

Original Research Article

# Dementia Patients Are More Sedentary and Less Physically Active than Age- and Sex-Matched Cognitively Healthy Older Adults

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## Keywords

Sedentary behaviour · Dementia · Physical activity · Actigraphy

## Abstract

**Aims:** The aim of this study was to examine physical activity and sedentary behaviour characteristics of ambulatory and community-dwelling patients with dementia compared to cognitively healthy age-, sex- and weight-matched controls. **Methods:** In this cross-sectional study, we included community-dwelling dementia patients ( $n = 45$ , age  $79.6 \pm 5.9$  years, Mini-Mental State Examination [MMSE]  $22.8 \pm 3.2$ ) and matched controls ( $n = 49$ , age  $80.0 \pm 7.7$  years, MMSE  $29.0 \pm 1.2$ ). Participants wore a wrist accelerometer for 7 days to assess sedentary time, sedentary bout duration and time spent in very light, light-to-moderate and moderate-to-vigorous physical activities. **Results:** Relative sedentary time and sedentary bout duration was significantly higher in dementia patients than in controls (median [interquartile range] 57% [49–68] vs. 55% [47–59] and 18.3 [16.4–21.1] min vs. 16.6 [15.3–18.4] min,  $p = 0.042$  and  $p = 0.008$ , respectively). In addition, dementia patients spent a lower percentage of their waking time in light-to-moderate and moderate-to-vigorous intensity physical activities (20% [15–23] vs. 22% [18–25] and 5% [2–10] vs. 10% [5–13],  $p = 0.017$  and  $p = 0.001$ , respectively). **Conclusion:** We revealed that dementia patients are more sedentary and perform less phys-

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ical activity than cognitively healthy controls. This may have clinically important consequences, given the observation that sedentary behaviour and little physical activity independently predict all-cause mortality and morbidity.

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## Introduction

The incidence and prevalence of dementia is rising [1]. Pharmacological treatment to slow disease progression shows limited benefits on cognitive functioning [2]. Therefore, non-pharmaceutical therapies are needed to attenuate or slow cognitive decline. Engagement in moderate-to-vigorous physical activity (i.e., exercise) is one of the most important modifiable risk factors for dementia [3].

Moreover, exercise interventions have beneficial effects on cognitive function in older adults with dementia [4]. Interestingly, recent research showed that sedentary behaviour (activities requiring low levels of energy expenditure, e.g., sitting and lying), independent of performance of physical activity, is strongly related to negative health outcomes and mortality [5, 6]. Moreover, sedentary behaviour is associated with lower cognitive performance [7], which stresses the relevance of understanding the prevalence and characteristics of sedentary behaviour in the context of dementia. Therefore, we aim to objectively determine physical activity and sedentary behaviour characteristics of community-dwelling dementia patients compared to cognitively healthy age-, sex- and weight-matched controls. Secondary, we will explore whether increasing age attenuates physical activity and sedentary behaviour in dementia.

## Materials and Methods

### *Participants and Design*

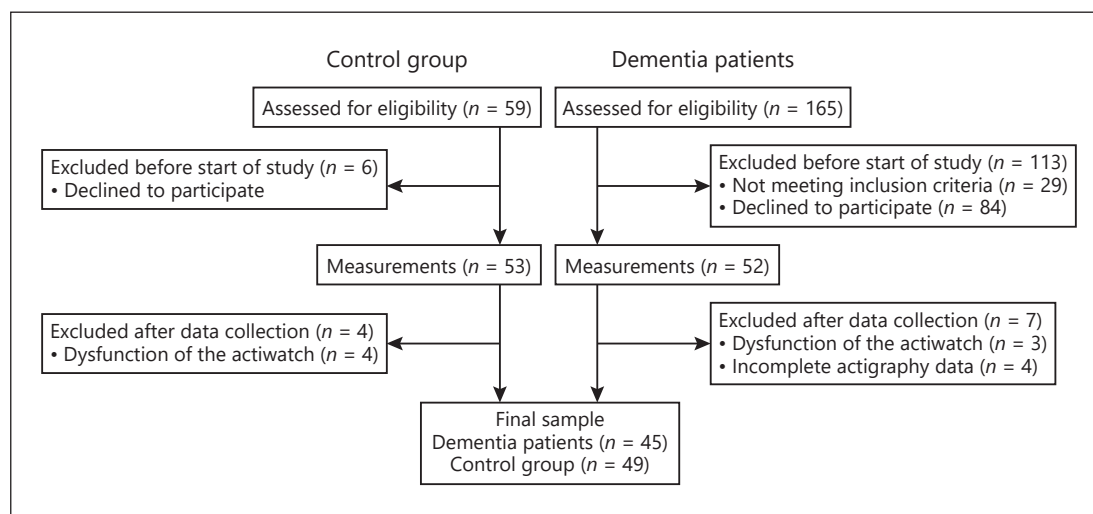
In this cross-sectional study, persons with a dementia diagnosis aged >60 years who were ambulatory and community dwelling were included. Dementia diagnosis was based on comprehensive clinical assessment by a physician, typically including neuropsychological assessment and imaging. We used the Mini-Mental State Examination (MMSE) to indicate severity of cognitive impairment [8]. Baseline measurements of a longitudinal trial examining the effects of exercise on cognitive functioning in dementia were used for the current study [9]. Cognitively healthy controls were age, sex and weight matched to dementia patients and had no history of cognitive impairment (MMSE >24 [8]). All participants were ambulatory and community dwelling. The study protocol was approved by the local Medical Ethics Committee in accordance with the latest revision of the Declaration of Helsinki. Written informed consent was obtained from all participants.

### *Physical Activity Monitoring*

Directly after screening, physical activity and sedentary behaviour were assessed by the Philips Actiwatch 2, a wrist-worn accelerometer validated in middle-aged females [10]. The Philips Actiwatch 2 contains an acceleration-responsive piezoelectric sensor which measures wrist accelerations in 3 directions every 30 s. These wrist accelerations were translated into a number of counts that were used to estimate physical activity and sedentary behaviour. The accelerometer was worn for 7 days on the non-dominant wrist to provide a reliable estimate of physical activity and sedentary behaviour [11, 12]. All participants wore the Actiwatch 24 h per day. The accelerometer was waterproof, and participants did not take it off during swimming or taking a shower. Therefore, non-wear time was not expected. Sleep intervals, including daytime naps, were filled in by the participants or their caregivers in a sleep diary.

### *Data Analysis*

Data was uploaded using the Philips Actiware 6 software. Data from the first day of testing were excluded from analysis to give participants the opportunity to familiarize with the device. Sleep intervals



**Fig. 1.** Flowchart of participants.

were manually set by the researcher using the Philips Actiware 6 software [13] and excluded by custom software written in MATLAB R2014b (MathWorks, USA). Hereby, only the data of the waking hours remained. Participants were included if they provided at least 6 valid days (>10 h of waking data). Data was converted from counts per epoch into counts per minute (CPM). Cut-off points of 145, 145–274, 274–597 and >597 CPM were used for sedentary behaviour and very light, light-to-moderate and moderate-to-vigorous physical activity, respectively [10]. To account for individual differences in waking time, our primary analysis expressed activity levels as a percentage of total (awake) measuring time. Interruptions in sedentary behaviour were defined as spending 1 min with  $\geq 145$  CPM after 5 min with  $< 145$  CPM. Prolonged sedentary behaviour was defined as spending 30 min with  $< 145$  CPM without 1 min of  $> 145$  CPM. Duration of average sedentary bout was defined by total time spent sedentary divided by the number of interruptions in sedentary behaviour.

#### Statistical Analysis

Statistical analyses were performed in IBM SPSS Statistics 20.0 (IBM SPSS; IBM Corp., Armonk, New York, NY, USA). We performed a complete case analysis, including only those participants that wore the Actiwatch for a minimum of 7 days.  $\chi^2$  tests for categorical variables and independent samples *t* tests for continuous variables were used to compare dementia patients and controls. Non-parametric tests were used for not normally distributed data (including physical activity and sedentary behaviour). To evaluate the impact of age, the same analyses were performed between participants aged  $< 80$  and  $\geq 80$  years. All data are presented as median (interquartile range) unless stated otherwise. Level of significance was set at  $p < 0.05$ .

## Results

Forty-five dementia patients (mean  $\pm$  SD age  $79.6 \pm 5.9$  years, MMSE  $22.8 \pm 3.2$ ) and 49 controls (mean  $\pm$  SD age  $80.0 \pm 7.7$  years, MMSE  $29.0 \pm 1.2$ ) were included (Fig. 1). Sex, body mass index, walking aid use and number of comorbidities did not differ between groups (Table 1). MMSE was significantly lower in dementia patients ( $p < 0.001$ ), and dementia patients received significantly more home care ( $p < 0.001$ ). The majority of dementia patients and controls lived independently (93 and 98%, respectively).

Total waking time tended to be lower in dementia patients than in controls (mean  $\pm$  SD  $14.9 \pm 1.3$  vs.  $15.4 \pm 1.0$  h/day,  $p = 0.053$ ; Table 2). Dementia patients had significantly lower activity counts and spent more hours in categories reflecting lower-intensity activity (Table

**Table 1.** Baseline characteristics

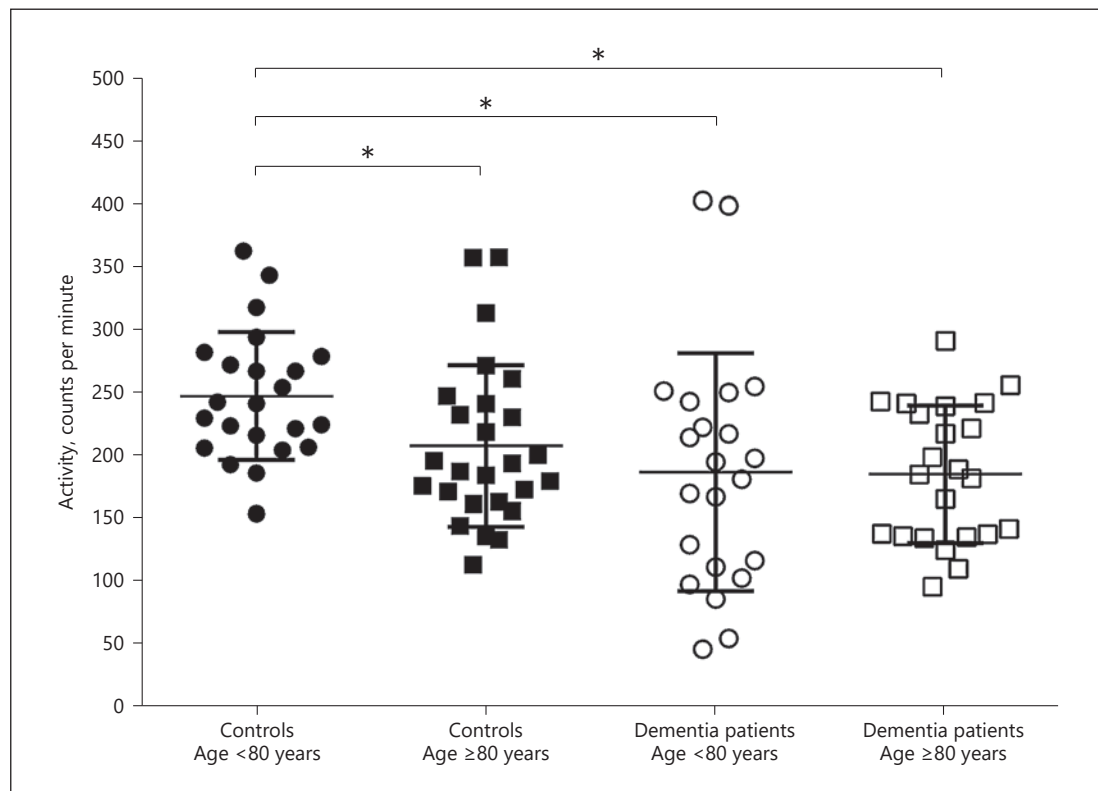
	Control (n = 49)	Dementia (n = 45)	p value
Age, years	80.0±7.7	79.6±5.9	0.744*
Females	25 (51.0)	22 (48.9)	0.836 <sup>†</sup>
Body mass index	25.5 (4.0)	26.3 (5.0)	0.411*
Mini-Mental State Examination <sup>a</sup>	29.0 ± 1.2	22.8±3.2	<0.001*
Walking aid users	10 (20.4)	16 (35.6)	0.101 <sup>†</sup>
Home care receivers	6 (12.2)	24 (53.3)	<0.001 <sup>†</sup>
Comorbidities <sup>b</sup>	2.7±1.8	3.3±1.9	0.150*
Residence			0.629 <sup>†</sup>
Independent, alone	18 (36.7)	14 (31.1)	
Independent, together	30 (61.2)	28 (62.2)	
Care home	1 (2.0)	3 (6.7)	
Nursing home	0	0	
Dementia type			
Alzheimer disease	n/a	25 (55.6)	
Vascular dementia	n/a	2 (4.4)	
Alzheimer disease/vascular dementia	n/a	12 (26.7)	
Dementia type not specified	n/a	6 (13.3)	

Values are presented as means ± standard deviations or n (%). Italics indicate statistical significance. n/a, not applicable. <sup>a</sup> Scores on the Mini-Mental State Examination range from 0 (severe impairment) to 30 (no impairment). <sup>b</sup> Comorbidities are scored using the Older Persons and Informal Caregivers Survey-Minimum Dataset (TOPICS-MDS) with a theoretical range of 0–17, and a higher score indicates more comorbidities [34]. \* Differences between groups were tested with the independent samples *t* test. <sup>†</sup> Differences between groups were tested with the  $\chi^2$  test.

**Table 2.** Physical activity and sedentary behavior characteristics

	Control (n = 49)	Dementia (n = 45)	p value
Total waking time, h/day	15.4±1.0	14.9±1.3	0.053 <sup>†</sup>
Counts per minute, day <sup>-1</sup>	226±61	186±76	0.005 <sup>†</sup>
Absolute values, h/day			
Sedentary time	8.1 (7.2–9.2)	8.5 (7.2–10.0)	0.216
Very light intensity activity	2.2 (1.9–2.6)	2.3 (1.7–2.9)	0.748
Light-to-moderate intensity activity	3.5 (2.7–4.0)	2.7 (2.0–3.7)	0.006
Moderate-to-vigorous intensity activity	1.5 (0.8–2.0)	0.8 (0.4–1.5)	0.001
Relative values, % of total measuring time			
Sedentary time	55 (47–59)	57 (49–68)	0.042
Very light intensity activity	15 (12–16)	16 (12–19)	0.284
Light-to-moderate intensity activity	22 (18–25)	20 (15–23)	0.017
Moderate-to-vigorous intensity activity	10 (5–13)	5 (2–10)	0.001
Sedentary behavior characteristics			
Number of interruptions in sedentary behavior, day <sup>-1</sup>	28.2 (26.2–32.5)	27.2 (24.5–31.0)	0.195
Number of 30-min prolonged sedentary bouts, day <sup>-1</sup>	2.0 (0.9–3.3)	2.3 (1.0–4.1)	0.227
Duration of average sedentary bout, min	16.6 (15.3–18.4)	18.3 (16.4–21.1)	0.008

Values are presented as means ± standard deviations or medians (interquartile ranges). *p* values represent Mann-Whitney *U* test. Italics indicate statistical significance. <sup>†</sup> Differences between groups were tested with the independent samples *t* test.



**Fig. 2.** Activity levels of dementia patients and cognitively healthy controls. Activity levels of younger and older age groups. Mean activity score (counts per minute) grouped by age. Controls age <80 years ( $n = 23$ ), controls age  $\geq 80$  years ( $n = 26$ ), dementia patients age <80 years ( $n = 22$ ), dementia patients age  $\geq 80$  years ( $n = 23$ ). Values represent medians and interquartile ranges. \* Significant difference between: controls age <80 years and controls age  $\geq 80$  years,  $p = 0.044$ ; controls age <80 years and dementia patients age <80 years,  $p = 0.004$ ; and controls age <80 years and dementia patients age  $\geq 80$  years,  $p = 0.002$ .

2). Relative sedentary time was significantly higher in dementia patients than in controls (57% [49–68] vs. 55% [47–59],  $p = 0.042$ ; Table 2). In addition, dementia patients spent a lower percentage of their waking time in light-to-moderate and moderate-to-vigorous intensity physical activity (20% [15–23] vs. 22% [18–25] and 5% [2–10] vs. 10% [5–13],  $p = 0.017$  and  $p = 0.001$ , respectively). Number of interruptions in sedentary behaviour and prolonged sedentary bouts did not differ. The duration of sedentary bouts was significantly longer in dementia patients than in controls (18.3 [16.4–21.1] min vs. 16.6 [15.3–18.4] min,  $p = 0.008$ ; Table 2).

When comparing younger with older subgroups, older participants showed more walking aid use. Whilst older controls showed significantly less physical activity and more sedentary behaviour than their younger peers, no such differences were present between dementia patients aged  $\geq 80$  years and those aged <80 years (Fig. 2). More specifically, younger controls had significantly higher activity counts, lower relative sedentary time, and spent more hours in categories reflecting light-to-moderate and moderate-to-vigorous intensity activity compared to older controls. Since no such differences were present between young and older dementia patients, differences in physical activity and sedentary behaviour characteristics between populations were most prominent in the younger groups (Fig. 2).

## Discussion

The aim of our study was to objectively investigate physical activity and sedentary behaviour characteristics of dementia patients compared to controls and assess whether age affects this comparison. First, in our relatively large sample, we found that dementia patients spent significantly more of their waking hours in a sedentary state and significantly less time in light-to-moderate and moderate-to-vigorous intensity activities. This may have clinically important consequences, given the observation of previous prospective studies that sedentary behaviour independently predicts all-cause mortality and morbidity [5, 14]. Secondly, we found that older age was associated with a decline in physical activity and increase in sedentary behaviour in controls, whilst no such age-related changes were found in dementia patients. Consequently, negligible differences in physical activity and sedentary behaviour characteristics were present when comparing older dementia patients and controls.

In line with observations from previous work [15, 16], our data confirm that community-dwelling dementia patients spend a large amount of time in sedentary behaviour and have low levels of physical activity. We add the novel finding that differences between dementia patients and controls remain when corrected for sleep time. Even though we used an accelerometer validated to measure physical activity and sedentary behaviour [10], time spent in moderate-to-vigorous intensity activity seems unusually high in both groups [17]. We have compared our findings to other studies that assessed physical activity and sedentary behaviour in older adults with and without dementia, and we note that sedentary behaviour ranged from 6.7 to 10.7 h between studies [15, 18, 19]. Moreover, the percentage of elderly meeting physical activity guidelines (150 min/week of moderate-to-vigorous physical activity) ranged from 27 to 69% [17, 20]. Differences in sedentary behaviour and physical activity duration between studies might relate to the use of different types of accelerometers, given that the reported studies used hip-worn accelerometers, wrist-worn accelerometers or questionnaires to estimate physical activity and sedentary behaviour [21]. However, this does not invalidate our primary comparison between subjects with dementia and healthy peers. Moreover, this highlights the importance of including a control group to provide valid interpretation of the results.

Our observation raises the question if differences in physical activity and sedentary behaviour are simply a consequence of dementia. A decline in executive functioning (i.e., necessary for goal-directed behaviour, such as physical activity) could lead to apathy [22], which is known to lower activity levels in Alzheimer disease patients [23]. However, it is important to realize that lower physical activity and higher sedentary behaviour have already been reported in the preclinical stages of dementia [24] and in subjects with mild cognitive impairment [25]. This might suggest that differences in physical activity and sedentary behaviour are causally linked to progression from mild cognitive impairment to later stages of dementia. Future research is necessary to answer this question on cause or effect. Nevertheless, since higher physical activity and lower sedentary behaviour are associated with better cognitive performance [7, 25], benefits of interventions promoting physical activity and reducing sedentary behaviour should be investigated.

In response to our second research question, we found that older age was associated with a decline in physical activity and increase in sedentary behaviour in controls. This observation can partly be explained by deterioration of walking and mobility and increased disability with older age [26]. Interestingly, no further decline in physical activity and increase in sedentary behaviour was found in dementia patients, despite the age-related increased number of walking aid users. This striking result suggests that cognitive impairment in dementia has a great impact on physical activity and sedentary behaviour and may be more important than the impact of other factors, such as deterioration of walking and mobility. An

alternative explanation is that a (near) minimum level is achieved in the decline in levels of physical activity and sedentary behaviour in community-dwelling subjects [17].

In addition to the duration of sedentary behaviour, previous work revealed that the frequency of breaking up sitting (and, therefore, duration of each sedentary bout) may have clinical relevance. Breaks in sedentary behaviour can prevent cardiovascular impairments [5] and play a role in maintaining glycaemic control, which may positively influence brain health [27]. Our study found that the average duration of a sedentary bout was higher in dementia patients compared to controls. This observation suggests that not only reducing sedentary time, but also preventing prolonged sedentary bouts by regularly breaking up sedentary behaviour, can be targeted as a lifestyle intervention [28].

### *Limitations*

Since we only included community-dwelling patients, our results cannot be generalized to institutionalized dementia patients. Furthermore, dementia patients in our study were enrolled in an exercise trial [9]. Therefore, this group may be more motivated to be physically active. Nonetheless, significant differences in physical activity characteristics were observed. Furthermore, physical activity characteristics were measured by wrist-worn accelerometry, which is associated with limited discriminative capacity between sedentary and very-light intensity activities [29]. Consequently, differences between dementia patients and controls might even be more pronounced. Another limitation relates to our accelerometer, which has only been validated in a group of middle-aged females [10] and was unable to correct for potential presence of short (~1-min) periods of non-wear time. Nonetheless, we do not expect this will invalidate our findings of between-group differences in physical activity and sedentary behaviour. In addition, using wrist-worn accelerometry may explain the 2 outliers in the younger dementia patients (Fig. 2), which could relate to restless arm movements. Whilst this may affect exploring individual differences in physical activity versus sedentary behaviour characteristics, significant differences remained present at group level. Furthermore, we did not discriminate between types of sedentary activities. Cognitively challenging sedentary activities, such as reading, might have a protective effect on cognition and are, therefore, less harmful than passive sedentary activities (e.g., television viewing) [30]. The final limitation is use of the MMSE as a cognitive screening instrument since this measure, especially in healthy highly educated older adults, has limited discriminative power to detect mild cognitive deficits [31, 32]. It is important to indicate that diagnosis of dementia was not made using the MMSE but included standard clinical procedures (including imaging if required).

### *Clinical Relevance*

Knowledge about physical activity characteristics across the entire activity spectrum in dementia is highly relevant given that physical activity is an important factor accelerating development and progression of dementia [3, 7]. In addition, a high amount of sedentary behaviour and low amount of physical activity are associated with higher mortality and morbidity [5, 6]. Even though we found relatively small differences in physical activity characteristics between dementia patients and controls, these may be highly relevant. For example, even very short breaks of light intensity activity (i.e., 2 min of walking) can already prevent acute metabolic [33] and cardiovascular [5] impairments. This underlines the importance to develop interventions suitable for this vulnerable patient group to safely engage in light intensity activities. However, future research should first explore the role of physical activity and sedentary behaviour in the progression and prevention of dementia.

## Conclusion

In the current study, we objectively demonstrated that dementia patients spend significantly more of their waking hours in sedentary behaviour and spend less time in light-to-moderate and moderate-to-vigorous intensity physical activity. Moreover, we found that older age attenuated sedentary behaviour and physical activity in controls, whilst this age-related decline was absent in dementia patients. This means that patients with dementia (independent of age) lead a physically inactive lifestyle characterized by significant time spent sedentary.

Taken together, these data improve our understanding of physical activity and sedentary behaviour characteristics in this highly relevant patient group and imply that targeting sedentary behaviour and physical activity may be relevant in dementia patients, especially at a younger age.

## Disclosure Statement

There are no conflicts of interest.

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