

Walking in their shoes: an ecological momentary assessment of physical activity and sedentary behaviors among urban and rural older adults

Caminando en sus zapatos: una evaluación ecológica momentánea de la actividad física y los comportamientos sedentarios entre adultos mayores urbanos y rurales

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Abstract. This study examines patterns of physical activity and sedentary behavior in individuals aged 65 years and older in the Beira Baixa region of Portugal with the aim of identifying differences between rural and urban settings. We analyzed data from 40 participants, including 19 rural residents (mean age = 74.7 years, SD = 8.5 years) and 21 urban residents (mean age = 70.1 years, SD = 5.2 years), using a retrospective cross-sectional design complemented by an ecological momentary assessment to capture real-time behavior. The thematic analysis revealed that both cohorts were predominantly sedentary, especially in terms of television consumption. Physical activities were mainly limited to tasks such as housework, gardening and occasional walking, with minimal social interactions. Urban participants, in particular, reported meeting more frequently with family at home and in the neighborhood. Both groups primarily used indoor spaces and nearby streets for physical activity. Our findings highlight the urgent need for tailored weekend physical activity programs to improve sedentary lifestyles among older adults in both rural and urban areas. This study contributes to the literature by highlighting the specific leisure-time preferences and activity patterns of older Portuguese adults, providing a basis for the development of adaptive, age-appropriate interventions.

Keywords: Movement behaviors, ageing, observational study, real-time data capture

Resumen. Este estudio examina los patrones de actividad física y comportamiento sedentario en individuos de 65 años o más en la región de Beira Baixa de Portugal con el objetivo de identificar diferencias entre entornos rurales y urbanos. Analizamos datos de 40 participantes, incluidos 19 residentes rurales (edad media = 74,7 años, DE = 8,5 años) y 21 residentes urbanos (edad media = 70,1 años, DE = 5,2 años), utilizando un diseño transversal retrospectivo complementado por una evaluación ecológica momentánea para capturar el comportamiento en tiempo real. El análisis temático reveló que ambos cohortes eran predominantemente sedentarios, especialmente en términos de consumo de televisión. Las actividades físicas se limitaban principalmente a tareas como el trabajo doméstico, la jardinería y caminatas ocasionales, con interacciones sociales mínimas. Los participantes urbanos, en particular, informaron reunirse más frecuentemente con la familia en casa y en el vecindario. Ambos grupos utilizaron principalmente espacios interiores y calles cercanas para la actividad física. Nuestros hallazgos resaltan la necesidad urgente de programas de actividad física personalizados para los fines de semana para mejorar los estilos de vida sedentarios entre los adultos mayores en áreas tanto rurales como urbanas. Este estudio contribuye a la literatura destacando las preferencias específicas de tiempo libre y patrones de actividad de los adultos mayores portugueses, proporcionando una base para el desarrollo de intervenciones adaptativas y apropiadas para la edad.

Palabras clave: comportamientos de movimiento, envejecimiento, estudio observacional, captura de datos en tiempo real

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Introduction

In recent years, an estimated 1.4 billion people, nearly a quarter of the global population, have experienced a decline in physical activity (PA) (Guthold et al., 2018). This trend is particularly pronounced among the over-60s, a demographic segment in which a significant proportion is not consistently moderately to highly physically active (Ramalho & Petrica, 2023). With this age group reportedly spending between eight and eleven hours per day on sedentary activities (Ekelund et al., 2019; Harvey et al., 2015) and the global population of older adults expected to reach two billion by 2050 (WHO, 2022), the need to address physical inactivity is becoming increasingly urgent.

The existing scientific literature strongly emphasizes the myriad benefits of PA for older adults, improving both physical health and mental well-being (Araque-Martínez et al., 2021; Meneguci et al., 2021). Despite these well-documented benefits, PA tends to decline with age, resulting in significantly lower activity rates among older adults compared to younger cohorts (Spiteri et al., 2019).

When the full range of activities is comprehensively assessed, the deleterious effects of prolonged physical inactivity become apparent. These detrimental effects, both biologically and psychosocially, reinforce the call for effective interventions (Katzmarzyk et al., 2009; Sutapa, Pratama, & Mustapha, 2024; Tremblay et al., 2017).

Within the context of our research, the distinction between PA and sedentary behavior (SB) is critical. PA includes activities with significant energy expenditure, such as walking and gardening (Caspersen et al., 1985), while SB refers to low-energy tasks such as watching television (Tremblay et al., 2017). However, for the purposes of this study, we will use a broader definition that emphasizes the complex and ever-evolving nature of PA: "Physical activity involves people moving, acting and performing within culturally specific spaces and contexts, and influenced by a unique array of interests, emotions, ideas, instructions and relationships" (Piggin, 2020, p. 5). While it is important to recognize these behaviors, the underlying motivations are not fully understood. A range of factors, from household tasks to leisure activities, shape these behaviors. A particular challenge is the lack of empirical data that sheds light on

the differential health consequences of different forms of SB and PA (Garzón Mosquera & Aragón Vargas, 2021; Stamatikis et al., 2012). In addition, the nuances of environmental factors and the temporal dynamics that shape PA and SB should be further explored. Deciphering these intricate relationships is central to developing strategies to promote active aging (Leask et al., 2015; Ramalho, Petrica, & Rosado, 2020).

Conventional assessment methods often focus only on specific activities and can overlook the complicated dynamics of PA and SB. It is critical to fully capture the factors driving PA and SB, considering both individual and environmental influences (Keadle et al., 2017). Theoretical frameworks that examine the reciprocal relationships between these influences offer valuable insights to improve our understanding of PA and SB patterns (Chastin et al., 2016; Michie et al., 2011). An integrative approach that incorporates psychological, social, and environmental aspects provides a deeper understanding of the triggers, modalities, and time course of these behaviors (Van Dyck et al., 2017).

To obtain a nuanced description of behaviors, researchers have turned to ecological moment analysis (EMA) or experience sampling methodology (ESM) (Shiffman et al., 2008), methods lauded for their ability to document behaviors in real time, capturing the authenticity often lacking in traditional approaches (Maher et al., 2018, 2021). This continuous observation, particularly when combined with digital technologies, enhances our ability to collect detailed data, which is particularly useful in studies of aging (Cain et al., 2009; Yao et al., 2023).

Although the use of EMA in the assessment of PA and SB in older adults is still developing, the evidence underlines its effectiveness. EMA facilitates the collection of contextual data in real time, enabling timely interventions. EMA integration with smartphones and other electronic devices has been shown to be effective in collecting up-to-date data on PA and health behaviors (Atienza et al., 2006; Kennedy-Malone et al., 2022). In addition, recent studies have shown how social and physical environments significantly influence behavioral and emotional responses to SB, highlighting the role of environmental factors in the development of PA and SB habits (Hevel et al., 2021; Maher et al., 2021). Research has also shown that increased PA can alleviate pain, suggesting a positive interaction between PA and health (Davis et al., 2022), while the influence of automatic cognitive processes on SB highlights the complexity of behavior change (Maher & Dunton, 2020). Supported by these findings, EMA is recognized as a powerful tool for deepening our understanding of health behaviors and promoting healthier lifestyles in older adults (Maher et al., 2018).

Despite advances, a gap remains in our understanding of SB and PA behaviors across different settings. Specifically, the variance between rural and urban experiences suggests the need for more detailed research. For instance, Köroğlu and colleagues (2023) observed that rural older

adults tend to be more physically active, likely due to differing sociocultural dynamics, in contrast to urban settings, which may hinder PA. This underscores the importance of conducting context-specific studies.

In line with this rationale, our study examines patterns of PA and SB in individuals aged 65 years and older in the Beira Baixa region of Portugal, with the aim of identifying differences between rural and urban settings. We seek not only to accurately describe their daily PA and SB patterns, but also to understand the complex socio-physical contexts that influence these behaviors. With this approach, we aim to comprehensively uncover the lifestyles of the aging Portuguese population in order to potentially develop targeted interventions to promote healthy aging and improve quality of life.

Method

This study used EMA as the primary data collection tool. The study design provides for the systematic collection of data at multiple time points, which enables a longitudinal analysis of the patterns and changes in the participants' SB and PA behavior. This methodology of self-report in the moment of daily life this has been referred to as a form of systematic phenomenology (Hektner, Schmidt, & Csikszentmihalyi, 2007), capturing life as it is lived, moment to moment, hour to hour, day to day (Shiffman et al., 2008).

Participants

For this study, we carefully selected participants aged 65 years and older who lived in both urban and rural areas in the center of Beira Baixa, Portugal, and all had independent mobility. The following inclusion criteria were considered: age ≥ 65 years and independent ability to communicate and mobility. Strict exclusion criteria were applied to ensure the greatest possible rigor and integrity of our data set. Exclusion criteria included: a life expectancy of less than 12 months, severe hearing or visual impairment, active cancer and autoimmune diseases, amputations, localized loss of strength or aphasia due to a major stroke, a cancer diagnosis within the last three years, a recent myocardial infarction, fractures of the upper or lower limbs in the last three months, and any condition affecting physical capacity.

Participants were carefully selected using a deliberate and convenient procedure. This procedure was based on the initial identification of some participants, who then recommended other potential participants from the target group, considering the selection and exclusion criteria. There was no financial compensation for participation in this study. Data collection was stopped upon reaching crucial theoretical data saturation (Robinson, 2014), which precluded the inclusion of additional participants. A thorough review of their previous diaries was essential to ensure holistic coverage of the various characteristics of our cohort. Specifically, in the context of EMA, information saturation was reached after 40 participants, as the answers and behavior patterns

began to show redundancy and consistency. The information collection technique used requires the active involvement of participants at multiple points over time, which can increase the richness of the data collected and allow for a detailed analysis of individual movement behavior (Dunton, 2017).

In the expansive region of Beira Baixa, we undertook a comparative analysis investigating the lifestyles of older adults residing in both rural and urban settings. The study cohort comprised 19 rural participants (mean age: 74.7 years; SD = 8.5) and 21 urban participants (mean age: 70.1 years; SD = 5.2). This deliberate distinction aimed to discern potential variations in the inclination toward SB and PA between these distinct environments. Details of the participants' characteristics can be found in the results section, demographic data. Participation was purely voluntary, with participants providing comprehensive informed consent in line with the principles of the Declaration of Helsinki (World Medical Association, 2013).

Measures

To achieve methodological precision, we used the EMA technique for data collection. Previous empirical research has highlighted the reliability of EMA in collecting real-time data that reflect the experiences and behaviors of older populations (Atienza et al., 2006; Maher et al., 2018; Yao et al., 2023). Given this endorsement, the use of EMA was deemed appropriate for an in-depth study of PA and SB. By skillfully integrating EMA, we were able to better identify associations between participants and their environment. This approach required participants to consistently record their behaviors and experiences in their natural environment in logbooks. Previous research (Maher et al., 2018; Shiffman et al., 2008) has confirmed the efficacy of EMA, particularly in studying SB and PA in geriatric populations. Such methodologic selection increases both accuracy and ecological validity and minimizes bias resulting from retrospective recall.

The decision to use traditional diaries rather than digital surveys or applications is based on several key considerations. First and foremost, these diaries provide a comprehensive record of participants' experiences and allow for a deep understanding of contextual subtleties. Second, they allow flexibility in the duration of data recording, which mitigates potential apprehension of older participants. Third, such diaries promote introspective observation, which is critical for recognizing longer-lasting behaviors (Bolger et al., 2003). Importantly, older adults' familiarity with paper diaries also mitigates potential technological barriers, leading to higher participation rates.

Procedures

The authors developed multi-page templates for data collection. The introductory sheet contained sociodemographic information, followed by sheets that recorded participants' activities over a predetermined five-day period,

namely three weekdays and two weekend days. The comprehensibility and feasibility of these templates were evaluated in advance in a pilot study with a selected cohort. Feedback from this phase informed subtle changes to the final instrument. At the same time, participants received a detailed guide and descriptive template.

Each participant kept meticulous records of their engagements over a seven-day period. These logs were divided into 49 different intervals, each lasting 20 minutes and thus covering the time window from 8:00 am to 12:20 pm. In cases where activities coincided in a single time window, participants were instructed to document the dominant activity. Daily prompts included the activity in progress (e.g., "What are you doing?"), the immediate company (e.g., "Who are you with?"), and the exact location (e.g., "Where are you?"). The latter pair of questions was designed to illuminate the current social environment and the broader environmental context of the observed behaviors (Hevel et al., 2021). Activities and contexts were classified using the SITAUNOMY taxonomy (Chastin et al., 2013). It is important to emphasize that this data collection took place in October 2023.

Analysis

After careful examination of the diaries, the behaviors were classified into different, non-overlapping categories. An inductive thematic analysis approach (Braun & Clarke, 2006) was used to identify salient patterns. After a comprehensive preliminary examination of the data, tentative codes were formulated. Behaviors were then coded according to their actual meaning, with preference given to those that occurred in at least 50% of the diaries. Frequently occurring behaviors were grouped under appropriate thematic headings for clarity. The integrity of the coding framework was also checked by cross-referencing coded excerpts.

Each diary was meticulously analyzed and categorized. To support the validity of our findings, the lead investigator collaborated with subject matter experts. These experts met at regular intervals to ensure both rigorous progress in data analysis and to promote a common understanding and consensus in interpreting the results. Peer evaluation protocols (Creswell & Miller, 2000) supported the methodological rigor of the study, while a structured questionnaire (Lincoln & Guba, 1985) provided important insights about participants.

To measure the amount of time participants devoted to each category, frequencies were multiplied by a factor of 20, assuming that behavior was maintained throughout the period. These measurements were then converted to an interpretable format – minutes per day – to ensure accuracy. Descriptive statistical methods were used for both weekday and weekend data to identify dominant behaviors. Paired-samples T-tests identified notable discrepancies between weekdays and weekends, with significance levels set at $p < 0.05$. All calculations were carefully performed using SPSS.

Results

Demographic data

In our study, we examined the demographic, socioeconomic, and lifestyle characteristics of rural and urban cohorts. The rural cohort included 19 participants (mean age: 74.7 ± 8.5 years), with a gender distribution of 52.6% women and 47.4% men. The urban cohort consisted of 21 participants (mean age: 70.1 ± 5.2 years), with a gender distribution of 52.4% women and 47.6% men.

When family and relationship structures were examined, 73.7% of participants from rural areas were married or cohabiting, 21.1% were widowed, and 5.3% were unmarried. The urban group had a different relationship composition: 90.5% unmarried, 4.8% either divorced or living independently, and 4.8% widowed.

There were educational differences between cohorts. Of rural respondents, 63.2% had completed elementary school, 21.1% had completed secondary school, 10.5% had a college degree, and 5.3% had no formal schooling. In contrast, urban respondents had predominantly completed elementary school (52.4%) and secondary school (38.1%), and only 9.5% had a college degree.

Physiologically, rural participants had a mean weight of 70.8 ± 13.2 kg, height of 1.6 ± 0.1 m, and BMI of 26.7 ± 4.5 kg/m², whereas the urban cohort had similar mean height (1.6 ± 0.1 m) but higher weight (73.6 ± 14.8 kg) and BMI (27.6 ± 3.4 kg/m²).

The data presented highlight nuanced differences in education and physiological profiles between rural and urban participants and underscore the need for context-specific intervention methods.

Sedentary Behavior

Table 1 shows the duration of 15 different SB observed in rural areas, excluding basic activities such as napping and personal hygiene.

Table 1.
Mean and percentage of time dedicated to SB - rural area (n=19)

SB activities	Average minutes per day (%)		Means comparison p (paired samples)
	Week	Weekend	
Napping	26.3 (5.2)	31.1 (5.6)	0.209
Meals	140.7 (27.8)	167.4 (30.0)	0.028
Watching television	151.2 (29.9)	185.8 (33.3)	0.084
Meditating	2.5 (0.5)	2.1 (0.4)	0.317
Reading	9.5 (1.9)	11.6 (2.1)	0.574
Resting while awake	15.8 (3.1)	15.8 (2.8)	0.826
Sitting conversations	39.6 (7.8)	43.7 (7.8)	0.727
Sitting household chores ¹	30.9 (6.1)	41.1 (7.4)	0.266
Sedentary hobbies ²	24.2 (4.8)	10.5 (1.9)	0.271
Use of cell phone while sitting	12.3 (2.4)	5.3 (0.9)	0.046
Listening to music	7.4 (1.5)	7.4 (1.3)	1.00
Using a computer	4.9 (1.0)	8.9 (1.6)	0.357
Writing	2.5 (0.5)	-	-
Religious activity	-	14.7 (2.6)	-
Passive transportation ³	38.6 (7.6)	12.6 (2.3)	0.019
TOTAL min/day	506.4	558	-

¹ For example: peeling fruits and folding clothes.

² For example: picking chestnuts, sewing, playing cards.

³ Motorized transportation to a destination (e.g., public transportation passenger, vehicle passenger, vehicle driver).

On weekdays, television consumption dominated with a duration of 151.2 minutes or 29.9% of the total time. This was closely followed by meals, which took 140.7 minutes or 27.8% of the total time. Other behaviors included talking, passive locomotion, sedentary household activities, stationary leisure activities, and resting while awake. Infrequent activities such as telephone conversations, reading, listening to music, computer use, meditation, and writing accounted for between 2.4% and 0.5% of the total time.

Weekend behavioral trends mirrored weekday patterns, with television viewing and mealtimes prominent. Significant statistical differences were found for meal duration ($p = 0.028$), mobile telecommunications ($p = 0.046$), and passive locomotion ($p = 0.019$).

Table 2 presents data on SB in an urban setting. The predominant activity is watching television, with an average duration of 164.1 minutes per day, accounting for 37.7% of the total observed time. This is followed by sedentary activity, which takes 44.8 min or 10.3% of the recorded time. Other activities include passive locomotion, computer use, sporadic naps, and work-related SB.

Table 2.
Mean and percentage of time dedicated to SB - urban area (n=21)

SB activities	Average minutes per day (%)		Means comparison p (paired samples)
	Week	Weekend	
Napping	34.0 (7.8)	30.5 (7.1)	0.767
Meals	14.3 (3.3)	26.2 (6.1)	0.109
Watching television	164.1 (37.7)	181.0 (41.9)	0.356
Meditating	2.5 (0.6)	1.9 (0.4)	0.655
Reading	20.6 (4.7)	16.7 (3.9)	0.374
Resting while awake	11.4 (2.6)	13.3 (3.1)	0.776
Sitting conversations	44.8 (10.3)	58.6 (13.6)	0.453
Sitting household chores ¹	7.9 (1.8)	1.9 (0.4)	0.085
Sedentary hobbies ²	8.3 (1.9)	9.5 (2.2)	0.594
Use of cell phone while sitting	10.2 (2.3)	3.8 (0.9)	0.010
Listening to music	4.4 (1.0)	2.9 (0.7)	0.109
Using a computer	35.6 (8.2)	10.5 (2.4)	0.008
Seated classes (Senior University) ⁴	4.1 (0.9)	-	-
Religious activity	3.2 (0.7)	11.4 (2.6)	0.045
Sedentary occupation activity	33.3 (7.7)	5.2 (1.2)	0.043
Passive transportation ³	36.5 (8.4)	59.0 (13.6)	0.158
TOTAL min/day	435.2	432.4	-

¹ For example: peeling food and folding clothes.

² For example: organizing documents, fishing, attending an artistic performance, going to the cinema, and playing cards.

³ Motorized transportation to a destination (e.g., public transportation passenger, vehicle passenger, vehicle driver).

⁴ For example: university lecture.

Weekend television viewing increased to a peak of 181.0 minutes and accounted for 41.9% of the total time. Significant differences were found for specific behaviors such as cell phone use ($p = 0.010$), computer engagement ($p = 0.008$), participation in religious ceremonies ($p = 0.045$), and work-oriented SB ($p = 0.043$).

Interestingly, the overarching trend of SB did not show pronounced discrepancies between weekdays and weekends. However, significant differences in time allocation between the two time periods were found in certain categories such as meal duration ($p = 0.028$), cell phone use ($p = 0.046$), and passive locomotion ($p = 0.019$).

Physical Activity

Table 3 provides information on the duration of PA among rural respondents. Household tasks were the predominant activity, accounting for 85.6 minutes daily, or 37.1% of the total. Gardening followed with 61.8 minutes (26.8%), while walking took 38.6 minutes or 16.7% of the total time. All other activities were significantly less time consuming.

Table 3.

Mean and percentage of time dedicated to PA - rural area (n=19)

PA behaviors	Average minutes per day (%)		Means comparison p (paired samples)
	Week	Weekend	
Household chores ¹	85.6 (37.1)	66.3 (31.7)	0.072
Walking	38.6 (16.7)	63.7 (30.5)	0.018
Working in the vegetable garden	61.8 (26.8)	53.7 (25.7)	0.836
Feeding animals	6.0 (2.6)	6.3 (3.0)	1.0
Exercise program	12.3 (5.3)	-	-
Walking the pet	1.8 (0.8)	1.1 (0.5)	0.655
Going shopping	13.7 (5.9)	15.8 (7.6)	0.722
Lifting weights	6.3 (2.7)	2.1 (1.0)	0.109
Playing with grandchildren	4.6 (2.0)	-	-
TOTAL min/day	230.7	209	-

¹ For example: For example: Hanging out laundry, tidying up clothes, cleaning the house, ironing, organizing clothes, and fetching firewood.

Even on weekends, household tasks remained the main occupation. In particular, the time spent on walks increased to 63.7 minutes, representing 30.5% of the total time. A comparative assessment of the temporal distribution of PA between weekdays and weekends showed a consistent pattern, with the only exception being the significant increase in time spent on walks, a difference that was statistically significant ($p = 0.018$).

Table 4 illustrates the dynamics of PA in an urban context. On weekdays, household activities were the most prevalent, with 72.7 minutes or 28.8% of the time. This was followed by walks and exercise programs, which took 63.5 minutes (25.2%) and 46.7 minutes (18.5%), respectively. On weekends, on the other hand, the focus was on family activities and longer shopping trips.

Table 4.

Mean and percentage of time dedicated to PA – urban area (n=21)

PA behaviors	Average minutes per day (%)		Means comparison p (paired samples)
	Week	Weekend	
Household chores ¹	72.7 (28.8)	69.0 (32.3)	0.872
Walking	63.5 (25.2)	58.1 (27.2)	0.811
Working in the vegetable garden	32.1 (12.7)	13.8 (6.5)	0.273
Exercise program	46.7 (18.5)	-	-
Walking the pet	13.0 (5.2)	7.7 (3.6)	0.068
Going shopping	22.9 (9.1)	32.9 (15.4)	0.556
Lifting weights	0.3 (0.1)	0.5 (0.2)	0.655
Playing with grandchildren	-	30.0 (14.1)	-
Gardening	1.0 (0.4)	1.4 (0.7)	0.317
TOTAL min/day	252.2	213.4	-

¹ For example: For example: Hanging out laundry, tidying up clothes, cleaning the house, ironing, and organizing clothes.

Contextual Insights on Sedentary and Physical Activities

In our study, participants provided insights into two important contextual dimensions relevant to their behavioral tendencies: the identity of their social interlocutors and their local disposition. Such granularity facilitates a thorough understanding of the relationship between socio-physical environments and the resulting behaviors.

The graphical representations in Figures 1 and 2 illustrate the contextual variables associated with SB in both rural and urban areas. In rural areas, older adults mainly talked about their daily activities in the company of relatives (65%) or in solitude (30%), especially in their home environment (89%). In urban areas, there were similar patterns, interspersed with sporadic visits to cafés or the workplace.

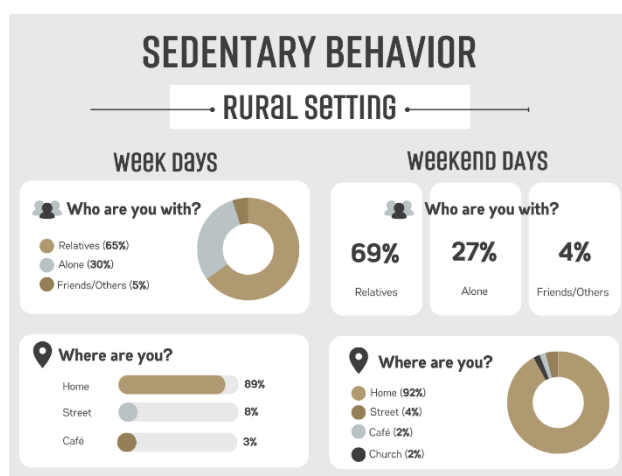


Figure 1. Contextual factors associated with SB in a rural setting.

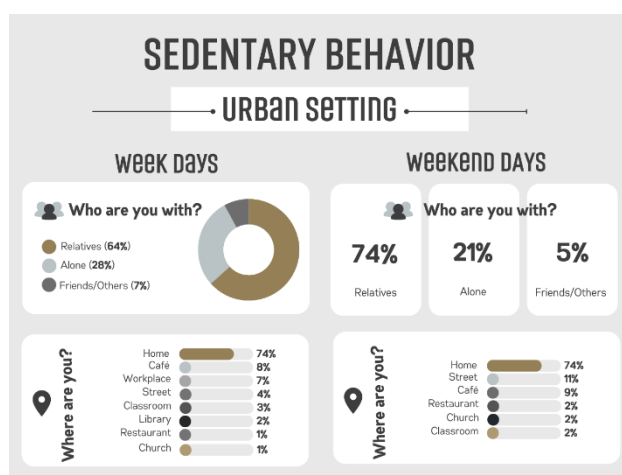


Figure 2. Contextual factors associated with SB in an urban setting.

Figures 3 and 4 illustrate the different spatial contexts affecting PA against the contrasting backdrop of rural and urban geographies. In rural areas, older adults stayed mainly in their homes, on nearby roads, and in gardens. In urban areas, respondents were similarly inclined, although they spent more time in gyms and supermarkets.

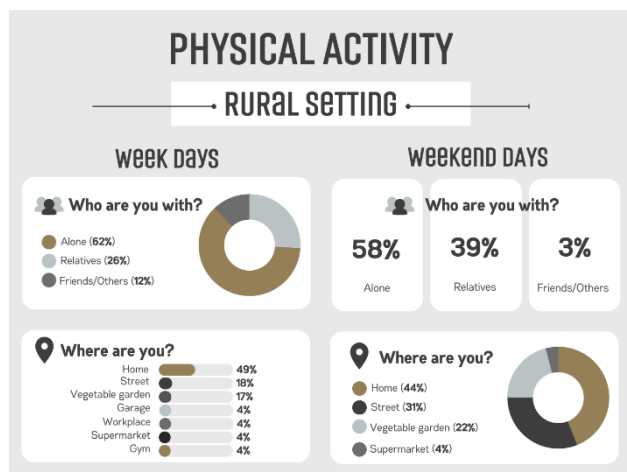


Figure 3. Contextual factors associated with PA in a rural setting.

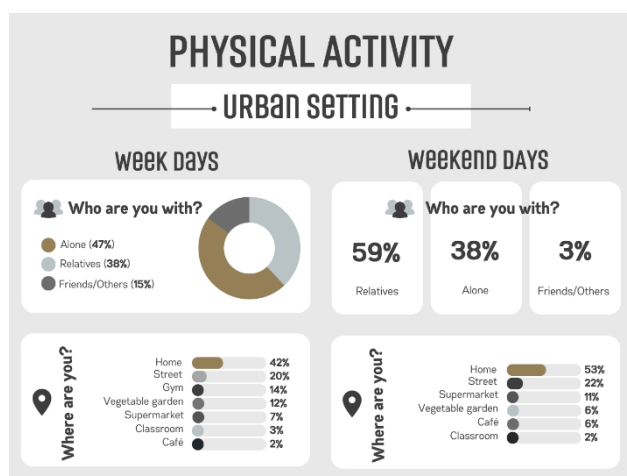


Figure 4. Contextual factors associated with PA in an urban setting.

Discussion

In this study, we provide a comprehensive explanation for SB and PA propensity scores observed in both rural and urban geriatric populations. We used the established reliability of the EMA method for time-dependent self-report (Maher et al., 2018) and examined the different contexts associated with these behaviors. A particular aspect of our study is the careful examination of the environments in which participants spent the majority of their time during the week. The remarkable adherence observed in our cohort, consistent with previous studies (Cain et al., 2009; Maher et al., 2018), vouches for the integrity of our data.

Analysis of the data revealed distinct daily patterns. On weekdays, rural older people spent an average of 506.4 minutes on SB and 230.7 minutes on PA. This changed slightly on weekends, where 558 and 209 minutes were recorded, respectively. Comparable trends were observed in urban areas: on weekdays, an average of 435.2 minutes were spent on SB and 252.2 minutes on PA; on weekends, these times increased slightly to 432.4 and 213.4 minutes, respectively. Interestingly, our results suggest a somewhat higher level of activity among urban older adults – a finding that differs from some previous studies (Kikuchi et al.,

2013) but is consistent with other studies (Köroğlu et al., 2023; Muntner et al., 2005). However, a gap in intensity measurements make direct comparison with established PA guidelines difficult.

The first aim of this study was to describe the patterns of SB and PA among older adults in rural and urban contexts. Our findings suggest that television viewing is the dominant SB in these groups, confirming previous scientific findings (Harvey et al., 2013, 2015; Palmer et al., 2019). In particular, increasing trends in the duration of television viewing have been noted in regions such as Australia and the United Kingdom (Clark et al., 2010; Gardiner et al., 2011; Wijndaele et al., 2011). Sedentary conversations and passive locomotion have also been found to be significant, confirming previous statements about older adults' propensity to SB (Nuwere et al., 2022; Palmer et al., 2019). However, detailed studies are essential to understand the multiple effects of these behaviors. For example, while activities such as watching television may have a negative impact on health, others such as reading may promote cognitive function (Ramalho et al., 2021; Saunders et al., 2020). A marked difference was observed in cell phone use on weekdays compared to weekends, possibly reflecting nuanced shifts in social interactions.

An in-depth examination of PA patterns in both rural and urban older populations found that housework significantly influences activity levels – a statement consistent with current scientific literature (Chastin et al., 2014). Activities such as gardening and walking also showed a significant influence, underscoring the propensity for and accessibility of outdoor activities. It is important to note that older adults living in urban areas have a greater propensity to engage in structured exercise programs. These findings underscore the importance of developing engaging and feasible activities while recognizing the central role of social engagement and family ties in increasing PA. Although numerous studies have chronicled traditional PA behaviors, addressing the pervasive nature of SB remains paramount (Go et al., 2019). To address this challenge, innovative strategies should be developed that not only negate the dangers of physical inactivity but are also consistent with active aging principles. As Maher and Dunton (2020) explain, a deep understanding of the conscious and unconscious factors that influence SB in the aging population is essential. Consequently, interventions should facilitate decisive action, increase self-confidence, and produce lasting changes in entrenched perceptions of PA routines.

There is an identifiable gap in the literature addressing prevalent activities and conditions in the geriatric population. Numerous studies have examined energy expenditure and temporal patterns in detail, but research often falls short when addressing the intrinsic and extrinsic factors that influence PA behavior (Haga et al., 2018). To address this issue, it is critical to examine not only the temporal distribution of sedentary and active behaviors, but also the underlying catalysts that influence these decisions (Haga et al., 2018; Leask et al., 2015). Although previous research has

considered individual, dyadic, and environmental influences on PA and SB (Chastin et al., 2014), our study aimed to take a holistic view supported by real-time EMA diaries. In addition, we aimed to identify which underlying conditions favor both SB and PA inclinations. Our methodology, which includes leisure, locomotion, and housework, is consistent with a socio-ecological approach (Haga et al., 2018; Sallis et al., 2006) that considers the complex interplay of behavior and environment.

Our assessment found that regardless of their urban or rural setting, older adults tend to spend a lot of time at home, often alone or with family. Their outdoor activities, such as visits to cafés, were mainly sedentary. These findings are consistent with those of Palmer and colleagues (2019), who emphasize the importance of sedentary leisure activities. Our data support Owen's (2011) socio-ecological framework linking home environment, leisure time, and transportation as key factors for SB in older adults.

Our empirical research suggests a prevailing SB trend in the family environment. Specifically, there was a decline in social interactions among acquaintances, suggesting a possible shift toward social withdrawal – a known deterrent to activity (McGowan et al., 2019; Palmer et al., 2019). This pattern suggests that increasing feelings of loneliness may discourage older adults from active pursuits and increase their propensity to be sedentary. However, it is important to consider that sedentary activities with cognitive demands, such as reading or playing strategic games, can promote cognitive acuity and emotional health. Intervention strategies should therefore target scenarios characterized by cognitive stagnation and social withdrawal (Leask et al., 2015).

In discussing PA, Piggins' (2020) multifaceted definition that incorporates bodily actions and their broader contexts is noteworthy. Our results show that rural older adults often engage in PA at home or in their immediate environment, whereas their urban peers prefer structured gyms. Interestingly, urban older adults show more social interactions on weekends, especially in family settings. Nonetheless, homes and public streets emerge as dominant locations for PA, followed closely by commercial locations such as supermarkets. These patterns are consistent with the socio-ecological framework (Sallis et al., 2006), which emphasizes situational influences on active behavior. A recent study by Smith and colleagues (2023) supports this by demonstrating the relationship between social support and PA among people aged 60-65 years over a period of nearly ten years.

In our careful examination of SB and PA, focusing on the nuanced contextual determinants found in both rural and urban demographics of older adults, we must emphasize the limitations inherent in our research. While the robustness of EMA is anchored in its temporal precision in capturing behavior, ensuring accuracy with an older population is challenging. The limited geographic scope and non-representative sample underscore the need for cautious

generalization of our findings. In addition, the cross-sectional scope of our study does not allow us to establish causal relationships between the identified behaviors and their interactions. Subsequent studies should address these gaps by including larger and heterogeneous cohorts and a range of socioeconomic indices, and by combining EMA with tangible measurement tools such as pedometers or accelerometers.

The integration of ethnographic techniques promises insights into the specific life experiences of older adults. A harmonized approach that combines EMA with in-depth interviews or focus group discussions enhances comprehensive understanding of real-time dynamics. In addition, the emerging field of time-use epidemiology offers innovative methods to identify the intricate interplay between PA, SB, and sleep. This avant-garde paradigm posits the inseparable connections between these elements that embody the fulcrum of our everyday rhythms (Pedišić et al., 2017; Ross et al., 2020). By carefully assessing these facets together, researchers could uncover the likely impact of time redistribution between PA, SB, and sleep on overarching health outcomes.

Historical research paradigms have made SB reductionist to some degree by focusing primarily on its duration. To improve the effectiveness of interventions, an in-depth look at everyday behaviors is essential. The COM-B framework (Michie et al., 2011) provides a multi-layered theoretical framework that highlights the complex dynamics between capacities, opportunities, motivations, and behaviors. Understanding the intricacies of these factors is critical to developing health strategies that are attuned to individual nuances and increase the likelihood of successful outcomes.

In summary, our research highlights the need for a range of integrated strategies to curb SB while promoting PA in the aging population. Holistic interventions that skillfully combine educational interventions and sophisticated mechanisms are of paramount importance. Recognizing the multifaceted impact of SB – while certain manifestations may have cognitively salutary effects – interventions should offer nuanced perspectives rather than categorically condemning all forms of SB. Simply disseminating information is not enough to effect substantive change. Precise, demographic-specific strategies are essential to skillfully address the nuances of SB.

Conclusion

From our study, it appears that older adults, regardless of whether they live in rural or urban areas, lead a predominantly sedentary lifestyle, mostly at home, either alone or with family members. In terms of leisure activities, there is a clear tendency towards screen-mediated activities, especially watching TV, which is sedentary but offers both social and cognitive benefits. Housework is a notable form of PA, often supplemented by activities such as gardening and walking. Worryingly, these activities often do not involve interactions with peers, suggesting limited sociability. In

contrast, urban older adults show increased social engagement, particularly on weekends, which are often characterized by family interactions both at home and in public spaces. This strong dichotomy between weekdays and weekends underscores the need for tailored strategies to promote weekend activities.

Given the pronounced home-centric tendencies of older adults, incorporating more PA into their daily routines offers many opportunities. Leask and colleagues (2017) have shown a way forward with an intervention aimed at reducing SB in this population. The intervention, developed in collaboration with representatives of the target population, fits seamlessly into daily routines and includes educational modules, regular prompts to reduce SB, self-monitoring tools, and clear goal setting. Achieving these goals requires strategies tailored to the specific preferences and circumstances of this population. These include the promotion of PA through social and family support and the development of initiatives that overcome specific rural or urban barriers. Educating both older adults and their families about the benefits of integrating PA into daily life can highlight the harms of continued inactivity and act as a catalyst for lasting behavior change. When developing interventions for rural areas, it is important to consider the specific challenges and limited resources. Collaboration with local authorities, health experts and policy makers is essential for the development and implementation of targeted programs. Prioritizing outdoor activities can promote community cohesion and alleviate the loneliness that older adults often suffer from.

In summary, our study provides a comprehensive analysis of SB and PA behaviors of older adults and illuminates the myriad individual, social, and environmental determinants that influence their activity patterns. Recognizing these multiple influences enables the development of holistic, adaptive and contextualized interventions. By promoting engagement, bringing about lasting behavior change and improving holistic well-being, we can improve the quality of life of older people. We advocate for active interventions that promote both physiological and cognitive vitality, leading to aging characterized by reverence and gratitude. Our findings bode well for the development of strategies that not only increase PA but also enrich older adults' social and cognitive lives, paving the way for a future in which aging is embraced with energy and enthusiasm.

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