26 (0.05), p < .001♂, ♀	−0.11	−0.22 (0.02), p < .001♂, ♀	−0.13
≥1 APOE ε4 allele	−0.01 (0.03), p = .65	−0.02			−0.02 (0.02), p = .33	−0.02
MMSE	0.04 (0.13), p = .01♀	0.13	0.03 (0.004), p < .001♂, ♀	0.16	0.02 (0.003), p < .001♂, ♀	0.19
Categorical Fluency	0.006 (.003), p = .02♂	0.10			0.01 (0.003), p < .001♂, ♀	0.16
Trail-Making Task A	−0.04 (0.01), p = .01♀	−0.12			−0.001 (<0.01), p < .001♂	−0.15
Trail-Making Task B	−0.05 (0.02), p = .001♂, ♀	−0.16			−0.001 (<0.01), p < .001♂	−0.20
Trail-Making Task B – A	−0.0006 (0.0002), p = .01	−0.12			−0.001 (<0.01), p = .01♂	−0.11
Depressive symptoms	−0.02 (0.01), p = .19	−0.05			−0.03 (0.01), p < .001♂	−0.09
General health = Good	0.07 (0.03), p = .01♀	0.11	0.18 (0.02), p < .001♂, ♀	0.17	0.06 (0.02), p = .001♂, ♀	0.08
Current smoker	−0.01 (0.06), p = .81	−0.01	−0.05 (0.03), p = .11♀	−0.03	−0.02 (0.04), p = .57	−0.01
Current drinker	0.07 (0.04), p = .07	0.10	0.02 (0.02), p = .29	0.02	0.12 (0.06), p = .03♀	0.05
Moderate physical activity (vs minimal)	0.06 (0.04), p = .11	0.09			0.02 (0.03), p = .37	0.03
Vigorous physical activity (vs minimal)	0.06 (0.04), p = .15	0.09			0.12 (0.03), p < .001♂, ♀	0.13

Notes: Rows represent separate regression analyses adjusting for the sample-specific demographics (age, sex, and education). For sex-stratified results, ♂ indicates instances where the predictor was significant among men; ♀ indicates instances where the predictor was significant among women (p < .05). No symbols indicate that the variable was not significant in either sex-stratified analysis. Shaded areas denote when a variable was not available for this cohort. β reflects the standardized beta coefficient. APOE = apolipoprotein; MMSE = Mini-Mental State Examination; SE = standard error.

COSMIC become more common, we recommend that future cohort studies identify a common set of measures to include in their assessment. This will allow for better harmonization across studies and can better inform context-specific versus universal correlates of physical function and mobility. A second limitation of this study was that gait speed and its correlates were not assessed in all cohorts. For example, all studies reported general health, but only 3 studies reported APOE carrier status. Third, correlates were not assessed with the same sensitivity across cohorts. For example, smoking and drinking behavior assessments ranged from weekly consumption in standardized units (eg, number of cigarettes per pack or ounces of alcohol) to a binary yes/no for lifetime engagement in these behaviors. Although the current study reports a positive association between gait speed and alcohol consumption, evidence suggests this is a nonlinear association such that light-to-moderate drinkers may outperform their abstinent and heavy-drinking peers (57). Future research with more sensitive measures of such behaviors is warranted before strong conclusions about the associations with gait speed among older adults are drawn. These results should also be interpreted with caution as they reflect cross-sectional differences rather than developmental changes. For example, longitudinal evidence implicates APOE polymorphism (67) and hypertension (47) as potential contributors to accelerated gait slowing, whereas other studies find similar rates of gait change across different clinically relevant subgroups (68).

Lastly, it is important to consider differences in recruitment and eligibility that may contribute to the reported ranges in gait speeds. Although all cohorts reflect "community-dwelling" older adults, the eligibility criteria for the cohorts were not consistent across studies. For instance, adults in the Tanzanian (IDEA study) cohort were eligible for participation even if they were unable to attend the on-site screening. Furthermore, institutionalized care for older adults in Tanzania is uncommon, so the functional abilities of older adults from this region may have more variability (ie, more adults with limited functional abilities but still community dwelling) than elsewhere (69).

Limitations notwithstanding, there are several strengths to this study. Heterogeneous definitions of "slow gait" can contribute to inconsistent prevalence estimates of slow gait across cohorts. One major strength of this study was the ability to quantify gait speed in meters per second rather than relying on clinically relevant cutpoints that may be inappropriate for these populations. As noted earlier, a substantial number of COSMIC participants would have been classified as slow walkers despite representing community-dwelling, ambulatory older adults with high subjective general health. By using meters per second rather than arbitrarily dichotomizing for slow gait, we are able to use this information to re-evaluate the appropriateness of using U.S.-derived normative values for other populations (70). A final notable strength of this study was the ability to examine these associations in full sample as well as sex-stratified analyses.

Implications and Future Directions

Gait speed is an easily tested, sensitive, and valid indicator of multisystemic older adult health and well-being. Although the correlates of gait speed are well characterized among certain populations, research has primarily relied on highly industrialized, Western countries and has not emphasized common correlates across different ethnogeographic regions. Understanding the consistency of gait speed correlates across different populations is important, as it can begin to inform whether the heterogeneity across populations is driven by context-specific correlations. For example, the consistent association between BMI and gait speed across cohorts may suggest that weight management-type interventions may be equally appropriate to implement across these ethnogeographic contexts. Notably, both nonmodifiable and modifiable correlates had a similar magnitude of association across cohorts. Despite the consistency among the intercorrelations with gait speed, the average gait speed among the cohorts was remarkably heterogeneous. This would suggest that current normative gait speed values, such as recommended speeds of 0.6–0.8 m/s to indicate clinically relevant slow gait (2,71), may be too fast for universal use, especially on self-paced (ie, usual) gait speed. Future research should identify whether such cutpoints are clinically relevant among other aging populations and whether the correlates of clinically impaired gait are similar across contexts. Together, this work will help our understanding of what is more universal versus cohort-specific correlates of gait among older adults worldwide.

Conclusion

This study is among the first to describe the average usual and rapid gait speeds across cohorts of older adults in Africa, as well as Asia and Australia. Gait speeds among these cohorts were similar to the speed of older adults among underrepresented countries in gait speed research (11). In particular, the gait speeds among the COSMIC cohorts were lower than that reported in U.S.-based cohort studies (72,73), especially among the African cohorts. Furthermore, the impact of clinical, psychological, and health behaviors on gait speed was remarkably consistent across cohorts.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

None declared.

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