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Neighbourhood walkability as a moderator of the associations between older Ghanaians' social activity, and the frequency of walking for transportation: A cross-sectional study with sensitivity analyses

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ABSTRACT

Objective: To evaluate the associations between walking frequency and social activity as well as the potential moderating role of walkability in these relationships.
Methods: This study employed a cross-sectional design with a sensitivity analysis and techniques against common methods bias. The study population was community-dwelling older adults aged 60 years or more. A total of 927 older adults participated in the study after G*Power 3.1.9.4 was used to calculate the minimum sample size required for the study. A hierarchical linear regression (HLR) analysis was used to analyse the data.
Results: Older adults who walked 'many times' to socialize reported higher social activity than their peers who walked 'sometimes' or less frequently. Older adults who walked 'sometimes', 'many times' and 'always' for economic reasons reported higher social activity than their peers who did not walk at all. Neighborhood walkability positively moderated the association between at least one indicator of walking and social activity.
Conclusion: Frequent walking may better contribute to social activity among seniors in more walkable neighborhoods. Community design interventions aimed at enhancing walkability can encourage walking and social activity among seniors.

1. Introduction

Social activity or engagement, defined as "socialising with others and participating in social events" (Douglas et al., 2017, p. 456), is a necessary part of life and the ageing process. The disengagement theory of ageing (DTA) developed by Cumming and Henry (1961) argues that optimal health and physical functional capacity require the maintenance of social activity into later life; social isolation increases the risk of morbidity and disability. This reasoning has been supported by a growing body of studies conducted around the world. In Germany, for example, a multi-center prospective cohort study found that health-related quality of life increased with social engagement (Hajek et al., 2017). This study also confirmed a reduction in depressive symptoms caused by increased social engagement. In China, another longitudinal study found a positive association between social engagement and self-reported health (Liu et al., 2019). A systematic review conducted by Lu et al. (2021) reveals that the risk of dementia reduces with increasing social engagement.

In the field of gerontology, social activity is seen as a behavior necessary for healthy ageing because it is associated with social support that facilitates activities of daily living (ADL) and healthy behaviors such as healthcare utilization and physical activity (PA) (Chou et al., 2012; Kim et al., 2020). This assertion recalls the idea that engagement in social activities provides opportunities for PA. This view is premised around studies (Pan, 2009; Espernberger et al., 2021; Legh-Jones & Moore, 2012; Reinders et al., 2019) that have evidenced a positive effect of social activity on PA in different jurisdictions, with the systematic reviews of Espernberger et al. and Reinders et al. being noteworthy. Of particular interest are cross-sectional studies (Mejia-Arbelaez et al., 2021; Schmidt et al., 2019) that have reported positive associations between social activity and different forms of PA, including walking and bicycling. These observational studies suggest two scenarios: (1) PA as an outcome of social activity, and (2) social activity as an outcome of PA such as walking.

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Research over the years has been focused on the first scenario that recognises PA as an outcome of social participation (Mejia-Arbelaez et al., 2021; Reinders et al., 2019; Schmidt et al., 2019). Thus, empirical research treating social activity as an outcome of PA is limited. This situation is a major gap or shortcoming in the literature for a couple of reasons. First, people often meet friends and participate in social events with active transportation modes such as walking, which means that social activity can largely be attributed to walking at the population level. Given the above gap, it is understandable that empirical research has undermined the role of walking and other PA in social activity and participation. Secondly, a lack of sufficient evidence (including results from experimental designs) on the role of walking in social activity can discourage investments in walkable neighborhoods. Since social activity can have a positive effect on health, research confirming walking as an antecedent of social engagement may make investments in walkability and programmes encouraging walking more important. Neighborhood walkability is a measure of street connectivity, high residential density and mixed (commercial and domestic) land use (Sallis et al., 2010). Walkable neighborhoods are ideal for walking and other forms of active transportation as they provide access to services, streets, and other architectural attributes (e.g., sidewalks, traffic signs) that encourage people to widen out. Environmental gerontologists agree that ageing is healthier in more walkable neighborhoods because these environments support frequent or routine social activity and walking (Asiamah et al., 2021c, 2021a, 2021b; Wahl & Gerstorf, 2018).

Some researchers (Lee et al., 2018; Schmidt et al., 2019) recognize walking as the best type of PA for people with frailty and physiological limitations. This recognition is justified by a significantly high incidence of musculoskeletal injuries sustained by seniors in vigorous and high-intensity PA (Dipietro et al., 2019). With walking, older adults can avoid or at least minimize these injuries and other side-effects of high-intensity PA. For walking to benefit health, nevertheless, it must be frequent and sustained (Bull et al., 2020; Notthoff & Carstensen, 2015). What can be inferred from the foregoing thoughts is that walking frequency plays a crucial role in meeting recommended walking levels (e.g., 150 min of brisk walking a week) and maintaining social activities to age well into later life. Yet, research to date including systematic reviews (Espernberger et al., 2021; Mejia-Arbelaez et al., 2021; Reinders et al., 2019) has revealed the non-availability of studies examining the association between walking frequency and social activity in older adults. Secondly, the measurement of walking has not considered key goals tied to ADL, which are engaging with others (i.e., participating in social events), participating in economic activities, and performing tasks to maintain health (Clynes et al., 2019). In this study, therefore, we attempted to address these issues with two main research questions: (1) is the frequency of walking to socialize and for health and economic reasons associated with social activity, and (2) does neighborhood walkability moderate this potential association?

By treating social activity as a dependent variable in the above relationships, we tried to set a foundation for future experimental designs to test the causal effect of walking for key purposes tied to older adults' ADL and social activity. Understanding these relationships with cross-sectional and experimental designs would further enhance the evidence for investing in walkable neighborhoods, especially in developing countries where governments have not shown interest in walkability (Asiamah et al., 2021c, 2021a, 2021b; Oyeyemi et al., 2014). More specifically, this study is expected to unfold lessons for health promotion and guide future experimental researchers to identify sources of confounding, calculate the minimum sample size required for their study, and avoid potential sources of bias.

2. Methods

2.1. Design

This study employed a cross-sectional (correlational) design, a sensitivity analysis against potential confounding, and recommended procedures against common methods bias.

2.2. Sample and recruitment

A sample previously used by Asiamah et al. (2021c, 2021a, 2021b) was adopted for the current study. This sample comprised older adults aged 60 years or more, lived in Darkuman (a suburb of Accra, Ghana), and met relevant inclusion criteria. This sample was adopted because it was one of the most culturally diverse groups of older adults, was readily available through a registry, and is representative of older adults in Accra (Asiamah et al., 2021c, 2021a, 2021b; Kpessa-Whyte, 2018). The relevant criteria met by this sample are: (a) having at least a basic educational qualification, which was an indicator of one's ability to complete questionnaires in English; (b) being a permanent resident of Darkuman; (c) not having any health condition that precluded PA, and (d) willingness to participate in the study. There were 1092 individuals in the sample, but 82 of them could not be reached through five initial phone calls performed over a week. Thus, our initial screening of the sample confirmed 1010 individuals eligible to participate in the study. The G*Power 3.1.9.4 software was then used to calculate the minimum sample size required for the study. In this regard, the minimum sample size reached with statistics (i.e., significance = 0.05; power = 0.8, and effect size = 0.2) from a related previous study (Asiamah et al., 2021c, 2021a, 2021b) was 203. To maximize the representativeness of our sample and the power of our tests, we attempted to gather data from all 1010 eligible older adults.

2.3. Operationalization and measurement of variables

The main dependent variable of this study, social activity, was measured with an 8-item standard scale with three descriptive anchors (i.e., not at all, sometimes, and many times). This scale was used because it produced satisfactory psychometric properties, including a Cronbach's alpha coefficient = 0.72, on a Ghanaian sample of older adults (Asiamah et al., 2021c, 2021a, 2021b). In the current study, it produced a Cronbach's alpha coefficient = 0.87. Neighborhood walkability was measured using the 11-item Australian version of the Neighborhood Environment and Walkability Scale (NEWS). This scale, which is associated with five descriptive anchors (i.e., strongly disagree, disagree, somewhat agree, agree, and strongly agree) was transferrable to the current sample for a couple of reasons. First, it produced a satisfactory Cronbach's alpha ≥ 0.7 in previous studies focused on Ghanaian older samples (Asiamah et al., 2021c, 2021a, 2021b). Secondly, this scale is relatively short and is better suited for older adults with physiological and vision limitations who might not be able to complete longer questionnaires. Walking frequency was measured by asking participants to indicate on a 4-point scale (i.e., not at all, sometimes, many times, and always) how frequently they walked to socialize and for health and economic reasons. Table 1 shows a detailed description of how walking frequency and the potential confounding variables (e.g., gender, age, education, income) were measured and coded. As the table indicates, all categorical variables incorporated into the final analysis were dummy-coded.

2.4. Selection of potential confounding variables

A potential confounding variable is a lurking variable that affects the independent variable in a relationship and, therefore, increases or decreases the strength of this association (Asiamah et al., 2019; Li et al., 2021). Thus, potential confounders in this study were variables that could correlate with the primary predictors of this study, which were the three indicators of walking frequency (i.e., walking to socialize, walking for economic reasons, and walking for health). Drawing on the work of Asiamah et al. (2021c, 2021a, 2021b), only potential confounders recognized by relevant theories and available empirical evidence were

Table 1
Operationalization of categorical and confounding variables.

SN	Category	Variable	Operational definition	Type	Group (codes)	Dummy-coded?
1	Indicators of walking	Walking to socialize	Frequency of walking to visit friends/relatives or participate in social/community events (e.g., church service) over the last week	Categorical	Not at all (1); sometimes (2); Many times (3); Always (4)	Yes
2		Walking for economic reasons	Frequency of walking to the market, supermarket, or similar places to shop or sell over the last week	Categorical	Not at all (1); sometimes (2); Many times (3); Always (4)	Yes
3		Walking for health	Frequency of walking to improve health or keep fit over the last week	Categorical	Not at all (1); sometimes (2); Many times (3); Always (4)	Yes
4	Personal variables (categorical)	Gender	The sex of the individual	Categorical	male (1); female (2)	Yes
5		Physical function	Whether or not the individual could perform physical tasks unaided	Categorical	Yes (1), No (0)	Yes
6		Employment status	Whether or not the individual was employed	Categorical	Employed (1); not employed (0)	Yes
7		Chronic disease status	Whether or not the individual had at least one clinically diagnosed chronic condition	Categorical	None (0); one or more (1)	Yes
8		Relationship status	Whether or not the individual was married or in a romantic relationship	Categorical	Yes (1), No (0)	Yes
9	Personal variables (continuous)	Education	The individuals years of schooling	Continuous	—	—
10		Income (GhC)	The gross monthly income of the individual in Ghana cedis	Continuous	—	—
11		Context experience (yrs)	How long (in years) the individual had lived in his/her current neighborhood	Continuous	—	—
12		Age (yrs)	The age of the individual	Continuous	—	—

Note: SN - serial number

considered and incorporated into this study. According to the DTA, PA including walking is associated with age; PA reduces as age increases due to physiological changes associated with ageing. Recently, a review of ageing theories suggested that any variable that is affected by ageing also affects PA such as walking (Asiamah, 2017). Some of such variables named in the review are income, education, functional capacity, chronic disease status, marital status, and gender. Deductively, age and these foregoing personal attributes could affect walking and its association with social activity. Cantor (1975) also reasoned that the frequency of walking in a neighborhood depends on how familiar the individual is with the neighborhood. Familiarity with the neighborhood depends on *context experience*, which we operationally define as how long the individual had lived in the neighborhood. Older adults with higher context experience are more likely to walk for any reason than their counterparts who recently joined the neighborhood. With this thinking, context experience was also treated as a potential confounding variable.

2.5. Questionnaire structure and validation

We gathered data with a self-reported questionnaire comprising four sections. Demographic and confounding variables were in the first section whereas the second section presented questions measuring walking frequency. Sections 3 and 4 captured scales measuring neighborhood walkability and social activity, respectively. The questionnaire had a preamble with survey completion instructions and information on the importance and purpose of the study. The preamble also emphasized our anonymized data collection method as well as the study's ethical requirements and statements.

Since common methods bias (CMB) is a major threat to the internal validity of cross-sectional studies (Jordan & Troth, 2019), we took steps recommended in the literature to avoid or minimize it. The first step was taken at the study design stage where the questionnaire was designed to avoid or minimize response bias. In this regard, sections were separated from each other with preambles describing how to respond to questions for each section. This effort enabled us to make each section distinguishable from the other sections, ensuring that participants did not mistake questions or items of previous scales for items of subsequent scales or sections. The second step was a statistical analysis involving exploratory factor analysis (EFA) with varimax rotation. In this vein, each scale was expected to produce a factor solution of more than one factor in the EFA to evidence the absence of CMB (Jordan & Troth, 2019; Asiamah et al., 2021c, 2021a, 2021b). We confirmed the absence of CMB with results indicating a three-factor solution for both neighborhood walkability and social activity.

2.6. Data gathering process

Before data collection, the study received ethical clearance (no. 02-2019ACE) after its protocol and proposal were reviewed by an institutional ethics review board. Further to this, every participant received, read, and signed an informed consent form that detailed potential project risks. Data gathering was led by one of the authors and supported by four field assistants, including 2 courier drivers. To maximize the response rate, two approaches to data collection were employed. First, older adults were asked to choose a location of convenience where they could complete the questionnaire. Since the participants were regular patients of health facilities in Darkuman, many of them chose to complete questionnaires at these facilities. The remaining participants who were the majority asked us to deliver the questionnaire to their home. A courier driver accompanied by a research assistant delivered questionnaires in sealed and stamped envelopes. While some participants responded instantly, most of them asked the courier to come back after two weeks. Data were gathered over six weeks (i.e., from September 15 to November 2, 2019). A total of 961 questionnaires were returned by participants, out of which 927 were analysed. Thirty-four (34) questionnaires that were not completed at all or were completed halfway were discarded.

2.7. Statistical analysis approach

The Statistical Package for the Social Sciences (SPSS) version 28 was used to analyse the data in two main phases. In the first exploratory phase, data on all variables were summarized with descriptive statistics; frequencies and percentages were used to summarise categorical variables whereas the mean and standard deviation were used to summarise continuous variables. The summary statistics generated formed a basis for identifying variables with missing items and outliers. Four of the confounding variables (see Table 2) contained up to 12% missing data. Based on a previous study (Asiamah et al., 2021c, 2021a, 2021b), we proceeded to analyse the data with these missing items since, for each variable, consecutive missing items were less than 10% of the data. As part of the first exploratory phase, we generated stem-and-leaf plots

Table 2
Descriptive statistics on walking frequency indicators and personal variables.

Variable	Group	Frequency/ Mean[a]	Percent/ SD[a]
Categorical variables			
Gender	Male	471	51%
	Female	456	49%
	Total	927	100%
Physical function	No	286	31%
	Yes	601	65%
	Missing	40	4%
	Total	927	100%
Employment status	Not employed	91	10%
	Employed	791	85%
	Missing	45	5%
	Total	927	100%
Chronic disease status	None	94	10%
	≥1	808	87%
	Missing	25	3%
	Total	927	100%
Relationship status	Not in a relationship	281	30%
	In a relationship	532	57%
	Missing	114	12%
	Total	927	100%
Walking to socialize	Sometimes	241	26%
	Many times	616	66%
	Always	70	8%
	Total	927	100%
Walking for economic reasons	Not at all	10	1%
	Sometimes	467	50%
	Many times	315	34%
	Always	135	15%
	Total	927	100%
Walking for health	Not at all	10	1%
	Sometimes	366	39%
	Many times	488	53%
	Always	63	7%
	Total	927	100%
Continuous variable			
Education (yrs)	—	18.14	9.30
Income (GhC)	—	768.08	390.59
Context experience (yrs)	—	11.16	5.46
Age (yrs)	—	67.77	5.22
Social Activity	—	18.71	1.56
Neighborhood Walkability	—	31.66	2.73

Note: SD – standard deviation.
[a] for continuous variables.

alongside Shapiro-Wilk's statistics and their significances to investigate whether the data associated with the continuous variables were normally distributed. Normality of the distribution of data associated with at least the dependent variable is a requirement for using linear regression analysis (Garson, 2012). Each variable produced a satisfactory plot (i.e., a square equally divided by a straight line) at $p > 0.05$, which evidenced the normal distribution of the data. Other assumptions (i.e., linearity, independence-of-errors, multi-collinearity) governing the use of linear regression were also assessed. Linearity was evaluated by plotting standardized residuals against standardized predicted values of the dependent variable in all models through which the primary relationships were assessed (Garson, 2012). The resulting charts met criteria recommended by Garson and, therefore, evidenced linearity of the relationships.

Our sensitivity analysis in which we screened the measured confounding variables for the ultimate confounding variables was part of the exploratory analysis. This analysis followed the procedure used in a recent study (Asiamah et al., 2021c, 2021a, 2021b) and was aimed at identifying the ultimate confounders or measured potential confounding variables that significantly correlated with the three predictors (i.e., walking to socialize, walking for economic reasons, and walking for health). The procedure was carried out on the outcome variables after they were dummy-coded and parcelled as done in a previous study (Asiamah et al., 2021c, 2021a, 2021b), resulting in the identification of the following ultimate confounders: employment status, relationship status, and age for 'walking to socialize'; relationship status, education, and chronic disease status for 'walking for economic reasons', and gender, context experience, and age for 'walking for health'.

The second phase of the analysis employed multiple linear regression analysis to address the research questions of this study. Two groups of models, with each group comprising six sub-models, were fitted. The first three of the first group (hereby referred to as the baseline or unadjusted models) examined the associations between the three indicators of walking and social activity whereas the last three models examined the associations between social activity and the interactions between the three indicators of walking and neighborhood walkability. We followed previous methods (Helm & Mark, 2010; Asiamah et al., 2021c, 2021a, 2021b) to generate dummy variables representing these interaction terms. In this regard, we were interested in a *pure moderation* influence signifying how neighborhood walkability changed the strength of the relationship between each indicator of walking and social activity. The second group of models, hereby called the adjusted (ultimate) models, only differed from the baseline models with the ultimate confounders. Thus, the ultimate models adjusted for the ultimate confounding variables identified in the sensitivity analysis and, therefore, formed the basis of this study's conclusions. As part of the analysis, we compared the baseline and ultimate models to demonstrate the potential influence of the ultimate confounders on our results. The statistical significance of the results was set at a minimum of $p < 0.05$.

3. Findings

Summary statistics on the relevant variables of the study are shown in Table 2. As the table shows, the average age of participants was about 68 years (Mean = 67.77; SD = 5.22), and about 51% (n = 471) of the respondents were men. About 26% (n = 241) of the participants 'sometimes' walked to socialize; 66% (n = 616) walked 'many times' to socialize, and 8% (n = 70) 'always' walked to socialize. The average social activity score was 19 (Mean = 18.71; SD = 1.56). Table 2 shows summary statistics on other relevant tables. Table 3 shows bivariate correlations of relevant variables, including the ultimate confounding variables. In this table, a positive correlation exists between social activity and walking 'many times' to socialize (i.e., walking_social_many_times) ($r = 0.121$, $p = 0.000$; two-tailed), which suggests that older adults who walked 'many times' to socialize scored higher on the social activity scale than those who walked 'sometimes'. Table 3 shows other relevant bivariate correlations that form the basis of the regression analysis.

In Table 4 are the baseline regression coefficients that are compared to the adjusted (ultimate) coefficients in Table 5. In Table 4, walking 'many times' to socialize (i.e., walking_social_many_times) is positively associated with social activity ($B = 0.15$; $t = 4.25$; $p < 0.001$), which confirms that seniors who walked 'many times' to socialize reported larger social activity scores compared with their counterparts who walked 'sometimes'. Table 5 (i.e., model 1), which shows the ultimate coefficients on which our conclusions are based, confirms this relationship but at a lower significance ($B = 0.11$; $t = 2.86$; $p < 0.05$). In model 2 of Table 5, the three indicators of walking for economic reasons have a positive association with social activity at $p < 0.05$, which means that older adults who walked 'sometimes', 'many times', and 'always' for economic reasons reported larger social activity scores compared with those who did not walk at all. In Model 4, the interaction between walking 'many times' to socialize and neighborhood walkability has a positive association with social activity ($B = 0.13$; $t = 3.47$; $p < 0.001$). This relationship is stronger compared to the association between walking 'many times' to socialize and social activity, suggesting that neighborhood walkability positively moderated the relationship between walking 'many times' to socialize and social activity. Table 5 shows other significant associations of interest.

Table 3
The correlation matrix of relevant variables.

Variable	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Social Activity	1	1	.121**	0.011	-0.003	0.054	-0.035	-0.089**	-0.05	.074*	-0.180**	-0.170**	.157**	-0.051	-0.123**	.124**	0.014
Walking_social_many_times	2		1	-0.400**	.563**	-0.775**	.287**	-0.469**	-0.339**	-0.093**	-0.138**	-0.206**	.065*	-0.048	-0.048	0.008	.186**
Walking_social_always	3			1	-0.167**	.268**	-0.115**	.064*	.136**	.175**	.127**	.095**	-0.024	0.017	0.038	0.049	0.019
Walking_economic_sometimes	4				1	-0.728**	-0.416**	-0.794**	-0.421**	-0.005	-0.01	-0.117**	-0.026	0.055	0.034	-0.035	.094**
Walking_economic_many_times	5					1	-0.290**	.618**	.439**	0.044	0.037	.130**	0.011	-0.057	-0.005	.076*	-0.225**
Walking_economic_always	6						1	.262**	0.037	-0.044	-0.067*	-0.02	0.038	-0.011	-0.070*	-0.041	.184**
Walking_health_sometimes	7							1	.539**	-0.207**	0.038	.091**	-0.044	-0.018	-0.03	0.032	-0.088**
Walking_health_many_times	8								1	-0.073*	.231**	0.03	-0.045	-0.070*	-0.069*	0.003	0.02
Walking_health_always	9									1	0.005	0.019	.122**	0.017	-0.093**	.110**	.164**
Gender ('female' as reference)	10										1	0.005	-0.035	.112**	-0.075*	0	0.037
ES ('employed' as a reference)	11											1	.103**	-0.117**	.131**	-0.199**	-0.161**
Education (yrs)	12												1	0.024	.076*	0.06	0.006
CDS ('≥1' as reference)	13													1	-0.118**	.143**	.202**
RS ('in a relationship' as ref.)	14														1	-0.105**	-0.192**
Context experience (yrs)	15															1	.127**
Age (yrs)	16																1

**$p < 0.001$; *$p < 0.05$; ES – employment status; CDS – chronic disease status; RS – relationship status.

Each model in Tables 4 and 5 produced a significant F-test at $p < 0.05$, which indicates that each model was good. Each model also produced a Durbin-Watson statistic that is approximately 2 as recommended (Garson, 2012), which suggests that the independence-of-errors assumption is met. Finally, the tolerance value of each predictor in the models met the criterion *tolerance* $\geq$*0.1* (Garson, 2012), which means the multi-collinearity assumption is met. So, all basic assumptions governing the use of multiple linear regression analysis were met.

4. Discussion

This study aimed to examine the associations between social activity and the frequency of walking to socialize and for health and economic reasons. The moderating influences of neighborhood walkability in these relationships are also examined.

The study found that older adults who walked more frequently to socialize and for health as well as economic reasons reported larger social activity scores. This result connotes the possibility of more frequent walking providing opportunities for social engagement in older adults. It is consistent with Cantor's (1975) P-E fit framework that avers that higher social activity can be the result of more frequent walking in neighborhoods providing access to services and walkable factors. A review of key ageing theories including the DTA also suggests that social activity is associated with walking and other forms of PA (Asiamah, 2017). Though research has affirmed the positive association between walking and social activity (Mejia-Arbelaez et al., 2021; Schmidt et al., 2019, 2019), there is little or no evidence in the literature on whether social activity is associated with the frequency of walking among community-dwelling older adults. This shortcoming makes our study relatively novel. It can be inferred, based on our result and available evidence (Mejia-Arbelaez et al., 2021; Notthoff & Carstensen, 2015; Reinders et al., 2019; Schmidt et al., 2019), that social activity does not only correlate positively with walking in terms of distance covered or time spent but also correlates with the frequency of walking. This outcome reinforces the importance of health education programmes emphasizing a need for older adults to walk as frequently as possible and enriches the diversity of the evidence as well as the literature to date.

The study further found that neighborhood walkability positively moderated the associations between social activity and the frequency of walking to socialize and for health and economic reasons, with this moderating role being more significant for walking for economic reasons. A practical implication of this result is that efforts among seniors to walk more frequently would result in higher social activity in more walkable neighborhoods. Moreover, walkable neighborhoods complement frequent walking to maximize social activity. These connotations point to the importance of the simultaneous rolling out of health education efforts aimed at encouraging walking behaviors and neighborhood design projects intended to improve walkability; these efforts would be complementary to each other, thereby maximizing outputs including social engagement or a reduction in social isolation among older adults. It is also interesting to note that a confirmation of the above moderating role corroborates Cantor's (1975) P-E model, which explains that social activity would be higher among individuals who walk more frequently owing to walkable attributes such as the availability of services, a key component of walkability (Asiamah et al., 2021c, 2021a, 2021b; Sallis et al., 2010; Wahl & Gerstorf, 2018).

One of the key contributions of this study is its focus on walking for three ADL goals. As our findings suggest, walking for these purposes have different associations with social engagement; walking to socialize has the strongest association with social activity whereas walking for economic reasons received the strongest intervention (i.e., moderation) from neighborhood walkability. These differences suggest that the extent to which walking interplays with social activity depends on its purpose. Walking to socialize would have the strongest association with social activity because, among the three purposes, it is the most focused on social interactions and events. Our result, thus, implies that future

Table 4
Baseline models showing the associations between walking frequency, neighborhood walkability, and social activity.

Model	Predictor	Coefficients			t	Sig.	95% CI	Tolerance	Model fit			
		B	SE	Beta (β)					R^2	Adjusted R^2	Durbin-Watson	F
1[a]	(Constant)	18.37	0.10		187.10	0.000	±0.38		0.019	0.017	1.98	9.08*
	Walking_social_many_times	0.49	0.12	0.15	4.25	<0.001	±0.45	0.84				
	Walking_social_always	0.42	0.21	0.07	2.01	0.045	±0.82	0.84				
2[b]	(Constant)	17.00	0.49		34.92	<0.001	±1.91					
	Walking_economic_sometimes	1.72	0.49	0.56	3.50	<0.001	±1.93	0.04	0.016	0.013	1.94	5.15*
	Walking_economic_many_times	1.84	0.49	0.56	3.73	<0.001	±1.94	0.05				
	Walking_economic_always	1.59	0.51	0.36	3.16	0.002	±1.98	0.08				
3[c]	(Constant)	18.80	0.07		254.25	0.000	±0.29		0.011	0.008	1.97	3.55*
	Walking_health_sometimes	-0.23	0.12	-0.07	-1.87	0.062	±0.49	0.68				
	Walking_health_many_times	-0.02	0.12	-0.01	-0.17	0.869	±0.47	0.71				
	Walking_health_always	0.37	0.21	0.06	1.76	0.079	±0.83	0.96				
4[d]	(Constant)	18.32	0.10		189.11	0.000	±0.38		0.025	0.023	1.99	11.98*
	Walking_social_many_times*NW	0.02	0.00	0.17	4.89	<0.001	±0.01	0.84				
	Walking_social_always*NW	0.01	0.01	0.08	2.22	0.027	±0.03	0.84				
5[e]	(Constant)	16.41	0.37		43.84	<0.001	±1.47		0.043	0.04	1.96	14.02*
	Walking_economic_sometimes*NW	0.07	0.01	0.76	6.15	<0.001	±0.05	0.07				
	Walking_economic_many_times*NW	0.08	0.01	0.75	6.38	<0.001	±0.05	0.07				
	Walking_economic_always*NW	0.07	0.01	0.49	5.48	<0.001	±0.05	0.13				
6[f]	(Constant)	18.79	0.07		255.38	0.000	±0.29		0.012	0.009	1.97	3.94*
	Walking_health_sometimes*NW	-0.01	0.00	-0.08	-2.10	0.036	±0.02	0.69				
	Walking_health_many_times*NW	0.00	0.00	0.01	0.24	0.813	±0.01	0.72				
	Walking_health_always*NW	0.01	0.01	0.07	1.97	0.049	±0.02	0.95				

*$p<0.05$; CI – confidence interval (of B); SE – standard error (of B).
[a] reference predictor is 'walking_social_sometimes'.
[b] reference predictor is 'walking_economic_not_at_all'.
[c] reference predictor is 'walking_health_not_at_all'.
[d] reference predictor is 'walking_social_sometimes*NW'.
[e] reference predictor is 'walking_economic_not_at_all*NW'.
[f] reference predictor is 'walking_health_not_at_all*NW'.

measurements of walking should consider purposes tied to ADL or daily routine. This is, nonetheless, not to say that our study has considered all ADL goals that older adults pursue; only the most pronounced goals in the literature (Chou et al., 2012; Kim et al., 2020) have been considered in this study, setting a basis for future research.

To reiterate, walking for transportation is independent of personal factors such as income, education, physical function, and age. This fact justifies our effort to control for potential confounding variables in a bid to improve the internal validity of our results. The baseline and adjusted models (see Tables 4 and 5) show different repression weights attributable to the confounding variables. This result implies that the study would have reported lower or higher regression weights if it did not incorporate relevant potential confounding variables. Evidently, adjusting for confounding variables, which is a STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) requirement, is necessary and counts toward more accurate results (Hawwash & Lachat, 2019). Even so, our effort to adjust for confounders would have been trivial if it did not include a sensitivity analysis, which is also an aspect of STROBE. This sensitivity analysis is justified by the fact that not all variables can act as confounders in a cross-sectional study and that confounding is not always possible (Asiamah et al., 2019; Li et al., 2021). In essence, our study design is resilient against common threats to internal validity and well aligns with standard recommendations for conducting observational studies.

This study, however, has some limitations that future researchers and decision-makers should consider. The first limitation is that this study does not establish cause and effect between the dependent and predictor variables. As a result, we could neither conclude that social activity increases with the frequency of walking nor say walking frequently supports the maintenance of social activity over the life course. These conclusions are important for practice and future research, but only experimental designs such as cluster-randomized prospective designs can warrant them (Asiamah et al., 2019; Susser, 1991). Interestingly, this study provides preliminary evidence and pieces of information for setting up future experimental studies. For example, this study provides clues regarding potential confounders as well as statistics that can be used to calculate future sample sizes and power. Our utilization of an existing sample and some selection criteria could also limit the generalizability of our findings, though our sample size calculation and decision to gather data on all eligible older adults may offset this limitation. We admit that our sample size is relatively small, so future studies are encouraged to use larger national, regional, or global samples that improve generalizability of our findings. Similarly, all our measures were subjective and were, therefore, potentially vulnerable to response bias. Based on this limitation, future researchers may apply objective measures, if possible, in their context. Drawing on commentaries and theories (Asiamah, 2017; Cantor, 1975; Wahl & Gerstorf, 2018), several other variables (e.g., social network size, socio-economic status of the neighborhood) could play intervening roles in the relationships tested in this study, but we could not incorporate these other variables into our analyses. Future researchers are encouraged to incorporate these variables in their study, if possible. In any case, this study can be a reliable foundation for future research.

5. Conclusion

Older adults who walked 'many times' to socialize reported higher social activity than their peers who walked 'sometimes' or less frequently. Similarly, older adults who walked 'sometimes', 'many times' and 'always' for economic reasons reported higher social activity than their peers who did not walk at all. It is, therefore, concluded that more frequent walking to socialize and for economic reasons among older adults can be associated with higher social activity. Neighborhood walkability positively moderated the association between at least one indicator of walking and social activity. Thus, social activity was associated with more frequent walking at higher neighborhood walkability. It is, therefore, concluded that frequent walking may better contribute to social activity among seniors in more walkable neighborhoods. Depending on how much these results are supported by future studies, improving the walkability of neighborhoods can be a pathway to

Table 5
Adjusted models showing the associations between walking frequency, neighborhood walkability, and social activity.

Model	Predictor	Coefficients			t	Sig.	95% CI	Tolerance	Model fit			
		B	SE	Beta (β)					R^2	Adjusted R^2	Durbin-Watson	F
1[a]	(Constant)	20.24	0.78		26.09	<0.001	±3.05		0.056	0.05	1.82	9.52*
	Walking_social_many_times	0.36	0.13	0.11	2.86	0.004	±0.50	0.80				
	Walking_social_always	0.14	0.23	0.02	0.63	0.531	±0.90	0.86				
	Employment status ('employed' as a reference)	-0.82	0.18	-0.16	-4.54	<0.001	±0.71	0.93				
	Relationship status ('in a relationship' as reference)	-0.35	0.12	-0.11	-3.00	0.003	±0.46	0.95				
	Age (yrs)	-0.01	0.01	-0.04	-1.16	0.245	±0.04	0.90				
2[b]	(Constant)	17.62	0.54		32.92	<0.001	±2.10		0.084	0.077	1.79	12.36*
	Walking_economic_sometimes	1.33	0.48	0.43	2.75	0.006	±1.90	0.05				
	Walking_economic_many_times	1.35	0.49	0.41	2.77	0.006	±1.91	0.05				
	Walking_economic_always	1.10	0.50	0.24	2.20	0.028	±1.97	0.10				
	Education (yrs)	0.04	0.01	0.21	6.27	<0.001	±0.02	0.99				
	Chronic disease status ('≥1' as reference)	-0.60	0.20	-0.10	-3.02	0.003	±0.78	0.96				
	Relationship status ('in a relationship' as reference)	-0.49	0.11	-0.15	-4.32	<0.001	±0.44	0.97				
3[c]	(Constant)	19.07	0.66		29.12	<0.001	±2.57		0.06	0.054	2.00	9.97*
	Walking_health_sometimes	-0.38	0.13	-0.12	-3.03	0.003	±0.49	0.65				
	Walking_health_many_times	0.20	0.12	0.07	1.65	0.099	±0.48	0.65				
	Walking_health_always	0.29	0.21	0.05	1.40	0.162	±0.82	0.93				
	Gender ('female' as reference)	-0.58	0.10	-0.19	-5.68	<0.001	±0.40	0.94				
	Context experience (yrs)	0.04	0.01	0.13	3.90	<0.001	±0.04	0.97				
	Age (yrs)	-0.01	0.01	-0.02	-0.67	0.505	±0.04	0.95				
4[d]	(Constant)	20.31	0.78		26.21	<0.001	±3.04		0.061	0.055	1.83	10.31*
	Walking_social_many_times*NW	0.01	0.00	0.13	3.47	<0.001	±0.02	0.79				
	Walking_social_always*NW	0.01	0.01	0.03	0.93	0.352	±0.03	0.86				
	Employment status ('employed' as a reference)	-0.80	0.18	-0.16	-4.43	<0.001	±0.71	0.93				
	Relationship status ('in a relationship' as reference)	-0.35	0.12	-0.11	-3.04	0.002	±0.45	0.95				
	Age (yrs)	-0.02	0.01	-0.05	-1.35	0.177	±0.04	0.89				
5[e]	(Constant)	17.01	0.45		37.72	<0.001	±1.77		0.104	0.097	1.81	15.62*
	Walking_economic_sometimes*NW	0.06	0.01	0.63	4.98	<0.001	±0.05	0.07				
	Walking_economic_many_times*NW	0.06	0.01	0.60	4.96	<0.001	±0.05	0.08				
	Walking_economic_always*NW	0.05	0.01	0.36	4.05	<0.001	±0.05	0.14				
	Education (yrs)	0.03	0.01	0.21	6.10	<0.001	±0.02	0.98				
	Chronic disease status ('≥1' as reference)	-0.56	0.20	-0.10	-2.86	0.004	±0.77	0.95				
	Relationship status ('in a relationship' as reference)	-0.48	0.11	-0.15	-4.36	<0.001	±0.44	0.97				
6[f]	(Constant)	19.10	0.65		29.24	<0.001	±2.56		0.063	0.057	2.00	10.44*
	Walking_health_sometimes*NW	-0.01	0.00	-0.12	-3.21	0.001	±0.02	0.67				
	Walking_health_many_times*NW	0.01	0.00	0.08	2.11	0.035	±0.01	0.66				
	Walking_health_always*NW	0.01	0.01	0.06	1.68	0.093	±0.02	0.93				
	Gender ('female' as reference)	-0.59	0.10	-0.19	-5.78	<0.001	±0.40	0.94				
	Context experience (yrs)	0.04	0.01	0.13	3.91	<0.001	±0.04	0.97				
	Age (yrs)	-0.01	0.01	-0.02	-0.73	0.465	±0.04	0.95				

*$p < 0.05$; CI – confidence interval (of B); SE – standard error (of B).
[a] reference predictor is 'walking_social_sometimes'.
[b] reference predictor is 'walking_economic_not_at_all'.
[c] reference predictor is 'walking_health_not_at_all'.
[d] reference predictor is 'walking_social_sometimes*NW'.
[e] reference predictor is 'walking_economic_not_at_all*NW'.
[f] reference predictor is 'walking_health_not_at_all*NW'.

encouraging walking and maintaining social engagement among older adults. Frequent walking to socialize and for economic reasons can also serve as an opportunity for maintaining social activity. Community design and health education programmes aimed at enhancing walkability and walking may benefit social engagement at the population level.

Declaration of Competing Interest

The authors had no competing interests to declare.

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Ethical approval

This study was approved by an institutional review committee in Accra after all participants provided informed consent to participate in this study. The ethics review number is 02-2019ACE.

Availability of data and materials

The data used for this paper will be made available by the corresponding author upon reasonable request.

Authorship contribution statement

AEB conceived the research idea, partly provided funds for the study, and wrote part of the manuscript. NA conducted statistical analysis and compiled the draft manuscript. Both authors proofread and approved the draft manuscript.

References

Asiamah, N., Mends-Brew, E., & Boison, B. K. T. (2019). A spotlight on cross-sectional research: Addressing the issues of confounding and adjustment. *International Journal of Healthcare Management, 14*(1), 183–196. https://doi.org/10.1080/20479700.2019.1621022

Asiamah, N., Vieira, E. R., Kouveliotis, K., Gasana, J., Awuviry-Newton, K., & Eduafo, R. (2021a). Associations between older African academics' physical activity, walkability and mental health: A social distancing perspective. *Health Promotion International, 0*(0), 1–12. https://doi.org/10.1093/heapro/daab093

Asiamah, N., Kouveliotis, K., Eduafo, R., & Borkey, R. (2021b). Psychometric properties of a new scale measuring neglect and abuse of older adults in the community: Implications for social activity. *International Quarterly of Community Health Education, 41*(2), 1–12. https://doi.org/10.1177/0272684×20915384

Asiamah, N., Conduah, A. K., & Eduafo, R. (2021c). Social network moderators of the association between Ghanaian older adults' neighborhood walkability and social activity. *Health Promotion International, 36*(1), 1–9. https://doi.org/10.1093/heapro/daaa156

Asiamah, N. (2017). Social engagement and physical activity: Commentary on why the activity and disengagement theories of ageing may both be valid. *Cogent Medicine, 4* (1), 1–3. https://doi.org/10.1080/2331205X.2017.1289664

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., et al. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British Journal of Sports Medicine, 54*(24), 1451–1462. https://doi.org/10.1136/bjsports-2020-102955

Cantor, M. H. (1975). Life space and the social support system of the inner city elderly of New York. *The Gerontologist, 15*, 23–27. https://doi.org/10.1093/geront/15.1_part_1.23

Chou, C., Hwang, C., & Wu, Y. (2012). Effect of exercise on physical function, daily living activities, and quality of life in the frail older adults: A meta-analysis. *Archives of Physical Medicine and Rehabilitation, 93*(2), 237–244. https://doi.org/10.1016/j.apmr.2011.08.042

Clynes, M. A., Jameson, K. A., Edwards, M. H., Cooper, C., & Dennison, E. M. (2019). Impact of osteoarthritis on activities of daily living: Does joint site matter? *Aging Clinical and Experimental Research, 31*(8), 1049–1056. https://doi.org/10.1007/s40520-019-01163-0

Cumming, E. & Henry, W.E. (1961). Growing Old. New York: Basic. p. 227.

Dipietro, L., Campbell, W. W., Buchner, D. M., Erickson, K. I., Powell, K. E., Bloodgood, B., et al. (2019). Physical activity, injurious falls, and physical function in aging. *Medicine & Science in Sports & Exercise, 51*(6), 1303–1313. https://doi.org/10.1249/mss.0000000000001942

Douglas, H., Georgiou, A., & Westbrook, J. (2017). Social participation as an indicator of successful ageing: An overview of concepts and their associations with health. *Australian Health Review, 41*, 455–462. https://doi.org/10.1071/AH16038

Espernberger, K. R., Fini, N. A., & Peiris, C. L. (2021). Personal and social factors that influence physical activity levels in community-dwelling stroke survivors: A systematic review of qualitative literature. *Clinical Rehabilitation, 35*(7), 1044–1055. https://doi.org/10.1177/0269215521993690

Garson, D. (2012). *Testing statistical assumptions*. Statistical associates publishing – Blue Book Publishing. Edition, NC, U.S.A. pp. 1-52.

Hajek, A., Brettschneider, C., Mallon, T., Ernst, A., Mamone, S., Wiese, B., et al. (2017). The impact of social engagement on health-related quality of life and depressive symptoms in old age - evidence from a multicenter prospective cohort study in Germany. *Health and Quality of Life Outcomes, 15*(1), 1–8. https://doi.org/10.1186/s12955-017-0715-8

Hawwash, D., & Lachat, C. (2019). Endorsing the strengthening the reporting of observational studies in epidemiology-nutritional epidemiology (STROBE-nut) statement at genes & nutrition. *Genes Nutrition, 14*, 1–2. https://doi.org/10.1186/s12263-019-0655-5

Helm, R., & Mark, A. (2010). Analysis and evaluation of moderator effects in regression models: State of art, alternatives and empirical example. *Review of Managerial Science, 6*(4), 307–332. https://doi.org/10.1007/s11846-010-0057-y

Jordan, P. J., & Troth, A. C. (2019). Common method bias in applied settings: The dilemma of researching in organizations. *Australian Journal of Management, 45*(1), 1–12. https://doi.org/10.1177/0312896219871976

Kim, J., Kim, J., Kim, Y., Han, A., & Minh, N. C. (2020). The contribution of physical and social activity participation to social support and happiness among people with physical disabilities. *Disability and Health Journal, 14*(1), 1–10. https://doi.org/10.1016/j.dhjo.2020.100974

Kpessa-Whyte, M. (2018). Ageing and demographic transition in Ghana: State of the elderly and emerging issues. *The Gerontologist, 58*(3), 403–408. https://doi.org/10.1093/geront/gnx205

Lee, D. R., Santo, E. C., Lo, J. C., Ritterman Weintraub, M. L., Patton, M., & Gordon, N. P. (2018). Understanding functional and social risk characteristics of frail older adults: A cross-sectional survey study. *BMC Family Practice, 19*(1), 1–12. https://doi.org/10.1186/s12875-018-0851-1

Legh-Jones, H., & Moore, S. (2012). Network social capital, social participation, and physical inactivity in an urban adult population. *Social Science & Medicine, 74*(9), 1362–1367. https://doi.org/10.1016/j.socscimed.2012.01.005

Li, X., Rai, S. N., Rouchka, E. C., O'Toole, T. E., & Cooper, N. G. F. (2021). Adjusted sample size calculation for RNA-seq data in the presence of confounding covariates. *BioMedInformatics, 1*(1), 47–63. https://doi.org/10.3390/biomedinformatics1020004

Liu, J., Rozelle, S., Xu, Q., Yu, N., & Zhou, T. (2019). Social engagement and elderly health in China: evidence from the China health and retirement longitudinal survey (CHARLS). *International Journal of Environmental Research and Public Health, 16*(2), 1–16. https://doi.org/10.3390/ijerph16020278

Lu, L., Lan, S., Hsieh, Y., & Lan, S. (2021). Effectiveness of intergenerational participation on residents with dementia: A systematic review and meta-analysis. *Nursing Open*, (0), 1–12. https://doi.org/10.1002/nop2.919, 0.

Mejia-Arbelaez, C., Sarmiento, O. L., Mora Vega, R., Flores Castillo, M., Truffello, R., Martínez, L., et al. (2021). Social inclusion and physical activity in ciclovía recreativa programs in Latin America. *International Journal of Environmental Research and Public Health, 18*(2), 1–24. https://doi.org/10.3390/ijerph18020655

Notthoff, N., & Carstensen, L. L. (2015). Promoting walking in older adults: Perceived neighbourhood walkability influences the effectiveness of motivational messages. *Journal of Health Psychology, 22*(7), 834–843. https://doi.org/10.1177/1359105315616470

Oyeyemi, A. L., Bello, U. M., Philemon, S. T., Aliyu, H. N., Majidadi, R. W., & Oyeyemi, A. Y. (2014). Examining the reliability and validity of a modified version of the international physical activity questionnaire, long form (IPAQ-LF) in Nigeria: A cross-sectional study. *BMJ Open, 4*(12), 1–11. https://doi.org/10.1136/bmjopen-2014-005820

Pan, C. Y. (2009). Age, social engagement, and physical activity in children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 3*(1), 22–31. https://doi.org/10.1016/j.rasd.2008.03.002

Reinders, N. J., Branco, A., Wright, K., Fletcher, P. C., & Bryden, P. J. (2019). Scoping review: Physical activity and social functioning in young people with autism spectrum disorder. *Frontiers in Psychology, 10*, 1–17. https://doi.org/10.3389/fpsyg.2019.00120

Sallis, J. F., Kerr, J., Carlson, J. A., Norman, G. J., Saelens, B. E., Durant, N., et al. (2010). Evaluating a brief self-report measure of neighborhood environments for physical activity research and surveillance: Physical activity neighborhood environment scale (PANES). *Journal of Physical Activity and Health, 7*(4), 533–540. https://doi.org/10.1123/jpah.7.4.533

Schmidt, T., Kerr, J., & Schipperijn, J. (2019). Associations between neighborhood open space features and walking and social interaction in older adults—A mixed methods study. *Geriatrics, 4*(3), 1–18. https://doi.org/10.3390/geriatrics4030041

Susser, M. (1991). What is a cause and how do we know one? A grammar for pragmatic epidemiology. *American Journal of Epidemiology, 133*(7), 635–648. https://doi.org/10.1093/oxfordjournals.aje.a115939

Wahl, H. W., & Gerstorf, D. (2018). A conceptual framework for studying context dynamics in ageing (CODA). *Developmental Review, 50*, 155–176. https://doi.org/10.1016/j.dr.2018.09.003