Research article

Objective physical activity in people with young onset dementia, late onset dementia, and without dementia: A UK Biobank study

Journal of Alzheimer's Disease
1–10

DOI: 10.1177/13872877251374261
journals.sagepub.com/home/alz

Nicholas H Lawlis[1,2,3], Nicolas Cherbuin[4], Ananthan Ambikairajah[3,4,5,6,7], Hollie Speer[1], Nathan M D'Cunha[3,8], Ben Rattray[2] and Joseph M Northey[1,2]

Abstract

Background: Current physical activity literature does not distinguish between young (dementia diagnosed before 65) and late onset dementia despite differences between these groups such as age, being known to influence physical activity levels.

Objective: The primary aim was to compare objective physical activity levels between people with young onset dementia, late onset dementia, and age-matched control participants without dementia.

Methods: This cross-sectional analysis included four groups (young onset dementia [n = 23]; young onset control [n = 782]; late onset dementia [n = 30]; late onset control [n = 918]) of participants aged 49 to 76 (56% male) from the UK Biobank. Objective light intensity physical activity, moderate-vigorous intensity physical activity, sedentary behavior, and sleep were measured using 7-day wrist-worn accelerometry.

Results: People with young onset dementia did more light and moderate-vigorous intensity physical activity than those with late onset dementia, with these differences becoming nonsignificant when controlling for age. There were no significant differences between people with young onset dementia and the young onset control group. Comparatively, people with late onset dementia did less light intensity physical activity and spent more time sedentary and sleeping than the late onset control group.

Conclusions: This study highlights the distinct physical activity levels of people with young onset and late onset dementia. Future physical activity research should distinguish between young onset and late onset dementia. Such an approach will be important for producing findings that are more applicable for individuals diagnosed with dementia at all stages of life.

Keywords

accelerometer, Alzheimer's disease, cognitive decline, early-onset dementia

Received: 14 February 2025; accepted: 15 July 2025

[1]UC Research Institute for Sport and Exercise, University of Canberra, Canberra, ACT, Australia
[2]Discipline of Sport and Exercise Science, Faculty of Health, University of Canberra, Canberra, ACT, Australia
[3]Centre for Ageing Research and Translation, Faculty of Health, University of Canberra, Canberra, ACT, Australia
[4]National Centre for Epidemiology and Population Health, Australian National University, Canberra, ACT, Australia
[5]Discipline of Psychology, Faculty of Health, University of Canberra, Canberra, ACT, Australia
[6]Brain and Mind Centre, The University of Sydney, Sydney, NSW, Australia
[7]School of Psychology, The University of Sydney, Sydney, NSW, Australia
[8]Discipline of Nutrition and Dietetics, Faculty of Health, University of Canberra, Canberra, ACT, Australia

Corresponding author:
Nicholas Lawlis, Discipline of Sport and Exercise Science, Building 12, University Drive, Bruce ACT, 2617, Australia.
Email: Nicholas.lawlis@canberra.edu.au

Handling Associate Editor: Shannon Halloway

Introduction

Dementia is characterized by significant cognitive decline and functional impairment, and is a growing public health concern.[1] Within the diverse spectrum of dementia, the age of onset can contribute substantially to distinctive clinical presentations, disease progression, and associated challenges.[2] Young onset dementia refers to a diagnosis of any form of dementia prior to the age of 65[3] and is associated with a more diverse set of underlying pathologies and symptoms compared to late onset dementia.[4–6] For instance, in late-onset dementia (diagnosed ≥ 65 years), Alzheimer's disease accounts for 60–80% of all cases,[7] compared to approximately one third of all young onset dementia cases,[5] where variants such as frontotemporal dementia and vascular dementia are more prevalent.[5] These pathological differences, in conjunction with inherent differences in age at the time of diagnosis, have led to the assumption that people with young onset dementia are more physically active compared to those with late onset dementia.[8–10] While differences in physical activity levels between these groups are likely to have implications for optimal post-diagnostic support, there is currently little empirical evidence to quantify this.

The physical activity levels of people with young onset dementia are most likely reflective of the combined effects of dementia pathology and relatively younger age. Considering pathology, the limited available evidence suggests that people with dementia are generally less physically active and more sedentary than those without dementia, of the same age.[11] Initial evidence suggests this pathological effect appears similar in young onset dementia populations, where physical activity is different relative to those without dementia of a similar age.[12] While there is some evidence investigating the pathological effects of dementia on physical activity, there is even less known about the role of age and age of diagnosis. This is particularly important in the context of people with young onset dementia, who at the time of diagnosis are, by definition, younger than those with late onset dementia. As such, during this younger stage of life, those with young onset dementia are more likely to be engaged in employment, caregiving, social, or domestic responsibilities.[4,13] This combination of greater lifestyle demands, and presence of potentially less age-related functional decline present a logical rationale as to why people with young onset dementia are assumed to be more physically active than those with late onset dementia. Currently, a comparison of physical activity levels between young onset dementia and late onset dementia has not been reported. To more completely understand the physical activity levels within young onset dementia specifically, consideration of both the effects of dementia pathology and age would be beneficial.

An important reason to measure physical activity is to derive and inform recommendations, which exist to provide a target volume of physical activity that benefits physical, cognitive, and metabolic health.[14] Current physical activity recommendations suggest that individuals should aim for >150 min of moderate-vigorous intensity physical activity per week.[15,16] In healthy older people, evidence suggests that achieving these recommendations is protective against cognitive[16,17] and physical decline.[16] Total time in other activities, such as sleep, is associated with cognition[18] and regional brain volumes[19] in apparently healthy populations. Greater time spent in sedentary behavior is also associated with declines in physical[20] and cognitive[21] health. Hence, identification of differences in physical activity between those with young onset, and late onset dementia may support the need to investigate more informed recommendations for people with dementia.

To better understand the physical activity levels of people with young onset dementia, we employed two complementary comparison approaches. First, by comparing people with young onset and late onset dementia, we sought to explore the influence of both age of dementia diagnosis and current age on physical activity. Second, by comparing each dementia group to an age-matched control group, we sought to investigate the influence of dementia pathology on physical activity. As such, the specific aims of this study were to: (i) Compare the duration of objectively measured light and moderate-vigorous intensity physical activity, sedentary, and sleep behavior of participants with young onset dementia to those with late onset dementia; (ii) investigate how the objective physical activity of people with young onset and late onset dementia may differ compared to individual age and sex-matched control groups without dementia; and (iii) identify what proportion of people with young onset and late onset dementia meet current physical activity recommendations.

Methods

Study design and participants

Participants were sampled from members of the United Kingdom (UK) population that participated in the UK Biobank study, a large ongoing prospective study assessing environmental, lifestyle and genetic information of participants across the United Kingdom.[22] The UK Biobank study includes 502,655 participants aged 37–73 years at baseline who were recruited from April 2007 to December 2010. This initial assessment will be referred from here on as the baseline assessment, where environmental, lifestyle, and genetic data were collected at one of 22 UK Biobank assessment centers. Between February 2013 and December 2015, participants with valid contact information were chosen at random, and invited via email to participate in an accelerometry sub-study.[23] A subset of participants ($n = 103{,}648$) wore an accelerometer for seven days to measure sleep and physical activity, referred from here on as the accelerometer assessment.

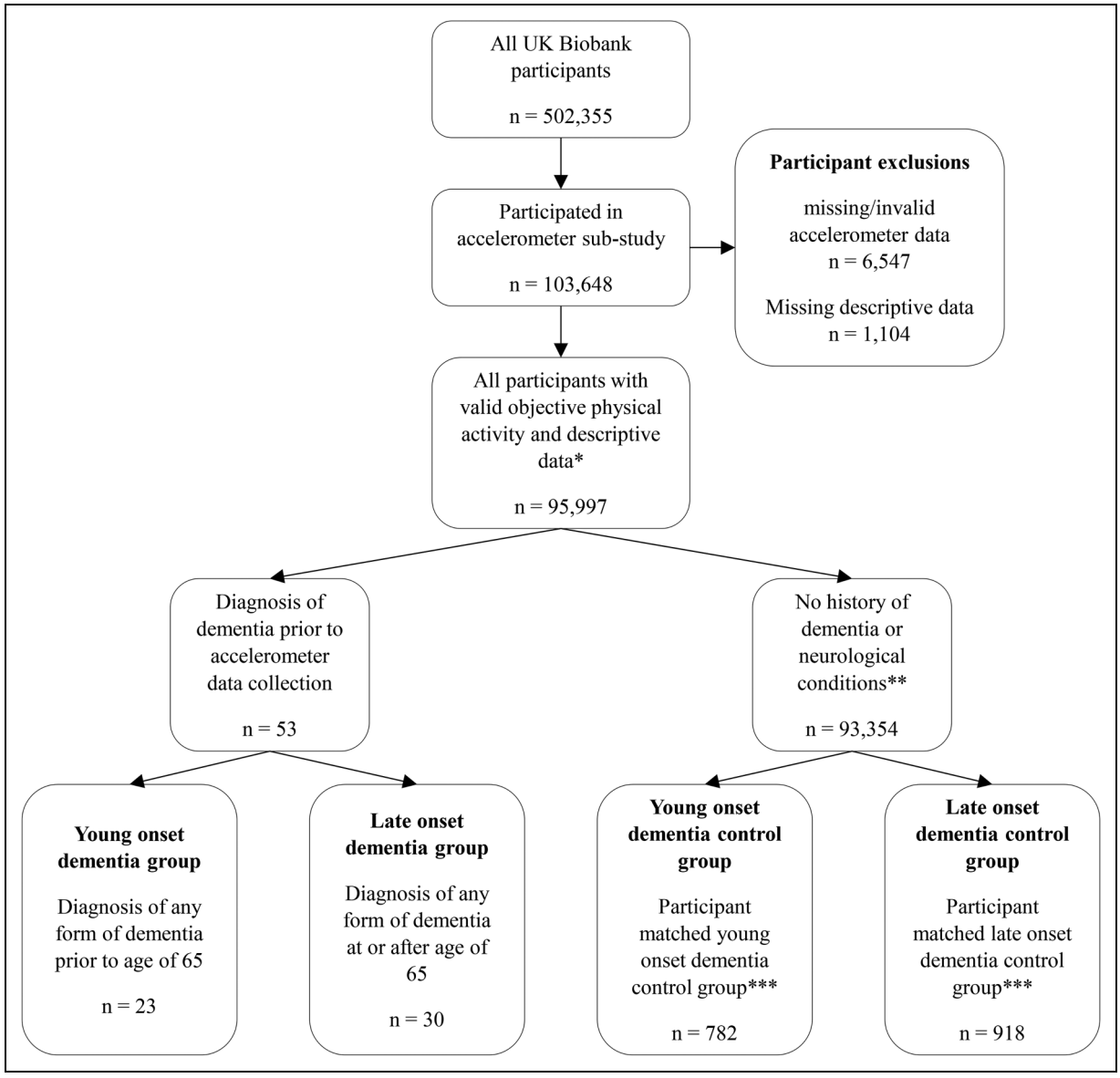

Figure 1. Participant selection from the main UK Biobank study. *Descriptive data: Body mass index, cardiovascular health, years of education, socioeconomic status. **Neurological conditions: Huntington's disease, multiple sclerosis, Parkinson's disease, stroke. ***Control group participants were matched exactly for age, sex, and month of accelerometer collection, and nearest neighbor matched for date of accelerometer collection.

The selection of participants for both people with young onset and late onset dementia is further detailed in Figure 1. Dementia diagnoses were obtained from a combination of hospital admissions records and primary care records. This approach has been validated within the UK Biobank study.[24,25] Participants with a diagnosis of dementia were included in this analysis if they had available medical history, demographic, and accelerometer data. Participants were then categorized as having young onset dementia (n = 23) if they were diagnosed with dementia before the age of 65, or late onset dementia (n = 30) if they were diagnosed with dementia at or after the age of 65.

The age-matched control groups for both the young onset dementia and late onset dementia groups were selected from the participants with complete medical history, demographic and accelerometer data, but with no known diagnosis of dementia or other neurological conditions. Both age-matched control groups were created by selecting participants that exactly matched their age, and the month which they completed the accelerometer sub-study to participants with dementia. Controls were then assigned to either the young onset control, or late onset control group depending on whether they were matched to participants with young onset dementia or late onset

dementia. Participants were nearest neighbor matched for sex, and the day of accelerometer collection using the R package *Match-It.*[26] The reason that participants were exact matched for the month of accelerometer assessment and nearest neighbor matched for day of accelerometer assessment was to reduce potential seasonal effects on physical activity.[27] As a result, *Match-It* identified 782 young onset control, and 918 late onset control participants with no significant differences between the age-matched control and groups of young onset and late onset dementia for all matched variables. The UK Biobank received ethical approval from the Northwest Multi-centre Research Ethics Committee (REC reference: 11/NW/0382). All participants gave written informed consent before enrolment in the study, which was conducted in accordance with the principles of the Declaration of Helsinki. This project was conducted under UK Biobank approval number: 47813.

Objectively measured physical activity, sedentary behavior, and sleep

Physical activity was measured objectively with an accelerometer (AX3 triaxial accelerometer, Axivity, United Kingdom) worn on the wrist for 7 full days. The wrist-worn AX3 triaxial accelerometer is a validated measure of physical activity within older populations.[28] The accelerometers collected data at a sampling rate of 100 Hz (1 Hz = 1 sample per second). Participants were excluded if their accelerometer recorded implausible average acceleration values (>100 milligravities) or they wore the accelerometer for <3 days.[23] Categories of physical activity are routinely utilized within physical activity literature to contextualize the amount of time spent in different intensities of activity throughout the day, and typically include, sedentary, light intensity and moderate-vigorous intensity.[29] Sedentary activity includes time which is spent seated or lying with little additional movement, light intensity activity can be sustained for over 60 min and does not noticeably alter breathing rate, and moderate-vigorous intensity includes those activities which cannot be sustained for over 60 min, alter breathing rate, and ability to maintain a conversation.[29] Established cutoffs for each category of physical activity were utilized in the processing of raw data.[23] Processed data was provided to the UK Biobank as a supplementary dataset,[30] which contained the variables used within this study. The derived accelerometer data was separated into four categories (light intensity, moderate-vigorous intensity, sedentary behavior, and sleep), each expressed as the average minutes spent in each activity per week (mins/wk^{-1}).

Health and sociodemographic variables

To contextualize the study population, several variables that are associated with dementia risk and physical activity were included within the descriptive statistics. Constitutional risk factors reported include age, sex, body mass index, cardiovascular disease incidence, years of education, and *APOE* ϵ4 carrier status. Additional clinical characteristics included date of dementia diagnosis, and date of baseline and accelerometer assessments. These variables were used to calculate the age of participants at their accelerometer assessment, and the length of time between dementia diagnosis and accelerometer assessment as a measure for time living with dementia. Health and sociodemographic variables are presented in Table 1.

Statistical analysis

Statistical analysis was conducted in, R version 4.2.2,[31] in RStudio version 2023.9.0.463.[32] The mean and standard deviation of outcome measures were calculated individually for the dementia and control groups. Linear regression models were computed to investigate the difference in objective physical activity, sedentary, and sleep behavior between groups. In each model, the dependent variable was a single measure of physical activity intensity, sedentary, sleep behavior, or proportion of participants meeting physical activity guidelines (Figure 1). Statistical significance was reported at an adjusted $p < 0.050$ using the Benjamini-Hochberg procedure.[33] As outlined below, separate models were created in line with the aims of this study. This enabled selection of the most appropriate covariates depending on the population included in the model.

To address aim 1, which compared young onset dementia to late onset dementia, a base set of models (model 1) were computed with participant group as the independent variable (2 levels: young onset dementia, late onset dementia), and length of time the participants had been diagnosed with dementia, and sex included as covariates. To consider for the role of age in any observed differences, a second set of models (model 2) included age, as age is regarded as a predictor of declining physical activity.[34]

To address aim 2, separate models were computed to compare the young onset dementia or late onset dementia participants to their respective age-matched control groups, with sex and age included as predetermined covariates.

The linear models are supported graphically and were visualized in R Studio using *ggplot2,*[35] with raincloud plots of the raw data that identify the differences between groups for time spent in physical activity, sedentary, and sleep behaviors.

To address aim 3, participants were grouped depending on whether they achieved an average of 150 min or more of moderate-vigorous intensity physical activity per week, in line with suggested physical activity recommendations.[15,16] Separate models were computed to compare the proportion of individuals with young onset dementia, late onset dementia, and the respective age-matched control

Table 1. Demographic and health characteristics of the study population.

	Young onset dementia		Late onset dementia	
	Dementia (N = 23)	Age-matched control (N = 782)	Dementia (N = 30)	Age-matched control (N = 918)
Sex – Male, n (%)	12 (52%)	408 (52%)	16 (53%)	539 (59%)
Age (y) – mean (SD)	63 (± 5)	63 (± 5)	72 (± 3)	71 (± 3)
Age of dementia diagnosis (years) – mean (SD)	56 (± 6)	NA	70 (± 3)	NA
Time since dementia diagnosis (days) – mean (SD)	2510 (± 1740)	NA	832 (± 974)	NA
Body mass index (BMI) – mean (SD)	26 (± 4)	27 (± 5)	28 (± 5)	27 (± 4)
Education (y) – mean (SD)	17 (± 4)	16 (± 5)	14 (± 5)	15 (± 5)
Cardiovascular disease, n (%)	9 (39%)	235 (30%)	22 (73%)	444 (48%)
APOE ϵ4/ϵ4 allele, n (%)	5 (22%)	21 (3%)	1 (3%)	17 (2%)
Objective Physical Activity Behavior (min/wk^{-1})				
Light physical activity (SD)	2210 (± 758)	2080 (± 675)	1630 (± 777)	2060 (± 647)
Moderate-vigorous physical activity (SD)	307 (± 244)	323 (± 254)	196 (± 199)	266 (± 228)
Sedentary physical activity (SD)	3950 (± 915)	3960 (± 733)	4280 (± 952)	3980 (± 737)
Sleep (SD)	3610 (± 608)	3720 (± 498)	3980 (± 737)	3770 (± 521)
Achieved physical activity guidelines of >150 min of moderate-vigorous physical Activity per week, n (%)	15 (65%)	574 (73%)	15 (50%)	582 (63%)

groups that achieved the threshold of 150 min of moderate-vigorous activity per week. The summary of group comparisons is reported in Supplemental Table 7.

Results

Participant characteristics

The demographic and health characteristics of the study sample are presented in Table 1. By design, there were no significant differences in age between people with young onset or late onset dementia and their respective age-matched control groups (all $p > 0.950$). Individuals with young onset dementia were living with dementia for a longer period of time compared to those with late onset dementia ($p < 0.001$). Those with young onset dementia were also more likely to be homozygous for *APOE* ϵ4 than both people with late onset dementia, and the young onset control group (all $p < 0.001$). Excluding objective physical activity outcomes which are reported below, there were no other statistically significant differences between groups of interest for any of the health and demographic variables outlined in Table 1.

Comparison of young onset dementia and late onset dementia

Addressing aim 1, model 1 identified that people with young onset dementia engaged in more light intensity ($p = 0.011$; Figure 2A) and moderate-vigorous intensity ($p = 0.047$; Figure 2B) physical activity than those with late onset dementia, with no differences between groups in time spent in sedentary behavior, or sleep (Table 2). Model 2, which investigated the role of age, resulted in the differences for both light intensity ($p = 0.182$) and moderate-vigorous intensity ($p = 0.922$) physical activity becoming non-significant (Table 3).

The proportion of participants with young onset dementia achieving current physical activity recommendations (65%) was not significantly different to those with late onset dementia (50%; $p = 0.277$; Supplemental Table 7).

Comparison of dementia groups to their age-matched control groups

Addressing aim 2, there were no differences in the duration of physical activity, sedentary behavior or sleep between people with young onset dementia and the young onset control group (Table 4). However, people with late onset dementia did significantly less light intensity physical activity ($p < 0.001$; Figure 2A), and spent more time in sedentary behavior ($p = 0.024$; Figure 2C) and sleeping ($p = 0.040$; Figure 2D) compared to the late onset control group (Table 4). There were no differences in moderate-vigorous intensity physical activity when comparing either dementia group to their respective age-matched control group (Table 4).

There were no differences in the proportion of individuals meeting current physical activity recommendations when comparing individuals with young onset dementia (65%) to the young onset control group (73%; $p = 0.383$; Supplemental Table 7) or comparing those with late onset dementia (50%) to the late onset control group (63%; $p = 0.135$; Supplemental Table 7).

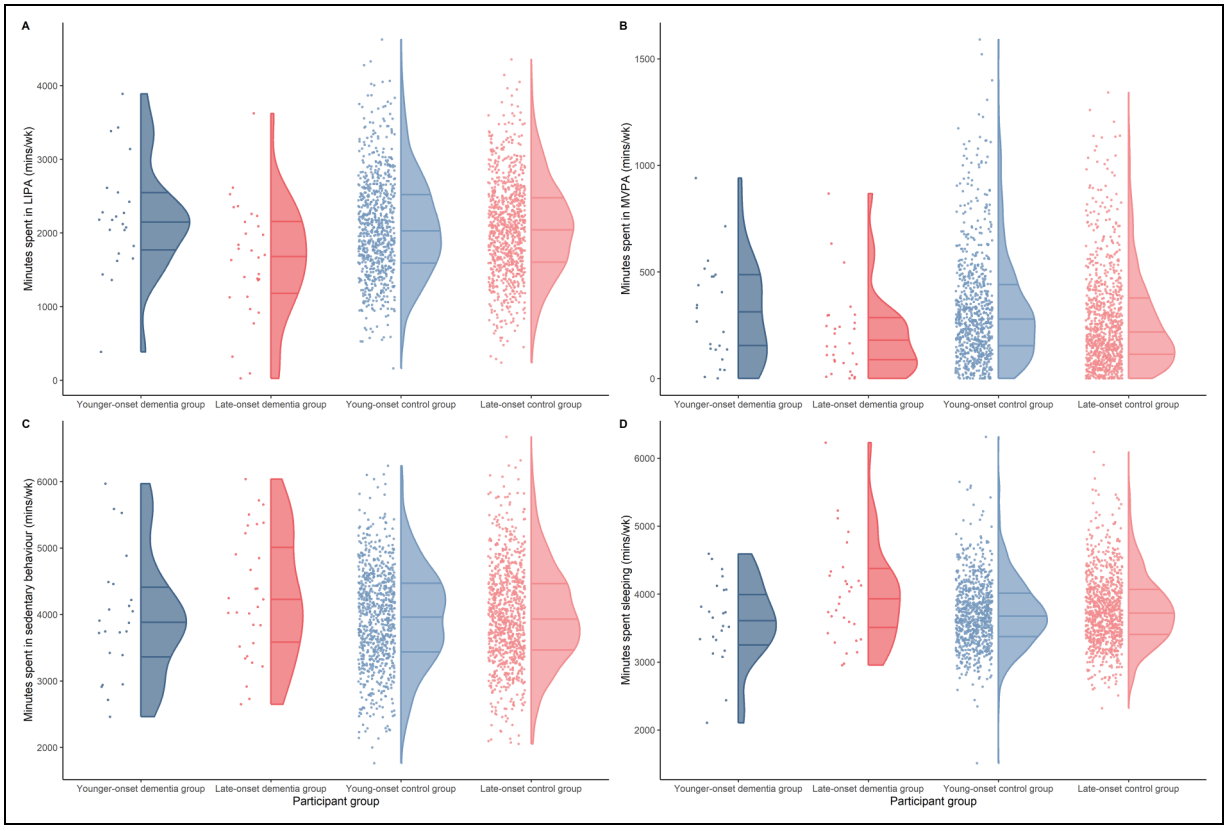

Figure 2. Raincloud plots of raw data displaying the differences between the young onset dementia, late onset dementia, young onset control, and late onset control groups. Each panel represents a different category of physical behavior: (A) light intensity physical activity (LIPA), (B) moderate-vigorous intensity physical activity (MVPA), (C) sedentary behavior, and (D) sleep, and are reported as minutes per week.

Table 2. Summary of group comparisons of objectively measured physical activity, sedentary and sleep behavior between groups from model 1.

Objective Physical Activity, Sedentary and Sleep Behaviors								
	Light intensity physical activity		Moderate-vigorous intensity physical activity		Sedentary behavior		Sleep	
Comparison	b (CI)	p*	b (CI)	p*	b (CI)	p*	b (CI)	p*
Young onset dementia - Late onset dementia**	−578 (−1016, −139)	**0.011**	−119 (−237, −1)	**0.047**	348 (−178, 875)	0.189	349 (−29, 726)	0.069
Young control - Late control***	2 (−59, 63)	0.942	−63 (−86, −41)	**<0.001**	7 (−62, 76)	0.835	54 (5, 103)	**0.031**

b: unstandardized regression coefficient; CI: 95% confidence interval.
*Adjusted p-value, with p-values which met the criteria for statistical significance being represented in bold.
**This model controls for the length of time since being diagnosed with dementia and sex, the full model summary can be found in Supplemental Table 1.
***This model controls for sex; the full model summary can be found in Supplemental Table 2.

Discussion

Previous literature has postulated that individuals with young onset dementia are more physically active than people with late onset dementia.[8–10] Here, we add to the limited evidence available to support this claim, by taking an approach that considers the role of age and pathology in a complimentary manner. Within the present study, individuals with young onset dementia engaged in more light and moderate-vigorous intensity physical activity compared to their late onset dementia counterparts, with age appearing to be a primary explanatory factor. Further supporting the distinction between these groups, people with young

Table 3. Summary of group comparisons of objectively measured physical activity, sedentary and sleep behaviors between groups from model 2, which controlled for age.

Objective Physical Activity, Sedentary and Sleep Behaviors								
	Light intensity physical activity		Moderate-vigorous intensity physical activity		Sedentary behavior		Sleep	
Comparison	b (CI)	p*	b (CI)	p*	b (CI)	p*	b (CI)	p*
Young onset dementia - Late onset dementia**	−438 (−1090, 213)	0.182	−8 (−179, 162)	0.922	59 (−717, 836)	0.878	387 (−175, 950)	0.173
Young control - Late control***	−45 (−133, 43)	0.315	−38 (−71, −6)	**0.022**	41 (−59, 141)	0.422	43 (−28, 113)	0.240

b: unstandardized regression coefficient; CI: 95% confidence interval.
*Adjusted p-value, with p-values which met the criteria for statistical significance being represented in bold.
**This model controls for age, the length of time since being diagnosed with dementia and sex, the full model summary can be found in Supplemental Table 3.
***This model controls for age and sex; the full model summary can be found in Supplemental Table 4.

Table 4. Summary of group comparisons of objectively measured physical activity, sedentary and sleep behavior, comparing each young onset and late onset dementia group to their respective age and sex-matched control groups.

Objective Physical Activity, Sedentary and Sleep Behaviors								
	Light intensity physical activity		Moderate-vigorous intensity physical activity		Sedentary behavior		Sleep	
Comparison	b (CI)	p*	b (CI)	p*	b (CI)	p*	b (CI)	p*
Young onset dementia - Young control**	−128 (−400, 143)	0.354	16 (−88, 121)	0.761	5 (−296, 306)	0.974	107 (−101, 315)	0.314
Late onset dementia - Late control**	448 (220, 677)	**<0.001**	204 (−19, 142)	0.134	−307 (−576, −40)	**0.024**	−202 (−395, −9)	**0.040**

b: unstandardized regression coefficient; CI: 95% confidence interval.
*Adjusted p-value, with p-values which met the criteria for statistical significance being represented in bold.
**These models control for age and sex; the full model summaries can be found in Supplemental Tables 5 and 6.

onset dementia were similarly active to their age matched controls, while people with late onset dementia did less light intensity physical activity and were more sedentary relative to their controls. These distinctions in findings highlight a nuanced relationship where the influence of dementia pathology on physical activity appears to be closely related to age at diagnosis and current age. Given that current dementia interventions are designed for people with late onset dementia, emphasis should be placed on developing young onset dementia specific research and interventions.

In the current study, people with young onset dementia were more physically active compared to people with late onset dementia, with age as a likely explanatory factor. Similar age-related differences have been observed in cognitively healthy populations of a comparative age to the current study.[36] Our findings suggest that differences in age between our dementia groups may account for the differences in physical activity between those with young onset dementia and late onset dementia. This effect of age is likely due to a combination of factors associated with age related physiological declines in bone density,[37,38] cardiovascular function,[39] and muscle mass.[40] Furthermore, age related declines in domestic, employment, caregiving or social responsibilities that people with young onset dementia are more likely to engage in, may also contribute.[4,13] Future research, investigating the nuanced factors associated with age, beyond considering it as simply a variable, would be beneficial in identifying and explaining differences in physical activity and optimizing post-diagnostic interventions for both young onset and late onset dementia.

The differences between people with young onset dementia and late onset dementia were further exemplified when we compared them to their age-matched controls. In this sense, these models provided distinction from normal age-related changes and may be reflective of the role of dementia. Interestingly, there were no differences in physical activity between the young onset dementia group and young onset control group. In the one other study specifically examining objective physical activity in people with

young onset dementia, Hayes et al. (2024) found that people with young onset dementia did less moderate-vigorous physical activity and spent more time sedentary compared to age-matched controls without dementia.[12] It is not clear why Hayes et al. (2024) found these differences between groups, given similarities in young onset dementia sample size and age ranges with our study.[12] While speculative, it could be that our more exact matching for age alongside a larger control group which may be more representative of the population, contributed to these differences. In contrast to our findings for young onset dementia, we found that people with late onset dementia did less light intensity physical activity and spent more time sedentary compared to the age matched control group. While the late onset dementia group did 70 min per week less moderate-vigorous physical activity than the late control group, this difference did not reach statistical significance. This may be due to the relatively large variability in moderate-vigorous physical activity within groups and the smaller sample size in the late onset dementia group, which together may have reduced the statistical power to detect a difference. These findings add to the limited evidence available that people with late onset dementia engage in more sedentary lifestyles than those without dementia.[11] Previous literature has hypothesized that such declines in physical activity may be a consequence of dementia symptomology. For example, impairment to executive functioning may lead to apathy[41] and subsequently lower physical activity levels[42] compared to those without dementia. Our overall findings add to the literature by suggesting that the effect of dementia on physical activity levels may become more pronounced with increased age.

Currently, physical activity recommendations for people with dementia are identical to those for healthy adults, being >150 min of moderate-vigorous intensity per week.[15,16] Compared to the broader population in 2016, the NHS Health Survey for England, which used a self-report measure of physical activity, estimated that 44% of adults aged over 65 met these recommendations.[43] This does not align with the current study, where 68% of all participants (young onset dementia: 65%; late onset dementia: 50%; young onset control: 73%; late onset control: 63%) met this threshold. While this could be interpreted that this study's sample was highly active, it is more likely that physical activity recommendations, which are derived from self-reported measures of physical activity, are not equivalent to objective measures such as accelerometry.[44] Future work to align these measures in the context of physical activity guidelines, alongside the development of more individualized guidelines for dementia groups will be essential for the translation of research findings for practical and clinical applications.

These findings must be considered in the context of several limitations. Firstly, the sample size in the two dementia groups for this investigation is relatively small within a heterogeneous population, although comparable to existing literature.[12] Whilst the findings still provide valuable insights in conjunction with the limited evidence available, a larger sample size would enhance the generalizability of the results and may enable further subgroup analyses (e.g., by dementia subtype). Secondly, the cross-sectional nature of the study meant the trajectory of physical activity levels and dementia progression could not be assessed. A longitudinal study would enable investigation of changes in physical activity, sedentary behavior, and sleep time with dementia progression. Thirdly, although the UK Biobank provides a date of diagnosis, there is no clinical data reporting dementia severity and as such we were unable to account for this. Finally, the number of individuals with a dementia diagnosis in the accelerometer assessment sample is disproportionately low relative to population prevalence. Therefore, it is unknown whether the criteria for reporting dementia diagnoses may be a limitation, or whether the sample may be biased toward those with greater functionality, who could complete the accelerometer assessment. Despite this, the time between dementia diagnosis and accelerometer collection was reported, providing information for the length of time participants were living with dementia prior to wearing the accelerometer to provide some context on disease progression.

In conclusion, this study highlights the distinct physical activity levels of individuals with young onset and late onset dementia. These findings support the need to distinguish between young onset and late onset dementia in future research. Such an approach will be important for producing findings that are more applicable and representative to individuals diagnosed with dementia at all stages of life, with the goal of preserving physical health, cognitive health, and quality of life.

Acknowledgments

We would like to acknowledge and thank all UK Biobank participants and the UK Biobank team for their work. This project has been conducted using the UK Biobank resource under application number 47813. This work uses data provided by patients and collected by the NHS as part of their care and support.

ORCID iDs

Nicholas H Lawlis https://orcid.org/0009-0008-8990-9945
Nicolas Cherbuin https://orcid.org/0000-0001-6481-0748
Ananthan Ambikairajah https://orcid.org/0000-0002-5808-8020
Hollie Speer https://orcid.org/0000-0003-2023-0973
Nathan M D'Cunha https://orcid.org/0000-0002-4616-9931
Ben Rattray https://orcid.org/0000-0002-1652-7726
Joseph M Northey https://orcid.org/0000-0001-6204-4250

Ethical considerations

The UK Biobank received ethical approval from the Northwest Multi-centre Research Ethics Committee (REC reference: 11/NW/0382). This project was conducted under UK Biobank approval number: 47813.

Consent to participate

All participants gave written informed consent before enrolment in the study, which was conducted in accordance with the principles of the Declaration of Helsinki.

Author contributions

Nicholas Lawlis: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Visualization; Writing – original draft; Writing – review & editing.
Nicolas Cherbuin: Data curation; Methodology; Project administration; Resources; Writing – review & editing.
Ananthan Ambikairajah: Formal analysis; Methodology; Supervision; Writing – review & editing.
Hollie Speer: Formal analysis; Methodology; Supervision; Writing – review & editing.
Nathan D'Cunha: Conceptualization; Methodology; Project administration; Supervision; Writing – review & editing.
Ben Rattray: Conceptualization; Investigation; Methodology; Supervision; Writing – review & editing.
Joseph Northey: Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Supervision; Writing – review & editing.

Funding

No funding was sought to conduct this research. N Lawlis was supported by an Australian Government Research Training Program (RTP) Domestic and Fee-Offset Scholarships, and the 2024 Dementia Australia Research Foundation Dr Maree Farrow Clinical Postgraduate Stipend.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data availability statement

Researchers can apply to use the UK Biobank resource and access the data used. No additional data are available.

Supplemental material

Supplemental material for this article is available online.

References

1. Livingston G, Huntley J, Liu KY, et al. Dementia prevention, intervention, and care: 2024 report of the Lancet standing Commission. *Lancet* 2024; 404: 572–628.
2. Rabanal LI, Chatwin J, Walker A, et al. Understanding the needs and experiences of people with young onset dementia: a qualitative study. *Br Med J Open* 2018; 8: e021166.
3. Rossor MN, Fox NC, Mummery CJ, et al. The diagnosis of young-onset dementia. *Lancet Neurol* 2010; 9: 793–806.
4. Mendez MF. The accurate diagnosis of early-onset dementia. *Int J Psychiatry Med* 2006; 36: 401–412.
5. Mendez MF. Early-onset Alzheimer disease and its variants. *Continuum (Minneap Minn)* 2019; 25: 34–51.
6. World Health Organization. Dementia fact sheet, https://www.who.int/news-room/fact-sheets/detail/dementia#:~:text=Dementia%20results%20from%20a%20variety,60%E2%80%9370%25%20of%20cases]. (2024).
7. Alzheimer's Association. 2024 Alzheimer's disease facts and figures. *Alzheimers Dementia* 2024; 20: 3708–3821.
8. Hooghiemstra AM, Eggermont LH, Scheltens P, et al. Study protocol: EXERcise and cognition in sedentary adults with early-ONset dementia (EXERCISE-ON). *BMC Neurol* 2012; 12: 75.
9. Hooghiemstra AM, Eggermont LH, Scheltens P, et al. Exercise and early-onset Alzheimer's disease: theoretical considerations. *Dement Geriatr Cogn Dis Extra* 2012; 2: 132–145.
10. Roman de Mettelinge T, Calders P and Cambier D. The effects of aerobic exercise in patients with early-onset dementia: a scoping review. *Dement Geriatr Cogn Disord* 2021; 50: 9–16.
11. Hartman YA, Karssemeijer EG, van Diepen LA, et al. Dementia patients are more sedentary and less physically active than age-and sex-matched cognitively healthy older adults. *Dement Geriatr Cogn Disord* 2018; 46: 81–89.
12. Hayes LD, Berry EC, Sanal-Hayes NE, et al. Body composition, vascular health, cardiorespiratory fitness, lung function, muscle architecture, and physical activity in people with young onset dementia: a case-control study. *Am J Med* 2025; 138: 277–286.e1.
13. Burkinshaw K, Tsourtos G and Cations M. System and policy-level barriers and facilitators for timely and accurate diagnosis of young onset dementia. *Int J Geriatr Psychiatry* 2023; 38: e5859.
14. Blair SN, LaMonte MJ and Nichaman MZ. The evolution of physical activity recommendations: how much is enough? *Am J Clin Nutr* 2004; 79: 913S–920S.
15. Lautenschlager NL, Cox K, Hill KD, et al. *Physical activity guidelines for older Australians with mild cognitive impairment or subjective cognitive decline*. Melbourne: Dementia Collaborative Research Centres: University of Melbourne, 2018.
16. Piercy KL, Troiano RP, Ballard RM, et al. The physical activity guidelines for Americans. *JAMA* 2018; 320: 2020–2028.
17. Dougherty RJ, Ellingson LD, Schultz SA, et al. Meeting physical activity recommendations may be protective against temporal lobe atrophy in older adults at risk for Alzheimer's disease. *Alzheimers Dement (Amst)* 2016; 4: 14–17.
18. Yaffe K, Falvey CM and Hoang T. Connections between sleep and cognition in older adults. *Lancet Neurol* 2014; 13: 1017–1028.

19. Namsrai T, Ambikairajah A and Cherbuin N. Poorer sleep impairs brain health at midlife. *Sci Rep* 2023; 13: 1874.
20. Dunlop DD, Song J, Arntson EK, et al. Sedentary time in US older adults associated with disability in activities of daily living independent of physical activity. *J Phys Act Health* 2015; 12: 93–101.
21. Falck RS, Davis JC and Liu-Ambrose T. What is the association between sedentary behaviour and cognitive function? A systematic review. *Br J Sports Med* 2017; 51: 800–811.
22. Collins R. What makes UK biobank special? *Lancet* 2012; 379: 1173–1174.
23. Doherty A, Jackson D, Hammerla N, et al. Large scale population assessment of physical activity using wrist worn accelerometers: the UK biobank study. *PloS One* 2017; 12: e0169649.
24. Wilkinson T, Ly A, Schnier C, et al. Identifying dementia cases with routinely collected health data: a systematic review. *Alzheimers Dement* 2018; 14: 1038–1051.
25. Wilkinson T, Schnier C, Bush K, et al. Identifying dementia outcomes in UK biobank: a validation study of primary care, hospital admissions and mortality data. *Eur J Epidemiol* 2019; 34: 557–565.
26. Stuart EA, King G, Imai K, et al. Matchit: nonparametric preprocessing for parametric causal inference. *J Stat Softw* 2011; 42: 1–28.
27. Tucker P and Gilliland J. The effect of season and weather on physical activity: a systematic review. *Public Health* 2007; 121: 909–922.
28. Clarke CL, Taylor J, Crighton LJ, et al. Validation of the AX3 triaxial accelerometer in older functionally impaired people. *Aging Clin Exp Res* 2017; 29: 451–457.
29. Norton K, Norton L and Sadgrove D. Position statement on physical activity and exercise intensity terminology. *J Sci Medicine Med Sport* 2010; 13: 496–502.
30. Walmsley R, Chan S, Smith-Byrne K, et al. Reallocation of time between device-measured movement behaviours and risk of incident cardiovascular disease. *Br J Sports Med* 2022; 56: 1008–1017.
31. R Development Core Team. *R: A language and environment for statistical computing*. Vienna, Austria: R foundation for statistical computing, 2024.
32. Posit Team. *RStudio: Integrated Development Environment for R*. Boston, MA: Posit Software, PBC, 2023.
33. Benjamini Y and Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J R Stat Soc Series B Stat Methodol* 1995; 57: 289–300.
34. Suryadinata RV, Wirjatmadi B, Adriani M, et al. Effect of age and weight on physical activity. *J Public Health Res* 2020; 9: 1840.
35. Wickham H. Ggplot2. *Wiley Interdiscip Rev Comput Stat* 2011; 3: 180–185.
36. Evenson KR, Buchner DM and Morland KB. Objective measurement of physical activity and sedentary behavior among US adults aged 60 years or older. *Prev Chronic Dis* 2011; 9: E26.
37. Wishart J, Need A, Horowitz M, et al. Effect of age on bone density and bone turnover in men. *Clin Endocrinol* 1995; 42: 141–146.
38. Steiger P, Cummings SR, Black DM, et al. Age-related decrements in bone mineral density in women over 65. *J Bone Miner Res* 1992; 7: 625–632.
39. Lakatta E. Changes in cardiovascular function with aging. *Eur Heart J* 1990; 11: 22–29.
40. Keller K and Engelhardt M. Strength and muscle mass loss with aging process. *Age and Strength Loss. Muscles Ligaments Tendons J* 2014; 3: 346–350.
41. McPherson S, Fairbanks L, Tiken S, et al. Apathy and executive function in Alzheimer's disease. *J Int Neuropsychol Soc* 2002; 8: 373–381.
42. David R, Mulin E, Friedman L, et al. Decreased daytime motor activity associated with apathy in Alzheimer disease: an actigraphic study. *Am J Geriatr Psychiatry* 2012; 20: 806–814.
43. Scholes S. Health survey for England 2016. In: *Physical activity in adults*. Leeds, UK: NHS Digital, 2017, pp.14–15.
44. Northey JM, Rattray B, Pumpa KL, et al. Can the intensity of physical activity be accurately measured in older adults using questionnaires? *J Sci Med Sport* 2019; 22: 803–807.