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What happens behind doors? Exploring everyday indoor activities when ageing in place

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ABSTRACT

Engaging in social interaction and physical movement during everyday activities has a positive influence on wellbeing in later life. For older adults who age in place, the majority of activities occur indoors, yet studies typically focus on outdoors. Gender influences social and physical activities but is understudied in an ageing-in-place context. We aim to address these gaps by increasing insight into the indoor activities in later life, with a focus on gender differences in social interaction and physical movement. Through a mixed-methods approach, data were collected using global positioning system (GPS) trackers, pedometers and activity diaries. Twenty community-dwelling older adults (11 women and 9 men) who were living in Lancashire collected these data over seven days. An exploratory spatio-temporal analysis was conducted on the 820 activities they undertook. We discovered that our participants spend large amounts of time indoors. We also found that social interaction increases the duration of the activity and, conversely, decreases levels of physical movement. When zooming in to gender differences, men's activities took significantly longer than women's activities and were characterised by higher level of social interaction. Based on these results, we argue that there is a trade-off between social interaction and physical movement in everyday activities. We suggest establishing a balance between socialising and moving in everyday activities in later life, specifically because maintaining high levels of movement and social interaction at the same time seems unachievable. In conclusion, it is important to design indoor environments that facilitate choice between being active and resting, and between being social and being on one's own rather than assume they are mutually-exclusive and/or universally "good" or "bad" per se.

Introduction

The global population is ageing fast. In 2050, it is estimated that the number of adults over 60 will have reached 2.1 billion, which is twice as much as the current population (United Nations, 2019). Such demographic change is increasing the demand for healthcare and support for older adults, and has led policy makers to seek the best living situation for this population. Ageing in place refers to people who age independently in their own homes and communities and rather than in an institutionalised setting (Boyle, Wiles, & Kearns, 2015; Fernández-Carro, 2016; Pani-Harreman, Bours, Zander, Kempen, & Van Duren, 2021; Stones & Gullifer, 2016; Swindle, 2005; Vitman Schorr & Khalaila, 2018). For expediency, the word "home" in this study is understood as the dwelling in which a person lives. An older adult ageing in their home might live together with children, a spouse or a friend, or live alone. Evidence supports the assumption that older adults

overwhelmingly prefer to remain in their own homes and familiar communities (Iecovich, 2014; Stones & Gullifer, 2016; Wang et al., 2019). However, not everyone can age in place because of various reasons, such as health or financial limitations. For instance, around 90% of Spanish older adult wished to age at home as long as they are physically and cognitively healthy (Fernández-Carro, 2016). Individuals who age in place in theory stay more connected to their informal support networks and thus are arguably protected from isolation and loneliness (Vitman Schorr & Khalaila, 2018). Consequently, ageing in place also contributes to controlling public healthcare costs (Graybill, McMeekin, & Wildman, 2014; van Hees, Horstman, Jansen, & Ruwaard, 2017) and increases older adults' wellbeing (Van Dijk, Cramm, Van Exel, & Nieboer, 2015). The wellbeing of older people is associated with maintaining physical movement and social interactions in their everyday activities at home and in the community (Katz, 2000; Taylor, Buchan, & van der Veer, 2019). Gaining an insight into the exact nature of these

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activities, and particularly the amount of physical movement and social interaction involved, is crucial to understanding one aspect of how adults may maintain their wellbeing in later life.

Ageing in place and the spatio-temporal contexts of everyday activities

Ageing in place helps individuals retain their “life history meanings, social identity and autonomy” (Iecovich, 2014, p. 22), which positively influences their wellbeing. However, studies by Braubach and Power (2011) and Baldassar, Wilding, Boccagni, and Merla (2017) reveal a potentially negative consequence of ageing in place: older adults with physical and cognitive impairments can end up becoming homebound, experiencing social isolation and loneliness. Their impairments may limit their ability to maintain everyday activities, social interactions and physical movements. Therefore, it is important to understand “specific lived experiences” to realise how older adults can age well in place (van Hees et al., 2017, p. 11) rather than universalise or idealise home-based living.

Among the primary aspects of ageing in place are the spatial and temporal contexts of growing old. The two theoretical contexts used in this study are built upon time-geography (Hagerstrand, 1970) and activity-space (Smith, Foley, & Panter, 2019) theories, which employ a structured approach to explore everyday activities. The spatial context of ageing in place relates to one’s home, a place where an individual has a degree of autonomy, familiarity, connectedness and independence in relation to the surrounding environment (Stones & Gullifer, 2016). Indeed, the concept of ageing in place is not limited to one’s home but rather extends to neighbourhoods and other everyday places. In a review about geographies of ageing, Skinner, Cloutier, and Andrews (2015) underline the importance of the relationship between place, social experience and quality of ageing. Accordingly, place can influence activity and wellbeing by shaping older adults’ identity, social relations, physical movement and, ultimately, their lives. The temporal context can be described as the role of time in creating connectedness for people who age at home. Iecovich (2014, p. 24) states that ageing in place means “living somewhere for long periods of time and developing a sense of environmental control by creating an idiosyncratic rhythm and routine”. A slower rhythm of daily life for older adults, which affects the duration and order of activities in comparison with their surrounding environment, can cause a sense of being “out of sync” in later life (Lager, Van Hoven, & Huigen, 2016, p. 1565). Routine activities, such as cooking, exercising, reading and household chores, occur frequently and contribute to maintaining cognitive and physical functionalities and a sense of independence over time (King et al., 2017; Loprinzi, Lee, & Cardinal, 2015).

In everyday life, older adults engage in a range of activity types, including shopping, running errands, socialising, doing recreational activities, working, and maintaining routines and personal care (Nimrod, 2007; Oswald et al., 2007; Wurtele, 2009). These activities, linked to their spatio-temporal contexts, are defined as “series of acts that are continuous in time and undertaken at a single location in space” (Schwanen & Wang, 2014, p. 837). This definition describes human behaviour within the constraints of time and space and helps us understand the manner and quality of everyday activities. Schwanen (2004) studied the influence of environmental characteristics on the duration of shopping activities. He discovered, for instance, that the presence of other people in an activity usually makes the activity last longer.

Physical movement and social interaction during everyday activities

The relationship between physical movement and ageing well is complex: in one way, moving around can improve overall wellbeing in later life (Taylor et al., 2019); in another way, declining health can negatively influence the capacity for physical activity (Crowe et al., 2008; Peel et al., 2005). Movement per se is not always a sign of doing

well in later life, of course, which is arguably true for the person with a physical impairment who, out of necessity, has to walk long distances to the supermarket or a retired manual labourer who simply wishes to be less active than was required of them during their working years. Indeed, to fulfil their everyday needs, older adults have to do all kinds of activities which result in various levels of movement, from intensive walking to sedentary activities. Activities can also be recreational. Ku, Fox, and Chen (2016) identified a variety of leisure activities, from walking and running to reading and watching TV, which have a positive influence on feeling well. Therefore, it seems that maintaining a balance between high and low levels of physical movement in everyday activities can contribute to many older adults’ wellbeing.

Maintaining social interaction during activities consists of two essential but slightly contradictory aspects. On the one hand, the ability to carry out activities independently is considered a positive measure of wellbeing in later life (Ziegler & Schwanen, 2011). On the other hand, a level of social interaction and support from family and friends is also often needed (Chen & Feeley, 2014). In relation to these aspects, Lee (2021) studied social interaction and wellbeing among older adults in Europe. He argued that older adults from Nordic countries, which place a high value on autonomy, do not acknowledge social interaction as key to their wellbeing. Contrarily, older adults from southern European countries, which have a family-oriented life structure, consider social life essential for their wellbeing. It seems that despite cultural differences in autonomy preference among older adults, both aspects of social interaction (independency and social support) are necessary for later life wellbeing. Social contact with unfamiliar people, inside the home and away from the home, also plays an important role in ageing well (Wiles, Leibing, Guberman, Reeve, & Allen, 2012) because it reflects community care and neighbourhood support towards older adults (Buffel & Handler, 2018).

Older adults in particular spend a considerable amount of time indoors (Brasche & Bischof, 2005), whether at community centres, shops, leisure places, at home or other environments (Musselwhite, 2020). Although indoor places are important in later life, most studies about older adults’ everyday activities do not examine what they do indoors. Herbolzheimer et al. (2021), for instance, studied the association between older adults’ living environment and physical and social activities, but they mostly focus on the parks, public transports, outdoor places to sit and rest and public facilities. Recent studies that did concentrate on indoor activities foreground specific activities such as leisure (Cha, 2018; Ryu & Heo, 2018; Yeh, Pai, & Jeng, 2019). Little research has focused on “places of ageing” (Lewis & Buffel, 2020, p. 1) and among those places, indoor places are studied the least of all. Moreover, it is necessary to acknowledge that there is a gender difference in the level of physical movement and social interaction within indoor places. Older women have been found to be more sedentary than older men, record lower average daily steps and less moderate-to-vigorous physical movement during everyday activities (Lee, 2005). However, older women have reported higher frequency of physical activity inside their homes than men (Li et al., 2017). When looking at social interaction within indoor places, older women are more prone to be exposed to social isolation at home and have a poorer social network out of the home. This gender difference might be due to several reasons, including the higher likelihood of women outliving their spouses than men, as well as men spending more time outside the home than women do (Forlani et al., 2014). Yet, studies have not investigated the level of physical movement and social interaction of older men and women across indoor spaces. Therefore, this paper aims to explore everyday activities within indoor places in later life, with a focus on gender differences in social interaction and physical movement.

Methods

Data collection

This study is part of a larger project, the Meaningful Mobility (Meijering, 2021), which aims to understand mobility patterns and practices in later life in relation to wellbeing. The project studies everyday mobility of impaired and healthier adults, aged 55 and older, living in the United Kingdom, the Netherlands and India. In the project, we use a range of methods to get insight into mobility and well-being in later life, including GPS tracking, pedometer tracking, activity diaries, ecological momentary assessment, in-depth interviews, graphic elicitation and surveys. The current study contributes to the development of spatio-temporal approaches in later life research, and combines GPS-tracking, pedometer tracking and activity diaries to get insight into older adults' indoor mobility.

Data were collected in Lancashire, a north-western county in England with a combination of urban, suburban and rural areas. According to Lancashire County Council (2021), the county is among the most rapidly ageing regions in Europe. In 2019, it had a population density (422) higher than the average for England and Wales (394), with more people concentrated in urban areas, such as Lancaster city. The County Council reported that in 2019 the main mode of transport was private motor vehicle, and that in 2018 the walking and cycling rates were lower than the national average. The ageing population and elevated topography might have contributed to these low rates.

Twenty-two participants were recruited by contacting local communities and gatekeepers and through snowballing. The participant group consisted of 12 women and 10 men who were living in the community and aged between 59 and 82 years (mean age = 72.3, Standard deviation = 6.1). Although some participants ($N = 8$, five men and three women) had cognitive or physical impairments, all were able to move around inside their homes and in neighbourhood places near the home, and all had opportunities to engage in everyday activities and social interaction. Participants with impairment usually needed assistance in navigating their way outside the home. Therefore, they usually travelled outside the home accompanied by a friend or family member. However, their activities within indoor places away from the home did not always require assistance. Prior to consenting to participate in the study, potential participants were informed about the research aim, the research team and recruitment criteria. Individuals interested in participation were provided with a copy of the consent form prior to deciding to meet with the researchers. The form explained how the participants' data would be collected, used and stored securely, and that participants had the right to withdraw from participation without negative consequences at any time. The content of the informed consent form, which was supported by infographics, was also explained to the participants in simple words during the first meeting, prior to signing the forms. The researcher's contact information was provided for participants should they have any question or concern. More detailed ethical and data management considerations in relation to the General Data Protection Regulation (GDPR) and British regulations have been published elsewhere (Meijering, Osborne, Hoorn, & Montagner, 2020).

Participants were asked to collect data for a period of 7 full days in September and October 2019 by: a) carrying a GPS tracker (QStarz BT Q1000XT) when they were away from the home, b) wearing a pedometer wristband (Fitbit Inspire) from wake-up time in the morning to bedtime at night, and c) writing down (or typing in) their daily activities in the activity diaries provided (see Appendix). According to the daily weather history of the Time and Date (2019), the average temperature in Lancashire was 13 degrees Celsius and it rained on 27% of the days in the data collection period. An overview of data types collected by method is provided in Table 1. Participants were free to record their activities, locations, interactions and times in activity diaries as they saw fit. During the subsequent data preparation process, we identified and categorised the data types as appropriate.

Table 1

Summary of data types collected by method.

Device	Collected data	Data collection interval
Activity diary	Activity type, start and end time, location, social interaction, mode of transport, mobility aids	Everyday activities (not restricted)
GPS tracker	Location and time	Every 10 s
Pedometer	Steps and time	Every 5 min

Data integration

Data preparation involved manually integrating each participant's data from the three different datasets: the activity diary, GPS tracker and pedometer. Integrating spatio-temporal data collected by various methods can provide an in-depth insight into everyday mobilities, locations and activities in later life (Crist et al., 2021; Meijering & Weitekamp, 2016). Activity diaries are useful tools to record subjective accounts of older adults' everyday activities (Cristoforetti, Gennai, & Rodeschini, 2011), which are not collectable with GPS tracker or pedometer devices. Step one in the integration was to employ a content analysis approach (Babbie, 2020) to quantify and categorise the activity diary data in Microsoft Excel based on type, duration and location of activities, and on social interaction category during each activity. We drew upon studies by Nordbakke and Schwanen (2015) and Strain, Grabusic, Searle, and Dunn (2002) to categorise our participants' everyday indoor activities (Table 2).

Step two was to indicate and categorise the interaction types during activities. Performing activities with the presence and direct engagement of familiar people, such as family or friends, created social interactions. Likewise, receiving assistance from these people to perform activities also resulted in social interactions. In contrast, activities carried out without the presence or engagement of familiar people were considered as non-social interactions.

The third step was to map GPS data in ArcGIS software and check the time and location of activities by associating the reported activities to their mapped data. After that, we categorised indoor locations into two groups: inside the home and away from the home. Activities were assigned to these indoor groups. Temporal data were divided into two categories: duration, which indicated the number of minutes spent on each activity; and frequency, which refers to the repetition of the

Table 2

Later life indoor activity categories.

Categories of indoor activities	Details
Shopping	For groceries, goods or services
Running errands	Examples: visiting bank and post office or doing administrative work at home
Internet and telecommunications	Examples: sending email or text, video/audio call
Eating and drinking	Including time for cooking and preparing food and drink
Activities of daily living	Examples: showering, grooming, taking medicine, cleaning home
Recreational sport and exercise	Examples: exercise, gym, sports, yoga
Other recreational activities	Examples: social activities with family and friends; playing games; dancing; visits to cinema, theatre, café and restaurant; reading; knitting; singing; watching TV; non-routine cooking, eating and drinking
Working	Official and voluntary work, caring, education, organisational activity
Resting	Outside of regular sleep time at night
Health and hygiene care	Examples: visiting doctor, dentist, pharmacy, physiotherapist, barbershop
Religious, meditative and other spiritual activities	Examples: praying and doing meditation
Waiting	Examples: waiting for a person, vehicle or event
Other activities	Not clarified in activity diary

activity over the data collection period.

We used walking, measured as steps taken, as an indicator of physical movement because it is the most common way to move within and between places in the everyday lives of older adults (Lager, Van Hoven, & Huigen, 2019; Scherder et al., 2007). The pedometers measured the number of steps per 5 min. In a study by Sturge et al. (2020), this time-threshold was considered appropriate to define the minimum duration for creating an activity. Therefore, activities which lasted 5 min or longer were included in this study. Pedometer data were exported manually from the Fitbit portal into Excel files; then the number of steps taken during each activity was added to separate Excel sheets containing the activity details of individuals. Given that one participant failed to use the GPS tracker and pedometer, and that the GPS data of another participant was dysfunctional, we decided to exclude those two our analysis. Combining the data from the 20 remaining participants (11 women and 9 men) yielded a dataset of 820 indoor activities with information on the activity type, gender, location, duration, social interaction category and number of steps.

Data analysis

Given that activity data were not normally distributed, nonparametric methods were used for statistical data analysis. A Mann-Whitney U test compared differences between groups, a Pearson’s r test measured associations between variables and a Pearson Chi-Square test the association between two categorical variables. A statistical significance threshold of 0.05 was considered in the tests, which were performed using SPSS version 25.0. Further, median values were used to determine central tendencies of activity duration, frequency and movement.

Data analysis consisted of three stages: 1) spatio-temporal and gender analysis of activities, 2) spatio-temporal and gender analysis of movement during activities, and 3) spatio-temporal and gender analysis of social interaction during activities, alongside an analysis of the relationship between movement and social interaction for each activity type. In stage 1, the difference between the duration of indoor activities inside the home and away from the home was explored by a Mann-Whitney U test. Next, the relationship between the duration and frequency of activity types was tested with Pearson’s r. Moreover, gender differences in activity location and duration were investigated by a Mann-Whitney test and descriptive statistics. Afterwards, activity types were classified by duration and frequency. Table 3 provides a summary of all classification methods used. In stage 2, a descriptive summary of spatio-temporal analysis was followed by a Mann-Whitney test to observe the differences between indoor activity type and level of

Table 3
Classification methods for each activity type.

Variable	Classification method	Class of activity type
Duration (minutes)	Median duration of activity type is equal to or higher than median duration of all activities	Long
	Median duration of activity type is lower than median duration of all activities	Short
Frequency	Frequency of activity type is equal to or higher than median frequency of all activity types	High
	Frequency of activity type is lower than median frequency of all activity types	Low
Movement level (steps per minute)	Median steps/min of activity type is equal to or higher than median steps/min of all activities	High
	Median steps/min of activity type is lower than median steps/min of all activities	Low
Social interaction	Majority of interactions for activity type are non-social	Mostly non-social
	Majority of interactions for activity type are social	Mostly social

movement. The gender difference in physical activity level was also investigated by a Mann-Whitney U test. Then, activity types were classified according to movement and frequency. The correlation between duration and level of movement was checked using a Pearson’s r test. This stage was finalised by categorising activity types by movement and duration levels. In stage 3, activity types were classified based on interaction category and frequency. After that, the relationship between activity duration and level of social interaction was explored by a Mann-Whitney test, and activity types were then grouped by level of social interaction and duration. The gender difference in social interaction level was investigated with a Pearson Chi-Square test. Thereafter, a Mann-Whitney test explored relations between levels of physical movement and social interaction during activities, and each activity type was subsequently classified based on the relationship between social interaction category and movement level.

Results

Spatio-temporal analysis of everyday indoor activities

On average, 85% of participants’ activity from wake-up time in the morning to bedtime at night took place indoors, and 15% outdoors. A frequency analysis of all 820 indoor activities revealed that 61% occurred inside the home, and 39% away from the home. Moreover, the number of activities was 40% for men and 60% for women. Shopping and healthcare occurred only away from the home, whereas resting, activities of daily living, and internet and telecommunication took place only inside the home. Recreational activities, such as meeting friends, going to a restaurant, reading and watching TV, formed the largest segment of everyday activities, with an average duration of 145 min and frequency of 253; waiting had the shortest average duration at 14.86 min; and religious activities, resting and waiting had the lowest frequencies by 7 records for each activity type. The duration of indoor activities inside the home (Mdn = 80.5) was longer than those away from the home (Mdn = 45) and a Mann-Whitney test showed that the difference was significant, $U(N_{\text{inside the home}} = 500, N_{\text{away from the home}} = 320) = 53,881.50, z = -7.930, p = .000$. The activities of both male and female participants took place at home more than away from the home. A Mann-Whitney U test showed that, men’s activities (Mdn = 84) took significantly longer than women’s activities (Mdn = 56), $U = 65,214.500, z = -4.732, p < .001$. Activity types were grouped based on their duration and frequency (Fig. 1). A Pearson’s r test showed that the medians of frequency and duration were not significantly correlated ($r = 0.222, n = 18, p = .376$). This means that no matter how many times the activity was repeated; the duration could be long or short.

As demonstrated in Fig. 1, indoor activities both inside the home and away from the home occurred with high and low frequencies, and had short and long durations. In other words, no spatial trend was observed in the relationship between frequency and duration of activity types.

Physical movement analysis of everyday indoor activities

Activities which induced the highest levels of physical movement included running errands (average 31.13 steps/min), shopping (average 23.83 steps/min) and exercising (average 23.23 steps/min). Religious and meditative activities constituted the lowest levels of movement, with an average of 2.59 steps/min. A Mann-Whitney test showed that movement was significantly higher for indoor activities away from the home (Mdn = 11.21) than for those inside the home (Mdn = 6.18), $U(N_{\text{inside home}} = 500, N_{\text{away from home}} = 320) = 61,632.50, z = -5.591, p = .000$. A Mann Whitney U tests showed no significant difference in average physical movement during activities of men and women. Fig. 2 shows activity types grouped by movement level and frequency. No significant correlation was found between frequency and movement, based on a Pearson’s r test ($r = -0.041, n = 18, p = .871$). This means that activities with a high frequency do not have a higher or lower level

		Median duration of activity type (minutes)	
		Short (< 65)	Long (≥ 65)
Frequency of activity type	High (≥ 16)	<ul style="list-style-type: none"> - Preparing and having food and drink inside home - Internet and telecommunication inside home - Shopping away from home 	<ul style="list-style-type: none"> - Activities of daily living inside home - Recreational activities inside home and away from home - Exercising inside home and away from home - Working inside home and away from home
	Low (< 16)	<ul style="list-style-type: none"> - Running errands inside home and away from home - Healthcare activities away from home - Religious activities inside home - Waiting inside home and away from home 	<ul style="list-style-type: none"> - Religious activities away from home - Resting inside home (outside of regular sleep time at night)

Fig. 1. Classification of indoor activity types based on duration and frequency.

		Median steps/minute of activity type	
		Low (< 8.11)	High (≥ 8.11)
Frequency of activity type	High (≥ 16)	<ul style="list-style-type: none"> - Preparing and having food and drink inside home - Internet and telecommunication inside home - Recreational activities inside home and away from home - Working away from home 	<ul style="list-style-type: none"> - Exercising inside home and away from home - Shopping away from home - Working inside home - Activities of daily living inside home
	Low (< 16)	<ul style="list-style-type: none"> - Religious activities inside home and away from home - Resting inside home (outside of regular sleep time at night) - Waiting inside home and away from home 	<ul style="list-style-type: none"> - Running errands inside home and away from home - Healthcare activities away from home

Fig. 2. Classification of indoor activity types based on movement level and frequency.

of movement than less frequent activities.

As a general observation, the median steps per minute was higher for activities occurring away from the home. The exception to this trend was working inside the home, which for our participants included caring and educational activities.

A positive significant correlation between duration and movement level was found, based on a Pearson’s r test ($r = 0.255, n = 820, p = .000$). Longer activities are therefore more likely to have a high level of movement. Fig. 3 provides further insight into movement and duration.

Activities with a long duration and a high level of movement –

		Median steps/minute of activity type	
		Low (< 8.11)	High (≥ 8.11)
Median duration of activity type (minutes)	Long (≥ 65)	<ul style="list-style-type: none"> - Recreational activities inside home and away from home - Religious activities away from home - Resting inside home (outside of regular sleep time at night) - Working away from home 	<ul style="list-style-type: none"> - Exercising inside home and away from home - Activities of daily living inside home - Working inside home
	Short (< 65)	<ul style="list-style-type: none"> - Preparing and having food and drink inside home - Internet and telecommunication inside home - Religious activities inside home - Waiting inside home and away from home 	<ul style="list-style-type: none"> - Running errands inside home and away from home - Healthcare activities away from home - Shopping away from home

Fig. 3. Classification of indoor activity types based on movement level and duration.

Table 4
Influence of indoor place type on frequency of interaction category.

		Activities by interaction category		
		Non-social	Social	Grand total
Activities by indoor place type	Inside home	355	147	502
	Away from home	108	210	318
	Grand total	463	357	820

exercising inside the home and away from the home, activities of daily living and working inside the home – are also among the most frequent.

Social and non-social interaction analysis of everyday indoor activities

Our findings revealed that the majority of the recorded activities (463 = 56% of all activities) were non-social (i.e., did not involve social interaction) while the rest (357 = 44%) were social (Table 4). Furthermore, the indoor type had an influence on the frequency of each interaction category. Accordingly, 77% (355) of non-social indoor activities occurred inside the home and 23% (108) away from the home, whereas 41% (147) of social indoor activities took place inside the home and 59% (210) away from the home. In other words, non-social indoor activities predominantly take place inside the home.

Some activities were limited to one interaction category: running errands (frequency = 14), exercising (frequency = 16), religious activities (frequency = 4) and waiting (frequency = 2), all inside the home, and waiting within indoor places away from the home (frequency = 5) involved no social interaction; religious activities away from the home (frequency = 4) always occurred with social interaction. A Pearson Chi-Square test indicated that there is a significant association between gender and social interaction during activities, $\chi^2(1, N = 820) = 67.724, p < .001$. Men were more likely to have social interaction during their activities and women were more likely to engage in non-social activities. A classification of activity types according to interaction category and frequency is provided in Fig. 4.

Most non-social activities, except for healthcare, occurred inside the home; the majority of social activities, except for preparing and having food and drink, happened away from the home.

A Mann-Whitney test showed that social activities (Mdn = 75) were significantly longer than their non-social alternatives (Mdn = 60), $U(N_{\text{non-social}} = 463, N_{\text{social}} = 357) = 73,157.50, z = -2.885, p = .004$. Fig. 5 shows activity types grouped by interaction category and duration.

A clear pattern can be seen from this classification: all long, non-social activities took place inside the home; in direct contrast, all long, social activities occurred away from the home.

We ran a Mann-Whitney test to discover possible relationships between levels of social interaction and physical movement. It indicated that participants moved significantly more during non-social activities

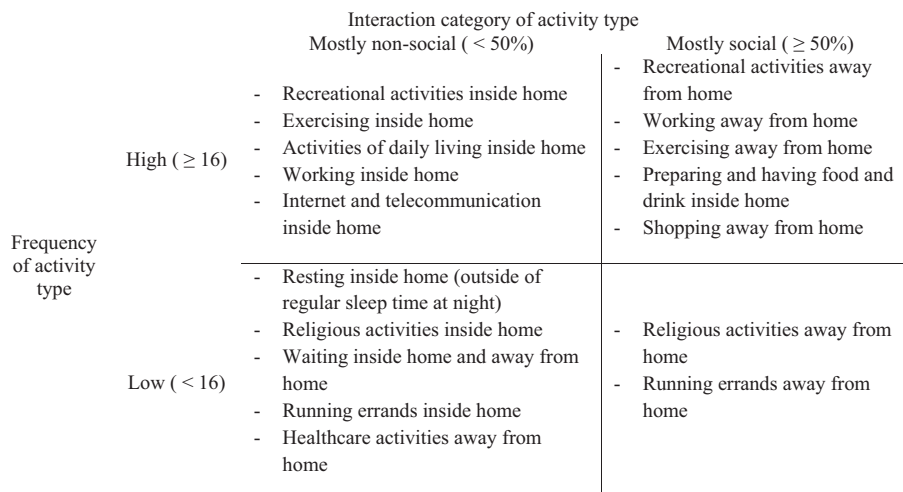


Fig. 4. Classification of indoor activity types based on interaction category and frequency.

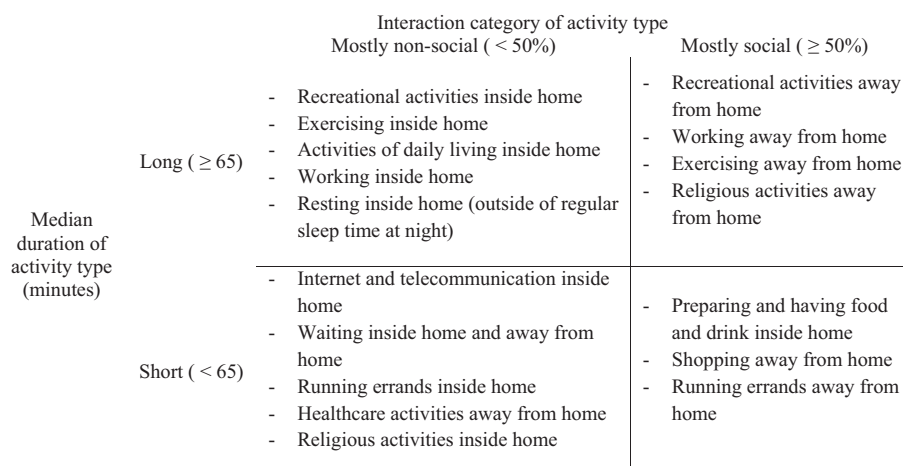


Fig. 5. Classification of indoor activity types based on interaction category and duration.

Median steps/minute of activity type	Interaction category during activity type	
	Mostly non-social (< 50%)	Mostly social (≥ 50%)
High (≥ 8.11)	<ul style="list-style-type: none"> - Exercising inside home - Activities of daily living inside home - Working inside home - Running errands inside home - Healthcare activities away from home 	<ul style="list-style-type: none"> - Exercising away from home - Shopping away from home - Running errands away from home
Low (< 8.11)	<ul style="list-style-type: none"> - Recreational activities inside home - Resting inside home (outside of regular sleep time at night) - Internet and telecommunication inside home - Waiting inside home and away from home - Religious activities inside home 	<ul style="list-style-type: none"> - Recreational activities away from home - Religious activities away from home - Preparing and having food and drink inside home - Working away from home

Fig. 6. Classification of indoor activity types based on interaction category and movement level.

(Mdn = 9.15) when compared with social alternatives (Mdn = 6.96), U (N_{non-social} = 463, N_{social} = 357) = 75,836.50, z = -2.040, p = .041. Activity types grouped by interaction category and level of movement are presented in Fig. 6.

The categorisation revealed which activity types involved the most simultaneous social interaction and physical movement, and those which entailed the least. Exercising, shopping and running errands away from the home occurred with social interaction and high levels of movement. In contrast, recreation, resting, internet and telecommunication, and religious activities inside the home, as well as waiting (regardless of location), were primarily non-social with low levels of movement. Despite our general results that participants moved significantly more during non-social activities than their social alternatives, there were some activities that were both social and high movement or both non-social and low movement. It is also interesting to observe that although movement tended to be higher away from the home (see Section 3.2), some non-social activities performed inside the home involved high levels of movement.

Discussion and conclusion

The aim of this paper was to increase insight into everyday indoor activities in later life vis-à-vis ageing in place. We also explored gender differences in social interaction and physical movement within indoor places. We discovered that our participants tend to spend large amounts of time at home and inside other buildings away from home. In relation to indoor activities, we focused on two aspects which are commonly believed to contribute to ageing well, namely social interaction and physical movement. Exploring the spatio-temporal contexts, we sought to ascertain if there was any relationship between these two aspects, and to explain how the specific features of each activity might contribute to that relationship.

Our results revealed a negative relationship between levels of physical movement and social interaction during activities, which implies that there might be a trade-off between the two. Current studies about later life activities recommend that older adults maintain high levels of social interaction and physical movement in their everyday lives. For instance, McConatha (2018) studied the later life benefits of sustained physical activity for wellbeing; Cabrita, Lousberg, Tabak, Hermens, and Vollenbroek-Hutten (2017) found that activities with social interaction increase feelings of pleasure and wellbeing in older adults. However, according to our results, the more participants moved during their activities, the less social interaction they had. The reverse was also true: the more they socialised, the less they moved. The cause of this dynamic between the two aspects is unknown and requires further

study. Be that as it may, we would argue that older adults need a balance between moving and socialising and, therefore, that non-social or sedentary activities throughout the day have a valuable role to play in creating that balance. A number of studies have indeed highlighted this value. For instance, Weedon et al. (2020) discussed the sedentary benefits of some everyday activities, such as reading, eating, resting or daily self-care. Lagerqvist (2013) discovered that sedentariness can be as important as movement for mental wellbeing. In addition, Lay et al. (2020, p. 364) showed that when older adults choose non-social activities, they find time “to escape social pressures, to work, or to relax”. All of these findings suggest clear evidence of the potential benefits of resisting neoliberal tenets to unquestioningly “do more”.

Furthermore, our study provided valuable information about the duration and frequency of everyday indoor activities in later life, specifically in relation to the two aspects of physical movement and social interaction. Recreational activities, whether inside the home or away from the home, had the longest duration and highest frequency among all indoor activity types. This result justifies the current trend in later life studies to concentrate on recreation and leisure activities. When these activities took place inside the home, they involved low levels of social interaction and, in contrast, when participants engaged in recreational activities within indoor places away from home, they socialised more. The level of movement did not vary (remained low) by indoor location type.

Measuring physical movement revealed which activity types had the highest levels of movement (shopping, doing sports and running errands) and those which had the lowest (meditative and religious acts). Furthermore, we discovered that the indoor location type (being at home or away from home) had a relationship with the level of movement. Activities had higher levels of movement away from home than inside the home, except for when participants were working. This result implies that indoor places away from home are important for physical movement in later life. Drilling down into social aspects, we found that participants spent the majority of their time on non-social activities especially when they were inside the home. This finding has various possible explanations, including older adults’ preference for independence in activities inside the home, or (less positively) as a result of loneliness and being homebound. The former assumption is possible because managing everyday activities inside the home aligns with the meaning of autonomy and independency for older adults (Sixsmith et al., 2014); and the latter is also possible because other research has shown that, in some cases, over 80% of older adults spend the majority of their days at home, 9% of them feel stuck inside and 12% feel cut-off from their social environments (Musselwhite, 2017). When being active within indoor places away from home, our participants were mostly

involved in social activities. This result might also be influenced by activities of impaired older adults who did not require assistance inside the home but needed their friends or families to accompany them when travelling outside the home. Our results also showed that activities with social interaction had a longer duration. This result is in line with Schwanen's conclusion (2004) that activities last longer when undertaken with other people rather than alone.

Our gender analysis revealed that both men and women engaged more frequently in activities at home than away from the home. Moreover, men's activities lasted significantly longer than women's activities and were characterised by higher levels of social interaction. The longer duration of men's activities might be related to their higher engagement in social activities, which on average take longer than non-social activities. The higher level of social interaction during men's activities might be explained by the slightly higher physical and cognitive impairment rate among our male participants, since having impairments may lead to a greater need for involving families and friend in their activities. Our results in terms of gender differences in social interaction align with previous work by Dury et al. (2021) who found that women experience greater wellbeing when they perform activities alone inside home, while men feel better when others are engaged in their activities inside the home. We did not find significant differences in physical movement during activities of male and female participants.

Two major methodological strengths of this study include collecting data about everyday activities within indoor places, as well as using a mixed-methods approach in data collection. Our contribution adds to the scarce but growing body of research into the indoor activities of older adults. The mixed-methods approach enabled us to provide a rich combination of self-reported and objectively measured data, which captures a multi-dimensional image of participants' activities. The self-reported (activity diary) data were sometimes lacking in accuracy in terms of time and location but provided us with activity details which could not be collected with the GPS trackers or pedometers. Mixed methods also fill the gaps of missing data from one method by using the outcome of other methods. Another strength is that we tried to include all everyday activities in our study, in contrast to much of the literature which focus on one or a selection of activities. This inclusion helped us see a fuller picture of older adults' everyday lives.

This study also has limitations. First, duration and frequency were the only temporal aspects of everyday activities we measured. Other temporal aspects which could be incorporated into future research include rhythm analysis, seasonal differences, and weekday and weekend differences. Second, data recorded through the activity diary, GPS tracker and pedometer were not always consistent. Third, the subjective nature of activity diary records makes it difficult to interpret reasons behind the personal differences in activities. For instance, it is not clear whether men recorded less or actually did less activities than women. Our results cannot be generalised to all older adults and they are impacted by the socio-economic context of Lancashire. However, our approach to understanding the gender differences and the balance between physical movement and social interaction during everyday activities can be applied to other studies and contexts.

The results of our study are a helpful starting point for future research. It would be worthwhile to delve deeper into older adults' experiences of indoor places, their social interactions and physical movements. Including such qualitative elements in future studies would increase our understanding of this population's activity preferences and subjective wellbeing. For instance, an in-situ interview or a go-along ethnography within indoor places can provide substantial details about the connection of individuals with their everyday places (Marcotte, Grandisson, Milot, & Dupéré, 2022; Reed & Ellis, 2019). Such methods also help researchers "immerse themselves in the participant's world" (Marcotte et al., 2022, p.1). We also suggest a longitudinal design for repeating a similar study in two different points of time. This would provide an opportunity to investigate the change in physical movement and social interaction during activities with relation to seasonal

differences, ageing and various life events. Another suggestion is to look at variations in activities among individuals with diverse characteristics living in different socioeconomic contexts. Moreover, observing the specific characteristics of indoor places could provide further insight into places which enable or disable older adults' activities. These details could include the interior design features of the home or place away from the home, the geographic location of indoor places and land use. Finally, it would be useful to explore what constitutes the ideal balance between social and non-social activities, and between moving and sedentariness in later life, from the perspectives of older adults across demographic factors such as race, class, gender, age and ability/cognitive status.

In line with our research suggestions, this study has provided policymakers with valuable information to better understand later life activities. Boyle et al. (2015) make a distinction between home and outdoor neighbourhood environment in their study about ageing in place policy. We would recommend to also include indoor places beyond the home when observing and planning for older adults' everyday activities. For instance, there should be a focus on providing access to the indoor places out of home, such as community and recreational centres, or even grocery shops, to improve the possibility of socialising, especially for older adults who live alone. This can be done alongside designing and providing houses and other indoor places that are conducive to older adults' physical movement. Moreover, understanding gender and age differences in everyday activities could improve the planning for activity places across the life course. Lastly, we recommend that policy-makers should create a context-specific categorisation of everyday activities, similar to the one that we made based on duration, frequency and level of social interaction and physical movement, although the result of this categorisation might differ in each socio-economic and geographical context. Most importantly, efforts to support ageing in place should be informed by the life experiences, desires and values placed on physical and social activity held by elders themselves rather than approaching older adults as a homogeneous group.

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Author statement

Z. Sattari N.: Data curation, conceptualisation, methodology, validation, formal analysis, investigation, writing – original draft, writing – review and editing, visualisation, project administration; G. Weitkamp: Methodology, validation, writing – review and editing, supervision; L. Meijering: Methodology, validation, writing – review and editing, supervision, project administration, funding acquisition.

Declaration of Competing Interest

None.

Data availability

The data that has been used is confidential.

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Appendix A. Appendix

A sample of our activity diary

This activity diary is designed to gather comprehensive activity and mobility data for a larger project and some of the data collected were used for this paper.

Day	Time	What did you do?	Mobility aid used?	Destination/Location/Route	Transport taken	Who did you travel with?
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