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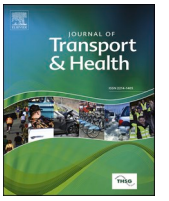

The associations between pro-environment behaviours, sustainability knowingness, and neighbourhood walkability among residents of Accra Metro in Ghana: A cross-sectional analysis

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ABSTRACT

Background: Physical activities such as walking are a form of transportation in the neighbourhood; people reach their destinations through walking. Research to date has substantially evidenced the beneficial effects of walking and other physical activities on health outcomes. From these perspectives, neighbourhood walkability and behaviours that improve it play a crucial role in healthy transportation.

Aim: To assess the associations between pro-environment behaviours (i.e., socially responsible consumption (SRC) and pro-environment behaviour (PEB)) and neighbourhood walkability, and to ascertain whether these relationships are moderated by sustainability knowingness.

Methods: This study employed a cross-sectional design with sensitivity analysis and recommended steps against common methods bias. The participants were residents in the Accra Metropolitan Area (Accra Metro), Ghana. Self-reported questionnaires were used to gather data from 625 residents. Exploratory factor analysis and hierarchical linear regression analysis were used to present the results.

Results: PEB and SRC had a positive association with neighbourhood walkability, with the latter having a stronger association with neighbourhood walkability. The relationship between these behaviours and neighbourhood walkability was significantly strengthened by sustainability knowingness.

Conclusion: Higher neighbourhood walkability was associated with higher SRC and PEB, which means that residents can contribute to improved neighbourhood walkability with their pro-environment behaviours. Residents' sustainability knowingness or their knowledge about

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sustainability and its importance can enhance the positive influence of pro-environment behaviours on neighbourhood walkability.

1. Introduction

Enabling people to maintain social and physical activities, including active forms of transportation (e.g., walking), over the life course is a leading public health agenda that has been informed by empirical evidence regarding the positive association between physical activity (PA) and health outcomes, including quality of life (Steindorf et al., 2011; Kadariya et al., 2019; Guure et al., 2017). PA including walking has also been evidenced to delay mortality (Reimers et al., 2012; Asiaman et al., 2021) and protect the individual against chronic conditions (e.g., diabetes, hypertension, dementia) (Guure et al., 2017; Kadariya et al., 2019). Interventions aimed at encouraging lifelong utilization of active transportation modes (e.g., walking) in the neighbourhood are, therefore, a worthwhile public health pursuit. Community design programmes aimed at enhancing neighbourhood sanitation, drainage, and street connectivity have been the core of these interventions (Asiaman et al., 2021; Van Holle et al., 2016).

Neighbourhood walkability is characterised by high residential density, street connectivity, and mixed (i.e., commercial, and residential) land use (Sallis et al., 2010). It is also the extent to which built environment attributes (e.g., services, parks, gardens, sidewalks, destinations) available in public space encourage walking and other social and physical activities (Chudyk et al., 2017; Edwards and Dulai, 2018). Research to date has shown that social activity and walking are higher in more walkable neighbourhoods (Cantor, 1975; Asiaman et al., 2021; Edwards and Dulai, 2018). Cantor's (1975) New York study is one of the earliest investigations into the role of walkable attributes such as services in walking for transportation and social activity. It showed that neighbourhood services and other walkable factors encourage social engagement and walking in context. In Canada, Chudyk and associates found a positive association between neighbourhood walkability and physical activity, including walking. The systematic review of Edwards and Dulai also reported a positive association between neighbourhood walkability and PA including walking. Recently, Asiaman et al. (2021) found a positive association between neighbourhood walkability and social activity. Undoubtedly, a collective effort for improving neighbourhood walkability is an important way forward in public health and environmental sustainability campaigns.

Individuals have a role in creating and improving walkable neighbourhoods, at least in the way of proper waste disposal, preservation of green spaces, and the utilization of neighbourhood services that are part of walkable neighbourhoods or are environment-friendly. This role is recognized by the United Nation's 17th sustainable development goal, which emphasizes a partnership between all stakeholders for realizing key sustainability goals. In African countries, however, individuals do not only undermine their role in the above partnership but also take actions that degrade residential space and mar neighbourhood walkability (Asiamah et al., 2020; Asiaman et al., 2021). No wonder some studies (Oyeyemi et al., 2016; Asiaman et al., 2021) have reported that African countries such as Ghana and Nigeria are among the least walkable places. The individual's role in enhancing neighbourhood walkability is, therefore, more crucial in developing African countries.

We reason based on recent commentaries (Lazaroiu et al., 2019) that socially responsible consumption (SRC) and pro-environment behaviour (PEB) are primary ways people can contribute to the walkability of their neighbourhoods. SRC is a measure of how much individuals consider the environmental consequences of private consumption and seeks to minimise the damage of environmental resources while maximising long-term benefits to society (Webb et al., 2008). PEB, on the other hand, is a conscious action people take to minimise the negative impact of their activities on the environment (Liu et al., 2014). We consider PEB and SRC as pro-environment behaviours because they are characterised by deliberate actions aimed at preserving neighbourhood services, green spaces, and other built environment attributes. Hence, maximising these behaviours may improve neighbourhood walkability in African settings where neighbourhood improvement interventions are rare (Asiaman et al., 2021). The potential incremental effect of SRC and PEB on neighbourhood walkability may have encouraged some researchers (Koohsari et al., 2018; Asiamah et al., 2020) to call for studies providing an understanding of how individuals can more significantly contribute to sustainable and walkable neighbourhoods.

This study attempted to respond to this call by examining the associations between SRC, PEB, and neighbourhood walkability in an African context. We further examine how this relationship is moderated by sustainability knowingness, which is the extent to which individuals know and understand sustainability efforts and their relevance to the realization of the sustainable development goals. Our assessment of this moderating role is based on the idea that pro-environment behaviours are more likely in contexts where residents are aware of the importance of environment-friendly actions. This study addresses two main research gaps in the literature. First, many studies have indicated that pro-environment behaviours protect or preserve environmental factors necessary for human survival such as air quality, greenspaces, and services. Since these factors form the core of walkability, they can be positively associated with walkability, which means that environment-friendly actions can benefit walkability. Yet, there is no identifiable study examining the associations between these behaviours and walkability. As later discussed in this paper, pro-environment behaviours and their associations with walkability would depend on personal factors such as age and education, but these factors have not been considered in analyzing or discussing the role of pro-environment behaviours in environmental sustainability. This study, therefore, tested four hypotheses in an attempt to address these gaps. We expect our analyses of these hypotheses to provide implications for health promotion and neighbourhood walkability improvement. The specific hypotheses tested are formulated in the following section.

2. Literature review

Over the years, the Theory of Planned Behaviour (TPB) proposed by Ajzen (1985) has been used to describe and predict

pro-environment behaviours including SRC and PEB. According to the TPB, a behaviour is performed after the individual has evaluated it as good, observed that society or people call for this behaviour, and realized he/she can perform this behaviour successfully. An inherent attribute of the theory is what is called *behavioural control*, which is analogous to perceived self-efficacy and the ability to perform a task. Intentions to perform a behaviour are likely to result in the actual behaviour if people have self-efficacy or believe that they can enact the behaviour. An evaluation of a behaviour (referred to as attitude) strongly correlates with behavioural intention, which in turn correlates with the actual behaviour.

A key attribute of the TPB that is of interest in this study is the concept of *subjective norm*, which concerns an endorsement of the intended behaviour by other people or the general society. Rational people would endorse a behaviour when it is beneficial to the wider society, including the individual intending to perform this behaviour. Research to date (Netuveli and Watts, 2020; Lazaroiu et al., 2019; Villa Castaño et al., 2016) has shown that environment-friendly behaviours such as SRC and PEB lead to changes that are viewed as a common good. Some of these changes are the preservation of contextual factors such as community air quality, neighbourhood green spaces, and neighbourhood sanitation, all of which are essential elements of neighbourhood walkability. Pro-environment behaviours such as using products with recyclable packs instead of those associated with single-use plastics contribute to a safe and clean neighbourhood. Similarly, the consumption of products and services that are environment-friendly benefits walkability by sustaining essential services that are a part of walkability and enhancing the revenue of businesses that contribute to community design projects. The import of the above examples is that people would endorse SRC and PEB because of their protective influence on the environment, including walkability. Thus, walkability is one of the most likely outcomes of any nature-supporting actions taken by residents. We, therefore, argue that walkability can be higher in contexts or neighbourhoods where residents perform higher SRC and PEB.

The Health Belief Model (HBM) attributed to Hochbaum et al. (1952) is a popular paradigm used to explain and predict health-supporting behaviours. The model assumes that health-seeking behaviours are encouraged by a belief in the value of health and the ability to perform these behaviours. People who value their health and have optimal functional capacity are, therefore, likely to act to protect their health. The HMB shares some principles with the TPB, one of which is the idea that behaviours are performed in the individual's pursuit for a reward that may be shared by members of the community. The second shared principle is that self-efficacy and self-perceived functional ability are required to perform a behaviour. It can, therefore, be deduced that all residents of a community who have ample health and physical functional capacity can perform a behaviour perceived to be beneficial. Like the TPB, therefore, the HBM endorses the positive association between walkability and PEB (hypothesis 1, H1) as well as SRC (hypothesis 2, H2). These hypothesized relationships, which are depicted in Fig. 1, are probable in any context for a couple of reasons. First, several commentators and stakeholders recognize SRC and PEB as health-seeking behaviours that can increase individual and public health (Zhang and Tu, 2021; Lange and Dewitte, 2021; Liu et al., 2014; Netuveli and Watts, 2020). Responsible consumption, for example, can benefit health and long-term physiological development as nature-friendly products are healthier (Zhang and Tu, 2021; Liu et al., 2014; Netuveli and Watts, 2020). Secondly, devastating environmental conditions (e.g., ocean acidification, flooding, extreme weather) caused by global warming affect everyone, so behaviours aimed at environmental protection or redemption are seen by society as worthwhile courses of action.

Worth mentioning are viral campaigns about sustainability and a need for everyone to be responsible in their consumption. Genç (2008) has averred that mass communications on the importance of sustainability and its behaviours have increased in the last decade, which has enhanced awareness about sustainability. Recognising how widespread sustainability campaigns are, Marcos-Merino et al. (2020) recently developed a scale measuring sustainability knowingness, a construct describing how well the individual knows about the importance of sustainability and key actions required on the part of individuals to achieve it. We reason that apart from the above-mentioned factors (i.e., recognition of the value of behaviour, having the ability to successfully perform the behaviour),

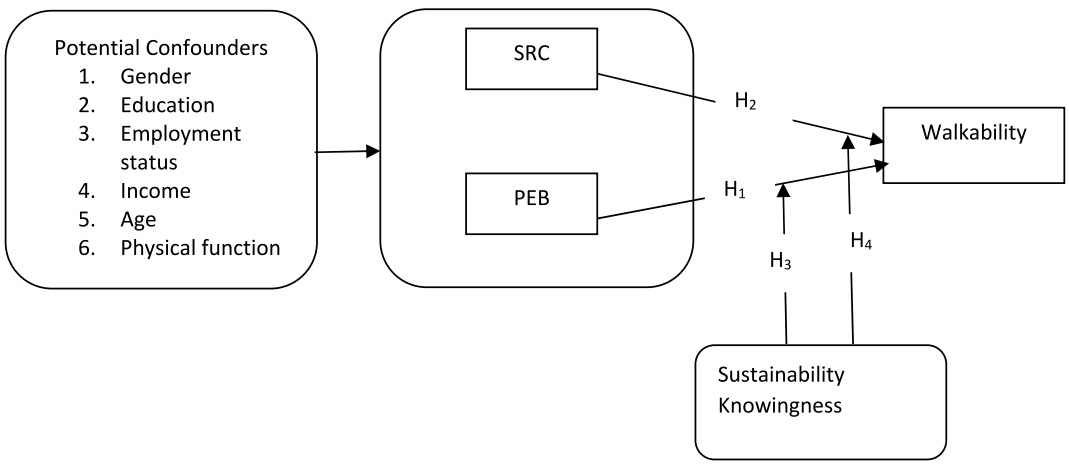

Fig. 1. A framework of the associations between SRC, sustainability knowingness, PEB, and walkability
Note: SRC – socially responsible consumption; PEB – pro-environment behaviour; potential confounders in the framework are not exhaustive.

sustainability knowingness is another major determinant of SRC and PEB. This is to say that sustainability knowingness can be an extra resource or advantage complementing determinants of pro-environment behaviours recognized by the TPB and HBM. For this reason, people who have met all the conditions recognized by TPB and HBM for enacting a behaviour can perform SCR and PEB but may not perform these behaviours as much as those who have met these conditions and have sustainability knowingness as an extra advantage. From this perspective, sustainability knowingness can strengthen the positive associations of SRC and PEB with neighbourhood walkability. Suffice it to say that PEB would be more strongly associated with walkability among residents with higher sustainability knowingness (hypothesis 3, H3). Similarly, SRC would be more strongly associated with walkability among residents with higher sustainability knowingness (hypothesis 4, H4).

To reiterate, both the TPB and HBM recognize self-efficacy and physical ability as requirements for performing environment-friendly actions. These two factors differ from person to person and can be associated with personal variables such as age, gender, education, and income. For instance, older adults, compared to adolescents, may be less physically capable to perform key pro-environment tasks such as planting neighbourhood vineyards and participating in community-level cleaning events. Highly educated people may also perform higher SRC and PEB because they may better understand the value of these behaviours. The import of these illustrations is that personal factors can affect the associations between the two pro-environment behaviours and walkability, so they can confound these relationships. The arrow linking personal factors and the pro-environmental variables in Fig. 1 represents this confounding influences. As later explained in this paper, therefore, relevant personal variables are incorporated into this study as potential confounders.

3. Methods

3.1. Design

This study employed a cross-sectional design with a sensitivity analysis against potential confounding variables and measures against common methods bias.

3.2. Participants, selection, and sample size

Participants of this study were residents of Accra Metro, a suburb of Accra that provided access to a culturally diverse group, including individuals with low, moderate, high socio-economic status (Kpessa-Whyte, 2018). Participants were selected at parks, supermarkets, community centres, and a university campus (i.e., Accra Technical University). Four main selection criteria were used to select participants, namely: (a) ability to walk independently; (b) having a minimum of a basic educational qualification (e.g., basic school leaving certificate), which was an indicator of the ability to speak and write in English, the medium in which questionnaires were administered; (c) having resided in the community for at least a year, and (d) willingness to participate in the study voluntarily. The third criterion above was applied in the selection process to ensure that only individuals who had sufficient experience with the chosen neighbourhoods and therefore knew much about the characteristics of their communities were included in the study. The exclusion criteria used were having a physical or health problem that precluded independent walking, non-availability at the time of data collection, and a lack of interest to participate in the study. The G*Power 3.1.9.4 software was used to determine the minimum sample appropriate after 921 resident volunteers were selected. The minimum sample size determined with this tool with relevant statistics (i.e., effect size = 0.18, power = 0.8, $\alpha = 0.05$) from a related recent study (Asiaman et al., 2021) was 92. To maximise the power of our tests, we encouraged all 921 volunteers to participate in the study.

3.3. Variables, measurement and instrumentation

The core variables of this study are neighbourhood walkability, PEB, SRC, and sustainability knowingness. Neighbourhood walkability was measured with the Australian version of the Neighbourhood Environment Walkability Scale (NEWS-A), which is associated with 11 items and five descriptive anchors (i.e., strongly disagree – 1; disagree – 2; somewhat agree – 3; agree – 4, and strongly agree – 5). This scale was transferrable to Ghana for a couple of reasons. First, it produced satisfactory internal consistency indicators (Cronbach's alpha coefficient = 0.8) on a Ghanaian sample in a recent study (Asiaman et al., 2021). In this study, it produced a Cronbach's alpha coefficient = 0.87, which affirms the scale's internal consistency and usability in Ghana. Secondly, the scale is relatively short and was, therefore, more convenient to complete by respondents. Other related scales, including neighbourhood walkability scales validated in Africa (Oyeyemi et al., 2016), are long and could result in a high non-response rate. Appendix A shows items of NEWS-A used in this study. PEB was measured with a 12-item scale associated with five descriptive anchors (i.e., never – 1, rarely – 2, sometimes – 3, often – 4, and very often – 5). This measure was adopted in whole from Lange and Dewitte (2021) and produced a satisfactory Cronbach's alpha coefficient of 0.9 in the current study. Appendix B shows items of this scale. A 21-item validated scale associated with the same descriptive anchors as NEWS-A was adopted in whole from Syed and Shanmugam (2020) to measure SRC. Appendix C shows items of this scale. Finally, sustainability knowingness was measured with a 9-item standard scale adopted in whole from Marcos-Merino et al. (2020). The scale shares descriptive anchors with NEWS-A and produced a satisfactory Cronbach's alpha coefficient = 0.766 in the study of Marcos-Merino and colleagues. It produced a Cronbach's alpha coefficient = 0.81 in this study.

Confounding variables are lurking variables that are correlated with the primary predictor in a relationship and, therefore, affect the primary relationship of interest (Asiamah et al., 2019). Thus, any variable that could correlate with PEB and SRC in this study were

potential confounding variables. According to person-environment fit models (Cantor, 1975; Lawton, 1989; Wahl and Gerstorf, 2020), behaviours (e.g., PEB, SRC) in the neighbourhood are a function of personal factors such as age, education, income, gender, and other measures of socioeconomic status. This view implies that the relationship between these behaviours and neighbourhood walkability can be due to these personal factors. For instance, people with higher education are more likely to show pro-environment behaviours such as PEB and SRC. Other studies (Lange and Dewitte, 2021; Asiaman et al., 2021) have also indicated that behaviours in the neighbourhood and their effects on other variables can be affected by physical functional status, chronic disease status (CDS), employment status, and other personal variables identified above. Hence, the above personal variables were measured and statistically analyzed as potential confounding variables.

Employment status (employed versus not employed), gender (male versus female), and CDS (none versus one or more) were measured as dichotomous variables and were, therefore, dummy-coded twice in statistical analysis. CDS was measured by asking participants to report any clinically diagnosed chronic condition they had. Education was measured as the highest level of formal education acquired whereas physical function was measured with a single item adopted from Asiaman et al. (2021). Income was measured as the individual's gross monthly salary in Ghana cedis. Education was measured as an ordinal categorical variable with four groups (i.e., basic/secondary, diploma/first degree, Master's degree, PhD or equivalent) and was, therefore, dummy-coded in statistical analysis.

3.4. Instrumentation and common methods bias assessment

Two questionnaires were used in this study. The first questionnaire was used by field assistants to recruit participants in the chosen neighbourhoods and centres. The second questionnaire was a self-reported survey used to collect the main data of the study. This tool had two main sections; the first section comprised the demographic and personal variables whereas the second section presented the four main measures (i.e., SRC, PEB, neighbourhood walkability, and sustainability knowingness). There was an introductory statement that disclosed the purpose of the study, selection criteria, ethics statement, and survey completion instructions.

As a cross-sectional design, this study was subject to common methods bias (CMB). As such, two recommended steps were taken to avoid or minimise this bias (Jordan and Troth, 2020; Asiamah et al., 2020). First, the main survey instrument was designed in harmony with recommendations by presenting the demographic variables and information on the main variables in different blocks of information. Thus, each block was separated by a preamble to a scale or section. The second step concerned Herman's one-factor method, a statistical technique that evidences the absence of CMB if it produces two or more factors with exploratory factor analysis (EFA) on each of the measurement scales (Jordan and Troth, 2020). In this study, an EFA (specifically principal components) produced more than one factor on the various scales as follows: neighbourhood walkability – 2 factors; PEB – 3 factors; SRC – 2 factors, and sustainability knowingness – 2 factors. Items of these variables produced factor loadings $\geq$0.5 as recommended (Jordan and Troth, 2020). The above results evidenced no or minimal CMB in the data.

3.5. Data gathering process

All participants consented to participate in this study following a review and approval of the study protocol by an institutional ethics review committee (ethics approval number 002-ACE-2019). Data were collected in two phases. In the first phase, field assistants used a screening tool (survey) to select participants of the study and collated their relevant characteristics including contact information. In the second phase, the main survey instrument in sealed envelopes was delivered to participants through a private courier accompanied by a field assistant. The envelopes containing the survey were delivered at locations chosen by the participants in the first phase. Each participant was guided by research assistants and information on the questionnaire to complete the survey instantly, but those who could not complete and return the questionnaire immediately were given up to two weeks to do so. All participants were able to return their completed questionnaires over five weeks (May 2 to June 10, 2019) through the private courier. Of the 921 questionnaires administered, 625 were analyzed; 296 questionnaires were not returned or had a major section not completed. Analyzing 625 questionnaires was acceptable given that the minimum sample size calculated for this study was significantly smaller than 625.

3.6. Statistical analysis technique

Data gathered were analyzed in three phases with the Statistical Package for the Social Sciences (SPSS) version 26 for Windows. The first phase was a regression diagnostic analysis performed to ascertain if hierarchical linear regression (HLR) could be used to analyze the data. Following Madley-Dowd et al. (2019), the questionnaires with missing data were not removed from the data as the missing data points were less than 10 and were distributed randomly. Satisfactory levels of kurtosis and skewness (i.e., skewness $\leq \pm 2$; kurtosis $\leq \pm 2$) recommended were achieved (Garson, 2012). Though the Kolmogorov-Smirnov test evidenced the non-normality of the data associated with the dependent variable at $p < 0.05$, this was not a problem since the foregoing skewness and kurtosis statistics were satisfactory and the study sample was relatively large (Garson, 2012). As part of the diagnostic analysis, regression was used to verify the linearity of the primary relationships (i.e., hypotheses) assessed in this study. In this vein, we followed Garson (2012) to plot standardized residuals against standardized predicted values of the dependent variable in all regression models through which the hypotheses were tested. The resulting graphs showed non-random patterns indicating that the primary relationships were of a linear form. These graphs also showed a distribution of points without a discernible pattern. This graphic outcome confirms homoscedasticity, another requirement for regression analysis. The independence of errors and multicollinearity assumptions were not assessed

since the hypotheses were tested through univariate models rather than multivariate regression analysis (Garson, 2012).

A sensitivity analysis was subsequently performed with HLR analysis in harmony with recent studies (Rezai et al., 2008; Asiaman et al., 2021) to identify and select the ultimate confounding variables for the final analysis. This technique was performed to ensure that only confounding variables that could significantly affect the primary relationships are incorporated into the final regression models. Regarding this analysis, measured potential confounding variables that may significantly correlate with the primary predictors (i.e., PEB and SRC) were identified in two series of analyses; series 1 was performed on PEB as a primary predictor of neighbourhood walkability and series 2 was conducted on SRC as a primary predictor of neighbourhood walkability. For each series, univariate regression models were fitted to estimate the regression weight between a primary predictor and neighbourhood walkability. Further to this, the regression weights between the confounding variables measured and the primary predictors were computed using a multiple linear regression model. At this stage, confounding variables with $p \geq 0.25$ were removed from the analysis. In this vein, four of the original confounding variables were retained for the next stage of the analysis. Following the foregoing step, we examined the effects of the remaining confounding variables and each of the primary predictors on neighbourhood walkability through a multiple linear regression model. Confounding variables that led to a change in primary regression weights (i.e., the regression weight between the predictors and neighbourhood walkability) by at least 10% were to be selected as the ultimate confounding variables.

As Table 1 indicates, no variable qualified as the ultimate confounding variable in both series 1 and 2. The first two hypotheses (H1 and H2) were subsequently tested by estimating the regression weights between the pro-environment behaviours and neighbourhood walkability through univariate regression models (i.e., models 1 and 2). Two other univariate regression models (i.e., models 3 and 4) were fitted to test the third and fourth hypotheses. In our effort to test hypotheses 3 and 4 (i.e., H3 and H4), we computed two dummy variables representing the interaction between PEB and sustainability knowingness (i.e., PEB*SK) and the interaction between SRC and sustainability knowingness (i.e., SRC*SK). The relationships between these terms and neighbourhood walkability were then assessed through the third and fourth univariate models. The moderating analysis focused on *pure moderation* (Asiaman et al., 2021) because we were interested only in how the influences of PEB and SRC on neighbourhood walkability were increased or reduced by sustainability knowingness. The statistical significance of the results was detected at a minimum of $p < 0.05$. Fig. 2 shows the key phases of the statistical analysis process.

4. Results

Table 1 shows the summary statistics on participants' demographic variables. In this table, about 53% (n = 330) of the participants were men whereas about 47% (n = 295) were women. About 72% (n = 450) of the participants were unemployed while about 28% (n = 175) were employed. About 8% (n = 50) of participants had one or more chronic conditions, and the average age of the participants was about 22 years (Mean = 22.29; SD = 4.73). Thus, the study sample was youthful.

Table 2 shows the main results of the sensitivity analysis. In the first series of analyses, physical function and age were removed at the first stage while the other variables were removed in the second stage. In the second series, gender and employment were removed in the first stage whereas the other variables were removed in the second stage. So, none of the personal and demographic attributes qualified as the ultimate confounding variables. For this reason, none of the potential confounding variables was incorporated into the final regression models.

Table 3 shows relevant descriptive statistics and correlation coefficients between variables of interest. In this table, a positive but weak correlation exists between pro-environment behaviour and neighbourhood walkability ($r = 0.095$; $p < 0.05$; two-tailed). There is also a positive correlation between socially responsible consumption and neighbourhood walkability ($r = 0.158$; $p = 0.000$; two-

Table 1
Summary and descriptive statistics on personal variables.

Variable	Group	Frequency/Mean	Percent (%)/SD
Categorical variables			
Gender	Male	330	52.80
	Female	295	47.20
	Total	625	100.00
Education	Basic/Secondary	325	52.00
	Diploma/first degree	235	37.60
	Master's degree	65	10.40
	Total	625	100.00
Employment status	Unemployed	450	72.00
	Employed	175	28.00
	Total	625	100.00
Chronic disease status	None	575	92.00
	≥1	50	8.00
	Total	625	100.00
Continuous variables			
Income (Ghc)	–	1021.21	102.11
Physical function	–	2.90	0.98
Age (yrs)	–	22.29	4.73

¯Not applicable; SD – standard deviation (of Mean); Mean and SD are for continuous variables whereas frequency and percent are for categorical variables.

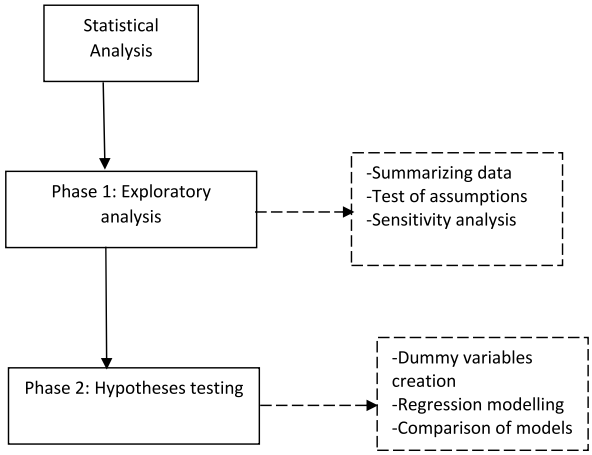

Fig. 2. A flow chart of the statistical analysis method.

Table 2
Key findings from the sensitivity analysis.

Independent variable	Stage 1			Stage 2		
	β	*t*	p	Adjusted β	Change in β	% Change in β
Series 1 (Pro-environment behaviour as a primary predictor)						
Pro-environment behaviour[c]	0.095	2.390	0.017	–	–	–
Gender (reference – male)[b]	−0.167	−3.490	0.001	0.100	0.005	5%
Income (Ghc)[b]	0.073	1.336	0.182	0.088	−0.007	−7%
Physical function[a]	−0.032	−0.646	0.519	–	–	–
Employed (reference – unemployed)[b]	−0.279	−4.601	0.000	0.096	0.001	1%
CDS (reference – none)[b]	−0.160	−3.466	0.001	0.086	−0.009	−9%
Age (yrs)[a]	−0.045	−0.753	0.452	–	–	–
Basic/secondary (reference – basic)[b]	0.133	2.594	0.010	0.098	0.003	3%
Diploma/first degree (reference – basic)[b]	0.352	6.738	0.000	0.097	0.002	2%
Series 2 (Socially responsible consumption as a primary predictor)						
Socially responsible consumption[d]	0.421	11.570	0.000	–	–	–
Gender (reference – male)[a]	−0.046	−1.002	0.317	–	–	–
Income (Ghc)[b]	−0.283	−5.430	0.000	0.435	0.014	3%
Physical function[b]	−0.112	−2.391	0.017	0.434	0.013	3%
Employed (reference – unemployed)[a]	0.028	0.480	0.631	–	–	–
CDS (reference – none)[b]	−0.096	−2.175	0.030	0.404	−0.017	−4%
Age (yrs)[b]	0.152	2.644	0.009	0.405	−0.016	−4%
Basic/secondary (reference – basic)[b]	0.340	6.925	0.000	0.435	0.014	3%
Diploma/first degree (reference – basic)[b]	0.162	3.238	0.001	0.422	0.001	0%

Note: ¯ Not applicable.
[a] Variable removed in the first stage (series 1 and 2) of the sensitivity analysis.
[b] variable removed at the second stage (series 1 and 2) of the analysis.
[c] pro-environment behaviour serving as the predictor of neighbourhood walkability at stage 1 of series 1.
[d] Socially responsible consumption serving as a predictor of neighbourhood walkability at stage 1 of series 2.

Table 3
Summary statistics and correlation matrix.

Variable	#	Mean	SD	1	2	3	4	5	6
Pro-environmental Behaviour	1	32.82	9.90	1	.158**	0.035	.873**	.154**	.095*
SRC	2	76.03	15.46		1	.456**	.361**	.889**	.421**
Sustainability knowingness	3	37.04	6.40			1	.502**	.791**	.360**
PEB*SK	4	–	–				1	.509**	.253**
SRC*SK	5	–	–					1	.452**
Neighbourhood Walkability	6	34.15	7.84						1

¯ Not applicable; **$p < 0.001$; *$p < 0.05$; SRC – socially responsible consumption; PEB – pro-environment behaviour; SK – sustainability knowingness; SD – standard deviation.

tailed). The interaction between pro-environment behaviour and sustainability knowingness (PEB*SK) is also positively correlated with neighbourhood walkability ($r = 0.253$; $p = 0.000$; two-tailed). The interaction between socially responsible consumption and sustainability knowingness (SRC*SK) is positively correlated with neighbourhood walkability ($r = 0.452$; $p = 0.000$; two-tailed). Other relevant correlations are shown in Table 3.

Table 4 shows the results of the regression analysis. In the first model, pro-environment behaviour has a positive association with neighbourhood walkability ($\beta = 0.10$; $t = 2.39$; $p < 0.05$), which suggests that higher neighbourhood walkability scores were reported by residents with higher pro-environment behaviour. In the second model, socially responsible consumption has a positive association with neighbourhood walkability ($\beta = 0.42$; $t = 11.57$; $p = 0.000$), which connotes that higher neighbourhood walkability was associated with higher socially responsible consumption. PEB*SK ($\beta = 0.25$; $t = 6.52$; $p = 0.000$) and SRC*SK ($\beta = 0.45$; $t = 12.65$; $p = 0.000$) had a positive relationship with neighbourhood walkability. The regression weight of $\beta = 0.25$ accounted for by PEB*SK on neighbourhood walkability implies that the original weight of pro-environment behaviour on neighbourhood walkability (which is 0.10) increased to $\beta = 0.25$ due to sustainability knowingness. Thus, the strength of the association between pro-environment behaviour and neighbourhood walkability was increased by sustainability knowingness by 150%. Similarly, the strength of the relationship between socially responsible consumption and neighbourhood walkability increased by 7%; the standardized regression coefficient increased from $\beta = 0.42$ to $\beta = 0.45$ due to sustainability knowingness. Fig. 3 depicts the association between PEB*SK and neighbourhood walkability whereas Fig. 4 shows the association between SRC*SK and neighbourhood walkability. It can be seen from these charts that low and high values of the interaction terms overlap with neighbourhood walkability, with the high values producing a larger variance (R^2).

5. Discussion

This study aimed to examine the associations between neighbourhood walkability and two pro-environment behaviours (i.e., PEB and SRC) as well as the moderating influences of sustainability knowingness on these relationships. To address these objectives, four hypotheses were tested with linear regression analysis.

This study found a positive association between PEB and neighbourhood walkability and, thus, provisionally supports our first hypothesis (H1). Similarly, a positive association between and neighbourhood walkability was found, supporting the second hypothesis of the study (H2). These results suggest that residents who reported higher pro-environment behaviours in the forms of PEB and SRC reported higher walkability of their neighbourhoods, which supports our reasoning that residents could contribute to the sustainability of their communities as well as the walkability of these communities through environment-friendly consumption behaviours and social activities that favour the preservation or protection of walkable neighbourhood resources such as parks, lawns, green spaces, and services. This thought is congruent with the TPB and HMB. The TPB implies that behaviours are encouraged by benefits perceived by individuals to be associated with these behaviours. If, for instance, individuals think that avoiding single-use plastics is a way to keep the environment clean and minimise the impact of climate change on humans, they are likely to avoid using products that come with single-use plastics. In this vein, the avoidance of single-use plastics is the behaviour resulting from the perceived benefits of not adding to hazardous inorganic or non-biodegradable waste in circulation. Research to date (Netuveli and Watts, 2020; Villa Castaño et al., 2016; Annerstedt van den Bosch and Depledge, 2015) has indicated that pro-environment behaviours directly or indirectly contribute to individual and population health. These behaviours indirectly contribute to population health by making human ecosystems safer and more sociable. As such, people in such ecosystems better engage in health-seeking behaviours such as social and physical activities (Netuveli and Watts, 2020). Pro-environment behaviours may directly enhance individual health because socially responsible consumption (e.g., eating vegetables and fish rather than meat and other dairy products) is healthier (Netuveli and Watts, 2020; Villa Castaño et al., 2016). The TPB implies that these health benefits can encourage pro-environment behaviours and, in effect, enhance neighbourhood walkability.

The HBM also explains why people may pursue health benefits by engaging in pro-environment behaviours. This theory has several facets, but the specific aspect of its argument that aligns with our result is the notion that people engage in health-seeking behaviours such as SRC and PEB given the benefits that compete with perceived barriers to engaging in the behaviours. Further to this, people will engage in pro-environment behaviours if they know the health benefits accompanied by these behaviours and if they have self-efficacy.

Table 4
The association between pro-environment behaviour, socially responsible consumption, sustainability knowingness and neighbourhood walkability.

Model	Predictor	Coefficients			95% CI	Model fit		
		B	SE	β(t)		R^2	Adjusted R^2	F-test
1	(Constant)	31.67	1.08	(29.23)**	±4.26	0.009	0.007	5.71*
	PEB	0.08	0.03	0.10 (2.39)*	±0.13			
2	(Constant)	17.92	1.43	(12.52)**	±5.62	0.177	0.176	133.92**
	SRC	0.21	0.02	0.42 (11.57)**	±0.07			
3	(Constant)	29.01	0.85	(34.31)**	±3.32	0.064	0.062	42.52**
	PEB*SK	4.22	0.65	0.25 (6.52)**	±2.54			
4	(Constant)	22.37	0.97	(22.98)**	±3.82	0.204	0.203	159.93**
	SRC*SK	4.12	0.33	0.45 (12.65)**	±1.28			

**$p < 0.001$; *$p < 0.05$; SRC – socially responsible consumption; PEB – pro-environment behaviour; SK – sustainability knowingness; SE – standard error (of B); CI – confidence interval.

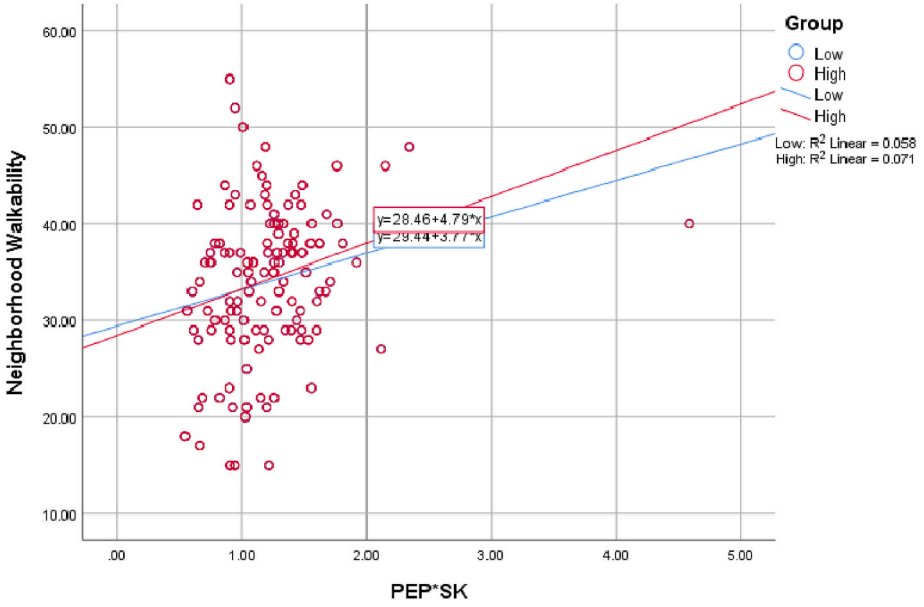

Fig. 3. The relationship between neighbourhood walkability and low and high levels of the interaction between PEB and sustainability knowingness (Low = 313; High = 312).

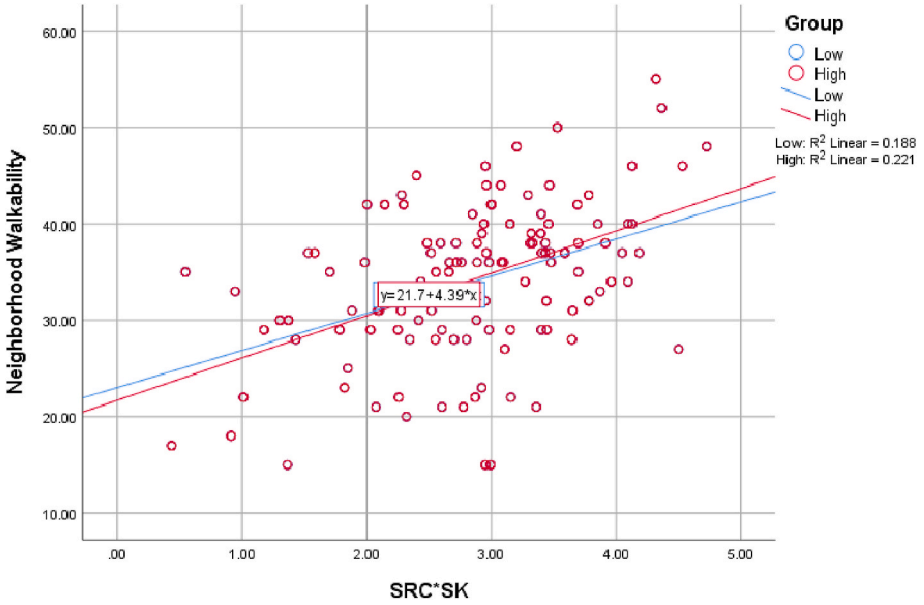

Fig. 4. The relationship between neighbourhood walkability and low and high levels of the interaction between SRC and sustainability knowingness (Low = 313; High = 312).

Since people can only value a behaviour if they are aware of its benefits, knowledge about healthy behaviours and their beneficial outcomes are implied by the HBM to be necessary for pro-environment behaviours. Thus, people can only engage in pro-environment behaviours if they are aware of their benefits. The HBM also emphasizes the role of self-efficacy in healthy behaviours such as the PEB and SRC. This emphasis is corroborated by studies that indicate that frail older adults with low or no self-efficacy are unlikely to engage in pro-environment behaviours; physically fit people (e.g., the youth) who use neighbourhood resources (e.g., services, parks) more often would have the ability and incentive to engage in environment-friendly behaviours (Balundė et al., 2020). As such, self-efficacy, which is intrinsic of our sample given our inclusion criteria and the youthful nature of the sample (Mean age = 22 years), is a companion determinant (with knowledge about healthy behaviours) of pro-environment behaviours. Furthermore, neighbourhood walkability has been substantially evidenced to support individual and population health (Keats et al., 2020; Asiaman et al., 2021;

Chudyk et al., 2017), which means that residents may be encouraged by a need to maintain or improve the walkability of their neighbourhoods to engage in pro-environment behaviours. From this perspective, the HBM recognizes neighbourhood walkability and its health benefits as some of the rewards associated with pro-environment behaviours.

Our confirmation of the first two hypotheses is also backed by several studies carried out around the world. In China, for example, Sheng et al. (2020) reported that air quality, which is necessary for neighbourhood walkability, is associated with pro-environment behaviour. In Singapore, pro-environment behaviours (e.g., lower use of herbicides and other chemicals on neighbourhood green space) were associated with neighbourhood greenness, a key component of neighbourhood walkability (Zhang and Tu, 2021). In Canada, Walker et al. (2021) reported that the avoidance of single-use plastic contributed to neighbourhood sanitation, which is an important part of neighbourhood walkability. The use of electric vehicles over vehicles powered by fossil fuels in the future is an aspect of SRC that may improve neighbourhood air quality and walkability. Noteworthy is our evidence suggesting that SRC, compared to PEB, better predicts neighbourhood walkability. This result may be due to the SRC construct embodying behaviours that better align with the preservation of walkability factors such as sanitation, green spaces, and parks. The PEB construct (see Appendix B) is characterised by behaviours that improve or protect environmental attributes such as air quality that are not always noticeable and are not part of the neighbourhood walkability scale (see Appendix A). So, there are more behaviours in SRC than in PEB that overlap with neighbourhood walkability, which means that health promotion programmes may have to prioritize the improvement of SRC in situations where both PEB and SRC cannot be enhanced due to resource constraints.

More interesting is this study's confirmation of the third and fourth hypotheses (i.e., H3 and H4), indicating that sustainability knowingness positively moderated the associations between neighbourhood walkability and each of the two pro-environment behaviours. In other words, neighbourhood walkability is more strongly associated with higher PEB and SRC at higher sustainability knowingness. These results are also consistent with the HBM in terms of its insinuation that people are more likely to perform health-seeking behaviours if they are knowledgeable of these behaviours and their benefits. From the perspective of the TPB, it is this knowledge that encourages pro-environment behaviours to relish the rewards of environment-friendly actions. This explanation draws on recent studies (Marcos-Merino et al., 2020; Pauw et al., 2015; Saqib et al., 2020) that have reported that pro-environment behaviours are higher in residents with higher sustainability knowingness. Since sustainability campaigns have a public health promotion dimension, people's knowledge of them is likely to include awareness about how individual and population health is affected by environmental sustainability. Thus, the broader people's knowledge about sustainability and its importance, the more they recognize health as an outcome of pro-environment behaviours. What could be inferred from this reasoning is that public health education, health promotion, or sustainability programmes should include an agenda to improve people's literacy in sustainability issues. A more impactful way to improve sustainability knowingness is to incorporate into formal education curricula society's sustainability values and standard strategies for achieving environmental sustainability.

A potentially compelling aspect of this study is the 150% moderation influence of sustainability knowingness on the relationship between PEB and neighbourhood walkability, which is more than the 7% moderating influence of the same moderator in the relationship between SRC and neighbourhood walkability. A key lesson from this difference is that, though PEB has a weaker relationship with neighbourhood walkability when compared with SRC, it better predicts neighbourhood walkability at high sustainability knowingness. Similarly, some behaviours within the PEB constructs may better overlap with or predict neighbourhood walkability at higher sustainability knowingness, which emphasizes the significance of programmes aimed at enhancing people's knowledge of sustainability and its value for society. The difference above also suggests that stakeholders could consider the improvement of PEB as important as the improvement of SRC in situations where it is feasible to enhance these behaviours simultaneously. As suggested by some researchers (Marcos-Merino et al., 2020; Pauw et al., 2015; Saqib et al., 2020), therefore, efforts to improve residents' sustainability knowingness is a way to maximise PEB while improving SRC concurrently.

5.1. *Strength and limitations*

This study has some limitations that future researchers should consider. First, the sample used in this study was predominantly younger people, which reflects a national situation in Ghana (Kpessa-Whyte, 2018). Nevertheless, the youthful nature of the sample makes our evidence less applicable to older adults or populations including a significant proportion of people with limited physical functional ability. Our selection of participants with relevant inclusion criteria also rendered our sampling process non-probabilistic. We also acknowledge that our sample size ($n = 625$) is relatively small and needs to be increased in future studies. These shortcomings, coupled with our removal of people with poor English skills from the sample, limits the generalizability of our results. This study, by employing the cross-sectional design, does not establish causation between the variables. This notwithstanding, the current study is novel as it was the first to assess the nexus between neighbourhood walkability and pro-environment behaviours (i.e., PEB and SRC) as well as the moderating role of sustainability knowingness in these relationships. Thus, this research sets the foundation for stronger research designs and reports implications for enhancing neighbourhood walkability with the support of residents. More so, recommended measures against CMB were taken to avoid or minimise the risk of bias associated with the cross-sectional design. Finally, a resilient statistical process was employed to minimise the risk of confounding, which the STROBE (i.e., Strengthening the Reporting of Observational Studies in Epidemiology) recognizes as another major threat to the internal validity of cross-sectional studies (Da Costa et al., 2011). Future researchers can follow these statistical procedures against CBM and confounding to improve the strength of their cross-sectional designs.

6. Conclusion

There was a significant positive association between pro-environment behaviour and neighbourhood walkability, which signifies that neighbourhood walkability was higher among residents who reported higher pro-environment behaviour. Similarly, SRC has a positive association with neighbourhood walkability, suggesting that the neighbourhood was more walkable for those who reported higher SRC. It could be concluded, therefore, that neighbourhood walkability can be improved by residents through pro-environment behaviours including SRC. The respective influences of pro-environment behaviour and SRC were increased by sustainability knowingness, which suggests that the positive relationships between the pro-environment behaviours (including SRC) and neighbourhood walkability were positively moderated by sustainability knowingness. This is to say that these pro-environment behaviours are more strongly associated with higher neighbourhood walkability at higher scores of sustainability knowingness. Therefore, residents' knowledge about sustainability and its importance can enhance the positive influence of pro-environment behaviours on neighbourhood walkability. Socially responsible consumption, compared to pro-environment behaviour, is more strongly associated with neighbourhood walkability, which suggests that SRC may be more strongly associated with neighbourhood walkability than pro-environment behaviour. Even so, pro-environment behaviour, compared to SRC, is more strongly supported by sustainability knowingness to positively affect neighbourhood walkability.

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Author statement

FFO conceived the research idea, partly provided funds for the study, and coordinated data gathering. NA conducted statistical analysis and supervised the project whereas ED, CKR, ECO, and FQ critically reviewed the manuscript. All authors proofread and approved the draft manuscript.

Data availability

The data will be made available upon request.

Declaration of competing interests

The authors declared no conflicts of interest.

Ethical statement

This study was approved by an institutional review committee in Accra after all participants provided informed consent to participate in this study. The ethics review number is 002-ACE-2019.

Declaration of competing interest

A conflict of interest may exist when an author or the author's institution has a financial or other relationship with other people or organizations that may inappropriately influence the author's work. A conflict can be actual or potential. At the end of the text, under a subheading 'Disclosure Statement', all authors must disclose any actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations within three (3) years of beginning the work submitted that could inappropriately influence (bias) their work. Examples of potential conflicts of interest which should be disclosed include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding.

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Appendix D. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jth.2022.101375.

Appendix A. Items used to measure neighbourhood walkability

#	Statement	1	2	3	4	5
1	Many places are easy to go within walking distance					
2	It is easy to walk to a public transport stop					
3	There are footpaths on most of the streets					
4	There are crosswalks and pedestrian signals					
5	The streets in my neighbourhood are not hilly					
6	Walkers in my neighbourhood can easily be seen					
7	There is lots of greenery around my neighbourhood					
8	There are many interesting things to look at					
9	There is not much traffic along nearby streets					
10	My neighbourhood has parks and walking trails					
11	Crime rate in my neighbourhood is not a problem					

Note: *1 = strongly disagree; 2 = disagree; 3 = somewhat agree; 4 = agree, and 5 = strongly agree.*
Source: Asiaman et al. (2021)

Appendix B. Items used to measure pro-environmental behaviour

#	Please describe how often you:	Never	Rarely	Sometimes	Often	Very often
1	looked for ways to reuse things					
2	recycled newspapers					
3	recycled cans or bottles					
4	encouraged friends or family to recycle					
5	purchased products in reusable containers					
6	picked up litter that was not your own					
7	composted food scraps					
8	conserved gasoline by walking or bicycling					
9	wrote a letter supporting an environmental issue					
10	voted for a candidate who supported environmental issues					
11	donated money to an environmental group					
12	volunteered time to help an environmental group					

Source: Lange and Dewitte (2021).

Appendix C. Items used to measure socially responsible consumption

#	Statement	1	2	3	4	5
1	I make an effort to support and buy from companies that promote the conservation of natural resources.					
2	I make an effort to support and buy from companies that have fair business practices.					
3	I make an effort to support and buy from companies that practice waste management and recycling.					
4	I make an effort to buy from companies that promote clean production and avoid contaminating the environment.					
5	I make an effort to support and buy from companies that hire employees who are refugees (displaced or reincorporated people) in society.					
6	I enjoy buying from companies that promote products that are beneficial to good health.					
7	I make a conscious effort to limit my use of products made from scarce resources.					
8	I enjoy buying handcrafted products as a way of supporting national labour.					
9	I make an effort to support and buy from companies that have good labour practices regarding their employees.					
10	I make an effort to buy from companies that pay fair and decent salaries.					
11	I avoid buying products from companies that exploit resources and workers from my country.					
12	I make an effort to buy from companies that hire disabled people.					
13	I avoid buying from companies that discriminate based on gender, religion or race.					
14	I make an effort to rationalize the consumption of products that seem to have contaminants (i.e., detergents, aerosols, batteries).					
15	I consume only those goods and services I need so that our resources will last longer.					
16	I make an effort to limit the consumption of gas and water in my home.					
17	I make an effort to buy energy-saving appliances.					
18	When I buy vegetables or preserved food, I worry that these may contain pesticide residue and preservatives.					
19	I avoid consuming products that are health hazards (i.e., cigarettes and alcohol).					
20	I avoid consuming in restaurants, bars or closed spaces where smoking is permitted.					
21	I avoid eating food products high in calories or saturated fats.					

Note: *1 = strongly disagree; 2 = disagree; 3 = somewhat agree; 4 = agree, and 5 = strongly agree.*
Source: Syed and Shanmugam (2020).

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