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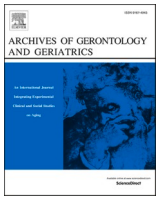

Information technology ability mediates the association between older adults' subjective age and social activity: A STROBE-compliant cross-sectional analysis

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ABSTRACT

Background: The association between subjective age and social activity has been reported in the extant literature, but whether this association is mediated by information technology ability and its domains (i.e., *internet use assessment, packaged software use assessment,* and *innovativeness attitude*) has not been examined.
Aim: To assess the association between subjective age and social activity and to ascertain whether this association is mediated by information technology ability.
Methods: This study adopted a cross-sectional design characterising sensitivity analyses and common methods bias. The participants were 895 community-dwelling older adults aged 60 years or higher in Accra, Ghana. We measured subjective age, information technology ability, and social activity with previously validated Likert scales, each of which was internally consistent at a Cronbach's $\alpha \geq 0.7$. The data were analysed with partial least squares structural equation modelling (PLS-SEM) and hierarchical linear regression (HLR) analysis.
Results: Subjective age was positively associated with social activity, and this association was partially mediated by information technology ability but none of the three domains of information technology ability mediated this relationship. Subjective age was positively associated with information technology ability and its three domains. Information technology ability (but not its domains) was positively associated with social activity.
Conclusion: Older subjective age was associated with higher social activity through information technology ability. Social activity and information technology ability levels among older adults depend on subjective age, which has implications for ageing and gerontology as reported in this paper.

1. Introduction

Empirical research has evidenced that social activity can support the maintenance of health over the life course (Bath & Deeg, 2005; Luo et al., 2020; Ramsay et al., 2008). Social activity also protects against long-term conditions such as stroke, hypotension, and dementia (Kamiya et al., 2010; Ramsay et al., 2008; Saczynski et al., 2006). Older people develop, maintain, or replenish social ties and support in later life in the way of social engagement (Asiamah et al., 2021; Ryan et al., 2008). As such, enabling older adults to maintain social activity can be considered an apex public health improvement strategy. Studies have confirmed information technology use at the individual level as one of the ways to maintain or enhance social activity (Yu & Chao, 2014; Yu et al., 2022). Khan et al. (2016) affirm that information technologies (e.g., social media) are used by older adults for building online social connections, which facilitate neighbourhood social engagement. Online social interactions are the budding stage of in-person social activities through which older adults secure community identity and maintain normal engagement with life (Khan et al., 2016; Ollevier et al., 2020).

Despite researchers agreeing that information technologies play a role in social participation in old age (Chiu, 2019; Kim et al., 2017), there is limited research on information technologies for older adults

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and ageing (Kim et al., 2022; Ollevier et al., 2020). Though information technology ability is low among older adults (Chiu, 2019; Nakagomi et al., 2022; Xu & Huang, 2021; Yu & Chao, 2014) and is necessary for the effective use of information technologies, it is among the least studied aspects of information technology, especially in relation to social activity (Khan et al., 2016). We define information technology ability as being able to use information technologies independently to communicate with others (Yu & Chao, 2014). Effective use of information technology for social activity would be high at higher information technology ability since the beneficial use of technology requires relevant skills such as the ability to experiment with new features (Yu & Chao, 2014). *The first objective of this study was to assess for the first time the association between information technology ability and social activity among older adults* in response to recent calls for research (Kim et al., 2017; Ollevier et al., 2020).

Another factor that can predict older adults' social activity but has not been sufficiently studied is subjective age (Takatori et al., 2018), which is defined as how old people think they are, regardless of their chronological age (Seifert & Wahl, 2018). People can either feel younger (younger subjective age) or older (older subjective age) than their actual (chronological) age, and several factors determine this feeling, with common examples being health, cognitive skills, physical functional ability, life experiences tied to culture, and the age of the individual's social ties (Bergland et al., 2014; Bergman & Shrira, 2022; Seifert & Wahl, 2018). Individuals with poor health, physiological limitations, and specific life experiences (e.g., becoming a grandparent early in life or around age 40) are likely to report a older subjective age or an age higher than their chronological age. Noteworthy is the idea that subjective age can influence multiple behaviours such as social activity and information technology ability (Bergland et al., 2014; Bergman & Shrira, 2022; Yu & Chao, 2014). For instance, reported associations between subjective age and information technology use (Seifert & Wahl, 2018), subjective age and social activity (Takatori et al., 2018), and information technology use and social activity (Khan et al., 2016) connote that subjective age can predict social activity and information technology ability, with the latter serving as a mediator. This mediation means that information technology ability can be associated with subjective age and can transmit its influence from subjective age to social activity. *The second objective was to examine this potential mediation role.*

We addressed the above objectives by testing hypotheses presented

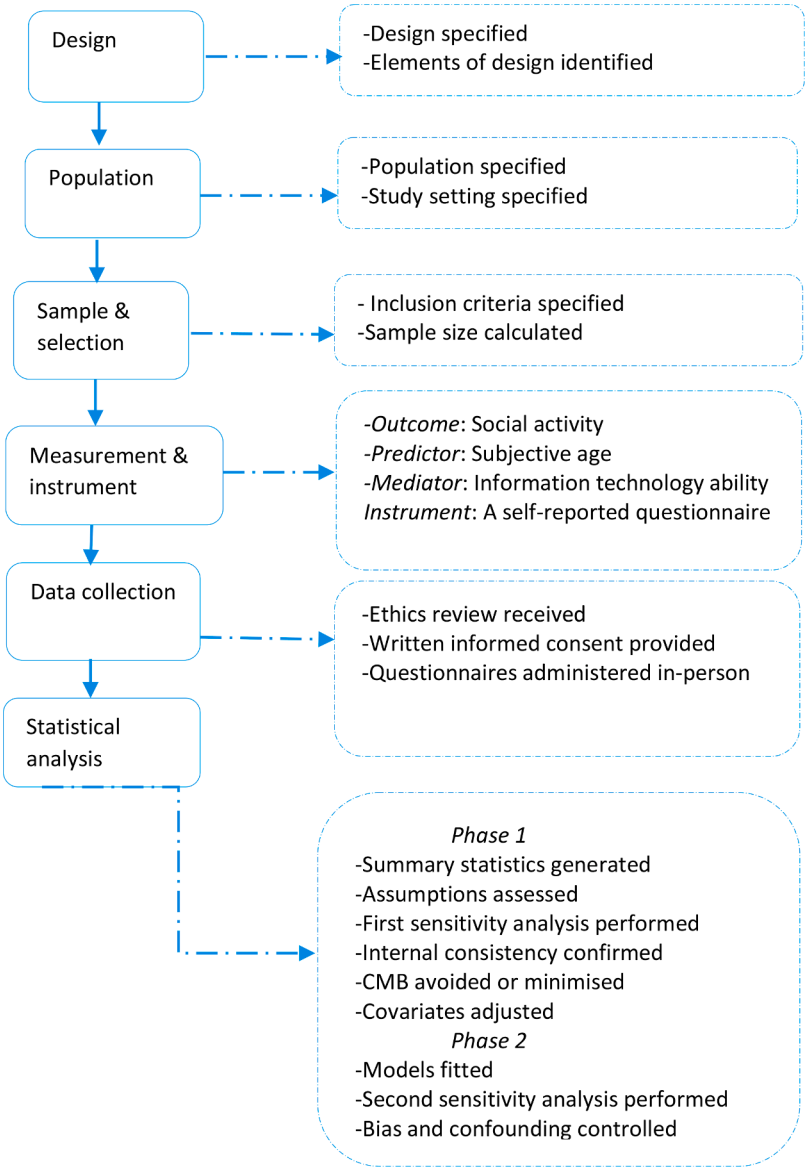

Fig. 1. A flow chart of the STROBE-compliant design applied
Note: CMB – common methods bias.

later as part of our models. The main problem addressed is the non-availability of empirical evidence on the above mediation role in a healthy ageing context, which we deem a major shortcoming in gerontology since technologies have become a normal part of life for older adults, and it is high time gerontologists incorporated information technology use and its ability into key healthy ageing theories. We, therefore, tested the above mediation to proffer implications for ageing in the context of the activity theory of ageing (ATA) and continuity theory of ageing (CTA), which are further discussed later in this paper. Finally, the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) is a standard checklist and guideline for designing cross-sectional studies, but most cross-sectional studies do not comply with it (Eluwole et al., 2022; Marques-Sulé et al., 2021). In this study, we seize the opportunity to apply a STROBE-compliant cross-sectional design to guide future gerontological research.

2. Methods

2.1. Design

This study adopted a cross-sectional design characterised by sensitivity analyses and common methods bias. Sensitivity analyses and measures against confounding and common methods bias (CMB) were performed in harmony with the STROBE. Fig. 1 is a flowchart of our design.

2.2. Population, sample, and selection

The population was community-dwelling older adults aged 60 years or higher who were permanent residents of Accra, Ghana. These older adults were predominantly retired workers who depended on their gratuity, were members of a research registry recently used in some studies (Asiamah et al., 2021; Bempong & Asiamah, 2022), and met the following inclusion criteria: 1) being a permanent resident of Accra; 2) having a minimum of a basic education, which we used as an indicator of the ability to complete questionnaires in English; 3) not having any health condition that precluded PA, and 4) willingness and readiness to complete the survey. Through a phone call performed over a week, members of the registry were screened against the above criteria, but 102 individuals were not reached, so 1,090 older adults were selected for the study. We used the G*Power 3.1.9.4 software with relevant statistics (effect size = 0.2; α = 0.05; power = 0.8) to calculate the minimum sample size necessary. The minimum sample reached was 91. To maximise generalisability and power, we gathered data on all the eligible individuals.

2.3. Variables and their measurement

The primary variables of this study were subjective age, information technology ability, and social activity. Subjective age was measured using a 4-item scale with 7 descriptive anchors (i.e., 20s – 2, 30s – 3, 40s – 4, 50s – 5, 60s – 6, 70s – 7, 80s – 8) adopted in whole from a previous study (Goldsmith & Heiens, 1992). This scale produced a satisfactory Cronbach's α = 0.75 and was scored according to the above study. Its scores ranged from 8 to 32, with higher scores indicating older subjective age. Appendix 1a shows the scale used to measure subjective age. Information technology ability was measured with a 13-item scale with 5 descriptive anchors (i.e., *strongly disagree – 1; disagree – 2; somewhat agree – 3; agree – 4; strongly agree – 5*) adopted in whole from a previous study (Yu & Chao, 2014). This was the only validated scale measuring information technology ability and comprised three domains, namely *internet use assessment* (5 items), *packaged software use assessment* (4 items), and *innovativeness attitude* (4 items). Internet use assessment measures the ability to use the internet safely; packaged software use assessment measures the ability to safely use packaged software (e.g., WhatsApp) to communicate, and innovativeness attitude is the ability to experiment with new packaged software and related technologies. The scale produced a satisfactory Cronbach's α = 0.71 (innovativeness attitude = 0.82; packaged software use assessment = 0.81; internet use assessment = 0.79). Appendix 1b shows items of the information technology ability scale used. Social activity was measured with an 8-item scale with three descriptive anchors (i.e., *not at all – 1; sometimes – 2; always – 3*) adopted in whole from a recent study (Asiamah et al., 2021). This scale measures the frequency of social activity in the community and produced a Cronbach's α = 0.76. Appendix 1c shows the scale used to measure social activity.

2.3.1. Potential confounding variables

Variables previously found to predict subjective age and could, therefore, confound the primary relationships were also measured. These variables are gender, education, income, physical function, chronological age, employment status, marital status, and self-reported health (Soylu, 2022; Stephan et al., 2013). We followed previous studies (Asiamah et al., 2021; Bempong & Asiamah, 2022; Soylu, 2022) to measure these variables. Gender was measured as a categorical variable (male – 1; female – 2). Education was measured as a continuous variable and as the number of years of schooling whereas income was measured as the individual's net income in Ghana cedis. Physical function was measured with a single item with four descriptive anchors (i.e., not at all – 1, low extent – 2; moderate extent – 3; high extent – 4) indicating the extent to which the individual could perform physical tasks unaided (Asiamah et al., 2021). Chronological age was measured as the individual's actual age whereas employment status was measured as a categorical variable with two groups (i.e., married – 1; not married – 2). Employment status (i.e., employed – 1; not employed – 2) and self-reported health (i.e., good – 1; poor – 2) were also measured as categorical variables. All categorical variables were coded into dummy-type variables for statistical modelling.

2.4. The questionnaire and measures against common methods bias

A self-administered questionnaire comprising four main sections was used to gather data. The first section presented items on subjective age whereas the second section measured information technology ability. The third and fourth sections measured social activity and the demographic or confounding variables respectively. The questionnaire had an introductory section where the study aim, ethics statement, and instructions for survey completion were captured. We followed some studies (Bempong & Asiamah, 2022; Jakobsen & Jensen, 2015) to avoid or minimise CMB with *Herman's one-factor method*. At the study design stage, we separated sections with preambles to scales to ensure that responses to a scale did not affect responses to other scales. At the statistical analysis stage, we performed exploratory factor analysis (EFA) with a varimax rotation on each scale. The resulting factor solution was satisfactory for all scales: information technology ability (3 factors, variance = 73%, loadings ≥0.5), subjective age (3 factors, variance = 89%, loadings ≥0.5), and social activity (3 factors, variance = 67%, loadings ≥0.5). These statistics reflect low or no CMB in our data.

2.5. Data collection approach

This study received ethics approval from an institutional ethics review committee in Accra (No. 001-2022ACE) after the study protocol was reviewed. All the participants provided written informed consent to participate. Three field assistants supported by two courier drivers administered questionnaires in sealed and stamped envelopes at the homes of participants. The participants were given two weeks to complete and return their questionnaires through the research assistants and courier drivers. An extra week was given to the participants who could not return their completed questionnaires within the initial two weeks. Data collection was closed after four weeks when it was not possible to retrieve newly completed questionnaires. Thus, data collection lasted

about four weeks (January 15 – February 16, 2022). A total of 902 questionnaires were returned, but 7 were discarded because they were not completed at all or were completed halfway. So, 895 questionnaires were analysed.

2.6. Statistical analysis methods

We analysed the data with SmartPLS 3 and SPSS 28 (IMB Inc., New York). Two main phases of data analysis were performed; the first phase was focused on using SPSS to summarise the data, test relevant assumptions, and conduct the first sensitivity analysis. None of the variables accounted for more than 8% of missing data, and the missing data were removed in the PLS-SEM. In the second phase, the relevant models were fitted with PLS-SEM to test the hypotheses. Figs. 1 and 2 show the hypotheses tested. As part of the exploratory analyses, basic assumptions (i.e., multivariate normality, linearity, multicollinearity, independence of errors, homoscedasticity) governing the use of PLS-SEM and hierarchical linear regression (HLR) analysis were assessed based on recommendations and previous studies (Bempong & Asiamah, 2022; Garson, 2012). Appendix 2a shows the steps followed in the statistical assessment of these assumptions. Subsequently, the first sensitivity analysis was performed with the HLR analysis based on a previous procedure (Bempong & Asiamah, 2022; Rezai et al., 2009) to screen for the ultimate confounding variables. This analysis revealed income and chronological age as the ultimate confounders. Appendix 2b shows the steps taken in the first sensitivity analysis.

In the second phase of the analysis, we fitted four structural (reflective) models; two baseline models that excluded the ultimate confounders (i.e., models 1 and 2) and two ultimate models that included or adjusted for the ultimate confounders (i.e., models 3 and 4). Model 1 tested the association between subjective age, information technology ability, and social activity, with emphasis on the mediation role of subjective age. Model 2 is the disaggregated version of model 1 as it examines the mediation role of information technology ability that is disaggregated into its three domains. Model 3 (Fig. 2) builds on model 1 by infusing the ultimate confounders whereas model 3 (Fig. 3) builds on model 2 by incorporating the ultimate confounders. Direct and indirect coefficients and their significance were computed to assess partial or full (complete) mediation. *Partial mediation* is confirmed if subjective age directly predicts social activity and has an indirect influence on social activity through information technology ability (Leroux et al., 2012; Ohrnberger et al., 2017). *Complete mediation* is confirmed if subjective age does not directly predict social activity but predicts social activity through information technology ability. In the second sensitivity analysis, we compared the baseline and ultimate models to see potential changes in the coefficients due to the ultimate confounding variables. The conclusions of this study were based on the ultimate models. A satisfactory overall model fit was achieved for our ultimate models with the standardised root mean square residual (SRMR) <0.08 as recommended (Obery & Bangert, 2017), and the statistical significance of the result was detected at a minimum of $p<0.05$.

3. Findings

Table 1 shows key findings from the sensitivity analysis for confounding variables. In the table, only income and chronological age produced a minimum change of 10% in the beta (β) coefficient and, therefore, qualified as the ultimate confounding variable. As such, only these two variables were infused in the ultimate models. Table 2 shows the summary characteristics of the participants. The average chronological age is about 67 years (Mean = 66.64; SD = 5.2) whereas the average subjective age is about 25 (Mean = 25.14; SD = 3.09).

Table 3 shows bivariate (Pearson's) correlations between relevant variables; this table shows a positive correlation between subjective age and social activity ($r = 0.15$; $p <0.001$; two-tailed) as well as information technology ability ($r = 0.44$ $p <0.001$; two-tailed) and its three domains. Thus, higher social activity and information technology ability was associated with older subjective age.

Table 4 shows results from the four models fitted. The first ultimate model (i.e., model 3) shows that subjective age has a direct positive association with information technology ability ($\beta = 0.44$; $t = 16.67$; $p <0.001$) and social activity ($\beta = 0.12$; $t = 3.59$; $p <0.001$) after adjusting for income and chronological age. Information technology ability has a positive association with social activity ($\beta = 0.07$; $t = 4.02$; $p <0.001$). The indirect association between subjective age and social activity through information technology ability ($\beta = 0.03$; $t =4.04$; $p<0.001$) is significant; this represents a partial mediation of information technology ability. Our data, thus, support the first three hypotheses (H_1, H_2, and H_3). Further to the above, subjective age has a direct positive association with the three domains of information technology ability at $p<0.001$,

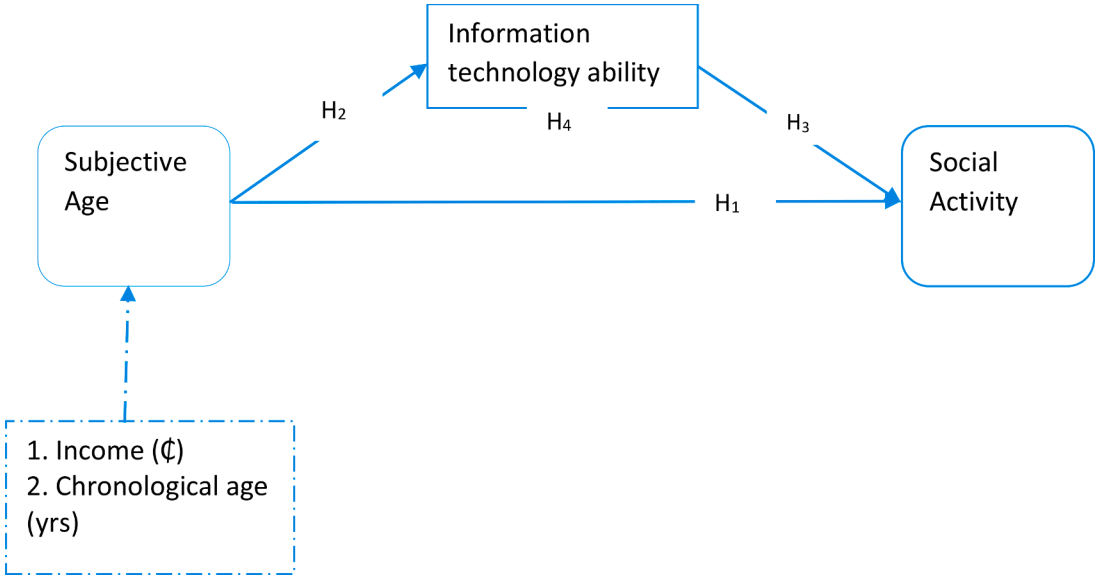

Fig. 2. The association between subjective age, information technology ability, and social activity (first ultimate model, model 3).
Note: H_1 – the potential association between subjective age and social activity; H_2 – the potential association between subjective age and information technology ability; H_3 – the potential association between information technology ability and social activity; H_4 – the mediation role of information technology ability.

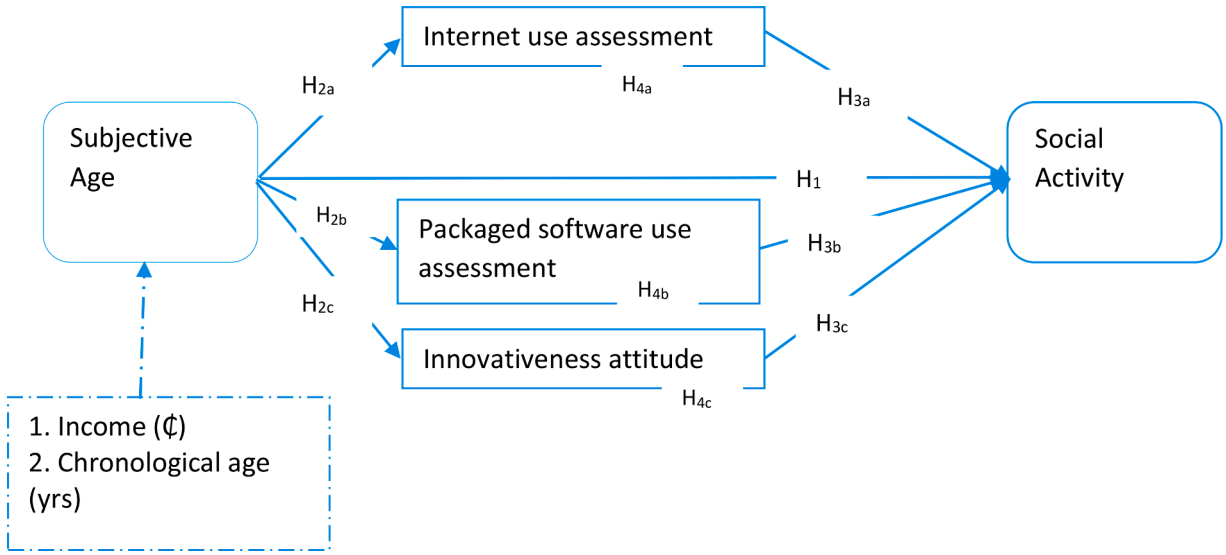

Fig. 3. The association between subjective age, information technology ability, and social activity (second ultimate model, model 4).
Note: H_1 – the potential association between subjective age and social activity; H_{2a} – the potential association between subjective age and internet use assessment; H_{2b} – the potential association between subjective age and packaged software use assessment; H_{2c} – the potential association between subjective age and innovativeness attitude; H_{3a} – the potential association between internet use assessment and social activity; H_{3b} – the potential association between packaged software use assessment and social activity; H_{3c} – the potential association between innovativeness attitude and social activity; H_{4a} – the mediation role of internet use assessment; H_{4b} – the mediation role of packaged software use assessment; H_{4c} – the mediation role of innovativeness attitude.

Table 1
A summary of key findings from the first sensitivity analysis.

Predictor	Stage 1			Stage 2		
	Beta	t	p	Adjusted Beta	Change in Beta	% Change in Beta
Simple model (Social activity as dependent variable)						
Subjective age	0.157	4.64	<.001	—	—	—
Multiple models (Subjective age as the DV at stage 1 and social activity as the DV at stage 2)						
Gender (ref – men)[b]	0.114	3.215	<.001	0.162	0.005	3%
Age (yrs)[c]	0.528	13.797	<.001	0.141	-0.016	-10%
Education (yrs)[a]	0.001	0.191	0.821	—	—	—
Physical function[a]	-0.009	-0.263	0.792	—	—	—
ES (ref – not employed)[a]	0.034	0.96	0.337	—	—	—
Income (¢)[c]	-0.224	-6.073	<.001	0.104	-0.053	-34%
MS (ref – not married)[b]	0.146	3.896	<.001	0.158	0.001	1%
SRH (ref – good)[b]	-0.161	-4.506	<.001	0.150	-0.007	-4%

Note: DV – dependent variable; ES – employment status; MS – marital status; SRH – self-reported health
[a] potential confounding variables removed at stage 1 of the sensitivity analyses
[b] potential confounding variables removed at stage 2 of the sensitivity analyses
[c] variables retained as the ultimate confounding variables.

but none of these domains has a significant association with social activity ($p>0.05$). Moreover, the indirect associations between subjective age and social activity through these domains were not significant ($p>0.05$). So, 3 sub-hypotheses of the disaggregated model (H2a-H2c) were supported by our data, but the other 6 (H3a-H3c; H4a-H4c) were not. Table 4 shows changes in the coefficients (e.g., β, t) between the baseline and ultimate models due to the confounding variables, which signify the importance of our adjustment for confounding.

4. Discussion

This study assessed the association between subjective age and social activity as well as the mediation role of information technology ability in this relationship. Four hypotheses were tested between two ultimate models.

This study found a positive association between subjective age and social activity, which suggests that higher social activity was associated with older subjective age. This result confirms the first hypothesis and has implications for the ATA propounded by Havighurst (1961) and for the CTA developed by Atchley (1989). The CTA posits that older people can maintain or enhance social and physical activities in late life by adapting previous experiences and abilities. Though a decline in social and physical activities over the life course due to the individual losing social, cognitive, and environmental resources in the ageing process is also considered a regular phenomenon of ageing (Asiamah, 2017; Asiamah et al., 2021; Duedahl et al., 2020), this proposition of the above ageing theories has been confirmed in research in contexts where older adults have maintained social support, access to neighbourhood resources such as services and parks, and relevant opportunities in the form of access to relevant technologies and health education (Duplaga, 2021; Wan et al., 2022). Thus, our result suggests that the participants of this study may have had one or more of these resources and opportunities. Some studies (Asiamah, 2017; De Cocker et al., 2014; Professions, 2021) have reported that retired older adults with some formal education may have the above resources including health literacy and the ability to access services and support. Since our participants had a minimum of basic education and were retired workers, the above argument well explains our result. A higher social activity at older

Table 2
Summary statistics on personal characteristics and main variables.

Variable	Group	M/n	SD/%
Continuous variables			
Education (yrs)	—	18.32	4.21
Chronological age (yrs)	—	66.64	5.20
Physical function	—	2.18	0.46
Income (₵)	—	1111.94	623.45
Subjective Age	—	25.14	3.09
Internet use assessment	—	17.21	2.56
Packed sotfware use assessment	—	13.83	1.81
Innovatiness attitude	—	13.80	1.99
Information technology user ability	—	44.84	5.67
Social Activity	—	19.78	2.65
Categorical variables			
Gender	Men	405	45.25
	Women	490	54.75
	Total	895	100
Employent status	Not employed	145	16.2
	Employed	680	75.98
	Missing	70	7.82
	Total	895	100
Marital Status	Not married	155	17.32
	Married	710	79.33
	Total	895	100
Self-reported health	Good	355	39.66
	Poor	530	59.22
	Missing	10	1.12
	Total	895	100

Note: — Not applicable; M – mean; SD – standard deviation; n – frequency; % - per cent; M and SD apply to continuous variables only whereas n and % apply to categorical variables only.

subjective age suggests that remaining socially engaged may also be influenced by how ageing people feel about their age, not only by their actual age. This idea calls for a reframing of healthy ageing through the CTA and ATA as later discussed.

This study also found a positive association between subjective age and information technology ability and its domains, which means that higher information technology ability was reported by older adults who reported older subjective age. This result supports our second hypothesis and further supports the CTA and ATA, which both premise in part that ageing people can maintain or enhance abilities (i.e., information technology ability) in old age if they can adapt previous competencies, resources, and experiences. This result also aligns with results from a study indicating that older adults feel older when they use information technologies (Caspi et al., 2019). Since information technology ability is a requirement for the use of technologies, their argument suggests that older adults can feel older with a high ability to use information technologies. Their argument was, nevertheless, opposed by Seifert and Wahl (2018) who observed that older adults feel younger when using information technologies. More so, a study in Japan found that higher social activity was associated with lower subjective age (Takatori et al., 2018). This study, nonetheless, employed a different method to measure and code subjective age, which might have explained the difference.

Putting the imports of the foregoing researchers and ageing theories together, we reason that higher information technology ability can be associated with older or younger subjective age depending on attributes of older people. Older adults may feel older than their actual age though they have higher information technology ability, possibly because they use the technologies to perform tasks (e.g., accessing services including healthcare) that identify them with peers older than they are. These tasks may also be interpreted by socially active older people as activities meant for their seniors (i.e., peers older than they are), which can result in older subjective age (Vaportzis et al., 2017). This reasoning is consistent with the idea that older adults who engage with colleagues who are older than they are may report older subjective age though they have resources and abilities that enable them to perform social activities very frequently (Bergland et al., 2018; Bergman & Shrira, 2022). Their counterparts who engage in life with people younger than they are (possibly via social networks) may feel younger.

Information technology ability partially mediates the association between information technology and subjective age, which has two implications. First, information technology ability transmits the influence it receives from subjective age to social activity, which signifies the potential of subjective age predicting multiple behaviours including a mediator of its potential influence. Secondly, subjective age can be associated with health-seeking behaviours independent of chronological age. This deduction is based on our inclusion of chronological age as an ultimate confounder or covariate. So, though chronological age and subjective age are expected to be strongly correlated as reported in the literature (Goldsmith & Heiens, 1992) and seen in this study (see Table 3), the latter is potentially a unique variable and predictor of behaviours. If so, gerontologists need to consider both chronological age and subjective age as independent potential covariates in their studies and empirical models. By this recommendation, we recognise the failure of studies to adjust for subjective age as a potential covariate in their models or studies as a potential source of bias. We would also want to note that domains of information technology ability did not mediate the primary relationship possibly because of the relatively small sample used or the relative weakness of the association between these domains and social activity. This outcome unfolds a need for future research to consider larger samples with a higher statistical power.

4.1. Implications for theory and healthy ageing

The foremost theoretical implication concerns the link between information technology ability and social activity as well as subjective age. The relationship between information technology ability and social activity is consistent with the Technology Acceptance Model (TAM), which premises that the ability to use a technology precedes the actual use of the technology and benefits of the technology (Holden & Karsh, 2010; Rahimi et al., 2018). Since social activity has been established as a pro-health behaviour that contributes to healthy ageing, it can be one of the benefits accompanied by information technology ability. Our result also implies that subjective age could be one of the other factors that the TAM recognises as a determinant of the ability to use technologies (Rahimi et al., 2018). Deductively, subjective age is an antecedent of information technology ability, which in turn potentially produces a benefit in the form of social activity. Another implication is that the ATA

Table 3
Bivariate correlations between subjective age, information technology ability, social activity, and the ultimate confounders.

Variable	1	2	3	4	5	6	7	8
1. Subjective Age	1	.450**	.361**	.352**	.442**	.153**	.500**	-.239**
2. Internet use assessment		1	.761**	.617**	.911**	.110**	.257**	0.023
3. Packed software use assessment			1	.697**	.908**	.140**	.238**	0.022
4. Innovatiness attitude				1	.852**	.082*	.181**	-0.025
5. Information technology ability					1	.123**	.255**	0.009
6. Social Activity						1	.071*	-.134**
7. Chronological age (yrs)							1	-.248**
8. Income (₵)								1

**p<0.001; *p<0.05.

Table 4
The associations between subjective age, social activity, information technology ability, and the ultimate confounders.

Path	Original Beta (β)	Beta (β)	SD	t	p	95% CI
Model 1						
Direct coefficients						
Information Technology Ability -> Social Activity	0.069	0.07	0.017	4.021	p<0.001	±0.07
Subjective Age -> Information Technology Ability	0.442	0.443	0.025	17.391	p<0.001	±0.10
Subjective Age -> Social Activity	0.123	0.118	0.037	3.291	p<0.001	±0.15
Indirect coefficients						
Subjective Age -> Information Technology Ability -> Social Activity	0.03	0.031	0.008	4.048	p<0.001	±0.03
Model 2						
Direct coefficients						
Innovativeness attitude -> Social activity	-0.05	-0.038	0.072	0.695	0.487	±0.29
Internet use assessment -> Social activity	-0.037	-0.034	0.035	1.057	0.291	±0.14
Packaged software use assessment -> Social activity	0.156	0.144	0.082	1.913	0.056	±0.33
Subjective age -> Innovativeness attitude	0.352	0.351	0.025	14.069	p<0.001	±0.10
Subjective age -> Internet use assessment	0.45	0.451	0.029	15.344	p<0.001	±0.12
Subjective age -> Packaged software use assessment	0.361	0.361	0.026	13.819	p<0.001	±0.10
Subjective age -> Social activity	0.131	0.127	0.038	3.486	0.001	±0.15
Indirect coefficients						
Subjective age -> Packaged software use assessment -> Social activity	0.056	0.052	0.03	1.858	0.063	±0.12
Subjective age -> Innovativeness attitude -> Social activity	-0.018	-0.013	0.026	0.691	0.49	±0.10
Subjective age -> Internet use assessment -> Social activity	-0.017	-0.016	0.016	1.033	0.302	±0.07
Model 3						
Direct coefficients						
Information Technology Ability -> Social Activity	0.069	0.071	0.017	4.015	p<0.001	±0.06
Subjective Age -> Information Technology Ability	0.442	0.443	0.027	16.672	p<0.001	±0.11
Subjective Age -> Social Activity	0.123	0.119	0.034	3.586	p<0.001	±0.13
Age (yrs) -> Subjective Age	0.47	0.471	0.027	17.251	p<0.001	±0.11
Income (₵) -> Subjective Age	-0.115	-0.113	0.031	3.737	p<0.001	±0.12
Indirect coefficients						
Subjective Age -> Information Technology Ability -> Social Activity	0.03	0.031	0.008	4.039	p<0.001	±0.03
	Model 4					
Direct coefficients						
Information Technology Ability -> Social Activity	0.069	0.071	0.017	4.015	p<0.001	±0.29
Subjective Age -> Information Technology Ability	0.442	0.443	0.027	16.672	p<0.001	±0.14
Subjective Age -> Social Activity	0.123	0.119	0.034	3.586	p<0.001	±0.34
Age (yrs) -> Subjective Age	0.47	0.471	0.027	17.251	p<0.001	±0.11
Income (₵) -> Subjective Age	-0.115	-0.113	0.031	3.737	p<0.001	±0.12
Indirect coefficients						
Subjective age -> Packaged software use assessment -> Social activity	0.056	0.053	0.031	1.804	0.072	±0.13
Subjective age -> Innovativeness attitude -> Social activity	-0.018	-0.014	0.026	0.683	0.495	±0.10
Subjective age -> Internet use assessment -> Social activity	-0.017	-0.016	0.017	0.981	0.327	±0.07

Note: SD – standard deviation (of the original β); CI – confidence interval (of the original β); conclusions are based on original β.

can be modified to recognise subjective age, not only chronological age, as a central factor whose change may affect health outcomes or behaviours. Similarly, healthy ageing should not be framed around only chronological age; the framing of ageing by gerontologists should consider subjective age as well. Putting the above implications together, an overlap between the TAM and ATA is evident. We are of the view that this overlap can further be studied in the form of research investigating the role of information technology ability and related variables in models linking health behaviours, health, and personal factors (e.g., subjective age and chronological age). This overlap signifies the role of information technology in healthy ageing as recently demonstrated by some calls for gerontological research (Sixsmith et al., 2017; Yu & Chao, 2014). Therefore, developing a research agenda for understanding it may improve stakeholders' understanding of how to support healthy ageing with information technologies.

Furthermore, feeling older than one's age is an additional predictor of social activity as well as information technology ability and possibly other abilities. This result is important for two main reasons. First, it suggests that simply feeling older may encourage health-driven behaviours such as social activity in ways that benefit healthy ageing if well understood, encouraged, and monitored at the individual and population level. This said, our study unfolds a need for qualitative research into how and why subjective age can be associated with information technology ability, social activity, and possibly other abilities and health-seeking behaviours. Second, it makes it possible for researchers and policymakers to think about whether education and training programmes can shape the desired feeling about one's age and whether

these programmes can translate into social activity and other health-seeking behaviours. It is also possible that some behaviours and abilities may make older adults feel older than their age, which is consistent with some thoughts shared by researchers (Caspi et al., 2019; Vaportzis et al., 2017). A qualitative enquiry into these behaviours and how and why they may cause older adults to feel older than their actual age is necessary.

The mediation role of information technology ability implies that abilities and possibly behaviours can extend potential influences from subjective age to other behaviours or health outcomes. This inference calls for more research into multiple mediation roles, especially through causal models based on experimental designs. Potential multiple mediation roles would depict the significance of subjective age as a predictor of a chain of health behaviours and indicators of health. So, a confirmation of these roles through experimental and prospective designs can shed light on how important and relevant subjective age is to health-seeking behaviours and health in the ageing process. These implications and future research directions are an extension of not only findings from this study but also from studies assessing and confirming associations between subjective age and health-seeking behaviours (e.g., social activity, PA, healthcare utilisation); models including multiple mediators would be formed by these associations put together, which signifies the importance of future research investigating these potential mediators.

4.2. Study limitations and strengths

This study has limitations that decision-makers and future researchers should consider. The foremost limitation is our application of a non-probabilistic sampling method, a sample limited to Ghana, and a relatively small sample size, which means that our findings may have limited generalisability. Future replications of this study in other populations and the use of representative national and regional samples are recommended. Though this study was conducted after pandemic restrictions were lifted in Ghana, mental health conditions, fear of the pandemic, and isolation may have affected older adults' social activity ratings. For this study, we recommend replication of this study in settings completely void of pandemic-related fears, isolation, and other concerns. This study does not establish cause and effect between the variables, so the mediation role confirmed in this study is non-causal. Experimental designs such as a cluster randomised controlled trial can be used to test our associations as causal models. The mediation role assessed in this study may depend on the specific types of social activities (e.g., religious, leisure, recreational) performed, but these specific activities were not considered in this study. Similarly, trajectories of the main variables (i.e., subjective age, information technology ability, and social activity) can change over time, but this study as a cross-sectional design did not consider this change. Finally, this study as a quantitative study does not provide enough information regarding why and how older subjective age can be positively associated with health behaviours such as social activity. Mixed designs exploring perceptions about this 'why' and 'how' and testing our model as a causal framework would be ideal.

Despite the above limitations, our study is important for setting the foundation for the above studies by testing the models to generate key statistics and insights needed to design more resilient studies. For example, our study provides effect sizes and other statistics that could be used to calculate the minimum sample size necessary in future studies. Results also streamline the scope of exploration of experiences and opinions in the future; qualitative researchers, for instance, would focus on knowing why or how an older subjective age is positively associated with social activity and information technology ability. Our sample size calculation enabled us to apply a sample far larger than our minimum sample size required, which could give our findings some external validity. We adopted a resilient statistical analysis including controls against confounding and common methods bias. Our two-fold sensitivity analysis enabled us to avoid over-adjustment for confounding and to demonstrate the influence of the ultimate confounders on the ultimate models. Since most cross-sectional studies fail to employ these relatively robust analyses (Asiamah et al., 2021), our study may serve as a guide for stronger cross-sectional studies. Our study is consistent with relevant recommendations of STROBE. Please see Appendix 3 for recommendations of STROBE met. Since most cross-sectional designs are unable to meet all these recommendations (Eluwole et al., 2022; Marques-Sulé et al., 2021), this study may serve as a model for applying STROBE-compliant designs in future. This is not to say that our sensitivity analysis and other techniques are the only approaches compliant with the STROBE; there may be other techniques suited for cross-sectional designs in other contexts.

5. Conclusions

Social activity and information technology ability were higher at older subjective age, and higher social activity was associated with higher information technology ability. Information technology ability partially mediates the association between subjective age and social activity, which means that information technology ability transmits the potential influence of subjective age on social activity. None of the domains of information technology ability mediates the association between subjective age and social activity, but higher levels of these domains are associated with subjective age. Older adults who felt older than their actual age reported higher information technology ability and its three domains as well as social activity. A key implication is that higher levels of abilities and behaviours (i.e., social activity) that may benefit health can be associated with older subjective age. Similarly, feeling older than one's actual age could encourage the acquisition of abilities and participation in social activities, but qualitative studies exploring why older subjective age may positively influence information technology ability and social activity in older adults are needed.

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Ethical approval

This study received ethical approval from an institutional ethics review committee in Accra (No. 001-2022ACE) after the study protocol was reviewed. All the participants provided written informed consent to participate.

Availability of data and materials

The data will be made available upon request.

CRediT authorship contribution statement

Sarra Sghaier: Conceptualization, Investigation, Validation, Visualization, Writing – original draft, Writing – review & editing. **Nestor Asiamah:** Conceptualization, Data curation, Formal analysis, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Emelia Danquah:** Conceptualization, Validation, Visualization, Writing – review & editing. **Frank Frimpong Opuni:** Conceptualization, Validation, Visualization, Writing – review & editing. **Sylvester Hatsu:** Conceptualization, Validation, Visualization, Writing – review & editing.

Declaration of Competing Interests

The authors had no competing interests to declare.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.archger.2022.104790.

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