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CHARACTERIZING SEDENTARY BEHAVIOUR OF ELDERLY PEOPLE WITH COGNITIVE DECLINE, LIVING IN RESIDENTIAL CARE

Master's Dissertation in Advanced Neurological Physiotherapy

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Relatório de Investigação apresentado para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Fisioterapia em Neurologia, realizado sob a orientação científica da Professora Madalena Gomes da Silva e coorientação da Professora Teresa Dias.

[DECLARAÇÕES]

Declaro que este Relatório de Projeto de Investigação é o resultado da minha investigação/projeto pessoal e independente. O seu conteúdo é original e todas as fontes consultadas estão devidamente mencionadas no texto, nas notas e na bibliografia.

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It is hereby declared that this document has been written in accordance with the standards for submission to the journal "The Journal of nutrition, health and aging".

Abstract:

Introduction: Individuals experiencing cognitive decline frequently require specialised care being often institutionalised. In this context, sedentary behaviour (SB) tends to increase, and it is associated with increased mortality risk. However, few studies have examined SB patterns among institutionalised older adults with cognitive decline.

Objective: To characterise time spent in SB (total hours and bout duration), the nature of sedentary activities (location, social context, and type), and their distribution throughout the day.

Methods: A cross-sectional observational study was conducted with 109 institutionalised older adults (>65 years) with cognitive decline, able to move independently from sitting to standing. SB was assessed through direct observation using structured criteria and complemented by a wearable device to quantify daily steps. Sociodemographic data, physical performance (Short Physical Performance Battery), and cognitive capacity (Addenbrooke's Cognitive Examination–III) were evaluated.

Results: Participants were mostly female (mean age 86,31±7,34 years) and had multiple comorbidities. The mean they spent in SB was 9.6±2.1 hours per day (~77% of waking time), took 860 steps daily, and performed 13 sedentary bouts per day (40 minutes each). The most frequent activity was sitting (2,4±2,1 hours), in the shared living room (3,71±3,12 hours), mainly without interaction with others (6,25±2,37 hours). Sedentary time differed significantly ($p<0.001$) between morning and afternoon, and between afternoon and evening.

Conclusion: Institutionalised older adults exhibited high levels of SB, primarily in cognitively unstimulating activities and in the afternoon. These findings highlight the need for strategies to reduce SB, interrupt sedentary bouts, and promote cognitive engagement to support healthy ageing.

Keywords: residential facilities; aged; dementia; cognitive dysfunction; life style

Table of contents

1. List of Abbreviations

ACE-III – Addenbrooke's Cognitive Examination III

ADL's – Activities of daily living

DCA – Direct care assistant

GDPR – General Data Protection Regulation

MCI – Mild cognitive impairment

METs – Metabolic equivalents

SB – Sedentary behaviour

SD – Standard deviation

SPPB – Short Physical Performance Battery

T2DM – Type II diabetes mellitus

2. List of Tables

3. Introduction

With the ageing of the world's population, the number of people with cognitive decline has been increasing and is expected to grow exponentially (Nandi et al., 2022; Yang et al., 2024). Currently, more than 55 million people worldwide have dementia, and there are ten million new cases every year (WHO, 2021). Dementia is an overall term for several progressive diseases that mainly affect memory and other cognitive abilities, as well as behaviour (World Health Organization, 2018). In dementia, there is an impairment in performing activities of daily living (ADLs) independently, associated with a higher level of dependence (Hugo & Ganguli, 2014). Mild cognitive impairment (MCI) is an intermediate state between normal cognition and dementia, where the individual's functional abilities are still preserved and do not interfere with independence in their ADLs (Anderson, 2019; Hugo & Ganguli, 2014). Because of the increased dependence of people living with cognitive impairment and the burden for the caregivers, dementia is the leading cause for institutionalisation among elderly people (Luppa et al., 2010; Salminen et al., 2020).

Institutionalised elderly individuals have reported, through research questions, that their daily routines are characterised by a high degree of inactivity (Giné-Garriga et al., 2019). Previous studies have indicated that adults over the age of 60 spend approximately 80% of their waking time in sedentary behaviour (SB), equivalent to 8 to 12 hours per day, with this figure rising to 85-90% in institutionalised people (Henson et al., 2023; Parry et al., 2019; Pomiersky et al., 2024; Reid et al., 2013). SB is defined as any type of behaviour characterized by an energy expenditure of less than or equal to 1.5 metabolic equivalents (METs) in a sitting, reclining, or lying position during waking hours (Tremblay et al., 2017). Several articles have demonstrated that increased time spent in SB is associated with an elevated risk of multifactorial mortality, increased mortality in people diagnosed with cancer, and a higher incidence of cardiovascular diseases and type II diabetes mellitus (T2DM) (Henson et al., 2023; Patterson et al., 2018; Yerramalla et al., 2022). Consequently, an increase in time spent in SB (more than 10 hours/day) is associated with a 48% increase in the risk of all-cause mortality (Ekelund et al., 2019; Patterson et al., 2018).

Although previous studies have analysed SB and cognitive function in the elderly, few of them have compared the time spent in SB between elderly people with different levels of cognitive decline or dementia living in institutions (Dillon et al., 2022; Lu et al., 2018). Those that analyse this specific population have not characterized SB, have not used wearable devices for SB data collection, had small samples, and tend to analyse the correlations between SB and cognitive function (Barber et al., 2015; Leung et al., 2017; Parry et al., 2019; Van Alphen et al., 2016).

Considering the aforementioned points, the reality of individuals with cognitive decline who are institutionalised in Portugal remains unexplored and undocumented. This encompasses the duration of time that institutionalised elderly individuals, exhibiting varying degrees of cognitive decline, spend in SB, in addition to the nature of the activities engaged in during such behaviour.

Taking this into account, the primary objective of this study is to characterise the time that institutionalised elderly people with cognitive decline or dementia spend in SB, namely the total time in hours and the duration of each bout, as well as the activities they engage in during this time. These activities will include the location, the presence of other individuals, and the context/activity in which they take place, as well as their distribution throughout the day. Additionally, this study compares the total time spent in SB of institutionalised elderly people with different levels of cognitive decline (severe dementia, moderate dementia, mild dementia, and MCI).

4. Material and methods

4.1. Study Design

A cross-sectional observational study was conducted. The study protocol was approved by the Ethics Committee of the Polytechnic Institute of Setúbal (CE-IPS PI no. 25 / 2022) and the local ethics committee when it existed in each residential care facility.

This study has considered the General Data Protection Regulation (GDPR), complying with the rules on protecting the processing of the data collected and guaranteeing its anonymity. The study also considered the Declaration of Helsinki, which consists of a set of ethical principles governing research with human beings.

4.2. Participants

Subjects were included if they met the following criteria: they were older than 65 years of age (Lu et al., 2018; Parry et al., 2019), they resided in residential care (Amagasa et al., 2020; Parry et al., 2019), they exhibited cognitive decline as measured by the Addenbrooke's Cognitive Examination III (ACE-III) (Falck et al., 2017; Parry et al., 2019), and they were able to make an independent transition from a seated to a standing position (Falck et al., 2017; Parry et al., 2019). Those who were physically restrained, had an acute illness, were terminally ill, had an active infection, or had severe speech or hearing impairments were excluded (de Oliveira et al., 2019).

To calculate the sample size, the number of elderly people living in residential care in the Portuguese municipalities where data was collected was considered. From these, the proportion of institutionalised elderly people meeting the eligibility criteria was used. Considering the exclusion criteria, it was stipulated that around 10% of the elderly people institutionalised in residential care would meet the criteria for inclusion in the study. An online calculator (https://www.calculator.net/sample-size-calculator.html) was used, with a population size of 5911, a confidence level of 90% and a margin of error of 5%, and a proportion of 10%, resulting in a number of 97 participants.

The sample was recruited between December 2022/August 2023 and September 2024/ August 2025, in 8 residential care facilities in Portugal. A non-probabilistic sample was recruited at Santiago do Cacém, Setúbal, Lisboa, and Sesimbra.

The institutions were contacted, and the procedures explained. Following their acceptance, the researchers initiated the recruitment process. Participants were provided with written information that included all the relevant details, and informed consent was obtained from each participant. In the case of potential participants who were incapable of responding and deciding autonomously (accompanied adult process - Law no. 49/2018, 2018), their legal guardians were contacted. Once written informed consent had been completed, the data collection process began (ACE-III), sociodemographic sheet and Short Physical Performance Battery (SPPB)).

Subsequently, the wearable device (Xiaomi Mi Band 5) was introduced. A suitable day for all involved was defined to initiate the utilisation of the wearable device. The wearable device was placed on each participant every day (put on when they woke up and taken off when they went to bed) for a period of 7 consecutive days. On one typic day, of the 7 days when the device was used, one of the researchers went to the residential care facility and observed and registered the participant's behaviour (see supplementary material).

Prior to this, a pilot was conducted. This comprised the delivery of competence training to the researchers involved in data collection. The training focused on the process of applying the different instruments.

4.3. Variables and Tools

4.3.1. Primary variables

In this study, sedentary behaviour was characterised through the total time in hours, the time of each bout in minutes (min.), the number of bouts per day, and the number of steps (some authors consider <5000 steps per day is considered to have SB) (Tudor-Locke et al., 2013). To assess sedentary behaviour, the researcher used a Sedentary Behaviour Characterisation Form (see supplementary material). This form was completed by the researcher and enabled the collection of information regarding the time spent in SB. In addition, a Xiaomi Mi Band 5 device was utilised to complement the SB information by providing data on the number of steps taken.

4.3.2. Contextualisation variables

To provide a comprehensive characterisation of SB, it was necessary to consider the context (common room, bedroom, other common spaces, dining room, among others) and activity (sitting doing nothing, watching television, talking with other residents, among others) in which SB occurs, as well as the individuals involved (alone, other residents, technician, among others). This data was collected using the Sedentary Behaviour Characterisation Form (see supplementary material).

4.3.3. Characterisation variables

The study sample was characterised by age, sex, literacy level, marital status (Compernolle et al., 2022); anthropometric data: weight, height and body mass

index (BMI) (Copeland et al., 2017); clinical data: comorbidities/clinical personal history (hypertension, diabetes, hearing and visual acuity, respiratory disease, depression, stroke, other) (Parry et al., 2019), consumption (alcohol, tobacco) (Chastin et al., 2015), use of walking aids and type (Parry et al., 2019), number of medications administered per day; institutional data: length of institutionalisation, number of residents per direct care assistant (DCA), activities and/or therapies carried out (Chastin et al., 2015), physical performance (Compernolle et al., 2022) and cognitive ability (Lu et al., 2018; Peixoto et al., 2018).

The SPPB test was used to evaluate physical performance. This validated test assesses lower limb function in the elderly by evaluating three domains: balance, walking ability, and the ability to sit and stand (Guralnik et al., 1994). A final score between 0 and 12 is calculated, considering that the higher the final value, the better one's physical condition (Guralnik et al., 1994).

To assess the presence of cognitive impairments, the ACE III (Peixoto et al., 2018) was used. This test assesses different cognitive dimensions that provide insight into the individual's neurocognitive function (Peixoto et al., 2018). Using this instrument, it is possible to discriminate between people with dementia, mild cognitive decline, and individuals without cognitive alterations (Bruno & Schurmann Vignaga, 2019; Potts et al., 2022). To differentiate between different levels of cognitive decline, different cut-off points for ACE-III have been studied: a cut-off point of 82 distinguishes people with MCI from people without cognitive impairment, a cut-off point of 74 distinguishes between people without cognitive impairment and dementia, and a cut-off point of 66 distinguishes between MCI and dementia (Peixoto et al., 2018). The use of ACE-III cut-off points has been a subject of study in order to differentiate between varying levels of dementia. For cases of severe dementia, a score of 37 or lower is indicative. For moderate dementia, the score falls between 37 and 54. For mild dementia, the score ranges from 55 to 65 (So et al., 2018).

4.4. Statistical Methods

The mean, median, standard deviation (SD), and minimum and maximum values were calculated for continuous variables – time in SB (total time, duration of

sedentary bouts, number of bouts), number of steps per day, ACE-III and SPPB scores, age, weight, height, length of time institutionalised, and number of medications administered per day. For categorical variables such as gender, education, marital status, comorbidities, consumption, use of walking aids, and therapies/activities carried out, their absolute and relative frequency were described.

A statistical analysis was used to compare the mean time of SB among elderly individuals with MCI and three levels of dementia, according to the ACE-III. Subsequent analyses investigated variations in total time in SB according to the utilization of walking aids, gender, medication, comorbidities, and physical performance (SPPB score). The distribution of SB and the number of steps across different periods of the day were also examined. The normality of the data for each group was assessed using the Shapiro–Wilk or Kolmogorov-Smirnov test. Depending on the results of the normality test and the number of groups being compared, different statistical approaches were applied. In instances where a comparison was made among more than two groups and the data were found to be normally distributed, a one-way analysis of variance (ANOVA, a parametric test) was employed, subsequently followed by Bonferroni post-hoc tests. In instances where the assumption of normality was not met, the Friedman test (non-parametric test) was performed. In instances of comparing two independent groups (e.g., men vs. women, users vs. non-users of walking aids), an independent-sample t-test (parametric test) was applied when normality was confirmed, or the Mann–Whitney U test (non-parametric test) when the data were not normally distributed.

The methodology was described according to the STROBE checklist (STROBE Statement, n.d.).

5. Results

5.1. Participant characteristics

As shown in Table 1, the participants (N=109) had a mean age of 86.31± 7.34 years, and the majority were female (65,1%). Most of the participants were widowed (58,7%). The mean Body Mass Index was 27.05±5.21, so most of them were

overweight or obese (61,5%). Most of the participants had multiple comorbidities: hypertension (15,6%), osteoarticular disorders (10,1%), and cardiovascular disorders (9,5%). Participants took a mean of 9.96 (± 4.55) pills per day. Most of the participants used a walking aid (56,9%). Many had been institutionalised for a mean of 2.86 (± 3.36) years. The most common activities during the day were socio-cultural activities (33,3%) and physiotherapy (17,1%). The mean score for physical performance was 3.88 (± 2.81) on the SPPB, indicating a poor physical condition. The average ACE-III score was 41.42 (± 20.71). The study population comprised 43 participants with severe dementia (score < 37), 33 participants with moderate dementia (score between 37 and 54), 18 participants with mild dementia (score between 55 and 65), and 15 participants with mild cognitive impairment (score between 66 and 82).

Table 2 - Participants Characteristics

Characteristics (N=109)	**N (%)**	**Mean ± SD**	**Median**	**Minimum**	**Maximum**
Age (years)		86,31 ± 7,34	88,00	65	97
<75	9 (8,3)				
75-84	26 (23,9)				
≥85	74 (67,9)				
Sex					
Female	71 (65,1)				
Male	38 (34,9)				
Marital status					
Widow	64 (58,7)				
Single	19 (17,4)				
Married	15 (13,8)				
Divorced	9 (8,3)				
Unknown	2 (1,8)				
Literacy levels					
Not able to read/ write	19 (17,4)				
Incomplete 1st Cycle of basic education	10 (9,2)				
1st Cycle of basic education	42 (38,5)				
2nd Cycle of basic education	7 (6,4)				
3rd Cycle of basic education	6 (5,5)				
Secondary or vocational education	12 (11,0)				
Graduate	7 (6,4)				
Unknown	6 (5,5)				
BMI (kg/m2)		27,05 ± 5,21	26,82	18,00	44,38
Underweight (<18,5)	3 (2,8)				
Normal weight (18,5-24,9)	37 (33,9)				
Overweight (25-29,9)	40 (36,7)				
Obese (≥30)	27 (24,8)				
Morbidity (dementia diagnose)	8 (4,5)				
Comorbidities					
Hypertension	28 (15,6)				
Osteoarticular disorder	18 (10,1)				
Cardiovascular disorder	17 (9,5)				

(continuation) Table 3 - Participants Characteristics

Characteristics (N=109)	N (%)	Mean ± SD	Median	Minimum	Maximum
Comorbidities					
Others	17 (9,5)				
Neurological disorder	14 (7,8)				
Visual impairment or hearing acuity	11 (6,1)				
Dyslipidaemia	11 (6,1)				
Mental Health Disorders	9 (5,0)				
Respiratory disorder	8 (4,5)				
Type 2 diabetes mellitus	7 (3,9)				
Kidney/Urinary System Disorders	7 (3,9)				
Digestive System Disorders	6 (3,4)				
Dependencies	5 (2,8)				
Oncological disorder	4 (2,2)				
Anaemia	4 (2,2)				
None	2 (1,1)				
Number of pills per day		9,96 ± 4,55	9,50	0	24
Walking aid	62 (56,9)				
Consumption					
None	102 (93,6)				
Alcohol and tobacco	7 (6,4)				
Number of falls		0,77 ± 1,30	0,00	0	7
Time spent in institutional care (years)		2,86 ± 3,36	1,81	0,01	21,61
Racio of direct care assistants (number of residents per direct care assistant)		10,4 ± 3,79	9,5	6,00	20,00
Therapies/activities					
Physiotherapy	38 (17,1)				
Socio-cultural activities	74 (33,3)				
Nursing	8 (3,6)				
Psychology	10 (4,5)				
Occupational therapy	6 (2,7)				
Gymnastics	15 (6,8)				
Yoga	6 (2,7)				
Physical performance – SPPB (0-12)		3,88±2,81	3,00	0	12
Cognitive Status - ACE-III (0-100)		41,42±20,71	42,00	0	8
Severe dementia (<37)	43 (39,4)				
Moderate dementia (37-54)	33 (30,3)				
Mild Dementia (55-65)	18 (16,5)				
Mild Cognitive Impairment (66-82)	15 (13,8)				

5.2. Sedentary behaviour

Participants spent a mean of 9h35min ± 2h04min of their day in SB, which is equivalent to approximately 77% of their waking time (12h23min ± 1h32min). Per day, the mean of daily steps was 859,85 ± 1435,25 (median of 294,57), but most of them (65,7%) took less than 500 steps per day. In terms of sedentary bouts per day, they had 12,79 ± 4,69 bouts, and the mean time of each bout was 40±19 minutes. They interrupted sedentary time 13,86 ± 5.96 times (number of times that they stand up). The activities that are most common during SB are: sitting doing nothing

(2h24min ± 2h06min), having a meal (2h24min ± 45min), sitting watching television (2h05min ± 2h24min), and napping (39min ± 1h01min). The place where they spent most of the time in SB was the common room (3h43min ± 3h07min), following the bedroom (1h52min ± 2h53min) and other common spaces (1h10min ± 1h54min). They only spent a mean of 2h30min ± 1h45min in activities that are not SB, such as standing, walking, or activities of daily living.

Table 2 - Sedentary behaviour

Sedentary Behaviour	N (%)	Mean ± SD	Median	Minimum	Maximum
Hours awake per day [a]		12,39 ±1,53	12,25	8,45	16,67
Steps per day [b]		859,85 ± 1435,25	294,57	24,40	8165,71
< 500 steps	69 (65,7)				
500-1500 steps	16 (15,2)				
1500-2500 steps	10 (9,5)				
≥ 2500 steps	10 (9,5				
Total time in SB (hours)		9,59 ± 2,07	9,28	2,43	14,68
< 6 hours	5 (4,6)				
6-8 hours	16 (14,7)				
8-10 hour	43 (39,4)				
10-12 hours	31 (28,4)				
> 12 hours	14 (12,8)				
Percentage in SB per daily waking hours? (%) [a]					
< 70%	30 (29,4)				
70-80%	20 (19,6)				
80-90%	33 (32,4)				
≥ 90%	19 (18,6)				
Mean time per sedentary bout (minutes)		39,87 ± 18,91	33,75	7,62	98,14
Number of bouts of SB per day		12,79 ± 4,69	13	4	27
Number of times standing up		13,86 ± 5.96	13,00	2	33
Total time not SB (hours)		2,5 ± 1,75	2,13	0,03	7,75
Time standing (hours)		0,17 ±0,34	0,05	0	2,35
Time walking (hours)		0,81 ± 0,65	0,67	0	3,30
Time in other non-SB activities (hours)		1,51 ± 1,47	1,13	0	7,62
Time in SB per activity (hours)					
Sitting watching television		2,08 ± 2,4	1,32	0	9,73
During meals		2,4 ± 0,75	2,2	0,63	4,30
Sitting doing nothing		2,4 ± 2,1	1,78	0	8,47
Sitting during other activities		2,16 ± 1,84	1,9	0	8,15
Napping		0,65 ± 1,02	0	0	4,30
Undefined		0,2 ± 0,78	0	0	5,13
Crossword puzzles		0,12 ± 0,61	0	0	5,52
Mobile phone use		0,09 ± 0,48	0	0	4,00
Cognitive stimulation		0,17 ± 052	0	0	4,20
Reading		0,06 ± 0,3	0	0	1,97
Bingo		0,06 ± 0,27	0	0	1,75
Conversation		0,4 ± 0,61	0	0	2,40
Lying down or reclining		0,58 ± 1,49	0	0	8,33
Time spent in SB per location (hours)					
Common room		3,71 ± 3,12	3,08	0,00	10,13
Bedroom		1, 86 ± 2,88	0,00	0,00	11,50
Other common spaces		1,16 ± 1,9	0,17	0,00	9,50
Dining room		0,19 ± 0,43	0,00	0,00	2,68
Outside		0,16 ± 0,59	0,00	0,00	4,35
Activity room		0,06 ± 0,41	0,00	0,00	3,37
Balcony or terrace		0,03 ± 0,27	0,00	0,00	2,83

(continuation) Table 2 - Sedentary behaviour

Sedentary Behaviour	Mean ± SD	Median	Minimum	Maximum
Social context of time spent in SB (hours)				
Alone	6,25 ± 2,37	6,4	0,35	11,50
Other residents	0,06 ± 0,13	0,00	0,00	0,77
Technician	0,07 ± 0,25	0,00	0,00	1,33
AAD	0,01 ± 0,04	0,00	0,00	0,40
Hairdresser	0,03 ±0,16	0,00	0,00	1,33
Family/visits	0,01 ±0,05	0,00	0,00	0,42

[a] N=102 (7 participants missing data regarding the wake-up or bedtime); [b] N=105 (4 participants missing at least 3 days of steps counting)

The mean time spent in SB was approximately 2.67±0.90 hours in the morning (8 a.m. – 12 p.m.), 3.30±0.75 hours in the afternoon (12 p.m. – 4 p.m.), and 2.75±0.87 hours in the evening (4 p.m. – 8 p.m.). Given that the normality of the variables was not met, the Friedman test was used to compare the mean of SB time for these three periods of the day, yielding a p-value<0.001, indicating statistical differences in the time spent in SB across the three periods. To ascertain the specific differences, post-hoc analyses with Bonferroni correction (α = .017) were conducted. As presented in Table 3, there were statistically significant differences (p<,001) in SB time between the morning and afternoon, as well as between the afternoon and the evening. However, no statistically significant differences were observed between sedentary behaviour in the morning and in the evening. To see if the number of steps in these 3 periods of the day was consistent with the previous analyses, it was also analysed the number of steps, comparing it during the morning, afternoon, and the end of the day. Conducting the same tests and applying the Friedman test, a test statistic of 33,829 and a p<0.001 was found, determining statistical differences between the number of steps in these 3 periods of the day. To determine in which periods of the day where statistical differences, the post-hoc analyses with Bonferroni correction (α = .017) were conducted, finding statistical differences in the number of steps in the morning compare to the afternoon and in the morning compare to the end of the day, but not statistical differences between the afternoon and the end of the day, as it's possible to see in table 3.

Table 3 - Distribution of sedentary behaviour throughout the day

Sedentary Behaviour (hours)	Mean ± SD	Median	Minimum	Maximum
Hours of SB in the morning (8 a.m.-12p.m.)	2,67 ± 0,90	2,72	0,27	4,00
Hours of SB in the afternoon (12 a.m.- 4 p.m.)	3,30 ± 0,75	3,52	0,30	4,00
Hours of SB at the end of the day (4 p.m.- 8 p.m.)	2,75 ± 0,87	2,78	0,42	4,00
Friedman test	test statistic	df	Sig.	
	29,641	2	<,001*	
Post-hoc analysis with Bonferroni correlation	test statistic	Sig.		
Morning – Afternoon	-5,362	<,001*		
Morning – End of the day	-0,423	0,672		
Afternoon – End of the day	-4,795	<,001*		
Sedentary Behaviour (steps)	Mean ± SD	Median	Minimum	Maximum
Mean steps in the morning (8 a.m.-12 p.m.) [b]	298,52 ± 608,55	88,57	1,71	4609,00
Mean steps in the afternoon (12 p.m.- 4 p.m.) [b]	218,50 ± 452,55	63,45	0,00	2985,43
Mean steps at the end of the day (4p.m.-8 p.m.) [b]	221,76 ± 409,59	72,15	0,00	2824,43
Friedman test	test statistic	df	Sig.	
	33,829	2	<,001*	
Post-hoc analysis with Bonferroni correlation	test statistic	Sig.		
Morning – Afternoon	-3,974	<,001*		
Morning – End of the day	-3,224	<,001*		
Afternoon – End of the day	-2,223	0,026		

[b] N=105 (4 participants missing at least 3 days of steps counting); Sig.: significance; * p<0,05

To check if there were statistical differences between the time spent in SB in different types of cognitive decline, normality was tested in the different groups of cognitive decline, and since all showed normal distribution, the parametric ANOVA test was used, where p=0.793, meaning that there were no statistically significant differences between SB times in the different groups of cognitive decline – table 4.

Table 4 - Sedentary behaviour and cognitive decline

Sedentary behaviour (hours)	N (%)	Mean ± SD	Median	Minimum	Maximum
Severe dementia	43 (39,4)	9,75 ± 2,12	9,58	2,43	14,68
Moderate dementia	33 (30,3)	9,27 ± 1,7	8,89	5,82	12,20
Mild Dementia	18 (16,5)	9,6 ± 2,28	9,66	4,75	12,58
Mild Cognitive Impairment	15 (13,8)	9,74 ± 2,49	9,15	6,82	14,58
ANOVA test	Sum of Squares	df	Mean square	F.	sig
Between groups	4,51	3	1,5	0,34	0,793

Sig.: significance; * p<0,05

In the absence of statistically significant differences in sedentary behaviour times in relation to different cognitive declines, the investigation expanded to encompass additional variables (Sebastião et al., 2019). Initially, normality was assessed, followed by the implementation of the relevant statistical test for the variables of walking aid utilisation, gender, medication, comorbidities, and SPPB. However, no statistically significant differences were identified for these variables either (p>0.05).

6. Discussion

The present sample has an average age above 85 years, which demonstrates the ageing of the population residing in residential care. Portugal is the second most aged country in the European Union (INE, 2025). As is known, increased age is strongly associated with cognitive decline (Alves et al., 2024). In this study, cognitive performance scores were quite low, with 94 participants having dementia and only 15 having mild cognitive impairment. However, only 8 participants had medical records with a diagnosis of dementia. The absence of a gold standard for the diagnostic criteria for dementia and the underdiagnosis of the condition in residential care home (Alves et al., 2024), could explain our findings.

Following thorough analysis, high levels of accumulated time in SB (9.59 ± 2.07 hours) were observed, which is consistent with the findings reported in the existing literature (8-12 hours of SB in elderly people living in residential care with or without cognitive impairment) (Parry et al., 2019; Reid et al., 2013). Studies evaluating SB bouts also demonstrate high values, with SB bouts lasting between 30-60 minutes (Reid et al., 2013), which is in alignment with the results obtained in this study, where SB bouts averaged at 39.87 ± 18.91 minutes. The observed parallels in SB can be attributed to the comparable characteristics of the study populations. However, it should be noted that one of the studies excluded individuals with severe dementia (Reid et al., 2013)., while the other employed a sample size of 28 participants, of whom only 8 had been diagnosed with dementia (Parry et al., 2019;).

A study by Huang and colleagues highlights SB as the main risk factor for cognitive decline in institutionalised older adults (Huang et al., 2023). As indicated by the findings of other study, it is imperative to differentiate the nature of the activity being undertaken during SB (Mellow et al., 2022). Certain activities are cognitively passive, such as watching television, and have been demonstrated to exhibit a negative correlation with cognitive function (Raichlen et al., 2022). Conversely, cognitively demanding activities, such as reading, playing cards, or computer use, have been shown to exhibit a positive correlation with cognitive function and with lower risk of dementia (De Rezende et al., 2014; Raichlen et al., 2022; Shuai et al.,

2023). According to our data, institutionalised elderly people tend to spend most of their time sedentary, engaging in activities such as watching television, doing nothing or napping, with minimal time allocated to cognitively stimulating activities (10 minutes on cognitive stimulation activities and 7 minutes doing crossword puzzles). The participants of this study engaged in conversation for 24 minutes a day, which is a practice that has been identified by Kotlarczyk and colleagues as having a positive impact on well-being due to its association with the social component (Kotlarczyk et al., 2020), although it is rarely done by the participants.

According to the existing literature, three main factors contribute to prolonged SB: individual, organisational, and environmental (Benjamin et al., 2016; Huang et al., 2023; Voss et al., 2020). It has been reported that elderly individuals are accustomed to performing activities of daily living independently before admission, and that these activities motivate them to break sedentary bouts (Huang et al., 2023; Voss et al., 2020). However, institutions often assume responsibility for these tasks, which can lead to a decline in autonomy and an increase in SB (Huang et al., 2023). Other organisational barriers include a lack of human resources and funding, and heavy workload (Benjamin et al., 2016). The predominant factors contributing to SB among residents were physical discomfort, fatigue, and health concerns (Benjamin et al., 2016; Voss et al., 2020). However, residents also perceived breaking SB as a means of alleviating pain and stiffness (Voss et al., 2020). Environmental barriers include a lack of space and resources for promoting more active lifestyles (Benjamin et al., 2016). This was observed during the participants' observation day, although it was not formally recorded on the observation sheet. Furthermore, the ratio of DCA exceeds the stipulated requirement set out in "*Portaria n.º 67/2012, de 21 de março*", which establishes a number of 1 DCA for every 8 residents. The data collected and analysed indicates that there is an average of 1 DCA for every 10 residents, reflecting an excessive workload.

In relation to the distribution of SB throughout the day, significant disparities have been observed between the morning and afternoon periods and the afternoon and end-of-day periods. These variations may be attributed to the patterns of hygiene routines and other daily activities, which are typically performed upon awakening

and prior to sleep. Furthermore, the after-lunch period is often characterised as the predominant time for rest and recuperation, including the occurrence of naps. These results are consistent with other studies (Leask et al., 2015; Reid et al., 2013). These data thus suggest a period in which it would be more relevant to introduce activities aimed at breaking up periods of sedentary behaviour.

According to the results obtained in this study, participants generally have low physical performance as well as poor cognitive performance. The existing literature suggests that older adults experience a progressive decline in physical activity, physiological function, and cognitive capacity (Lai et al., 2024; Lebuf et al., 2024). Such reductions in physical and cognitive functioning have been linked to unhealthy SB patterns (Lai et al., 2024; Lebuf et al., 2024). No statistically significant differences were found between the time spent in SB and the different levels of cognitive decline, as presented above. These results may be related to the fact that, although participants were divided into different levels of severity of dementia and mild cognitive impairment, the type of dementia that they had was not considered, which may have influenced the different behavioural patterns. The type of dementia was not considered in the analysis due to an absence of records, and because of the poor discriminatory value of the scale. Research into time spent in sedentary behaviour, considering different types of dementia, may be the subject of future research. Furthermore, no statistically significant differences were found between SB times and different levels of physical performance. One hypothesis for these results may be related to the fact that what motivates participants to break their SB is not only their physical condition but also their emotional state, the activities offered, and the social and environmental context.

The statistically non-significant results regarding the use of walking aids may be attributable to the fact that individuals who use walking aids are already well adapted and therefore able to move around independently. In contrast, those without walking aids, due to a lack of adaptation or because they have not been provided with walking aids, require the support of a third person to move around, which limits their autonomy. With regard to the findings concerning the tablets, the absence of differentiation between medications (e.g. antihypertensive or antidepressant) may have contributed to these outcomes. It is likely that the results

do not vary according to the quantity of medications, but rather according to the nature of the substances contained within them. This is because an individual may consume a high number of tablets that do not affect their alertness, while another person may take a single tablet that contains active ingredients capable of reducing their responsiveness. Future research could investigate whether there are differences in sedentary behaviour times between people who take tablets containing different active substances. With respect to the absence of statistically significant differences between individuals with varying numbers of comorbidities, this finding may be associated with the paucity of data available in institutional records. For instance, cardiovascular conditions are documented as a comorbidity in merely 9.5% and hypertension in 15,6% of the study population, and according to some authors, elderly people in Portugal have high prevalence of cardiovascular risk factors (Marques da Silva et al., 2019).

The present study demonstrated that elderly individuals with cognitive decline residing in residential care facilities in Portugal predominantly engage in SB during their day. A statistically significant variation in the time spent in SB was observed across the different periods of the day, with the afternoon exhibiting a notably higher proportion of SB. Furthermore, the activities that elicited the greatest SB involved passive pursuits that did not require cognitive activation or stimulation. Additionally, the total number of hours spent in SB wasn’t statistically significant in different levels of cognitive decline, use of walking aid, sex, number of medications, comorbidities and physical performance (score SPPB).

Given the large size of N, it would have been challenging for one researcher alone to collect such a substantial sample. To address this issue, the data was collected by different researchers. This introduces a limitation, as the data was collected by different people. However, this issue was resolved through skills training. One positive aspect of data collection by different researchers was that the data was collected in different municipalities, making it more comprehensive. An additional limitation identified was the utilisation of the mobile device during the stipulated seven-day period. This was attributed to the device's ease of removal by the user and the potential for forgetfulness on the part of DCAs to reattach the bracelet. To address these challenges, strategies were employed, such as the placement of

notices adjacent to the participants' beds and the direct contact with the DCAs weekly to identify which residents were to be studied each week. During data collection, several biases may have occurred: the Xiaomi Mi Band 5, does not adequately measure certain cases (people with little upper limb oscillation during walking or who use, for example, a walker). Confusion bias – data collection took place over several months of the year, but mainly during the winter, when there is a greater tendency towards periods of sedentary behaviour.

7. Conclusions

Elderly people in residential care spend most of their waking hours in SB, engaging in activities such as watching television, doing nothing, or eating meals. This type of activity (cognitively unstimulating) is negatively associated with cognitive performance. The time spent in SB occurs in uninterrupted bouts of 40 minutes. The data highlights the importance of breaking the SB in the afternoon, as this is the period when SB has a greater volume. Institutions should be aware of this and incorporate strategies to reduce time in SB.

Further research is required to ascertain the potential disparities in times spent in SB between individuals with and without cognitive decline in residential care settings. Additionally, further research is necessary to elucidate any differences in times spent in SB between different types of dementia and between individuals who take different types of medication, considering the active substance.

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9. Supplementary material

1. Sedentary behaviour characterisation form

REGISTO DE ATIVIDADE

CÓDIGO:

DATA:	Hora de acordar	Pequeno-almoço	Almoço	Lanche	Jantar	Hora de deitar
Hora de início						
Hora de fim						

COMPORTAMENTO/ ATIVIDADE	Hora de início	Hora de fim	Local	Com quem?
Sentado sem fazer nada				
Sentado a ver televisão				
Sentado noutras atividades				
Deitado ou reclinado durante o dia				
Em pé				
A andar				
Número de vezes em que se levanta				
Atividade: Posição:				
Atividade: Posição				
Atividade: Posição				
Atividade: Posição				
Atividade: Posição				
Atividade: Posição				