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Neighbourhood walkability as a moderator of the associations between older adults' information technology use and social activity: A cross-sectional study with sensitivity analyses

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ABSTRACT

Background: Research to date suggests that information technology use by older adults can be positively associated with social activity, but whether neighbourhood walkability can play a role in this relationship has not been investigated.
Aim: To assess the associations between information technology use and social activity as well as the moderating influences of walkability in these associations.
Methods: This study adopted a cross-sectional design with sensitivity analyses as well as techniques against common methods bias. The study population was community-dwelling older residents of Accra aged 60 years or higher. A total of 890 older adults participated in this study. The hierarchical linear regression analysis was used to analyse the data.
Results: Information technology use was found to be positively associated with social activity. Among the three domains of information technology use, only *packaged software use assessment* was positively associated with social activity. Walkability was found to positively moderate the associations between social activity and information technology use as well as *packaged software use assessment*. Walkability strengthened the negative association between *innovativeness attitude* (another domain of information technology use) and social activity.
Conclusions: Information technology use can facilitate social activity, but experimentation with new information technologies can discourage social engagement, even in higher walkability. Packaged software use assessment, which measures the ability to use packaged software such as WhatsApp, can more significantly support social activity in higher walkability.

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1. Introduction

Prophylactic behaviour over the life course, including social activity, can play a pivotal role in the maintenance of optimal health. Many studies (Legh-Jones and Moore, 2012; Lin et al., 2022; Lindsay Smith et al., 2017; Pan, 2009) have shown that higher social activity, defined as participation in social activities with others (Asiamah et al., 2021), is positively associated with physical activity (PA). Specifically, a systematic review conduct by Lindsay Smith et al. (2017) has shown that social activity over a period can increase PA and health. The above empirical evidence signifies the importance of interventions aimed at enabling older adults to maintain social activity and avoid social isolation in later life. The empowerment of seniors to understand and use information technologies (e.g., WhatsApp, Telegram) productively is among these interventions (Schehl, 2020; Szabo et al., 2019).

The use of the internet among older adults has gradually increased over the last two decades. In the United States, for example, internet use among seniors aged 65 years or higher increased from 12% in 2000 to 67% in 2016 (Hunsaker and Hargittai, 2018). A study conducted in Japan suggests that 22% of older adults with an average age of 73 years could use the internet daily (Nakagomi et al., 2022). While the increasing rate of information technology use among older adults is considered a positive development for public health (Duplaga, 2021; Wang et al., 2022), information technology use can have serious consequences including social isolation, sedentary behaviour, and a decline in mental health (Duplaga, 2021; Xu and Huang, 2021). These consequences are said to explain the negative association between information technology use and social activity among older adults and in the general population (Duplaga, 2021; Hofer and Hargittai, 2021; Hunsaker and Hargittai, 2018). Even so, most of the evidence suggests that information technology use is positively associated with social activity in older adults (Chen, 2020; Duplaga, 2021). The study of Chiu (2019) conducted in China, for instance, found a positive association between information technology (i.e., internet) use and social activity among older adults. A prospective study by Silva et al. (2022) that utilised data from 17 European countries has also shown that information technology use was associated with reduced social isolation. According to Chen (2020), these positive associations of information technology use with social activity can be due to people's use of the internet to access and share information beneficial to social inclusion and health-seeking behaviour. In some recent studies (Hunsaker and Hargittai, 2018; Nguyen et al., 2020; Silva et al., 2022), for example, older adults were reported to have used information technologies to share information about health and social events in the community.

A factor that can influence information technology use and its relationship with social activity is neighbourhood walkability (Mozaffar and Panteli, 2021), defined as mixed land use, street connectivity, and a high residential density (Sallis et al., 2010). Walkability is characterised by neighbourhood attributes (e.g., services, parks, pavements, safety) that encourage social activities (Bempong and Asiamah, 2022). Some researchers (Ji, 2019; Mozaffar and Panteli, 2021) have suggested that the utilization of these attributes for social activities is increasingly influenced by residents' use of information technologies. Some other studies (Bano et al., 2019; Boulianne, 2009; A. Francis and Sarangi, 2022; Ji, 2019; Schehl, 2020) have also shown that walkability factors such as neighbourhood greenspaces would facilitate health-seeking behaviours such as physical and social activities based on information from social media and information technologies. This is to say that older adults may use information technologies to access or share information about neighbourhood social activities, but this information may not encourage them to participate in social activities if their neighbourhoods are unsafe and fail to provide other essential factors (e.g., street connectivity, traffic lights) inherent in walkability. Deductively, walkability and information technology use can interact to influence social activity, which signifies a moderating role of walkability in the association between information technology use and social activity.

Personal factors (e.g., age, education, physical health status) have also been found to influence information technology use and its relationship with social engagement (Dos Santos et al., 2021; Duplaga, 2021; Kobayashi et al., 2015). Older adults who are more educated are likely to understand and use the internet to share or access health-supporting information. Physical health would also influence whether a person can utilize health information from information technologies to participate in social events. Thus, the said potential moderating role is subject to personal and demographic factors, so there is a need for these factors to be adjusted for as covariates in testing this moderating role. While the said moderating role can have key implications for gerontology and health promotion, it has not been assessed with a consideration of personal factors. Moreover, given the above-mixed results, it is unclear how information technology use would relate to social activity in less developed countries including Ghana not yet covered in the empirical literature. This study, therefore, aimed to examine the associations between information technology use and social activity as well as the potential moderating role of walkability in these relationships.

One of the methodological shortcomings in the literature is the inconsistent measurement of information technology use; some studies measured information technology use with psychometric scales (Hofer and Hargittai, 2021; Hunsaker and Hargittai, 2018; Nguyen et al., 2020) whereas others measured it with categorical variables (Kobayashi et al., 2015; Nakagomi et al., 2022). While psychometric measures with Likert scales are considered superior to categorical measures for being less susceptible to response bias (Hunsaker and Hargittai, 2018; Sullivan and Artino, 2013), their analysis in previous research has not considered their domains or dimensions. This shortcoming must be addressed since psychometric proxies of information technology use can differently relate to social engagement. So, an analysis of how different dimensions of information technology use are associated with social activity can result in more detailed evidence and implications for gerontology and health promotion. In this study, therefore, the associations between relevant domains of information technology use and social activity as well as the moderating influence of walkability in these relationships are evaluated. We considered three domains (i.e., internet use assessment, packed software use assessment, and innovativeness attitude) that best describe information technology use in this study's sample and has not been previously studied. This study attempted to address the following research questions: *(1) is information technology use associated with social activity,* and *(2) does walkability moderate the relationship between information technology use and social activity?*

2. Methods

2.1. Design

This study utilised a cross-sectional design with recommended measures against potential confounding and common methods bias (Jakobsen and Jensen, 2015).

2.2. Sample and selection

The study population was community-dwelling older adults aged 60 years or higher in Accra, Ghana. Participants were 3170 seniors in some research registries and groups who previously participated in similar studies (Asiamah et al., 2021) and met the following relevant inclusion criteria: (1) being able to respond to questionnaires in English, which was assessed with a minimum of a basic school certificate; (2) living permanently in one of the suburbs of Accra; (3) not having any health condition that precluded PA or walking unaided for at least 100 m, and (4) willingness to participate in the study voluntarily. The registry comprised community-dwelling older adults aged 60 years or higher in Accra who could perform physical activities unaided. This registry has been used in some previous studies (Asiamah et al., 2021) and is regularly updated as the demographic attributes of its members change over time. Because the registry is regularly updated, its sample used in this study was not necessarily the same as samples used in the above studies. The registry is representative of older adults aged 60 years or higher with at least a basic education (i.e., middle school leaving certificate) (Asiamah et al., 2021).

Through a phone call, a physician assistant applied a single question assessing physical function to screen potential participants based on the third criterion. Other relevant questions asked through a phone call were used to identify those who met the other three inclusion criteria. This selection process lasted three weeks and resulted in 1902 eligible individuals. A total of 892 from the registries were not reached over three weeks whereas 376 did not meet all the inclusion criteria. We subsequently employed the G*Power 3.1.9.4 software and statistics (i.e., effect size = 0.2; power = 0.8; $\alpha = 5\%$) from a previous related study (Asiamah et al., 2021) to calculate the minimum sample size required for the study. This process was based on a minimum of 10 predictors expected to be incorporated into the analysis and resulted in a minimum sample of 202 necessary. To maximise the generalisability and statistical power of our tests, we attempted to gather data on all older adults who were eligible.

2.3. Measures

The main variables of this study were information technology use, social activity, and walkability; all of these were measured with standard psychometric scales and analysed as continuous variables. Information technology use was measured with a 13-item scale adopted in whole from Yu and Chao (2014). This scale, which was associated with five descriptive anchors (i.e., strongly disagree (1), disagree (2), somewhat agree (3), agree (4), and strongly agree (5)), was preferred to others because it is the most elaborate measure of information technology use as it measures the use of both the internet and packaged software (e.g., WhatsApp) utilizing the internet. The scale is also relatively short and could, therefore, be easily completed by older adults. The three domains of the scale are *internet use assessment* (i.e., five items measuring the extent of use of the internet to access and share information), *packaged software use assessment* (i.e., 4 items measuring the extent of use of packaged software to share and access information), and *innovativeness attitude* (i.e., 4 items measuring the extent to which the individual experimented with new packaged software and internet-dependent technologies). This scale produced satisfactory internal consistency in the form of Cronbach's alpha $\alpha = 0.71$ (i.e., internet use assessment = 0.79; packaged software use assessment = 0.81; innovativeness attitude = 0.82). Appendix A shows items of the information technology use scale used.

Neighbourhood walkability was measured with the 11-item Australian version of the Neighbourhood Environment and Walkability Scale (NEWS-AU) adopted in whole from Asiamah et al. (2021). This scale was associated with the same descriptive anchors as information technology use, was used in whole, and produced a satisfactory internal consistency in the form of Cronbach's α coefficient = 0.71. Though NEWS-AU was originally validated in Australia, it was transferable to the current study because it produced satisfactory psychometric properties in previous studies (Asiamah et al., 2021; Bempong and Asiamah, 2022) focused on older adults in Ghana. Appendix B shows items of the neighbourhood walkability scale used. Social activity was measured with an 8-item scale adopted from Asiamah et al. (2021) measuring older adults' frequency of in-person social engagement in the neighbourhood. The scale produced a Cronbach's α coefficient = 0.85 and accompanied three descriptive anchors (i.e., never – 1; sometimes – 2; always – 3) that describe the frequency of participation in relevant social activities. A 'never' response describes not performing the social activity in a year (12 months); 'sometimes' describes performance of the activity at least once every 12 months, and 'always' describes performance of the activity at least once every month. Appendix C shows items of the social activity scale used. The data on walkability, information technology use, and social activity were generated by adding up all scores associated with items of the respective scales. Scores associated with the relevant items were also added up to generate the data on the three domains of information technology use. This step resulted in discrete data for each of the main variables.

Personal and demographic variables were measured in this study as potential confounding variables. Gender was measured as a categorical variable with two groups (i.e., male and female) whereas education was measured as a continuous variable of the individual's years of school. Age was measured as a continuous (discrete) variable by asking participants to report their age in years. Physical function was measured as a categorical variable with a method adopted from Bempong and Asiamah (2022). The specific question asked to measure physical function was: *on a scale of 1 to 4 (where 1 – not at all; 2 – to a low extent; 3 – to a moderate extent, and 4*

– to a high extent), to what extent can you perform physical tasks such as lifting a bucket of water unaided? Employment status was a categorical variable measuring whether the individual had a paid job or not (i.e., not employed, employed). Individual income was measured as a continuous variable by asking participants to report their gross monthly earnings in Ghana cedis. Finally, marital status (nor married, married) and self-reported health (i.e., poor, good) were measured as categorical variables. Since regression analysis supports only numerical variables, all categorical variables were dummy-coded before they were incorporated into our hierarchical linear regression analysis. In the process of creating the dummy variables, binary data were created for each group of the categorical variables and one group of the variable set as the reference. For example, 'men' was set as the reference for gender.

2.4. Instrumentation and measures against common methods bias

Data were gathered with a self-reported questionnaire with four main sections. The first section measured the demographic and personal variables whereas the second section measured information technology use. The third and fourth sections measured neighbourhood walkability and social activity respectively. The questionnaire had a preamble that introduced the study's aim and importance as well as instructions for completing all its sections. Two steps were taken to avoid or at least minimise common methods bias. First, questionnaire sections were organized distinctively as recommended in the literature (Bempong and Asiamah, 2022; Jakobsen and Jensen, 2015), the reason being to ensure that participants did not apply their understandings on a scale or section to another. In this regard, sections were separated by unique preambles describing the relevant scale and how to respond to it. The second step was a statistical technique involving the use of exploratory factor analysis to assess the factor structures of all psychometric scales used (Bempong and Asiamah, 2022). The exploratory factor analysis with varimax rotation on each scale was expected to produce a factor solution of at least two factors. This expectation was met as each scale produced more than 2 factors as shown as follows: neighbourhood walkability (3 factors; total variance = 89%); information technology use (3 factors; total variance = 91%), and social activity (3 factors; total variance = 82%). Thus, common methods bias was absent or minimal.

2.5. Identification of potential confounding variables

A confounding variable is any lurking variable that is correlated to the primary predictor in a relationship (Bempong and Asiamah, 2022; Morris et al., 2020). If so, personal factors that may be correlated to information technology use, the primary predictor in this study, can act as a confounder. In Ghana, English proficiency and literacy are required to use information technologies. As such, formal education is needed by the individual to use these technologies. Similarly, the ability to use information technologies is likely to be higher among those with higher education and income, which means that education and income can be associated with information technology use and can, therefore, serve as potential confounders. Younger people and individuals with paid employment may use information technology more frequently, which means that age and employment can also relate with information technology use and, therefore, confound the primary relationship. Finally, men and women may have different levels of access to information technologies due to socio-economic inequalities between men and women in Ghana (Asiamah, 2017), which means that gender can also confound the primary relationship of interest.

2.6. Data collection and ethics

This study received ethical clearance from an institutional review board (No. 004ACE2020) who reviewed the study protocol. The participants of the study also received and read the study's informed consent statement and subsequently consented to participate in the study. Four research assistants each accompanied by a dispatch rider administered questionnaires in sealed and stamped envelopes. While some participants received and completed questionnaires at designated health facilities where they received medical care within the study period, others received and completed questionnaires at home. Participants completed and returned their questionnaires over five weeks (January 3 to February 10, 2021) during which many of them were reminded via a phone call to complete the questionnaire. Data collection was ended after we realised no additional completed questionnaires could be retrieved. Out of 1149 questionnaires received, 890 were analysed; 203 were not completed at all whereas 56 were filled halfway.

2.7. Statistical analyses method

Data were analysed in two main phases with the Statistical Package for the Social Sciences (SPSS, IBM Inc. New York) version 28. The first phase of the analysis comprised a sensitivity analysis for the ultimate confounding variables and a descriptive analysis summarising the data. In the descriptive analysis, categorical variables were summarized with frequencies and percentages whereas continuous variables were summarized with the mean and standard deviation. Three categorical personal variables (i.e., gender, marital status, self-reported health) were associated with up to about 8% of missing data. Following previous studies (Asiamah et al., 2021; Bempong and Asiamah, 2022), we analysed the data with these missing items because none of the variables had up to 10% missing data points that were arranged in a row. Subsequently, the normality of the data associated with the main variables (i.e., social activity, walkability, information technology use) was assessed. The normality of data, which is a requirement for using linear regression (Casson and Farmer, 2014; Ernst and Albers, 2017), was evaluated by performing the Shapiro-Wilk test on relevant variables. The test on each variable was non-significant at $p > 0.05$, which evidenced the normality of the data as well as the absence of outliers in the data.

Other assumptions governing the use of multiple linear regression (i.e., linearity, multicollinearity, independence of errors) were assessed. Linearity was evaluated by generating a plot of standardised residuals against standardised predicted values of the dependent variable in regression models through which the primary relationships were assessed (Bempong and Asiamah, 2022). The resulting charts met the criteria recommended in the literature (Casson and Farmer, 2014; Ernst and Albers, 2017) and, therefore, evidenced the linearity of the relationships. Results on our assessment of multi-collinearity and independence of errors are presented later in this paper.

The exploratory analysis included a sensitivity analysis used in previous cross-sectional studies (Asiamah et al., 2021; Bempong and Asiamah, 2022) to identify the ultimate confounding variables. With this analysis, only potential confounders that are more likely to affect the primary relationships being assessed were identified and taken into the final analysis. This analysis comprised two main stages. At the first stage, the association between the potential confounding variables and the primary predictor (information technology use) was assessed through a multiple regression analysis. Potential confounders in this analysis with a $p \geq 0.25$ were removed from the analysis as shown in Table 1. Subsequently, the association between information technology use and social activity was assessed through a simple regression model. At the second stage, each of the potential confounders retained in stage 1 was adjusted for in the association between information technology use and social activity. The goal at this stage is to estimate the percentage change in the effect size (i.e., β coefficient) between information technology use and social activity due to the potential confounder. Potential confounders causing a 10% or higher change in the effect size were selected as the ultimate confounding variables for the final analysis. As shown in Table 1, three variables (i.e., age, physical function, self-reported health) were identified as the ultimate confounders in this study.

In the second phase, we employed hierarchical linear regression (HLR) analysis including another sensitivity analysis to examine the primary relationships. At this stage, 8 regression models were fitted. Models 1, 3, 5 and 7 were the baseline (non-adjusted) models excluding the ultimate confounding variables whereas models 2, 4, 6 and 8 were the confounder-adjusted models hereby called ultimate models. The conclusions of the study are based on the adjusted models. The second sensitivity analysis was about comparing the adjusted and non-adjusted models to see how the ultimate confounders affected the primary relationships. Model 1 tested the association between information technology use and social activity whereas model 2 built on this model by incorporating the ultimate confounders. Model 3 assessed the associations between social activity and the three domains of information technology use without including the ultimate confounders. Model 4 built upon model 3 by including the ultimate confounders.

Through models 5 to 8, we examined the moderating roles of walkability in the associations between information technology use (including its domains) and social activity. We focused on *pure moderation* (Bempong and Asiamah, 2022), which means we were interested in understanding how the strengths of the associations between information technology use (including its domains) and social activity were changed by walkability. To assess these moderating influences, we computed an interaction term representing the interaction between walkability and information technology use (i.e., ITU*NW). We subsequently computed similar terms representing the interaction between walkability and internet use assessment (i.e., IUA*NW); walkability and packaged software use assessment (i.e., PSUA*NW), and walkability and innovativeness attitude (i.e., IA*NW). Model 5 assessed the association between ITU*NW and social activity whereas model 6 built on this model to infuse the ultimate confounders. To generate the above terms, we used the 'compute function' in SPSS to multiply the relevant variables in their standardised forms. The interaction terms were not dichotomized, so they did not accompany cut-off values. Model 7 evaluated the associations between social activity and the domain-based interactions (i.e., IUS*NW, PSUA*NW, IA*NW) whereas model 8 built upon this model by incorporating the ultimate confounders. The statistical significance of the results was detected at a minimum of $p < 0.05$.

3. Findings

In Table 2 are summary statistics on the demographic characteristics of participants. About 44% (n = 395) of the participants were men whereas 55% (n = 490) were women. The average age of participants was about 67 years (Mean = 66.62; SD = 5.21), and the

Table 1
The ultimate confounders retained and removed in the sensitivity analyses.

Predictor	Stage 1			Stage 2		
	Beta	t	p	Adjusted Beta	Change in Beta	% Change in Beta
Simple model (Social activity as the outcome)						
Information technology use	0.123	3.71	<.001	–	–	–
Multiple models (information technology use as the DV at stage 1 and social activity as the DV at stage 2)						
Gender (ref – men)[a]	0.003	0.077	0.938	–	–	–
Education (yrs)[a]	0.001	0.532	0.621	–	–	–
Age (yrs)[c]	0.351	8.014	<.001	0.108	−0.015	−12%
Physical function[c]	0.067	1.677	0.094	0.100	−0.023	−19%
ES (ref – not employed)[b]	−0.075	−1.829	0.068	0.114	−0.009	−7%
Income (₵)[a]	0.012	0.276	0.783	–	–	–
MS (ref – not married)[b]	0.100	2.317	0.021	0.124	0.001	1%
SRH (ref – good)[c]	−0.215	−5.265	<.001	0.111	−0.012	−10%

Note: Adjusted Beta represents the beta values (standardised weights) resulting from the adjustment of the corresponding predictors. [a]variables removed at stage 1; [b]variables removed at stage 2; [c]ultimate confounders retained at stage 2; ES – employment status; MS – marital status; SRH – self-reported health; DV – dependent variable.

average social activity was about 20 (Mean = 19.78; SD = 2.66). Descriptive statistics on other variables are shown in Table 2. The bivariate correlation coefficients between relevant variables, many of which are weak, are shown in Table 3. Social activity was positively but weakly correlated to information technology use ($r = 0.123$; $p < 0.001$; two-tailed) and each of its domains at $p < 0.05$. Thus, larger social activity scores were associated with higher information technology use. Walkability is also positively but weakly correlated with information technology use, including each of its three domains at $p < 0.001$, which affirms that higher information technology use was associated with higher walkability. The weak nature of the correlations also suggests that the relationships between the variables are not strong.

In Table 4 (Model 2), information technology use has a positive association between social activity after adjusting for age, physical function, and self-reported health ($\beta = 0.07$; $t = 2.02$; $p < 0.05$), which confirms that higher social activity was associated with information technology use. In Model 4, only *packaged software use assessment* has a positive association with social activity ($\beta = 0.16$; $t = 2.53$; $p < 0.05$), which means that the influence of information technology use on social activity is attributable to this domain. In Model 6, the interaction between information technology use and walkability (i.e., ITU*NW) is positively associated with social activity ($\beta = 0.11$; $t = 3.09$; $p < 0.05$). Since $\beta = 0.07$ (i.e., the association between information technology use and social activity) is less than the coefficient of the interaction term ($\beta = 0.11$), walkability strengthened the positive association between information technology use and social activity. In Model 8, the interaction between walkability and packaged software use assessment (i.e., PSUA*NW) ($\beta = 0.37$; $t = 3.28$; $p = 0.001$) as well as innovativeness attitude (i.e., IA*NW) ($\beta = -0.24$; $t = -2.55$; $p < 0.05$) are associated with social activity, with the latter interaction having a negative association with social activity. Thus, walkability strengthened the relationships between two domains of information technology use and social activity. It can be observed that coefficients from the ultimate models (i.e., models 2, 4, 6, and 8) are different from coefficients of the baseline models (i.e., models 1, 3, 5, and 7), suggesting that the ultimate confounding variables influenced the primary relationships of interest. Each model in Table 4 shows a significant F-test at a minimum of $p < 0.05$, which implies that all models were good.

4. Discussion

This study examined the associations between older adults' information technology use and social activity as well as the moderating role of walkability in these relationships. It also investigated the associations between domains of information technology use and social activity and whether these associations are moderated by walkability.

The study found a positive association between information technology use and social activity, which suggests that higher information technology use was associated with more social activity. As reported in the introductory section, this finding is consistent with a growing body of studies (Boulianne, 2009; Chui et al., 2019; Duplaga, 2021) that have found or reported a positive association

Table 2
Demographic and personal variables of participants.

Variable	Group	Frequency/Mean	Per cent (%)/SD
Categorical variables			
Gender	Men	395	44.38
	Women	490	55.06
	Missing	5	0.56
	Total	890	100.00
Employment status	Not employed	140	15.73
	Employed	680	76.40
	Missing	70	7.87
	Total	890	100.00
Marital Status	Not married	155	17.42
	Married	705	79.21
	Missing	30	3.37
	Total	890	100.00
Self-reported health	Good	350	39.33
	Poor	530	59.55
	Missing	10	1.12
	Total	890	100.00
Continuous variables			
Education (yrs)	–	19.31	6.48
Age (yrs)	–	66.62	5.21
Physical function	–	2.18	0.47
Income (₵)	–	903.22	102.33
Social Activity	–	19.78	2.66
Walkability	–	36.13	6.33
Internet use assessment	–	17.21	2.56
Packed sotfware use assessment	–	13.83	1.81
Innovativeness attitude	–	13.80	1.99
Information technology use	–	44.84	5.67

Note: SD – standard deviation; Mean and SD apply to continuous variables whereas frequency and per cent apply to categorical variables.

Table 3
Bivariate correlations between relevant variables.

Variable	1	2	3	4	5	6	7	8	9
1. Social Activity	1	.110[a]	.140[a]	.082*	.123[a]	.121[a]	.071*	−0.011	−.084*
2. Internet use assessment		1	.761[a]	.617[a]	.911[a]	.476[a]	.257[a]	−0.045	−.123[a]
3. Packaged software use assessment			1	.697[a]	.908[a]	.419[a]	.238[a]	0.018	−.185[a]
4. Innovativeness attitude				1	.852[a]	.452[a]	.181[a]	0.025	−.104[a]
5. Information technology use					1	.507[a]	.255[a]	−0.006	−.151[a]
6. Walkability						1	0.025	−0.033	−.068*
7. Age (yrs)							1	−.167[a]	0.038
8. Physical function								1	0.027
9. Self-reported health (ref – good)									1

[a] $p < 0.001$; *$p < 0.05$.

between information technology use and social activity. More so, this study uniquely adds to the literature by confirming the foregoing relationship on an older sample from a developing country, Ghana. Studies (Boulianne, 2009; Duplaga, 2021; Hunsaker and Hargittai, 2018) suggest that research assessing this relationship has been predominantly conducted in high-income non-African countries. Moreover, an insignificantly small proportion of studies has focused on older adults, with none of these studies conducted in Africa (Hunsaker and Hargittai, 2018; Nguyen et al., 2020). So, this study makes a unique contribution to the gerontological and health promotion literature.

Among the three domains of information technology use, only packaged software use assessment, which is a measure of the extent to which older adults used packaged software such as WhatsApp, was associated with social activity. This result connotes that more social engagement was reported by older adults who reported higher use of packaged software. Within the scale used, packaged software use best describes social activities or behaviours encouraging social activities. For example, the item "I could share ideas and thoughts on specific topics through package software" (Please see Appendix A) is an indicator of the individual's ability to share information with social network members. As indicated in the introductory section, information sharing through packaged software can facilitate or result in social activity. Thus, packaged software use assessment, compared to the other two domains, comprises behaviours that could more conveniently (through the use of handy software such as WhatsApp) facilitate or result in social activity. Innovativeness attitude is a factor describing the ability of older adults to learn to use new technologies. Logically, learning to use a technology, compared to the ability to use the technology to share information (as measured with packaged software use assessment), is less likely to provide access to information for social activity. Internet use assessment is also a subscale describing the ability to use the internet in general to access or provide information. Since the internet is not necessarily accessible without packaged software, internet use assessment may not predict social activity among older adults or may be less associated with social activity, compared to packaged software use assessment. Further to this, many studies (Bano et al., 2019; Durst et al., 2013; J. Francis, 2022; Masip et al., 2021) have recognised packaged software such as WhatsApp and Telegram as a medium for sharing information about social events, health-seeking behaviours, and opportunities for engaging with society.

Consistent with our finding regarding the association between information technology use and social activity are the social capital theory of health (Szreter and Woolcock, 2004) and the Technology Acceptance Model (TAM) developed in the 1980s to explain factors influencing the adoption and use of technologies (Rahimi et al., 2018). The social capital theory of health assumes that people are likely to perform healthy behaviours such as social and physical activities if they have personal, economic, or psychosocial resources (e.g., trustworthy social ties, reciprocal ties, information technologies) needed to perform these behaviours. The TAM, in part, asserts that the use of a technology is influenced by perceived benefits and usefulness of the technology. Some studies (Holden and Karsh, 2010; Rahimi et al., 2018) have indicated that the perceived benefits of information technologies used in clinical practice and for health include access to health information that may encourage health-seeking behaviours. Research to date recognises social and physical activities as key health-seeking behaviours performed with information shared or accessed by individuals in a social network (Marcus et al., 1998; Tseng and Kuo, 2014), which is consistent with our confirmation of social activity as an outcome of information technology use. Since the use of information technology can also be associated with social isolation and disengagement (Tseng and Kuo, 2014), our confirmed association between information technology use and social activity suggests that older adults in this study may have used information technologies based on an initial assessment of potential benefits. This evaluation and their ability to use the technology likely impelled them to use relevant information technologies to perform tasks culminating in higher social activity. This view corroborates the idea that information technology can be a resource for accessing or providing information for social activities among individuals who have the potential to use it (Holden and Karsh, 2010; Rahimi et al., 2018). The TAM recognises the potential to use a technology as "perceived ability to use" (Rahimi et al., 2018), which complements one's awareness about the usefulness of the technology and precedes the actual use and benefit of the technology. If so, individuals who are not aware of the health benefits of information technologies may not use these technologies in ways that benefit their health.

Walkability positively moderated the association between information technology use and social activity, which means that information technology use was more strongly associated with social engagement in more walkable neighbourhoods. This result is a unique contribution of this study as no identifiable study has assessed and confirmed this moderating role of walkability. It is even more interesting to note that this role of neighbourhood walkability can be delineated with the person-environment (P-E) fit model of Cantor (1975), which argues that social and physical activities are higher in more walkable neighbourhoods where services, parks, green spaces, and related attributes can encourage engagement with the community or society. This framework adds that walkability

Table 4
The associations between information technology use, neighbourhood walkability, and social activity.

Model	Predictor	Coefficients			t	p	95% CI	Tolerance	Model fit			
		B	SE	Beta					R^2	Adjusted R^2	Durbin Watson	F
1	(Constant)	17.201	0.702		24.513	<.001	±2.76		0.015	0.014	–	13.740**
	Information technology use	0.058	0.016	0.123	3.707	<.001	±0.06	–				
2	(Constant)	17.713	1.446		12.246	<.001	±5.68					
	Information technology use	0.035	0.017	0.074	2.020	0.044	±0.07	0.897	0.013	0.008	2.090	2.719*
	Age (yrs)	0.017	0.019	0.034	0.918	0.359	±0.08	0.888				
	Physical function	−0.022	0.202	−0.004	−0.107	0.915	±0.79	0.969				
	SRH (reference – good)	−0.333	0.188	−0.062	−1.773	0.077	±0.74	0.974				
3	(Constant)	17.052	0.711		23.989	<.001	±2.79		0.02	0.017	2.100	6.138**
	Internet use assessment	0.015	0.054	0.014	0.271	0.786	±0.21	0.406				
	Packed sotfware use assessment	0.223	0.084	0.153	2.674	0.008	±0.33	0.337				
	Innovativeness attitude	−0.044	0.063	−0.033	−0.708	0.479	±0.25	0.496				
4	(Constant)	17.717	1.448		12.234	<.001	±5.69		0.021	0.013	2.100	2.840*
	Internet use assessment	0.006	0.058	0.006	0.111	0.911	±0.23	0.395				
	Packed sotfware use assessment	0.230	0.091	0.155	2.533	0.012	±0.36	0.321				
	Innovativeness attitude	−0.105	0.067	−0.079	−1.562	0.119	±0.26	0.468				
	Age (yrs)	0.013	0.019	0.024	0.657	0.511	±0.08	0.875				
	Physical function	−0.043	0.203	−0.008	−0.212	0.832	±0.80	0.959				
	SRH (reference – good)	−0.280	0.189	−0.053	−1.484	0.138	±0.74	0.962				
5	(Constant)	18.344	0.348		52.728	<.001	±1.37		0.020	0.019	–	18.250**
	ITU*NW	0.088	0.021	0.142	4.272	<.001	±0.08	–				
6	(Constant)	17.963	1.391		12.914	<.001	±5.46		0.020	0.015	2.100	4.090*
	ITU*NW	0.067	0.022	0.109	3.087	0.002	±0.09	0.965				
	Age (yrs)	0.020	0.018	0.038	1.080	0.281	±0.07	0.947				
	Physical function	−0.002	0.201	0.000	−0.009	0.993	±0.79	0.972				
	SRH (reference – good)	−0.329	0.186	−0.062	−1.769	0.077	±0.73	0.987				
7	(Constant)	18.262	0.350		52.157	<.001	±1.37		0.030	0.026	2.100	9.040**
	IUA*NW	−0.050	0.146	−0.033	−0.340	0.734	±0.58	0.119				
	PSUA*NW	0.668	0.214	0.331	3.125	0.002	±0.84	0.097				
	IA*NW	−0.305	0.166	−0.156	−1.836	0.067	±0.65	0.151				
8	(Constant)	18.127	1.386		13.079	<.001	±5.44		0.033	0.026	2.100	4.680**
	IUA*NW	−0.033	0.155	−0.021	−0.210	0.834	±0.61	0.116				
	PSUA*NW	0.744	0.227	0.369	3.275	0.001	±0.89	0.094				
	IA*NW	−0.458	0.179	−0.236	−2.554	0.011	±0.70	0.139				
	Age (yrs)	0.014	0.018	0.028	0.790	0.430	±0.07	0.937				
	Physical function	−0.028	0.200	−0.005	−0.141	0.888	±0.79	0.967				
	SRH (reference – good)	−0.264	0.186	−0.049	−1.417	0.157	±0.73	0.976				

Note: **$p < 0.001$; *$p < 0.05$; ¯Not applicable; SE – standard error; CI – confidence interval; NW – neighbourhood walkability; ITU – information technology use; IUA – internet use assessment; PSUA – packaged software use assessment; IA – innovativeness attitude.

factors are resources that can complement other social and economic resources to improve or encourage health-seeking behaviours. From this standpoint of the model, walkability is a resource that can spur the incremental influence of information technology use on social activity. In contexts of low walkability, a higher level of use of information technology may not encourage social activity because such communities do not provide the essential environmental factors (e.g., services, parks, peace, safety) necessary for social inclusion. Considering the high rate of use of information technology globally (Hunsaker and Hargittai, 2018; Nakagomi et al., 2022), opportunities for effectively using information technologies (e.g., availability of a strong internet connection) can be considered a potential domain of walkability. Our confirmed moderating role suggests that these opportunities may encourage social activities by enabling seniors to share and access information on social events and interactions. This reasoning is consistent with studies (Hunsaker and Hargittai, 2018; Duplaga, 2021) that have reported older adults' use of information technologies for accessing or providing information on social events and engagement. Our result, thus, suggests that interventions improving walkability do not only directly result in social and physical activities but also indirectly influence these healthy behaviours by providing a congenial environment where information accessed and shared through information technology translate into participation in events or organized group activities.

Furthermore, higher social activity was associated with higher packaged software use in neighbourhoods of higher walkability. This result indicates that the positive moderation role of walkability in the relationship between information technology use and social activity is limited to packaged software use assessment. It also further supports Cantor's (1975) recognition of the role of the environment in health-seeking behaviours in the sense that walkability resources in the community can make it easier for older adults to engage in social events and activities organized or facilitated through package software use. This notion is backed by commentaries describing different ways people including older adults have used packaged software to organize social events and access health information (Bano et al., 2019; Chiu, 2019; Durst et al., 2013). Also worth noting is the moderating influence of walkability between innovativeness attitude and social activity, a counter-intuitive outcome indicating that innovativeness attitude (which measures older adults' experimentation with new technologies) was associated with lower social activity in more walkable neighbourhoods. A potentially plausible explanation of this result is that people trying to use information technologies for the first time get engrossed with the technologies and, therefore, spend more time in social isolation. People's obsession with new technology can be linked to their anxiety to use the technology well, which implies that new users may not know how to use their technologies to the benefit of health behaviours and wellbeing. This thinking is congruent with the idea that experimentation with new information technology can cause anxiety and obsession with these technologies (Nakagomi et al., 2022; Wang et al., 2022).

With its findings, this study suggests that the use of information technologies does not necessarily discourage social activities among community-dwelling older adults in a developing country. Since information technology use can be associated with lower social engagement (Duplaga, 2021; Hofer and Hargittai, 2021; Hunsaker and Hargittai, 2018), our evidence suggests the possibility of older adults deliberately using information technologies to maintain or enhance their engagement with others. Thus, as explained by the TAM, older adults' use of information technologies depends on their awareness of the usefulness of these technologies and their appropriate use for health-seeking behaviours such as social activity. Our results, therefore, signify the importance of health education programmes aimed at training older adults to understand the health benefits of information technologies and appropriate ways to use these technologies for health. The moderating role of walkability in the association between packaged software use assessment and social activity also supports community design programmes aimed at improving walkability; these interventions can be expected to improve the potential contribution of information technologies to social activity. Decisions made by researchers and other stakeholders based on our results, nevertheless, must be cognizant of the limitations of this study. First, this study, as a cross-sectional design, does not establish causation between the variables. Future cluster-randomised controlled trials are, therefore, needed to establish causation between the variables. We also admit that our sample is relatively small and was determined with a non-probability selection procedure, which limits the generalisability of our results. Future studies utilizing nationally, regionally, or globally representative samples could improve upon the generalisability of our evidence.

Despite the above limitations, this study is important for a couple of reasons. First, this study is the first to provide more elaborate evidence by considering the associations between domains of information technology and social activity. By applying recommended procedures against common methods bias, we maximised the strength and internal validity of our study. We did not only adjust for confounding variables but also employed a two-stage sensitivity analysis screening for the ultimate sources of confounding and comparing adjusted and non-adjusted models. The first stage sensitivity analysis enabled us to avoid unnecessary confounders by screening for the ultimate confounders as done in some previous studies (Asiamah et al., 2021; Bempong and Asiamah, 2022). The second sensitivity analysis revealed the potential influence of the ultimate confounders on the regression models, thereby signifying the importance of our confounding adjustment. It can be observed that the adjusted and non-adjusted models accounted for different regression wights, suggesting that this study would have reported wrong associations if we did not adjust for the ultimate confounders. We also expect that our statistical analyses can be a model for future researchers given that our sensitivity analyses and efforts against common methods bias are recognised by standard checklists including STROBE (Strengthening the Reporting of Observational Studies in Epidemiology). According to STROBE, the best cross-sectional studies adjust for potential confounders, perform relevant sensitivity analyses, and minimise other forms of bias (von Elm et al., 2007). By designing this study in harmony with STROBE requirements, this study minimises bias and provides techniques that may benefit future research.

5. Conclusion

Information technology use among community-dwelling older adults can be associated with higher social activity. Even so, only *packaged software use assessment* was confirmed to be positively associated with social activity, probably because packaged software use assessment, compared to the other two domains, comprises behaviours that could more conveniently facilitate or result in social activity. As mentioned earlier, the internet is not necessarily accessible without packaged software, so internet use assessment may be less associated with social activity, compared to packaged software use assessment. Furthermore, information technology use more strongly predicts higher social activity in more walkable neighbourhoods, suggesting that walkability resources such as services, parks, and safety facilitate social engagement through information technology use. While walkability enhanced the positive association between packaged software use assessment and social activity, it increased the strength of the negative association between innovativeness attitude and social activity. This study concludes that information technology use in terms of internet use assessment can facilitate social activity among older adults. Moreover, while internet use assessment is likely to be more positively associated with social engagement in higher walkability, experimentation with new information technologies could discourage social activity in higher walkability.

Ethical statement

This study received ethical review and approval from an institutional review board (No. 004ACE2020) in Accra, Ghana. All participants provided informed consent to participate in this study.

Author contribution

NA conceived the research idea and wrote the original manuscript. AK, HTAK, SP, and SWM critically reviewed the manuscript and recommended ways to improve the draft manuscript. All authors proofread and approved the original draft of the manuscript.

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Declaration of competing interest

The authors declared no conflicts of interest.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jth.2022.101480.

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