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Intergenerational differences in walking for transportation between older men and women in six countries

Nestor Asiamah[a,b,*], Edgar Ramos Vieira[c], Kofi Awuviry-Newton[d,e], Anuj Kapilashrami[a], Hafiz T.A. Khan[f]

[a] Division of Interdisciplinary Research and Practice, School of Health and Social Care, Colchester, CO4 3SQ, Essex, United Kingdom
[b] Department of Gerontology and Geriatrics, Africa Centre for Epidemiology, Accra, Ghana
[c] Department of Physical Therapy, Nicole Wertheim College of Nursing & Health Sciences, Florida International University, United States
[d] Department of Social Work, Australian College of Applied Professions, Australia
[e] African Health and Ageing Research Centre (AHaARC), Department of Geriatrics and Gerontology, Winneba, Ghana
[f] College of Nursing, Midwifery, and Healthcare, University of West London, Paragon House, Boston Manor Road, Brentford, TW8 9GB, United Kingdom

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ABSTRACT

Background: – Research on potential differences in walking between men and women have mixed and inconclusive results, and no study has examined differences in walking between men and women across multiple countries and generations (i.e., young-old, old-old, and oldest-old). This study aimed to compare older men and women with respect to their walking for transportation across three generations and among six countries (i.e., China, Mexico, Russia, South Africa, Ghana, and India).
Methods: – This study adopted the cross-sectional design that utilised data from the World Health Organization Study on AGEing and Adult Health (SAGE – wave one). The sample included 12,125 older adults aged 60–114 years from the six countries. The participants were selected with a cluster random sampling method in each country. The data were analysed using three-way Analysis of Variance (ANOVA).
Results: – There were significant differences in walking for transportation among countries. In only South Africa there was a significant difference in walking between men and women, as well as among the three older generations. South African men reported more walking than South African women, and younger-old South Africans reported more walking than older-old and the oldest South Africans.
Conclusions: – There are differences in older adults' walking for transportation among countries. Differences in walking between men and women and among the three generations were only significant in South Africa.

* Corresponding author. Division of Interdisciplinary Research and Practice, School of Health and Social Care, Colchester, CO4 3SQ, Essex, United Kingdom.

E-mail addresses: n.asiamah@essex.ac.uk (N. Asiamah), EVieira@fiu.edu (E.R. Vieira), Kofi.Awuviry-Newton@acap.edu.au, newscous@gmail.com (K. Awuviry-Newton), a.kapilashrami@essex.ac.uk (A. Kapilashrami), hafiz.khan@uwl.ac.uk (H.T.A. Khan).

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1. Introduction

Physical activity (PA) protects against non-communicable diseases including stroke, type 2 diabetes and hypertension (Bauman et al., 2009; Guthold et al., 2020; Hallal et al., 2012), and reduces mortality (Guthold et al., 2020; Temporelli, 2021). The maintenance of PA over the life course is a hallmark of healthy ageing. Walking, a common type of PA, provides the aforementioned health benefits (Bempong and Asiamah, 2022; Goel et al., 2022; Notthoff et al., 2017). Walking is one of the most suited type of PA for older adults because, unlike vigorous and high-intensity PA (e.g., weightlifting, running), it requires relatively low energy expenditure (Bempong and Asiamah, 2022; Thornton et al., 2016) and can be performed by older adults with frailty and/or general physiological or cardio-vascular limitations. Walking for transportation is often a usual activity of daily living and social engagement; it is used to access services and enjoy hobbies (Ghani et al., 2016; Goel et al., 2022; Notthoff et al., 2017; Wang and Lee, 2010).

Studies have examined potential differences between men and women in walking for transportation. Noteworthy is a study in the United States (US) that found no significant difference in walking between older men and women (Gallagher et al., 2014). This result is consistent with other studies (Ghani et al., 2016; Lee, 2005) conducted in the US and Australia. In contrast, a group of researchers (Goel et al., 2022) found based on data from 19 cities that women in the general population were more likely to walk than their counterpart men. A systematic review (Notthoff et al., 2017) also revealed inconsistencies in findings from studies examining a difference in walking between older men and women and called for more research assessing this difference. Our assessment of the literature to date, including the above studies, unfolds the non-availability of a study comparing walking between older men and women across countries. Though the study of Goel and colleagues drew on data from 13 countries, their sample was from individual cities, included other segments of the population (e.g., adolescents), and were not nationally representative.

Over the last few decades, gerontologists have studied health behaviours and health across three generations of older adults (Cho et al., 2015; Garfein and Herzog, 1995; Ng et al., 2017). Garfein and Herzog (1995) are among the earliest researchers utilising this intergenerational approach to proffer 'robust ageing' and to discuss healthy ageing among three generations [i.e., young-old (people aged 60–69 years); old-old (people aged 70–79 years, and oldest-old (people aged 80 years or higher)]. Comparing walking across these older generations is of significance because of the growing effects of aging-related changes and functional decline with time (Cho et al., 2015; Garfein and Herzog, 1995).

Differences in walking may exist among these generations, and these can have implications for ageing and PA policy. Older adult health and frailty rates may also differ among countries, so walking may differ among older generations across countries. Kwak et al. (2016) observed that a comparison of PA between countries is necessary to enrich the evidence for targeted national, regional, and global PA policies. Moreover, understanding potential differences in walking between countries, generations, and sexes is necessary for prioritizing older adults that are in a greater need at the national or multi-national levels. Therefore, we compared intergenerational walking for transportation between representative samples of older men and women from six countries (i.e., China, Mexico, Russia, South Africa, Ghana, and India). The following three research questions were addressed: (*1) does walking for transportation differ among the six countries; (2) does walking differ between men and women across the six countries, and (3) Does walking differ between men and women across the three generations?* This study was focused on the above countries because a few low- and middle-income countries have data and evidence on older adults' health and disability as well as behaviours (e.g., walking) relating to them (Kowal et al., 2012; Sallis et al., 2016), and empirical evidence on which these countries can be compared to high-income countries is lacking. There has been a call for more PA research in low- and medium-income countries (Sallis et al., 2016). Moreover, studies (Gallagher et al., 2014; Ghani et al., 2016; Lee, 2005) that have compared walking between men and women across countries were carried out in only high-income countries.

Thus, this study is the first to compare older adults' walking levels across multiple low- and medium-income countries and, thus, produces evidence that could inform national PA policies. Secondly, this study is expected to produce statistics (e.g., effect size) that may be useful in setting up future studies utilising multinational samples. For instance, effect sizes in this study can be used in power and sample size calculations. Our intergenerational analytical approach builds upon previous studies (Cho et al., 2015; Garfein and Herzog, 1995; Ng et al., 2017) and enables us to explain key ageing theories based on older adults' walking for transportation. Finally, our statistical analysis is robust, answers the three research questions concurrently to minimise statistical bias, and could serve as a model for future research.

2. Methods

2.1. Design

This study adopted a cross-sectional design with an intergenerational analysis that enabled us to build on previous research (Cho et al., 2015; Garfein and Herzog, 1995; Ng et al., 2017) and to explain relevant ageing theories.

2.2. Study participants and their selection

This study utilised data from the first wave of the World Health Organization (WHO) Study on Global AGEing and Adult Health (SAGE). These data were collected from 2007 to 2010 on a cohort of older adults living in six countries (i.e., India, Mexico, Russia, Ghana, China, and South Africa) (Awuviry-Newton et al., 2022; Kowal et al., 2012). In each country, a cluster random sampling method was employed, resulting in nationally representative samples. Details about sampling, selection, and ethical considerations have been reported in a previous study (Kowal et al., 2012). We aligned the data with the intergenerational model adopted from

Garfein and Herzog (1995) by focusing on age entries from 60 years or higher, so data on 12,125 older adults without missing items were analysed.

2.3. Variables, measurement, and operationalisation

The dependent variable was walking for transportation, which was measured with two questions from the GPAQ (Global Physical Activity Questionnaire) originally from the WHO. The first question asked the participants to report the amount of time (in hours and minutes) spent on walking in the previous week whereas the other question asked for the number of days of walking for transportation in the previous week. Walking in MET (metabolic equivalent)-minutes/week was calculated with a formula provided by the WHO (Asiamah et al., 2021). The variables country, gender, and generations were analysed as categorical variables. Country was the country where the participants lived and had six groups (i.e., South Africa – 1; Ghana – 2; India – 3; Mexico – 4; Russia – 5, and China – 6). Gender had two groups (i.e., men – 1; women – 2). The variable 'generations' was generated from the variable age, which was a continuous variable in the original data. To create this variable, we sorted the data in ascending order and split it into three groups. The sorted data was truncated by removing age entries less than 60. Subsequently, the remaining part of the data was categorised as follows: 60–69 years or young-old coded as 1, 70–79 years or old-old coded as 2, and 80+ years or oldest-old coded as 3.

2.4. Statistical analyses

Data were analysed with SPSS 28 (IBM Inc., New York) in two phases. The first phase was aimed at identifying unwanted items in the data, testing relevant statistical assumptions, and summarising the data. Continuous and categorical variables were summarised with the mean and frequency respectively. As part of the exploratory analysis, codes in the original data (e.g., −8, −9) used to denote uncertainty were set as missing items. We subsequently assessed relevant assumptions (i.e., the multivariate normality of the data, linearity, and homogeneity of error variances) governing the 3-way Analysis of Variance (ANOVA), which was used to model the data.

We assessed multivariate normality by saving the Mahalanobis distance values and computing their corresponding p-values (Leys et al., 2018). Some of the p-values were less than 0.001, which evidenced the departure of the data from multivariate normality. Nevertheless, this outcome did not prevent us from using ANOVA for two reasons. First, multivariate normality of the data is said to be very unlikely for sample sizes as large as ours (Garson, 2012; Leys et al., 2018). Moreover, the variance in the data was increased by the constant 3.3, which is part of the formula used to compute walking in MET-minutes/week. The multiplication of the variance by 3.3 coupled with our relatively large sample meant that multivariate normality was unlikely. The linearity of the relationship was examined with a scatter plot of the standardised residuals and predicted values (Bempong and Asiamah, 2022). A cluster of points depicting a straight line in this plot evidenced linearity. Finally, homogeneity of error variances was examined with Levene's test of equality of variances (Y. J. Kim and Cribbie, 2018). This test was significant at $p < 0.05$; hence a posthoc analysis that supports a violation of this assumption was chosen.

In the second phase, we analysed our three research questions concurrently by fitting a 3-way ANOVA with four sub-models. Sub-model 1 tested a possible difference in walking among the six countries, sub-model 2 tested the possible difference in walking between men and women, and sub-model 3 tested a possible difference in walking among the three generations. The fourth sub-model integrates the first three sub-models by assessing whether country, gender, and the three generations interact on walking. This constituted the core of our intergenerational analysis as it concurrently assessed whether walking differed across the three generations and six countries for men and women. The statistical significance of the results was detected at a minimum of $p < 0.05$.

Table 1
Summary statistics on the participants.

Variable	Group	n/Mean	%/SD
Categorical variables			
Country	South Africa	713	6%
	Ghana	1881	16%
	India	2555	21%
	Mexico	984	8%
	Russia	1544	13%
	China	4448	37%
Gender	Men	5892	49%
	Women	6233	51%
Generations	Young-old [60–69 yrs]	6960	57%
	Old-old [70–79 yrs]	4132	34%
	Oldest-old [80+ yrs]	1033	9%
	Total	12125	100%
Continuous variables			
Age (yrs)	–	69.92	7.59
Walking (MET-minutes/week)	–	11751.225	94923.15

Note: MET – metabolic equivalent.

Table 2
Walking levels across countries, generations, and gender.

Gender	n	Generation	Mean (MET-min/week)	SD
South Africa				
Men	192	Young-old [60–69 yrs]	232809.96	359258.46
	72	Old-old [70–79 yrs]	165562.50	309198.91
	23	Oldest-old [80+ yrs]	192215.83	322615.32
	287	Total	212686.33	344673.06
Women	257	Young-old [60–69 yrs]	167781.39	254162.27
	131	Old-old [70–79 yrs]	160780.18	516452.59
	38	Oldest-old [80+ yrs]	111244.74	208806.87
	426	Total	160585.26	352904.81
Ghana				
Men	529	Young-old [60–69 yrs]	1404.43	1693.11
	332	Old-old [70–79 yrs]	1188.59	1270.41
	148	Oldest-old [80+ yrs]	1219.95	1097.17
	1009	Total	1306.35	1489.23
Women	392	Young-old [60–69 yrs]	1228.41	1197.92
	342	Old-old [70–79 yrs]	980.74	1181.34
	138	Oldest-old [80+ yrs]	967.71	909.35
	872	Total	1090.01	1155.99
India				
Men	931	Young-old [60–69 yrs]	1269.45	1190.50
	444	Old-old [70–79 yrs]	1207.09	2109.26
	102	Oldest-old [80+ yrs]	793.94	765.74
	1477	Total	1217.87	1510.81
Women	740	Young-old [60–69 yrs]	861.49	911.15
	278	Old-old [70–79 yrs]	744.90	1171.60
	60	Oldest-old [80+ yrs]	627.39	558.85
	1078	Total	818.39	971.86
Mexico				
Men	249	Young-old [60–69 yrs]	1816.38	2730.75
	139	Old-old [70–79 yrs]	1216.01	1489.99
	47	Oldest-old [80+ yrs]	1080.57	2593.21
	435	Total	1545.04	2404.18
Women	321	Young-old [60–69 yrs]	1100.66	1863.18
	184	Old-old [70–79 yrs]	1184.95	2101.64
	44	Oldest-old [80+ yrs]	1763.25	4660.52
	549	Total	1182.01	2288.55
Russia				
Men	274	Young-old [60–69 yrs]	1399.9708	1727.83
	208	Old-old [70–79 yrs]	1283.0019	1429.69
	36	Oldest-old [80+ yrs]	1032.2583	1279.12
	518	Total	1327.4473	1585.95
Women	504	Young-old [60–69 yrs]	1286.5155	2010.91
	423	Old-old [70–79 yrs]	1133.7879	1700.10
	99	Oldest-old [80+ yrs]	786.8333	2408.35
	1026	Total	1175.3339	1936.57
China				
Men	1229	Young-old [60–69 yrs]	1170.0044	1296.90
	791	Old-old [70–79 yrs]	1085.287	1176.10
	146	Oldest-old [80+ yrs]	1056.7911	1135.53
	2166	Total	1131.4353	1243.82
Women	1342	Young-old [60–69 yrs]	1082.3115	1363.17
	788	Old-old [70–79 yrs]	1021.1322	1231.84
	152	Oldest-old [80+ yrs]	1061.5579	2535.18
	2282	Total	1059.8032	1429.09
Total	6960	Young-old [60–69 yrs]	13734.362	90931.80
	4132	Old-old [70–79 yrs]	9015.5823	106094.98
	1033	Oldest-old [80+ yrs]	9332.1031	70556.52
	12125	Total	11751.225	94923.15

3. Findings

Table 1 shows summary statistics on relevant participant characteristics. In this table, the average age of the participants is about 70 years (Mean = 69.92; SD = 7.59) and about 51% (n = 6233) of the participants were women. The average level of walking in the sample was about 11751 MET-minute/week (Mean = 11751.225; SD = 94923.15). Table 2 shows estimate levels of walking between men and women as well as among the three generations across the six countries.

Table 3 shows the multiple comparisons test associated with the three sub-models. Walking among older adults from South Africa was significantly higher than levels of walking reported by older adults from the other five countries ($p < 0.001$). No significant difference in walking was found among the other five countries ($p > 0.05$). Men reported a higher level of walking, compared with women ($p < 0.001$). Young-old reported a level of walking significantly higher than old-old ($p < 0.001$) and oldest-old ($p < 0.001$). The powers from these sub-models ranged between 0.9 and 1, which means that there was at least a 90% chance that the above results would have come out significant.

Table 4 shows results from the full (interactive) sub-model that texts the interaction between country, gender, and generation on walking. This table shows that differences in walking between men and women and among the three generations are limited to South Africa; there is no significant difference in walking between men and women and among the three generations in the other five countries. In South Africa, young-old men reported higher walking, compared with old-old and oldest-old men ($p < 0.001$), but there is no difference between old-old and oldest-old ($p > 0.05$). Among women, young-old reported higher walking compared with oldest-old ($p < 0.001$) but not old-old. Oldest-old women reported lower walking, compared with both young-old and old-old ($p < 0.001$).

Table 3
Multiple comparisons associated with the univariate sub-models.

(I) Country	(J) Country	MD (I-J)	SE	p	95% CI
Sub-model 1 – Walking*Country					
South Africa	Ghana	180351.1560*	3725.74	<.001	±14606.10
	India	180507.8936*	3588.13	<.001	±14066.61
	Mexico	180214.7210*	4166.45	<.001	±16333.80
	Russia	180330.8506*	3835.88	<.001	±15037.86
	China	180462.5322*	3417.49	<.001	±13397.64
Ghana	South Africa	−180351.1560*	3725.74	<.001	±14606.10
	India	156.74	2573.79	0.95	±10090.08
	Mexico	−136.43	3333.02	0.97	±13066.49
	Russia	−20.31	2909.24	0.99	±11405.15
	China	111.38	2330.01	0.96	±9134.39
India	South Africa	−180507.8936*	3588.13	<.001	±14066.61
	Ghana	−156.74	2573.79	0.95	±10090.08
	Mexico	−293.17	3178.44	0.93	±12460.51
	Russia	−177.04	2730.78	0.95	±10705.54
	China	−45.36	2102.96	0.98	±8244.28
Mexico	South Africa	−180214.7210*	4166.45	<.001	±16333.80
	Ghana	136.43	3333.02	0.97	±13066.49
	India	293.17	3178.44	0.93	±12460.51
	Russia	116.13	3455.69	0.97	±13547.40
	China	247.81	2984.47	0.93	±11700.07
Russia	South Africa	−180330.8506*	3835.88	<.001	±15037.86
	Ghana	20.31	2909.24	0.99	±11405.15
	India	177.04	2730.78	0.95	±10705.54
	Mexico	−116.13	3455.69	0.97	±13547.40
	China	131.68	2502.34	0.96	±9809.99
China	South Africa	−180462.5322*	3417.49	<.001	±13397.64
	Ghana	−111.38	2330.01	0.96	±9134.39
	India	45.36	2102.96	0.98	±8244.28
	Mexico	−247.81	2984.47	0.93	±11700.07
	Russia	−131.68	2502.34	0.96	±9809.99
Sub-model 2 – Walking*Gender					
male	female	8509.672*	2538.449	<.001	±9951.532
female	male	−8509.672*	2538.449	<.001	±9951.532
Sub-model 3 – Walking*Generations					
Young-old [60–69 yrs]	Old-old [70–79 yrs]	6318.566*	2067.33	0.010	±9899.67
	Oldest-old [80+ yrs]	8280.013*	3425.06	0.050	±16401.31
Old-old [70–79 yrs]	Young-old [60–69 yrs]	−6318.566*	2067.33	0.010	±9899.67
	Oldest-old [80+ yrs]	1961.446	3604.43	1.000	±17260.25
Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−8280.013*	3425.06	0.050	±16401.31
	Old-old [70–79 yrs]	−1961.45	3604.43	1.000	±17260.25

Note: MD – mean difference; SE – standard error; CI – confidence interval; Univariate tests: sub-model 1 – [$F = 274.61$, $p < 0.001$, Eta = 0.1, power = 1]; sub-model 2 – [$F = 11.24$, $p < 0.001$, Eta = 0.001, power = 0.92]; sub-model 3 – [$F = 6.31$, $p < 0.05$, Eta = 0.001, power = 0.9].

Table 4
Multiple comparisons of walking between countries, generations, and gender.

Gender	(I) Generation	(J) Generation	MD (I-J)	SE	p	95% CI
South Africa						
Men	Young-old [60–69 yrs]	Old-old [70–79 yrs]	67247.458*	11694.96	<.001	±45847.99
		Oldest-old [80+ yrs]	40594.132*	18673.18	0.030	±73204.85
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−67247.458*	11694.96	<.001	±45847.99
		Oldest-old [80+ yrs]	−26653.3	20269.6	0.189	±79463.34
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−40594.132*	18673.18	0.030	±73204.85
		Old-old [70–79 yrs]	26653.33	20269.6	0.189	±79463.34
Women	Young-old [60–69 yrs]	Old-old [70–79 yrs]	7001.202	9085.049	0.441	±35616.3
		Oldest-old [80+ yrs]	56536.648*	14708.43	<.001	±57661.75
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−7001.2	9085.049	0.441	±35616.3
		Oldest-old [80+ yrs]	49535.446*	15592.99	0.001	±61129.53
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−56536.648*	14708.43	<.001	±57661.75
		Old-old [70–79 yrs]	−49535.446*	15592.99	<.001	±61129.53
Ghana						
Men	Young-old [60–69 yrs]	Old-old [70–79 yrs]	215.847	5925.409	0.971	±23229.5
		Oldest-old [80+ yrs]	184.482	7869.538	0.981	±30851.11
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−215.847	5925.409	0.971	±23229.5
		Oldest-old [80+ yrs]	−31.366	8364.391	0.997	±32791.09
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−184.482	7869.538	0.981	±30851.11
		Old-old [70–79 yrs]	31.366	8364.391	0.997	±32791.09
Women	Young-old [60–69 yrs]	Old-old [70–79 yrs]	247.671	6261.892	0.968	±24548.62
		Oldest-old [80+ yrs]	260.695	8376.623	0.975	±32839.05
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−247.671	6261.892	0.968	±24548.62
		Oldest-old [80+ yrs]	13.024	8534.57	0.999	±33458.25
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−260.695	8376.623	0.975	±32839.05
		Old-old [70–79 yrs]	−13.024	8534.57	0.999	±33458.25
India						
Men	Young-old [60–69 yrs]	Old-old [70–79 yrs]	62.36	4880.886	0.99	±19134.64
		Oldest-old [80+ yrs]	475.513	8826.506	0.957	±34602.73
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−62.36	4880.886	0.99	19134.64
		Oldest-old [80+ yrs]	413.153	9292.196	0.965	±36428.39
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−475.513	8826.506	0.957	±34602.73
		Old-old [70–79 yrs]	−413.153	9292.196	0.965	±36428.39
Women	Young-old [60–69 yrs]	Old-old [70–79 yrs]	116.594	5953.183	0.984	±23338.39
		Oldest-old [80+ yrs]	234.107	11359.71	0.984	±44533.69
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−116.594	5953.183	0.984	±23338.39
		Oldest-old [80+ yrs]	117.513	12046.86	0.992	±47227.56
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−234.107	11359.71	0.984	±44533.69
		Old-old [70–79 yrs]	−117.513	12046.86	0.992	±47227.56
Mexico						
Men	Young-old [60–69 yrs]	Old-old [70–79 yrs]	600.364	8960.297	0.947	±35127.23
		Oldest-old [80+ yrs]	735.804	13458.94	0.956	±52763.36
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−600.364	8960.297	0.947	±35127.23
		Oldest-old [80+ yrs]	135.44	14279.53	0.992	±55980.31
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−735.804	13458.94	0.956	±52763.36
		Old-old [70–79 yrs]	−135.44	14279.53	0.992	±55980.31
Women	Young-old [60–69 yrs]	Old-old [70–79 yrs]	−84.293	7825.244	0.991	±30677.46
		Oldest-old [80+ yrs]	−662.592	13604.46	0.961	±53333.83
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	84.293	7825.244	0.991	±30677.46
		Oldest-old [80+ yrs]	−578.299	14201.88	0.968	±55675.91
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	662.592	13604.46	0.961	±53333.83
		Old-old [70–79 yrs]	578.299	14201.88	0.968	±55675.91
Russia						
Men	Young-old [60–69 yrs]	Old-old [70–79 yrs]	116.969	7782.698	0.988	±30510.67
		Oldest-old [80+ yrs]	367.712	15002.65	0.98	±58815.19
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−116.969	7782.698	0.988	±30510.67
		Oldest-old [80+ yrs]	250.744	15276.56	0.987	±59889.02
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−367.712	15002.65	0.98	±58815.19
		Old-old [70–79 yrs]	−250.744	15276.56	0.987	±59889.02
Women	Young-old [60–69 yrs]	Old-old [70–79 yrs]	152.728	5580.435	0.978	±21877.09
		Oldest-old [80+ yrs]	499.682	9303.351	0.957	±36472.12
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−152.728	5580.435	0.978	±21877.09
		Oldest-old [80+ yrs]	346.955	9448.461	0.971	±37041

(continued on next page)

Table 4 (*continued*)

Gender	(I) Generation	(J) Generation	MD (I-J)	SE	p	95% CI
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−499.682	9303.351	0.957	±36472.12
		Old-old [70–79 yrs]	−346.955	9448.461	0.971	±37041
China						
Men	Young-old [60–69 yrs]	Old-old [70–79 yrs]	84.717	3857.67	0.982	±15123.3
		Oldest-old [80+ yrs]	113.213	7408.198	0.988	±29042.51
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−84.717	3857.67	0.982	±15123.3
		Oldest-old [80+ yrs]	28.496	7622.874	0.997	±29884.11
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−113.213	7408.198	0.988	±29042.51
		Old-old [70–79 yrs]	−28.496	7622.874	0.997	±29884.11
Women	Young-old [60–69 yrs]	Old-old [70–79 yrs]	61.179	3798.079	0.987	±14889.69
		Oldest-old [80+ yrs]	20.754	7242.539	0.998	±28393.08
	Old-old [70–79 yrs]	Young-old [60–69 yrs]	−61.179	3798.079	0.987	±14889.69
		Oldest-old [80+ yrs]	−40.426	7497.088	0.996	±29390.99
	Oldest-old [80+ yrs]	Young-old [60–69 yrs]	−20.754	7242.539	0.998	±28393.08
		Old-old [70–79 yrs]	40.426	7497.088	0.996	±29390.99

Note: MD – mean difference; CI – confidence interval; SE – standard error.

Appendix A shows power and model-summary estimates for the four sub-models.

4. Discussion

This study tested a potential difference in older adults' walking between men and women across six countries and three generations. Our analysis showed that a difference exists in walking between men and women as well as across the six countries and three generations; these differences exist between only South Africa and each of the other countries, which means five of the countries (i.e., China, Russia, Ghana, India, Mexico) reported walking levels not significantly associated with gender, country, and generation. Men reported higher walking compared with women but only in South Africa. A lack of a difference in walking between men and women across five out of six countries is consistent with most previous studies (Ghani et al., 2016; Goel et al., 2022; Notthoff et al., 2017); a lack of a difference in walking between men and women is more pronounced in the empirical literature (Gallagher et al., 2014; Ghani et al., 2016; Lee, 2005). A higher level of walking in men compared with women is supported by some studies (Notthoff et al., 2017; Widyastari et al., 2022), but the fact that this difference was limited to South Africa in this study implies that our result supports most of the evidence regarding the relationship between gender and walking.

The difference in walking between men and women as well as between South Africa and other countries could be owing to walking and other types of PA being influenced by culture and personal factors (Albawardi et al., 2016; Asiamah, 2017), which differ between men and women as well as among communities and countries (Asiamah, 2017; Cherry et al., 2013; Owen et al., 2007). As such, individuals and populations have different opportunities for walking or performing PA. In South Africa, men are more likely to report higher PA because most African cultures require men to play routine social and work roles (e.g., farming, construction) requiring walking and other physical activities but do not accord women the same opportunity to work and perform work-related PA. Women play domestic roles (e.g., babysitting, cooking) that limit their movement and walking, though some women perform house chores-related PA (Ainsworth, 2000; Shum et al., 2022).The opposite is true of developed non-African countries such as the UK, US, and Australia where women have reported a higher walking level (Goel et al., 2022) or levels not different from what men reported (Gallagher et al., 2014; Ghani et al., 2016; Lee, 2005). There is a consensus among researchers (Asiamah, 2017; Jaeschke et al., 2017; Morris et al., 2020) that the physical and social environment as well as culture in these countries equally encourage PA in men and women. This reasoning is seemingly counteracted by the non-significance of the difference between men and women in Ghana, which is later explained.

This study found a difference in PA among the three generations, with older generations reporting lower PA. This result is consistent with the disengagement theory of ageing (DTA), which argues that social and physical activities reduce in the ageing process because the individual loses social, environmental, and personal resources that facilitate engagement with life. For example, ageing people lose social support and physical functional abilities that are necessary for the maintenance of walking and other forms of PA (Asiamah et al., 2021; Pani-Harreman et al., 2021). If so, the oldest-old are expected to have the least ability to perform PA, including walking. This reasoning is supported by our data for South Africa where walking was higher for the young-old compared with the old-old and oldest-old. This argument is not supported by the data from countries that reported walking levels not significantly different. Thus, men and women in the three generations reported fairly the same walking level in five out of the six countries. This consistency across the five countries supports the activity theory of ageing (ATA), which comes at odds with the DTA and argues that people can adapt past experiences and abilities to maintain PA in later life. The ATA assumes that PA does not significantly change between generations (i.e., young to older generations) if people adapt previous abilities (e.g., the ability to walk 5 miles a day), resources (e.g., social support), and experiences (e.g., mastery of safe routes) to remain engaged with life.

In his agreement with the above theories, Asiamah (2017) averred that PA such as walking can reduce or increase over the life course depending on a combination of environmental, personal, and social factors that are not equitably accessible around the world. This line of reasoning suggests that ageing to maintain PA is possible, but this depends on equal opportunities for men and women in any country to perform PA over the life course. A key implication, therefore, is that inequalities in walking ought to be reduced by both national and individual efforts. Governments and politicians are responsible for rolling out national PA policies and designing walkable neighbourhoods that encourage PA. Stakeholders may implement public health education programmes intended to equally enable all segments of the population to utilise neighbourhood factors (e.g., parks, sidewalks) and social resources (e.g., social support) to maintain PA. Suffice it to say that individuals are responsible for relishing environmental, social, and individual resources to maintain PA into later life, which means that foregoing inequalities would persist even in the light of requisite governmental interventions if residents fail to savour opportunities to inculcate a healthy habit.

We have observed that all countries considered in this study, except South Africa, reported relatively low walking levels in MET-minutes/week. South Africa had more than 1000 times the walking level reported for each other country (see Table 2), which aligns with studies (Guthold et al., 2018, 2020) reporting the lowest PA insufficiency levels from Africa. Within national samples, therefore, differences between men and women and across the three generations are more likely to exist in populations reporting very high levels of walking, which may be the reason why Ghana produced a non-significant difference in walking between men and women as an African country. This idea makes sense since not all older adults can meet the physical requirements (e.g., high physical function, cognitive ability) to maintain a high level of walking. According to the DTA, the ability to meet these requirements and adapt past experiences declines in the ageing process (Asiamah, 2017; Duedahl et al., 2020), so inequalities in this ability in later life can be expected to be high and could cause a difference in high walking levels requiring sustained cognitive, physical, and social skills. While our argument is congruent with the import of the DTA, it needs to be substantiated and supported with empirical evidence. Researchers are, therefore, encouraged to investigate whether differences in walking across the three generations are sensitive to the amount of walking performed. Table 5 shows a summary of the evidence regarding the relationship between walking and each of the independent variables included in this study.

This study has some limitations that future researchers and potential decision-makers should consider. First, we truncated the data by removing age entries less than 60 to ensure that the data fitted the intergenerational model adopted. This step reduced the original sample size and could, therefore, comprise the representativeness of the national samples. This study was a cross-sectional design analysing only wave 1 of the SAGE; hence, our analysis did not establish cause and effect between the three categorical predictors and walking. The original wave of the SAGE utilised a subjective measure of walking instead of an objective tool such as a pedometer or accelerometer. Though subjective measures have been used by most studies and have produced reliable findings (Bempong and Asiamah, 2022; E. J. Kim et al., 2020; Notthoff et al., 2017), future researchers are encouraged to use objective measures of walking. The data used are about 10 years old and, therefore, do not reflect current population phenomena. The walking pattern of older adults in the six countries might have changed over time, especially after the outbreak of the Coronavirus disease 2019. As such, our findings may not be applicable in situations where current evidence and walking patterns are needed. The original data do not include all variables that could confound the relationships or differences confirmed in this study. Variables such as employment type, social support received, socio-economic status, and household income could confound the relationships, but these were not included in our analysis. Future studies are encouraged to include these and other potential confounding variables. Age groups and countries had unequal samples; India and the oldest-old group had significantly smaller samples. Different mean levels of walking may have resulted if the groups had the same sample, so we call for future studies utilising equal samples across the groups. We utilised secondary data to meet our research aim; hence, we were unable to choose more suitable countries such as countries with different macroeconomic statuses (e.g., low, medium, and high-income countries). Despite these limitations, this study is important for some reasons.

Noteworthy is our analysis of the interaction between walking, country, gender, and generations. A one-way ANOVA would have suggested a difference in walking among the generations, but the interaction analysis reveals that this difference as well as the difference between men and women is limited to South Africa. The interactive analysis, thus, enabled us to avoid the error of generalising the difference found to the six countries. Future studies are, therefore, encouraged to employ robust statistical techniques that consider the interaction between or among variables. The interactive analysis also reinforces the importance of interventions enabling older adults, especially the oldest-old, to walk or perform PA. This study was the first to investigate potential differences in walking between men and women across countries associated with national samples. As such, this study provides evidence more suited for national and regional PA policies as well as future research. Our evidence, for instance, reveals a need for qualitative studies investigating why walking was higher in South Africa and why differences between men and women as well as among the three generations were limited to this country. This study is also important for being the first study to assess at the multi-national level potential differences in walking among the three generations. This analysis reinforces the role of age in walking as healthy behaviour. Since walking is considered the ultimate type of PA for older adults (Bempong and Asiamah, 2022; Goel et al., 2022; Notthoff et al., 2017), our study plays an important role by relating it to the disagreement between the DTA and ATA. This study also supports a theoretical review (Asiamah, 2017) suggesting that the ATA and DTA are supported in different contexts providing varying opportunities for PA. Finally, this study did not only respond to calls for studies comparing older adults' walking between men and women across countries but also provides evidence that may be used in setting up prospective studies, especially cohort studies and cluster-randomised controlled trials intended to establish causation. For example, effect sizes and other statistics (e.g., power) can be used in calculating the minimum samples necessary for future studies.

5. Conclusion

There was a significant difference in older adults' walking between the six countries, and the highest level of walking was in South Africa. Walking was higher in South Africa, compared to the other five countries, but there was no difference in older adults' walking among those five countries. Men reported higher walking, compared with women but only in South Africa. In only South Africa, older

Table 5
Key studies on the relationship between walking and the independent variables (i.e., gender, age, and country).

Variable	Summary of the evidence	Key References
Gender	Most studies focused on older adults have found no difference in walking between men and women, but the evidence is mixed for the general population.	(Gallagher et al., 2014; Ghani et al., 2016; Goel et al., 2022; Lee, 2005; Notthoff et al., 2017; Yang et al., 2022)
Age	Older adults aged 50 years or higher, compared with younger ones, reported lower walking, though a few studies did not find any relationship between age and walking.	(Ghani et al., 2016; Van Cauwenberg et al., 2012; Van Dijk-De Vries et al., 2012; Yang et al., 2022)
Country	The few studies comparing walking between countries have reported mixed findings. No study has compared walking between the countries considered in the current study.	(Goel et al., 2022; Guthold et al., 2018, 2020)

Note: The variable "generations" is omitted in the table because there are no studies that have assessed the link between it (as measured in this study) and walking. Moreover, "generations" is analogous to age since it was created by putting participant ages into categories.

adults in the young-old category reported walking levels higher compared with those in the other two age groups (i.e., old-old and oldest-old) for both men and women. This study concludes that differences in walking between men and women and among the three generations were only in South Africa. Differences in walking among the generations may not exist in all countries, which is why future research investigating factors explaining these differences are needed. Moreover, interventions aimed at enabling individuals to maintain walking behaviour into later life in all contexts are necessary. Given the limitations of our study, we call for studies utilising primary data to compare older adults' walking across countries. Future studies also may compare older adults' PA across low, middle, and high-income countries.

Author statement

Nestor Asiamah: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review and editing.
Edgar Ramos Vieira: Conceptualization, Supervision, Validation, Visualization, Writing - review and editing.
Kofi Awuviry-Newton: Data curation, Resources, Validation, Visualization, Writing - review and editing.
Anuj Kapilashrami: Data curation, Resources, Validation, Visualization, Writing - review and editing.
Hafiz T.A. Khan: Data curation, Resources, Validation, Visualization, Writing - review and editing.

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Declaration of competing interest

There authors declared no conflict of interest.

Data availability

The data that has been used is confidential.

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Appendix A. Tests of Between-Subjects Effects for the Full Model

Source	Type III Sum of Squares	df	MS	F	p	Power
Corrected Model	22662140035601.080	35	6.47E+11	90.408	<.001	1.00
Intercept	3.89E+12	1	3.89E+12	542.711	<.001	1.00
Country	9.83E+12	5	1.97E+12	274.613	<.001	1.00
Gender	8.05E+10	1	8.05E+10	11.238	<.001	0.92
Generation	9.03E+10	2	4.52E+10	6.306	0.002	0.90
Country * Gender * Generation	1.27E+11	10	1.27E+10	1.769	0.061	0.84
Error	8.66E+13	12089	7.16E+09			
Total	1.11E+14	12125				
Corrected Total	1.09E+14	12124				

Note: MS – mean squared; R^2 – 0.207; Adjusted R^2 – 0.205; Homogeneity of variances test: [Levene's statistic – 136.4; df1 – 35; df2 – 12089; $p < 0.001$].

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