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Individual, social and area level factors associated with older people's walking: Analysis of an UK household panel study (Understanding Society)

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ABSTRACT

Background: Among older people, walking is a popular and prevalent activity. Walking is key to increasing physical activity levels and resulting physical and mental health. In the context of rapidly ageing populations, it is important to better understand what factors are associated with walking among older people, based on the socioecological model of health.

Methods: We used data from Understanding Society (n:6450), a national panel survey of UK adults aged 65 years and over living in Great Britain. Slope Indices of Inequality (SII) were calculated for weekly walking hours for older people according to individual, social and area characteristics. These include health, loneliness and social isolation, previous walking and sporting activity, residential self-selection, contact with neighbours, number of close friends and social activity. Spatial area-level data described local area crime, walkability, and proximity to retail, greenspace, and public transport amenities.

Results: Multivariable models indicated that poor health, particularly requiring help with walking, was the strongest predictor of weekly walking hours (SII (95% CI) comparing those needing help vs. no help: −3.58 (−4.30, −2.87)). However, both prior sporting activity (most vs. least active: 2.30 (1.75, 2.88)) and walking for pleasure (yes vs. no: 1.92 (1.32, 2.53)) were strongly associated with increased walking several years later. Similarly having close friends (most vs. fewest, 1.18 (0.72, 1.77)) and local retail destinations (any vs. none: 0.93 (0.00, 1.86)) were associated with more weekly walking.

Conclusions: Past engagement in physical activity and walking for pleasure are strong predictors of walking behaviour in older people, underscoring the importance of implementing and sustaining walking interventions across the lifespan to ensure continued engagement in later years and the associated health benefits. However, poor health significantly impedes walking in this demographic, emphasising the need for interventions that offer both physical assistance and social support to promote this activity.

1. Introduction

The number of older people globally is rising rapidly; the World Health Organisation (WHO) forecasts that the number of people aged 60 years and over will double from 1 billion in 2020 to 2.1 billion by 2050 (World Health Organisation, 2022). In England and Wales, the 2021 census showed an increase of 20% in the number of people aged 65 years and over since 2011 (2011: 9.2 million, 2021: 11 million) (Office for National Statistics, 2023). It is therefore important to ensure that this growing number of older people are able to live in good health, which will in turn reduce the burden on already limited health and social care resources (Welsh et al., 2021).

Physical inactivity has been shown to be associated with many chronic and degenerative diseases in older people that may affect their ability to lead their later life disability-free. Less physically active older people experience worse quality of life and cognitive function, reduced disability-free life expectancy, increased risk of all-cause and cardiovascular mortality, as well as increased risk of muscle degeneration and

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frailty (Cunningham et al., 2020; McPhee et al., 2016). Walking is a feasible and accessible leisure exercise for many older people, which is a mostly safe exercise that can benefit health (Mobily, 2014). Among older people, both recreational (Liu et al., 2020) and utilitarian (Fonseca et al., 2021) walking are often promoted as key to increasing physical activity levels (Li et al., 2014). Walking is the most popular and prevalent activity in this population subgroup, particularly among people who can no longer drive, or afford motorised transport options (Li et al., 2014; Liu et al., 2020). Given its importance to older people's physical activity, this study focuses on walking activity, specifically.

There are different risk factors for reduced walking, including aspects of individual physiology and psychology, demographic characteristics, social factors, and features of place (Mobily, 2014). The importance of community-level factors for healthy ageing was highlighted by the WHO in their 2007 *Global age-friendly cities* strategy (World Health Organization, 2007). This strategy promotes the design of cities, towns and rural areas to encourage active ageing by providing ample opportunities for health, community engagement, and safety aimed at improving quality of life for older people (World Health Organization, 2007). The concept has developed over time, using differing terminologies such as *liveable cities*, *age-friendly communities,* and *active ageing*, covering a similar range of concerns and priorities for ageing populations including physical environment, social connectedness and physical activity (Steels, 2015). The WHO *Global Action Plan for Physical Activity* situates walking at the centre of its strategic recommendations for creating *active environments* (World Health Organization, 2018). However, despite the conceptualisation of age-friendly environments and clear policy interest, empirical evidence is required to better understand the processes by which these influence health within different contexts (Menec et al., 2011). This will, in turn, support the evolution of the concept and policy decisions regarding liveable cities and active ageing.

Despite an increased knowledge base around individual predictors of walking, there is a lack of evidence regarding the role of community-level risk factors in socioecological model of health (Sallis et al., 2006). Research has shown that neighbourhood-level risk factors are regarded by older people as both barriers to, and facilitators of, physical activity, including walking. The barriers highlighted in both qualitative and quantitative studies include environmental factors, such as distance to green spaces and public transport stops, unsafe neighbourhoods, quality and connectivity of walking infrastructure (e.g. footpaths/walkability) and inadequate resources for socialising, as well as access to local services, amenities and public transport (Bonaccorsi et al., 2020; Cohen-Mansfield et al., 2016; Cotterell et al., 2018; Kerr et al., 2012; Noone and Yang, 2022; Yun, 2019). Facilitators include greater proximity to retail amenities, as well as feeling safe (Kerr et al., 2012).

At an individual-level, recent evidence has suggested that additional factors may be important predictors of walking activity, such as residential self-selection (Barnett et al., 2017) and previous participation in walking activities (Mertens et al., 2019; Stathi et al., 2012; Yun, 2019). There has been a call for longitudinal studies with large, representative samples to address this gap by providing knowledge of previous behaviours combined with individual, social and environmental factors that may influence current walking activity (Mertens et al., 2019; Yun, 2019). In the context of this work and the WHO *Global age-friendly cities*, it is important to better understand which features are associated with walking, based on the socioecological model of health that includes longitudinal individual, social and environmental factors; there is also a paucity of studies that have combined these three factors into a single study design (Krogstad et al., 2015). This study aims to address this gap.

The aims of this study were to: (i) define and extract individual, social and area-level factors that may be associated with older people's walking; and (ii) explore whether weekly walking hours are associated with individual, social and area-level factors for older people.

2. Methods

Analyses are based on data from Understanding Society, the UK Household Longitudinal Study (UKHLS) (University of EssexInstitute for Social and Economic Research, 2022), details of which have been reported previously (Buck and McFall 2011). Briefly, the UKHLS, which began in 2009, is a longitudinal survey of a stratified clustered sample of households in England, Scotland, Wales and Northern Ireland with data currently available from thirteen collection waves (Institute for Social and Economic Research, 2022; Lynn, 2009). Data collection waves 10 to 13 took place during the COVID-19 pandemic and associated lockdown measures, which may have impacted on respondents' activities, in particular walking and social contact outside the home, and the current analyses are therefore based on wave 9 of data collection (2017–2019), with longitudinal variables obtained from waves 2 (2010–2011) and 5 (2013–2014) (further detail in Section 2.2). Interview data on walking frequency, health, prior physical activity, and social contacts were linked to external data on local amenities. Analyses are restricted to wave 9 respondents aged 65+ at the time of interview and, as local amenities data were not available for Northern Ireland, are additionally restricted to respondents living in Great Britain (England, Scotland and Wales).

Supplementary Table 1 provides a summary of the outcome, individual, social, and area level variables used in our analysis, these are described in detail in the sub-sections below.

2.1. Weekly walking

Weekly walking was derived from relevant questions from the International Physical Activity Questionnaire – Short Form (IPAQ-SF), which has been shown to have high reliability and validity (Craig et al., 2003). Questions were asked about walking over the previous seven days, specifying that respondents should include walking at work and at home, walking to travel from place to place, and any other walking done solely for recreation, sport, exercise or leisure. Respondents were asked on how many days they walked for at least 10 min at a time, with follow-up questions asking for the usual number of hours and minutes spent walking each day. If respondents were unable to provide this information, follow-up questions asked how much time in total they spent walking over the past seven days, again specifying that they should only include walking done for at least 10 min at a time. Responses to these questions were combined to estimate respondents' hours per week spent walking.

2.2. Individual characteristics

Respondents were asked to rate their general health (excellent, very good, good, fair or poor) (Ware et al., 1996), whether they had any long-standing physical or mental impairment, illness or disability (LSI) likely to last 12 months or more (yes or no) (University of EssexInstitute for Social and Economic Research, 2022), and if they could "usually manage to go out of doors and walk down the road" (on their own, only with help from someone else or not at all; from Activities of Daily Living Index) (Katz, 1983). Respondents' mental health was assessed using the 12-item General Health Questionnaire (GHQ-12) with Likert scoring giving total scores between 0 and 12 (Goldberg, 1988). Respondents were also asked if they lived alone (yes or no), how often they felt lonely (hardly ever/never, some of the time or often), if they had access to a car or van (yes or no), and, as a measure of residential self-selection, if, given the choice, they would prefer to stay in their present home or move somewhere else (stay here or prefer to move). Prior walking and physical activity were derived from data collected in waves 2 (2010–2011) and 5 (2013–2014) as follows: responses to a direct question on rambling or walking for pleasure or recreation (yes or no) and a broader self-assessment of sporting activity (from 0 "doing no sport at all" to 10 "very active through sport") (University of

EssexInstitute for Social and Economic Research, 2022).

2.3. Social characteristics

Respondents were asked to rate their strength of agreement with the statements "The friendships and associations I have with other people in my neighbourhood mean a lot to me" and "I regularly stop and talk with people in my neighbourhood" (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree), both from Buckner's Neighbourhood Cohesion Instrument (Buckner, 1988). In addition, respondents were asked how many close friends they had and what proportion lived in the same area. Finally, respondents were asked if they went out socially or visited friends when they felt like it (yes or no) (University of EssexInstitute for Social and Economic Research, 2022).

2.4. Area characteristics

Local area crime and safety was based on the number of problems (out of 8) that were reported by the respondent as being very or fairly common in their area ('rubbish on the street', 'teenagers hanging about', 'drunks/tramps hanging about', 'vandalism', 'racial insults/attacks', 'homes broken into', 'cars broken into', 'people attacked on the street'). Urban-rural status was based on a UKHLS-derived variable based on the Office for National Statistics Rural and Urban Classification of Output Areas (2001) (UKDS Study Number 7454). Spatial data were obtained for green space access, recreational amenities, public transport for the period 2018, and retail centres (period: 2022), corresponding to the mid-point of UKHLS wave 9 data collection, as shown in Table 1. Data were geocoded and plotted within GIS software ArcPro v2.9.5. Special licence geographic identifiers were provided for Understanding Society participants according to their Lower Layer Super Output Areas (LSOAs) in England and Wales and data zones in Scotland (University of Essex, 2022). LSOA's are small geographical spatial areas comprising between 400 and 1200 households and have a usually resident population between 1000 and 3000 persons (Office for National Statistics, 2021); data zones are the Scottish equivalent (Scottish Government, 2021). Counts of green space access points, recreational amenities, and public transport stops were scaled to account for the LSOA size and population. Amenities other than retail centres were split into approximate tertiles to allow for larger numbers of areas with none, and for retail centres LSOAs and data zones were split into those containing a centre versus not.

Table 1
Local area amenities and sources.

Amenity	Description	Measure	Source
Green space access points	Public Park or Garden access points, playing field access points, play space access points.	Count of greenspace access points within LSOA	Ordnance Survey Open Greenspace Oct 2018; Ordnance Survey (2021a))
Recreational amenities	Sports and recreational facilities including pitches, swimming pools, courts.	Count of amenities within LSOA	Ordnance Survey Points of Interest, Jun 2018; Ordnance Survey, 2021b)
Public transport stops	Bus stops, railway stations, tram and underground stations	Count of amenities within LSOA	Ordnance Survey Points of Interest, Jun 2018; Ordnance Survey, 2021b)
Retail centre	Location, extent and function of retail agglomeration areas defined as: retail centres, regional centre, district centre, major town centre, town centre, and local centre.	Binary yes/no LSOA contains a retail centre.	Consumer Data Research Centre, 2022; Singleton et al. (2022)

2.5. Neighbourhood walkability score

Neighbourhood walkability scores were derived from dwelling numbers and street/path. In ArcGIS Pro v3.1.3, for each LSOA/data zone a measure of street/path connectivity was calculated using intersection density, i.e. the ratio of the number of true intersections (three or more) to the LSOA/data zone area (Frank et al., 2010). Z-scores were computed for both variables to standardise scores and walkability scores (WS) were calculated as: '*WS = (2 x intersection z-scores) + (dwelling density z-scores)*' (Intersection density weighted by two due to stronger influence on active travel). Neighbourhood walkability and amenities were linked to participants based on the LSOA/data zone in which they lived. Walkability scores were split into quartiles.

2.6. Statistical analyses

Associations of weekly walking hours with individual, social and area characteristics were assessed using multilevel least squares regression models to account for the non-independence of individuals clustered within LSOAs/data zones. Explanatory characteristics were, where appropriate, coded from most to least favourable in terms of their likely impact on weekly walking hours (e.g. excellent to poor self-rated health; never to often lonely) for consistency and to maximise statistical power. There was variation in the number and magnitude of categories in the individual, social and area characteristics, making direct comparison of their respective associations with weekly walking difficult. We therefore derived a separate Index of Inequality for each explanatory variable (Regidor, 2004), putting them all on the same scale and reducing the influence of extremes in the distribution of respondents in each category. The Index of Inequality is based on the cumulative proportion ranking of the study population and produces a score between 0 and 1 based on the midpoint of the proportion of the population in each category. For example, if the proportion of respondents in a four-category variable is 0.1 (lowest category), 0.3, 0.4, and 0.2 (highest category), then respondents in the lowest category are assigned its midpoint value of 0.05 (0.1 ÷ 2), and those in subsequent categories are given values of 0.25 (0.1 + (0.3 ÷ 2)), 0.6 (0.1 + 0.3 + (0.4 ÷ 2)), and 0.9 (0.1 + 0.3 + 0.4 + (0.2 ÷ 2)) respectively. Using this method, the different explanatory variables were all scaled from most to least favourable, on a scale between 0 and 1, and results based on the different Indices of Inequality are therefore comparable. Slope Indices of Inequality (SII) were obtained by regressing the continuous outcome (weekly walking hours) on the corresponding Index of Inequality. In these models the resulting SII represents the difference in weekly walking hours comparing the least versus most favourable category for each explanatory variable in terms of their hypothesised impact on weekly walking hours, e.g. worst versus best self-rated health or no versus any previous walking for pleasure. The use of SII coefficients allows comparison of the respective impact on weekly walking hours of the different individual, social and area characteristics.

Preliminary analyses of individual characteristics were based on univariable models with adjustment for age and sex. Multivariable models were then fitted including all individual characteristics that were univariably associated with weekly walking hours. Characteristics whose associations were completely attenuated by adjustment for other variables in the model were removed leaving those independently associated with weekly walking hours (Model 1). This process was repeated for social characteristics (Model 2) with additional preliminary adjustment for individual characteristics identified in Model 1. Similarly, area characteristics independently associated with weekly walking hours were identified (Model 3) after adjustment for individual and social characteristics from Models 1 and 2 respectively. Secondary stratified analyses compared differences in associations between (i) men and women and (ii) respondents aged 65–74 and 75+ years but results were very similar to those presented here for all respondents combined. Although weekly walking hours were negatively skewed, residuals from the final regression models were approximately Normally distributed.

Analyses were based on respondents with complete data on weekly walking hours and all potential explanatory variables. All models included inverse probability weights to take account of unequal selection probabilities into the study and differential drop-out (Kaminska and Lynn, 2019).

3. Results

A total of 8085 respondents were aged 65+ years and lived in England, Scotland and Wales. Of these, 6450 (79.8%) had complete data on weekly walking hours and all explanatory variables of interest. The characteristics of respondents in this analytical sample compared with all those aged 65+ years and living in Great Britain are presented in Table 2. Overall, there were no marked differences between respondents included in the analyses and the population from which they were drawn.

Table 3 presents univariable and multivariable associations of individual characteristics with weekly walking hours. Results from age and sex-adjusted models demonstrated marked associations with all individual characteristics other than residential self-selection. For example, respondents who rated their health as poor walked, on average, for 4 h less than those who rated their health as excellent (SII (95% confidence

Table 2
Characteristics of analytical sample versus all Great British respondents aged 65+.

	Analytical sample (N = 6450)	All Great British respondents aged 65+ (N = 8085)
Walking		
% less than 1 h walking per week	25.7	27.0
Sex		
% male	45.8	46.1
Age		
% aged 75+	38.4	40.2
Individual characteristics		
% fair/poor self-rated health	29.7	30.7
% with LSI	56.5	58.0
% need help from someone else with walking	8.8	10.4
% GHQ-12 score of 4+	12.3	12.9
% sometimes/often lonely	27.6	28.3
% live alone	31.8	30.2
% no access to car/van	19.0	20.8
% no prior walking for pleasure	53.2	55.6
% lowest prior activity	33.3	35.6
% prefer to move house	16.3	16.2
Social characteristics		
% disagree local friends mean a lot	6.2	6.5
% disagree talk to neighbours regularly	7.3	7.8
% no close friends	4.0	4.2
% no close friends locally	15.8	16.5
% don't go out socially	12.3	15.0
Area characteristics		
% least walkable quartile	34.5	32.4
% 1+ problems reported as very or fairly common	32.4	33.5
% lowest tertile of green space access	33.9	34.8
% lowest tertile of recreational amenities	35.9	36.7
% lowest tertile of public transport	30.1	31.0
% no retail	91.7	90.9
% urban	68.5	70.7

Table 3
Slope Index of Inequality[a] (95% CI) for hours walking per week according to individual characteristics.

	Age and sex adjusted	Reciprocally adjusted (Model 1)[b]
Sex		
Sex (female vs. male)	−0.88 (−1.39, −0.36)	
Age		
Age (oldest to youngest)	−3.21 (−3.67, −2.75)	
Individual characteristics		
Self-rated health (worst to best)	−4.17 (−4.64, −3.69)	−1.68 (−2.28, −1.08)
LSI (yes vs. no)	−3.46 (−4.05, −2.87)	−1.18 (−1.83, −0.52)
Need help from someone else with walking (most to least)	−6.83 (−7.47, −6.19)	−3.58 (−4.30, −2.87)
GHQ-12 score (highest to lowest)	−3.24 (−3.77, −2.72)	−1.32 (−1.88, −0.75)
Lonely (most to least)	−1.86 (−2.45, −1.28)	
Live alone (yes vs. no)	−1.27 (−1.89, −0.65)	
Access to car or van (no vs. yes)	−2.42 (−3.11, −1.73)	
Prior walking for pleasure (no vs. yes)	−3.78 (−4.35, −3.22)	−1.92 (−2.53, −1.32)
Prior activity (least to most active)	−3.95 (−4.45, −3.45)	−2.30 (−2.85, −1.75)
Residential self-selection (prefer to move vs. not)	0.38 (−0.40, 1.17)	

[a] Slope Index of Inequality represents the difference in weekly walking hours comparing females versus males, oldest versus youngest respondents, and the least versus most favourable category for all other explanatory variables.
[b] All individual characteristics independently associated with weekly walking hours after adjustment for age, sex and all other characteristics in the model.

interval) comparing respondents with worst versus best self-rated health: −4.17 (−4.64, −3.69)) with an association of similar magnitude between weekly walking and LSI (−3.46 (−4.05, −2.87)). The most marked association was observed for respondents who needed help with walking from someone else, with those requiring the most help walking almost 7 h less per week compared to those who did not need any help (−6.83 (−7.47, −6.19)). Strong associations were also observed for prior walking for pleasure (−3.78 (−4.35, −3.22)) and prior activity (−3.95 (−4.45, −3.45)). Weaker associations were observed for loneliness, living alone, and having access to a car or van. When all individual characteristics were included in a single reciprocally adjusted model (Model 1), independent associations with weekly walking remained for self-rated health, LSI, need help walking, GHQ-12 score of 4+, and prior walking and activity. The strongest associations were with needing help walking (−3.58 (−4.30, −2.87)), and with prior walking (−1.92 (−2.53, −1.32)), and sporting activity (−2.30 (−2.85, −1.75)).

Associations of weekly walking hours with social characteristics are presented in Table 4. Respondents who talked to their neighbours less, who had fewer close friends generally and locally, and who did not go out socially walked less than those with more favourable social outcomes. Age and sex-adjusted differences in weekly walking ranged from just over 1 h less walking among respondents with the fewest versus most local friends (SII (95% CI): −1.28 (−1.78, −0.77)) to 4 h less in respondents who did not go out socially compared with those who did (−3.98 (−4.69, −3.26)). Adjustment for individual characteristics from Model 1 attenuated these associations and, after reciprocal adjustment for other social characteristics (Model 2) only respondents' number of close friends (not necessarily in the local area) remained independently associated with weekly walking (−1.18 (−1.65, −0.72)).

Table 5 presents associations of weekly walking with area characteristics. Results for age and sex-adjusted associations were mixed with more hours walking amongst respondents living in areas that were less

Table 4
Slope Index of Inequality[a] (95% CI) for hours walking per week according to social characteristics.

	Age and sex adjusted	Adjusted for individual characteristics[b]	Reciprocally adjusted (Model 2)[c]
Social characteristics			
Local friends mean a lot (least to strongest agreement)	0.12 (−0.41, 0.64)		
Talk to neighbours regularly (least to strongest agreement)	−1.72 (−2.22, −1.21)	−0.64 (−1.12, −0.16)	
N close friends (fewest to most)	−2.07 (−2.56, −1.58)	−1.18 (−1.65, −0.72)	−1.18 (−1.65, −0.72)
N close friends locally (fewest to most)	−1.28 (−1.78, −0.77)	−0.89 (−1.36, −0.42)	
Go out socially (no vs. yes)	−3.98 (−4.69, −3.26)	−0.99 (−1.72, −0.26)	

[a] Slope Index of Inequality represents the difference in weekly walking hours comparing the least versus most favourable category for each explanatory variable.
[b] Univariable analyses of social characteristics adjusted for age, sex, and individual characteristics from Model 1.
[c] All social characteristics independently associated with weekly walking hours after adjustment for age, sex, individual characteristics from Model 1, and all other characteristics in the model.

Table 5
Slope Index of Inequality[a] (95% CI) for hours walking per week according to area characteristics.

	Age and sex adjusted	Adjusted for individual and social characteristics[b]	Reciprocally adjusted (Model 3)[c]
Area characteristics			
Walkability score (least to most walkable)	0.66 (0.15, 1.18)	−0.02 (−0.53, 0.48)	
Neighbourhood crime/safety (most to fewest items)	0.55 (−0.06, 1.17)	0.95 (0.34, 1.55)	0.90 (0.30, 1.51)
Green space access (fewest to most)	0.23 (−0.30, 0.76)	0.40 (−0.11, 0.91)	
Recreational amenities (fewest to most)	−0.61 (−1.14, −0.08)	−0.23 (−0.74, 0.28)	
Public transport (fewest to most)	0.09 (−0.44, 0.62)	0.14 (−0.37, 0.65)	
Retail (none vs. any)	−0.88 (−1.91, 0.16)	−1.07 (−2.02, −0.11)	−0.93 (−1.86, −0.00)
Urban-rural (rural vs. urban)	0.44 (−0.18, 1.07)	−0.11 (−0.73, 0.50)	

[a] Slope Index of Inequality represents the difference in weekly walking hours comparing the least versus most favourable category for each explanatory variable.
[b] Univariable analyses of area characteristics adjusted for age, sex, and individual and social characteristics from Models 1 and 2.
[c] All area characteristics independently associated with weekly walking hours after adjustment for age, sex, individual and social characteristics from Models 1 and 2, and all other area characteristics in the model.

walkable and with more perceived crime and, conversely, less walking among respondents living in areas with fewer recreational amenities and no retail centres. Associations were generally attenuated by adjustment for individual and social characteristics; conversely, associations with neighbourhood crime and safety and with retail centres were strengthened (SII (95% CI): 0.95 (0.34, 1.55) and −1.07 (−2.02, −0.22) respectively). In reciprocally adjusted models (Model 3) only crime and safety and retail centres remained independently associated with walking, again consistent with around an hour more walking per week among respondents living in areas with more crime (0.90 (0.30, 1.51)) and around an hour less walking per week among respondents living in areas with no retail centre (−0.93 (−1.86, −0.00)).

4. Discussion

Our study focuses on the weekly walking levels of older individuals and how this relates to a range of factors at the individual, social, and area-level. We discovered that older adults who perceived their health as poor and required assistance from someone else with walking engaged in 4–7 fewer hours of walking per week compared to those in good health or who did not need assistance. Conversely, individuals who engaged in prior walking for pleasure and sporting activities, as reported in data collected between 3 and 9 years earlier, tended to walk approximately 4 h more per week.

At a social level, having close friends was positively associated with weekly walking, while area-level factors such as crime rates and safety perceptions, as well as the presence of retail centres in the area, also influenced walking habits. Surprisingly, residing in an area perceived to have higher crime rates and poorer safety was associated with increased walking, while living in proximity to retail centres was associated with reporting higher levels of walking activity.

4.1. Comparison with other literature

Our findings highlight that individuals requiring support walking (can only go out of doors and walk down the road with support from someone else) and experiencing poorer health outcomes tend to engage in lower levels of weekly walking. This aligns with previous research indicating a negative correlation between health concerns, such as fear of falling (Leung et al., 2021), and physical activity among older adults, leading to a detrimental cycle of decreased physical function due to inactivity (Li et al., 2009). However, walking is a feasible and accessible leisure exercise for many older people, which is mostly safe and can benefit health (Mobily, 2014). Interventions aimed at increasing walking activity for older people with a range of health conditions, such as mild-to-moderate hypertension, have shown positive impacts in terms of increasing their exercise self-efficacy and reducing systolic blood pressure (Lee et al., 2007). It is therefore worth considering how interventions either at the individual or area-level might be used to encourage and support older people in poorer health to engage in regular walking activity. For example, research focussed on frail older people, particularly those reliant on wheelchairs or walkers, has highlighted features of the local area that restrict their ability to undertake local activities such as inaccessible streets, public transport and shops (Cramm et al., 2018). These factors highlight the need to measure the quality of local streetscapes that may be enablers or barriers to walking for older people which are difficult to measure in national spatial datasets.

More positively, we observed that past engagement in walking for pleasure or recreational activities reported 7–9 years earlier, as well as sports activities reported 3–6 years earlier, was strongly associated with current walking behaviours. This aligns with prior studies indicating that established activity habits are key influencers of current physical activity levels among older adults (Stathi et al., 2012). Our research also contributes to the limited longitudinal evidence, which highlights that older adults who incorporate walking for transport purposes are likely to maintain similar activity levels three years later (Mertens et al., 2019), however in our study we were unable to define the purpose of the walking trip. Although prior walking is a strong predictor of continuing activity, evidence also shows that increasing walking activity for previously sedentary older people is associated with health benefits (Diehr and Hirsch, 2010). Initiatives that encourage recreational walking pre-retirement age may therefore have an important and long-lasting impact on healthy walking in older age, even among those in poor health.

In terms of social factors, our findings revealed a connection between reporting a larger circle of close friends and higher levels of walking. Although we could not determine whether this walking activity was undertaken alone or with friends, existing evidence indicates that social interactions are linked to increased walking among older adults (Capalb et al., 2014; Leung et al., 2021). Interventions that recognise the social benefits of walking are therefore worthy of further consideration, particularly for more sedentary older adults or those in poorer health. For example, volunteer led wellbeing walks organised by charities and social groups that are 'open to all' and designed to support individuals with mobility issues to participate (Ramblers UK, 2024).

Regarding area characteristics, living in proximity to a retail centre was associated with increased walking among older individuals. Previous studies conducted in dense, walkable areas of Vancouver, Canada, have shown walking to be the primary mode of transport for local destinations, with grocery stores and restaurants being the most frequented (Cerin et al., 2020; Winters et al., 2015). However, our study did not find a significant association between walking and area-level walkability, this may be due to our walkability index being constructed using objective data measuring junction density and street/path network only. Subjective walkability, measuring perceived accessibility across a range of neighbourhood attributes including access to shops, good footpaths and 'inviting' local shops, has been associated with environments where more people walk for utilitarian and recreational purposes (Meng et al., 2023) and happiness of people, although this was an indirect association for older people which was mediated by the effect of walkability on health and satisfaction with neighbourhood appearance (Leyden et al., 2024; Meng et al., 2023). Subjective walkability also differs by individual-level sociodemographic characteristics and the purpose of the walking trip (Meng et al., 2023). A global systematic review and meta-analysis provided strong evidence of the impact of local destinations on older adults' overall walking, particularly emphasising the significance of shops and commercial destinations (Barnett et al., 2017). Notably, this review also observed a link between built environmental features and physical activity through walking, but not cycling. This underscores the importance of local retail amenities as key destinations for older individuals, with these journeys potentially yielding health benefits equivalent to approximately 1000 steps and 6 min of physical activity (Winters et al., 2015).

Older people living in areas characterised by higher crime rates and lower social cohesion reported engaging in more walking compared to their counterparts, a phenomenon observed in previous studies conducted in the UK and Australia (Foster et al., 2014, 2016; Mason et al., 2013). It has been theorised that the higher crime rates may be linked to residing in densely populated, urban, walkable areas (Foster et al., 2014), potentially explaining this association. However, in our study, this relationship remained significant even after adjusting for these factors. Interestingly, despite residing in areas with higher crime rates not leading to a decrease in reported walking, such neighbourhoods have been found to have adverse effects on the mental well-being of their residents (Pak and Gannon, 2023). Further research is required to investigate the associations between walking, area-level crime and safety measures, and impact on health.

4.2. Strengths and limitations

The study has a number of important advantages. Analyses are based on data from a large population-based survey of UK adults with analytical weights used in all analyses to increase representativeness of the sample, making results relevant to similar populations across the UK, Europe, and Western developed counties. We considered a wide range of individual and social characteristics, including longitudinally collected prior walking and activity levels, which reduced the possibility of recall bias. We linked individual data to robust spatial data of high quality across a national footprint, providing objective assessment of neighbourhood characteristics. In addition, analyses accounted for the non-independence of individuals within LSOAs and the use of SIIs made it possible to compare the relative strength of associations with different individual, social and neighbourhood characteristics.

However, there are also some limitations that should be considered. Local area data were only available for England, Scotland and Wales meaning that our analyses were restricted to respondents living in Great Britain, although we have no reason to suppose that associations would differ in Northern Ireland. In addition, analyses were restricted to respondents with complete data for walking and all explanatory variables of interests, although there were no marked differences between the analytical sample and the population from which it was drawn. Our outcome, weekly walking hours, was based on self-report rather than more objectively assessed pedometer or accelerometer data. However, questions on walking were detailed, specified all forms of walking and not just walking for pleasure, and allowed options for respondents who did not walk regularly. We also were unable to identify the location the individual walked and if this was in their local area or elsewhere. Our definition of "local area" was based on the scale at which the data were available, namely LSOA/data zone, and we recognise that the scale at which area effects are most important may vary, although a recent review of neighbourhood effects across outcomes found little theoretical or empirical guidance on which scale different effects might operate (Knies et al., 2021). In addition, although we were able to derive a measure of the quantity of amenities in an area, we were unable to assess the quality. For recreational domains, we do not know if they were private or council run, and were therefore cost-based accessibility measures, and we do not have information on whether they provided specific classes or services for older people. Finally, and importantly, although analyses were based on individual respondent outcomes, amenity data were only measured at LSOA/data zone level and there is therefore no way of knowing whether study participants living in areas with amenities actually used them.

4.3. Conclusions

Walking, a behaviour that can provide health benefits, is influenced by various individual, social, and area-level factors among older people, future research may consider the dynamics of the interactions between these levels (e.g. systems approach). The presence of close friends and accessible local retail outlets is associated with increased reported walking. Additionally, past engagement in physical activity and walking for pleasure emerge as strong predictors of walking behaviour in older people, underscoring the importance of implementing and sustaining walking interventions across the lifespan to ensure continued engagement in later years. However, poor health significantly impedes walking in this demographic, emphasising the need for interventions that offer both physical assistance and social support to promote this activity.

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Ethical approval statement

The University of Essex Ethics Committee has approved all data collection on Understanding Society main study and innovation panel waves, including asking consent for all data linkages except to health records. Requesting consent for health record linkage was approved at Wave 1 by the National Research Ethics Service (NRES) Oxfordshire REC A (08/H0604/124), at BHPS Wave 18 by the NRES Royal Free Hospital & Medical School (08/H0720/60) and at Wave 4 by NRES Southampton REC A (11/SC/0274). Approval for the collection of biosocial data by trained nurses in Waves 2 and 3 of the main survey was obtained from the National Research Ethics Service (Understanding Society – UK Household Longitudinal Study: A Biosocial Component, Oxfordshire A REC, Reference: 10/H0604/2).

For further details on the various committees which have provided ethical approval of the Understanding Society study and its components as appropriate see below:

Main survey: Ethics approval was received from the University of Essex Ethics Committee.

- By letter dated July 6, 2007 for Waves 1 and 2
- By letter dated December 17, 2010 for Waves 3 to 5
- By letter dated August 20, 2013 for Waves 6 to 8
- By letter dated October 4, 2016 for Waves 9-11

CRediT authorship contribution statement

Jonathan R. Olsen: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Elise Whitley:** Writing – original draft, Methodology, Formal analysis, Conceptualization. **Emily Long:** Writing – review & editing, Investigation, Conceptualization. **Benjamin P. Rigby:** Writing – review & editing, Investigation, Conceptualization. **Laura Macdonald:** Writing – review & editing, Methodology, Formal analysis. **Grace O. Dibben:** Writing – review & editing, Investigation, Conceptualization. **Victoria J. Palmer:** Writing – review & editing, Project administration, Investigation, Conceptualization. **Michaela Benzeval:** Writing – review & editing, Methodology, Investigation, Data curation. **Kirstin Mitchell:** Writing – review & editing, Investigation, Funding acquisition, Conceptualization. **Mark McCann:** Writing – review & editing, Investigation, Funding acquisition, Conceptualization. **Martin Anderson:** Writing – review & editing, Project administration, Investigation. **Meigan Thomson:** Writing – review & editing, Project administration, Investigation. **Laurence Moore:** Writing – review & editing, Investigation, Funding acquisition, Conceptualization. **Sharon A. Simpson:** Writing – review & editing, Project administration, Investigation, Funding acquisition, Conceptualization.

Data availability

Data are made available under licence via the UK Data Service (https://beta.ukdataservice.ac.uk/datacatalogue/series/series?id=2000053).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2024.117083.

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