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RESEARCH ARTICLE

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Prominent physical inactivity in acute dementia care: Psychopathology seems to be more important than the dose of sedative medication

Tim Fleiner[1,2] | Marleen Gersie[2] | Sayantan Ghosh[1,3] | Sabato Mellone[4] | Wiebren Zijlstra[1] | Peter Haussermann[2]

[1] Institute of Movement and Sport Gerontology, German Sport University Cologne, Cologne, Germany

[2] Department of Geriatric Psychiatry and Psychotherapy, LVR-Hospital Cologne, Cologne, Germany

[3] Faculty of Mathematics and Technology, University of Applied Sciences Koblenz RheinAhrCampus, Koblenz, Germany

[4] Department of Electrical, Electronic, and Information Engineering "Guglielmo Marconi", University of Bologna, Bologna, Italy

Correspondence
Dr Tim Fleiner, Institute of Movement and Sport Gerontology, German Sport University Cologne, Am Sportpark Müngersdorf 6, 50933 Cologne, Germany.
Email: t.fleiner@dshs-koeln.de

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Introduction: To objectively quantify patients' physical activity and analyze the relationships between physical activity levels, psychopathology, and sedative medication in acute hospital dementia care.

Materials and Methods: In this cross-sectional study, we assessed the patients' physical activity based on data collection by hybrid motion sensors attached on their lower back. Daily doses of antipsychotics have been converted to olanzapine-equivalents and daily benzodiazepine medication is reported as diazepam-equivalents. We assessed patients' neuropsychiatric symptoms with the Neuropsychiatric Inventory and the Cohen-Mansfield Agitation Inventory.

Results: We analyzed motion sensor data from 64 patients (MMSE M = 18.6). On average, patients were lying for 11.5 hours, sitting/standing sedentary for 10.3 hours, sitting/standing active for 1.0 hours, and walking for 1.2 hours per day. The analysis revealed no correlations between patients' physical activity and antipsychotic or benzodiazepine medication. More severe neuropsychiatric symptoms were associated with a decrease in the patients' physical activity (r = .32, P = .01). In particular, patients with apathy symptoms were less physically active than patients without apathy symptoms.

Discussion: The results reveal that most of the patients in acute dementia care had very low levels of physical activity. Their physical inactivity may be due to the severity of their neuropsychiatric symptoms, especially apathy. Antipsychotic and benzodiazepine medication appeared to have less impact on patients' physical activity. Dementia care should pay more attention to prevent physical inactivity in patients.

KEYWORDS

antipsychotics, benzodiazepines, body-worn motion sensors, dementia, hospital dementia care, physical activity

1 | INTRODUCTION

Dementia is one of the biggest global health care challenges of our time. In 2016, there were more than 47 million people suffering from dementia, and this number will increase to more than 131 million by 2050.[1] Alongside the cognitive impairment, neuropsychiatric signs and symptoms (NPS) in dementia are a big challenge for clinical psychiatry and lead to a high caregiver burden.[2] During the course of the disease, almost every patient suffers from NPS.[3] The term NPS covers psychological symptoms such as delusions, hallucinations, depression, sleeplessness and anxiety, and behavioral symptoms such as physical aggression, wandering, and restlessness.[4] Periods of exacerbated NPS often lead to hospital admission and early institutionalization.[5]

Pharmacological and non-pharmacological treatment of NPS is one of the key challenges in dementia care. Non-pharmacological treatments are generally the first-line treatments for NPS, eg, staff training in NPS management strategies, recreational activities, music therapy, or other forms of sensory stimulation.[6] Recent reviews indicate that physical exercise interventions have a positive impact on NPS.[7,8] The pharmacological treatments for NPS are antipsychotics, anticonvulsants, antidepressants, anxiolytics, benzodiazepines, cholinesterase inhibitors, and NMDA modulators.[9]

There is growing evidence of a link between dementia patients' physical activity level and NPS.[10] Christofoletti et al[11] found that more sedentary patients exhibited more NPS, which raises the issue of the impact of antipsychotic and benzodiazepine medication on the physical activity levels of patients in acute dementia care.

We aimed to take advantage of the increasing use of technology in geriatric psychiatry[12] to quantify acute dementia patients' physical activity objectively and analyze the relationship between patients' physical activity levels, psychopathology, and sedative medication.

Key points

- Patients in acute dementia care show an unexpected low level of physical activity
- Psychopathological symptoms—especially apathy—are related to the low level of physical inactivity, not the dose of sedative medication
- Dementia care should pay more attention to prevent physical inactivity in patients

2 | MATERIALS AND INSTRUMENTS

2.1 | Study design

We conducted a cross-sectional investigation in the Department of Geriatric Psychiatry of the LVR-Hospital in Cologne as part of a randomized clinical trial.[13] This analysis includes the baseline measurements of all patients before randomization. The Ethics Commission of the German Sport University Cologne and the Ethics Commission of the North-Rhine Medical Chamber approved the study (reference number: 2014216). German National Register of Clinical Trials: DRKS00006740, date of registration: 28.10.2014).

2.2 | Sample

The sample comprised patients from two closed dementia wards. The inclusion criteria were (1) diagnosis of dementia according to ICD-10-criteria,[14] (2) ability to perform the timed up and Go test (TuG)[15] without assistance, and (3) written informed consent from the patient, if the patient had a score of ≥20 in the Mini Mental Status Examination (MMSE)[16] and was able to rephrase the aims and content of the study in his own words; in patients with a MMSE <20, written consent from the patient and written informed consent from his or her legal guardian was required. The exclusion criteria were diagnosis of symptomatic, non-vascular or non-neurodegenerative dementia, diagnosis of delirium, and no legal guardian. In total 87 patients were recruited for the umbrella RCT. The baseline assessment results of this sample have been included in this analysis.

2.3 | Data acquisition

The assessment of the patients' physical activity was based on a 72-hour period of data acquisition by a hybrid motion sensor (uSense) fixed on the patients' lower back. Based on these recordings, we analyzed patients' physical activity over a 24-hour period from 00:00 and 24:00, using 1-second time bins. The uSense wearable sensor and its software for signal processing and activity recognition are an outcome of the FARSEEING EU project. The software allows quantitative data analysis, and it has already been used in patients with dementia,[17] in older people residing in independent-living retirement homes,[18] and in community-dwelling older adults.[19] The activity recognition software is able to identify four activity states: lying; sedentary, either sitting or standing; active, either sitting or standing; and walking. In addition, daily step counts were analyzed. For this trial, we analyzed dementia patients' doses of antipsychotics and benzodiazepines for the 24-hour period in which the activity assessment was carried out. Dose of antipsychotics was converted into the olanzapine-equivalent dose per day.[20] Dose of benzodiazepine medication was converted into the diazepam-equivalent dose per day.[21]

We used MMSE,[16] Demtect,[22] and Clock Drawing test[23] to assess cognitive impairment. Information about cognitive reserve was also captured.[24] The Bayer Activities of Daily Living scale was used to estimate patients' ability to perform everyday activities.[25] The TuG[15] and the 10-m gait speed test were used to measure patients' mobility.[25] Neuropsychiatric symptoms were assessed using the Neuropsychiatric Inventory (NPI)[27] and the Cohen-Mansfield Agitation Inventory (CMAI)[28] was used to rate the patients' agitation symptoms. All outcome measurements were conducted by experienced assessors from nursing and medical staff.

2.4 | Statistical analysis

All statistical analyses were performed using SPSS Version 24.0.[29] Outliers in the dependent variables (OPZ, DPZ, physical activity, CMAI, NPI) were excluded by the 1.5-fold inter-quartile from the upper or lower box plot quartile. We analyzed differences between the two medication groups (use of antipsychotics and/or benzodiazepines vs no medication) with Chi-squared tests in the case of categorical variables (sex, dementia diagnosis), Mann-Whitney U-test in the case of ordinal variables (NPI, CMAI, Bayer Activities of Daily Living), unpaired t-tests in the case of normally distributed continuous variables (body mass index, MMSE, Demtect, clock-drawing test, TUG, 10-m gait speed, physical activity levels), and Mann-Whitney U-tests in the case of nonparametric continuous variables. We used Pearson's correlations to assess of the relationship between use of antipsychotics and benzodiazepines and patient's physical activity.

Correlation ranges of .70 to .90 were regarded as high, ranges of .50 to .70 as moderate, and ranges of .30 to .50 as low.[30] A significance level of $\alpha = .05$ was used for all tests.

3 | RESULTS

Eighty-seven patients were recruited for this trial. Initially, 86 patients accepted the uSense sensor attachment. One patient refused the sensor attachment at the beginning. Five patients removed the device during the 72-hour recording period. In the raw data analysis, we discovered that four data sets were incomplete or missing. One patient who moved with the help of a four-wheeled walker was excluded from the analysis of gait time and total steps per day because we were unable to detect her steps accurately. Correction for outliers eliminated $n = 7$ patients due to their physical activity and $n = 6$ patients due to the applied sedative medication. No patient was excluded due to the NPS. Out of the $N = 87$ recruited patients, $n = 64$ patients with a synchronized 24-hour sensor-recording were included in the analysis. The group's characteristics are presented in Table 1.

Most of the patients (53%) suffered from mixed type of dementia. All patients completed the MMSE, and the mean MMSE score was 18.6 points. Not all patients performed the Demtect ($N = 58$) and Clock drawing test ($N = 57$) because some of them had problems understanding the instructions. Forty-eight of the 64 patients received antipsychotic medication, and 10 patients received benzodiazepine medication. We did not find any differences regarding patient characteristics, neuropsychiatric symptoms, and OPZ/DPZ between the $n = 64$ included and the $n = 10$ patients, who refused or had incomplete data sets and the $n = 13$ outliers. The neuropsychiatric symptoms of the sample are shown in Table 2.

The most common symptoms in the final sample ($N = 64$) were agitation and aggression (59%), depression and dysphoria (52%), and irritability and lability (56%). Means for physical activity parameters, based on the sensor data, are shown in Table 3.

Patients' daily number of steps ranged from 796 to 13 885, and the mean number of steps per day was 6193 ($SD = 3204$). The mean duration of physical inactivity (sum of daily hours of lying and

TABLE 1 Patient characteristics ($N = 64$; female $n = 30$ [47%])

	M	*SD*	Min.	Max.	*N* (%)
Age	81	6.2	67	95	64
Body mass index [kg/m^2]	25.6	4.1	18	34	64
Diagnosis					
Alzheimer's disease dementia					17 (27)
Vascular dementia					10 (16)
Dementia, mixed type					34 (53)
Parkinson's disease dementia					2 (3)
Lewy-body dementia					1 (1)
Mini-mental status examination	18.6	5.5	7	27	64
Demtect	4.2	1.6	1	6	58
Clock-drawing test	5.0	3.4	0	14	57
Neuropsychiatric inventory (NPI)	19.2	12.2	0	51	64
Cohen-Mansfield agitation inventory (CMAI)	49.1	12.0	29	83	64
Cognitive reserve capacity, years of education	11.9	2.6	7	18	63
Bayer-activities of daily living	7.7	1.6	2.3	9.7	64
Timed up and go test [s]	14.4	5.2	7.3	32.9	64
10 meter gait speed [m/s]	0.8	0.2	0.3	1.6	64
Benzodiazepine dose (DED) [mg/day]	4.0	1.9	0.3	7.5	10 (16)
Antipsychotic dose [mg/day]	2.2	1.4	0.3	5.7	48 (75)
Antipsychotics only					39 (61)
Only benzodiazepines					1 (2)
Benzodiazepines and antipsychotics					9 (14)
No benzodiazepines or antipsychotics					15 (23)

M = mean; *SD* = standard deviation; *Min.* = minimum; *Max.* = maximum; Range and scaling of psychopathometric instruments: NPI: 0-144 points (0 meaning no symptoms); CMAI: 29-203 points (29 meaning no symptoms); DED = Diazepam equivalent dose; OED = Olanzapine equivalent dose.

TABLE 2 Psychopathological symptoms in terms of the neuropsychiatric inventory (NPI) domains (N = 64)

NPI Domains	*n* (%)	*M*	*SD*	Min.	Max.
Delusions	22 (34)	6.5	3.0	2	12
Hallucinations	10 (16)	7.1	4.0	2	12
Agitation/aggression	38 (59)	5.7	2.8	2	12
Depression/dysphoria	33 (52)	4.8	3.0	1	12
Anxiety	18 (28)	5.8	2.8	2	12
Elation/euphoria	3 (5)	4.7	3.1	2	8
Apathy/indifference	29 (45)	4.7	2.1	1	8
Disinhibition	10 (16)	4.9	3.0	3	12
Irritability/lability	36 (56)	5.1	2.4	2	12
Aberrant motor behavior	30 (47)	5.1	1.9	3	8
Sleep and night-time behavior disorders	12 (19)	6.1	1.9	3	9
Appetite/eating changes	3 (5)	10.7	2.3	8	12

Patients symptoms; frequency*severity scores (0-12; 0 indicates absent); *M* = mean; *SD* = standard deviation; Min. = minimum; Max. = minimum.

TABLE 3 Sensor-based means for physical activity parameters (N = 64; N = 63 for "gait" and "steps" [see text for further explanation])

	N	*M*	*SD*	Min.	Max.
Posture/activity					
Lying, h/day (%)	64	11.5 (48)	2.1 (9)	6.5 (27)	16.0 (67)
Sedentary sitting/standing, h/day (%)	64	10.3 (43)	2.1 (9)	6.0 (25)	15.3 (64)
Active sitting/standing, h/day (%)	64	1.0 (4)	0.4 (2)	0.3 (1)	2.1 (9)
Gait, h/day (%)	63	1.2 (5)	0.6 (3)	0.2 (1)	2.6 (11)
Total steps per day	63	6193	3204	796	13 885

M = mean; *SD* = standard deviation; Min. = minimum; Max. = maximum.

sedentary sitting/standing) was 21 hours 50 minutes, representing 91% of the day (Figure 1). Duration of physical inactivity ranged from 19 hours 20 minutes to 23 hours 12 minutes per day.

Correlations between patients' physical activity and their doses of antipsychotic and benzodiazepine medication are shown in Table 4.

The analysis revealed no correlations between physical activity and dose of antipsychotics or benzodiazepines. Physical inactivity was not correlated with diazepam-equivalent dose (r = .09, P = .46) or olanzapine-equivalent dose (r = .20, P = .11). Compared with the group of patients who only received antipsychotics (n = 39), the group receiving both antipsychotic and benzodiazepine medication (n = 9) spent more time lying down (z = −2.31, P = 0.02). Physical activity was similar in the group of patients not taking either kind of medication (n = 15) and the nine patients receiving both, antipsychotics and benzodiazepines, eg, for lying h/day (z = −1.73, P = 0.08) or steps per day (z = −0.09, P = 0.95).

Total NPI score shows a moderate positively correlation to the patients' physical inactivity (r = .32, P = .01). Psychopathological symptoms expressed as NPI score were negatively associated physical activity. More severe psychopathological symptoms as rated with the NPI are associated with less physical activity. There were n = 29 patients (45%) suffering from apathy symptoms, and the mean duration of physical inactivity in this subgroup was 22 hours 5 minutes/day (*SD* = 4). On average n = 35 patients (56%) without apathy symptoms were active for 27 minutes more per day than patients with apathy symptoms (z = −2.12, P = 0.34). Total CMAI score was not correlated with physical inactivity (r = −0.21, P = .11).

4 | DISCUSSION

The aim of this study was to assess overall physical activity level in a large cohort of patients in acute dementia care. We also investigated the relationships between physical activity and psychopathological symptoms and use of antipsychotic and benzodiazepine medication in patients receiving acute dementia care.

The results revealed that most patients in acute dementia care had very low levels of physical activity. The NPI showed a positive correlation to the patients' physical inactivity, with more severe psychopathological symptoms related to a lower amount of physical activity. Overall, patients' level of physical inactivity does not seem to be associated with their dosage of antipsychotic or benzodiazepine medication, but the small group of patients receiving both antipsychotics and benzodiazepines (n = 9, 14%) were sedentary for a greater proportion of the day than other patients. This might be due to receipt of benzodiazepine medication in addition to antipsychotics. Alternatively, more severe psychopathology may be responsible for the low level of physical activity. Our results reveal that psychopathological symptoms, as measured by the NPI, play an important role in explaining physical inactivity in most of our patients. In particular, we found a

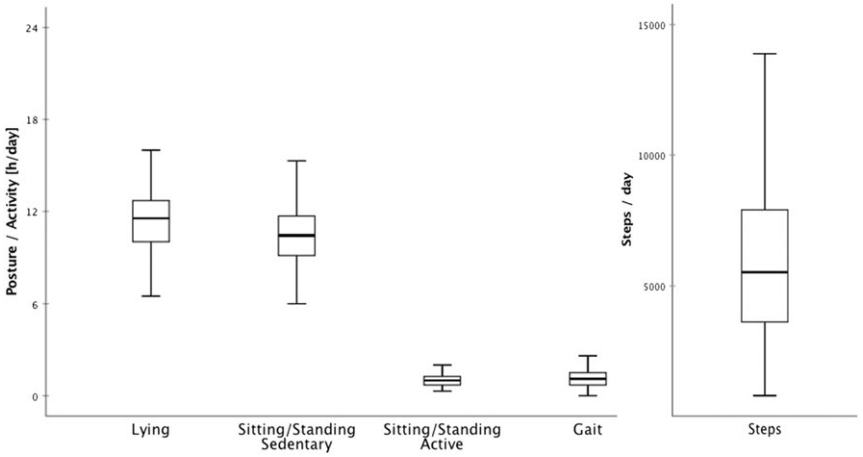

FIGURE 1 Sensor-derived physical activity data [mean total hours/posture/day] (N = 64; N = 63 for "gait" and "steps" [see text for further explanation])

TABLE 4 Correlations between patients' physical activity and benzodiazepine medication (diazepam-equivalent dose; DED) and antipsychotic medication (olanzapine-equivalent dose; OED)

		Lying, h/day		Sed, h/day		Act, h/day			Gait, h/day		Steps/day	
	n	*r*	*P*	*r*	*P*	*r*	*P*	*n*	*r*	*P*	*r*	*P*
DED	10	0.25	0.50	−0.20	0.57	0.21	0.57	9	−0.32	0.40	−0.19	0.63
OED	48	−0.01	0.93	0.11	0.46	−0.19	0.19	47	−0.13	0.75	−0.16	0.70

Sed = sedentary sitting/standing; Act = active sitting/standing; steps = total steps per day; r = Pearson correlation coefficient; Note: Gait and steps/day: one patient had to be excluded—see text for further explanation.

low correlation of the NPI score with the patients' physical inactivity and that apathy symptoms, present in 29 patients (45%) patients, were linked to lower physical activity; mean duration of physical activity in patients showing apathy was 27 minutes per day less than in the 35 patients (55%) who did not show apathy.

Our patients were physically inactive for more than 90% of the day, eg, some patients were inactive for more than 23 hours per day. Similar low levels of physical activity and correlations to NPS in dementia care have been reported by Christofoletti et al,[11] and studies in which wrist-worn actigraphic devices were used to assess patients' physical activity.[31-33] Unlike wrist actigraphy, using hybrid motion sensors attached to the lower back, as we did in this trial, allows to analyze mobility-related physical activity rather than just upper limb movement.

Using motion sensors allows patients' physical activity to be quantified objectively. The sensor data indicate that our sample was sedentary and physically inactive for most of the day (Figure 1), eg, some patients only get up from bed or stand up from a chair to go to the toilet or take meals. The use of objective measures of the patients' physical activity puts a focus on one of the major problems in dementia care: patients' physical inactivity. In acute dementia care settings, patients with particularly severe or disturbing NPS and those suffering from aberrant motor behavior are often more visible on the wards as they tend to require more medical and nursing resources. However, as our analysis has shown, the majority of patients was physically inactive and sedentary, and we assume from our clinical experience, that sedentary patients often go more or less unnoticed in acute dementia care. From the clinical expertise of the authors, this phenomenon can very often be translated to nursing-home or home-care settings. Furthermore, this study confirms the findings of Eggermont and Scherder,[34] who found that nursing home residents suffering from dementia were classified as ambulatory, were nevertheless sedentary for almost the whole day. This physical inactivity may be directly linked to the development and exacerbation of psychopathological symptoms.[10,11]

The availability of objective, quantitative data on dementia patients' physical inactivity could be used to prompt a change in care strategy and a new focus on physical activity in acute dementia care. There is increasing evidence that exercise programs have a beneficial effect on patients' ability to perform activities of daily living as well as decreasing the caregiver burden in dementia care.[35] Furthermore, structured physical exercise interventions have been shown to be an effective treatment for NPS in dementia.[7,8]

It is important to note that our analyses did not include all medications that could influence patients' physical activity, for example we did not assess use of antidepressants and antidementics. Because we wanted to analyze synchronized activity and medication data, only sensor data from the first complete 24-hour period from midnight were used in the analyses presented here. Recording activity over a longer period would allow a more robust analysis and interpretation of patients' physical activity. Because we excluded outliers our analysis does not cover the full spectrum of physical activity in dementia patients, eg, a patient who showed a wandering phenomenon and thus took more than 40 000 steps per day had to be excluded.

These limitations should be taken into account when interpreting the results. As objective assessments of dementia patients' physical activity become more widespread, we may see an increase in the emphasis on motor behavior. The availability of objective measures

of physical activity makes it possible to design and evaluate individualized exercise interventions that might help to reduce NPS and increase patients, caregivers', and medical professionals' quality of life.

In summary, physical inactivity in patients suffering from dementia seems to be a feature of the psychopathology of the disease rather than an effect of antipsychotic or benzodiazepine medication. Dementia care should pay more attention to prevent physical inactivity in patients. There is an urgent need for effective non-pharmacological treatments for NPS as use of antipsychotics and benzodiazepines to treat NPS in patients suffering from dementia has been linked to serious adverse effects.[36,37]

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AUTHOR'S CONTRIBUTION

T.F. and M.G.: study concept, data acquisition, statistical analysis, interpretation of data, draft and revision of the manuscript. S.G. and S.M.: analysis of the sensor raw data, revision of the manuscript. W. Z.: study concept, further data analysis, interpretation of data, draft and revision of the manuscript. P.H.: study concept, data acquisition, clinical interpretation of data, draft, and revision of the manuscript.

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CONFLICTS OF INTERESTS

None declared.

ORCID

Tim Fleiner https://orcid.org/0000-0003-2949-940X

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