Short Daytime Napping Reduces the Risk of Cognitive Decline in Community-Dwelling Elderly Individuals: a 5-Year Longitudinal Study

Kaori Kitamura (kitam@med.niigata-u.ac.jp)
Niigata University https://orcid.org/0000-0003-1480-5777
Yumi Watanabe
Niigata University
Kazutoshi Nakamura
Niigata University
Chikako Takano
Ojiya City Government
Naomi Hayashi
Ojiya Cty Government
Hisami Sato
Ojiya City Government
Toshiyuki Someya
Niigata University

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Abstract

Background: Beneficial effects of napping on cognition have been suggested in cross-sectional studies. This study aimed to clarify longitudinal associations between cognitive decline and sleep characteristics, particularly daytime napping, over a 5-year period in older adults.

Methods: Study participants were 389 community-dwelling individuals aged ≥65 years living in Ojiya City, Niigata, Japan. Baseline and follow-up examinations were conducted in 2011-2013 and 2016-2018, respectively. Trained nurses visited and interviewed participants to collect the following information: demographic characteristics, disease history, lifestyle habits including sleep and daytime napping, and cognitive function at baseline; and cognitive function at follow-up. The assessment of cognitive function was performed using the revised Hasegawa's dementia scale (HDS-R), with cognitive decline defined as a 5-year change in HDS-R of ≤−3. Odds ratios (ORs) for cognitive decline were calculated using multiple logistic regression analysis.

Results: Mean age of participants was 74.6 years (SD 6.4), and the cumulative incidence of cognitive decline was 106/389 (27.3%). The multivariable-adjusted OR for 1-29 min daytime napping was significantly lower compared to that for no napping (OR=0.47, 95%CI: 0.23-0.96). Bedtime was inversely associated with cognitive decline (multivariable-adjusted P for trend=0.0480).

Conclusion: Short daytime napping (<30 min) reduces the risk of 5-year cognitive decline in community-dwelling older people. A future study will be necessary to confirm the effect of short napping on the reduction of risk for clinically diagnosed dementia.

Background

Dementia places a tremendous burden on society worldwide. The total number of people with dementia in the world was estimated to be 35.6 million in 2010, and this number is projected to increase to 115.4 million in 2050 [1]. The total cost of dementia is also enormous, estimated at US$ 604 billion in 2010 [1]. Under these circumstances, the prevention of dementia and dementia-related disorders is one of the highest priority issues.

The role of sleep in cognitive function and dementia has drawn attention, although evidence is still insufficient [2]. According to recent reviews and meta-analyses, sleep duration and sleep disturbance are determinants of cognitive decline and dementia [3-7]. Moreover, daytime napping is reportedly associated with cognitive function in older adults [8-11]. However, previous study findings have been somewhat inconsistent; some reported possible adverse effects of napping, especially long napping, on cognitive function [9,11], whereas others reported possible beneficial effects of napping, especially short napping [8,10]. Furthermore, except for one longitudinal study [8], only cross-section studies [9-11] have been conducted. More longitudinal studies are awaited to accumulate evidence of higher levels.

We previously conducted an epidemiologic study to investigate associations between cognitive impairment and lifestyle factors, including sleep characteristics and daytime napping, in community-dwelling older adults [12]. The present study aimed to clarify longitudinal associations between cognitive decline and sleep characteristics, in particular daytime napping, based on 5-year follow-up data from the participants of study mentioned above.

Methods

Design and Participants

This study was a 5-year follow-up cohort study. Participants at baseline were community-dwelling older adults living in three areas of Ojiya City, Niigata, Japan. Among 592 residents aged ≥65 years receiving no long-term care insurance services who were invited to participate in the study, 535 (90.4%) underwent baseline examination. Of these, 509 participants who were considered cognitively normal were invited to participate in the present 5-year follow-up study, and 371 underwent follow-up examination. We also included 18 individuals who did not participate in the follow-up examination, but were diagnosed with dementia at medical facilities. The final study cohort thus comprised 389 individuals. Figure 1 shows the flow of participant enrollment. Informed consent was obtained from all participants. The consent was verbal because, according to the Ethical Guidelines for Medical and Health Research Involving Human Subjects in Japan [13], investigators are not required to obtain informed consent in writing for human studies which are not invasive or do not involve interventions. The protocol of this study was approved by the Ethics Committee of Niigata University.

Baseline examination

The baseline examination was conducted in three areas of Ojiya city in 2011 (Heisei-cho), 2012 (Matto), and 2013 (Katakai). Trained nurses visited and interviewed participants to collect the following information: demographic characteristics, health status (including cognitive function) and lifestyle, family environment (living with family or alone), current occupational status (unemployed or employed), and histories of hypertension, cerebrovascular disease, and diabetes. Cognitive function was assessed using the revised Hasegawa's dementia scale (HDS-R) [14]. We also collected information regarding alcohol consumption (classified into five categories: 1) non-drinker, 2) <7 *gou* (1 *gou* is equivalent to 180 mL of Japanese *sake*), 3) 7-13 *gou*, 4) 14-20 *gou*, and 5) ≥21 *gou* per week) and smoking status (classified into three categories: 1) non-smoker, 2) past smoker, and 3) current smoker). Usual bedtime and sleeping hours were asked and recorded, and the duration of daytime nap was recorded as 1) none, 2) <30 min, 3) 30-59 min, and 4) ≥60 min. The presence of current sleep disturbance and use of sleeping pills were also asked. Details of the baseline examination have been described previously [12].

Five-year follow-up examination

The follow-up examination, including the HDS-R test, was conducted in 2016 (Heisei-cho), 2017 (Matto in), and 2018 (Katakai), in the same manner as in the baseline examination.

Assessment of cognitive function

The HDS-R, a 30-point test, was used to assess general cognitive function, with a score ≤20 defined as cognitive impairment at baseline. The HDS-R was developed to screen for dementia (sensitivity: 0.90, specificity: 0.82) with a cut-off point of 20/21 [14]. The HDS-R has been used in East Asian populations [15,16] and demonstrated to have a diagnostic accuracy similar to that of the MMSE [17]. One advantage of using the HDS-R over the MMSE is its diagnostic accuracy regardless of education level [17]. The HDS-R was administered during baseline and follow-up examinations, and change in HDS-R (DHDS-R = [score at follow-up] – [score at the baseline]) was calculated. We used a cutoff of DHDS-R ≤-3 to detect the presence of cognitive decline, referring to the cutoff of DMMSE ≤-3 (30-point test) used in previous studies [18,19], based on the fact that longitudinal scores of HDS-R and MMSE change in the same direction in community-dwelling individuals [20]. We also considered 18 individuals who had normal cognitive function at baseline and did not participate in the follow-up examination, but were diagnosed with dementia at medical facilities, as having cognitive decline.

Statistical methods

The χ^2 test was used to test for independence of categorical data for participant characteristics. Cumulative incidence of cognitive decline was calculated and compared according to levels of potential predictor variables by odds ratios (ORs) computed using simple and multiple logistic regression analysis. First, unadjusted, and age- and baseline-HDS-R-adjusted ORs for cognitive decline according to potential predictors were calculated. Second, ORs for cognitive decline according to bedtime, duration of sleep, and duration of nap were calculated, adjusted for age, baseline HDS-R, sex, region (dummy variables), family environment, job status, histories of hypertension, cerebrovascular diseases, and diabetes, alcohol consumption, smoking status, bedtime, duration of sleep, duration of nap (0, 1-29 min and 1, others), presence of sleep disturbance, and use of sleeping pills. SAS statistical software (release 9.1.3, SAS Institute Inc., Cary, NC, USA) was used for data analysis. $P<0.05$ was considered statistically significant.

Results

The mean age of participants was 74.6 years (SD 6.4). Table 1 shows the baseline characteristics of participants by sex. Significant sex-based differences were observed in family environment, job status, alcohol consumption, bedtime, and duration of daytime nap.

The overall cumulative incidence of cognitive decline was 106/389 (27.3%). Table 2 shows the cumulative incidence, unadjusted ORs, and age- and baseline-HDS-R-adjusted ORs for cognitive decline according to levels of predictor variables. Age was robustly associated with unadjusted ORs for cognitive decline. The age- and baseline-HDS-R-adjusted OR was significantly lower for “1-29 (min)” daytime napping relative to no napping (reference).

The multivariable-adjusted OR (adjusted for all other predictors) was significantly lower for “1-29 (min)” daytime napping relative to no napping (OR=0.47, 95%CI: 0.23-0.96) (Figure 2). Bedtime was inversely

associated with cognitive decline (multivariable-adjusted P for trend=0.0480), and multivariable-adjusted ORs were 1.29 (95%CI: 0.55-3.04) for “9:00-9:59 p.m.,” 0.80 (95%CI: 0.32-2.00) for “10:00-10:59,” and 0.50 (95%CI: 0.18-1.39) for “11:00 p.m.-,” relative to “-8:59 p.m.” (reference). The duration of nighttime sleep was not associated with cognitive decline (multivariable-adjusted P for trend=0.7540), and multivariable-adjusted ORs were 1.33 (95%CI: 0.61-2.88) for “<6 hours,” 1.13 (95%CI: 0.57-2.24) for “6-6.9 hours,” 1.55 (95%CI: 0.74-3.26) for “8-8.9 hours,” and 1.47 (95%CI: 0.50-4.35) for “≥9 hours,” relative to “7-7.9 hours” (reference). Sleep disturbance and use of sleeping pills were not associated with cognitive decline (multivariable-adjusted P = 0.8585 and 0.7712, respectively).

Discussion

This study is the first to report a significant decrease in cognitive decline in older adults who habitually take short daytime naps (<30 min). Cross-sectional studies previously showed associations between daytime napping and cognitive impairment. Cross et al. [9] reported that longer napping is significantly correlated with increased levels of cognitive deficits in 133 adults aged >50 years. Similarly, Owusu et al. [11] showed that unintentional, longer naps were correlated with poorer performance on cognitive tests in 2,549 community-dwelling adults aged ≥65 years. While these studies suggested the unfavorable effect of longer napping, shorter napping reportedly had a favorable effect on cognitive performance [21]. In a cross-sectional study in clinical settings, Asada et al. [21] found that napping for up to 60 min, but not more than 60 min, was protective against the development of Alzheimer’s disease.

Lin et al. [10] conducted a large-scale cross-sectional study in 10,740 Chinese older adults (≥60 years) and found that short nappers (<30 min) had a significantly lower prevalence of cognitive impairment as assessed by the MMSE compared to no nappers and long nappers (≥30 min). Our findings are consistent with this report.

To date, only one longitudinal study of up to 10 years has been conducted [8], which reported that the risk of MMSE-assessed cognitive impairment was significantly lower in those who habitually take naps, regardless of duration, in a UK cohort. The discrepancy between their findings and ours may be due to the different definitions of cognitive impairment; the present study used a decrease in HDS-R score of ≤3 points to define cognitive impairment, whereas Keage et al. [8] used newly diagnosed cognitive impairment according to MMSE scores. It is also possible that factors such as the difference in ethnicity might have played a role.

A number of studies have reported on the physiologically beneficial effects of napping on cognitive performance in adults [22,23]. One study even suggested that napping leads to improved cognitive performance in older adults [24]. However, specific effects of short naps are not fully understood. Short naps (<30 min) reportedly improved cognitive performance and alertness and were associated with less sleep inertia [22,24]. Moreover, an epidemiologic study has shown that short naps, but not long naps, had a protective effect against cardiovascular risk [23], suggesting that short naps have stress-releasing

effects. These findings suggest that short naps might also be beneficial for cognitive function, since cognitive decline and dementia are considered stress-related conditions/diseases [25,26].

The present study did not find a significant association between the duration of night sleep and the risk of cognitive decline, although longer sleep groups (“8-8.9-hour” and “≥9-hour” groups) tended to have a higher risk of cognitive decline. These findings are in line with the current knowledge [3-7].

In the present study, earlier bedtime was associated with a higher risk of cognitive decline (multivariable-adjusted P for trend=0.0480). While evidence is scarce, a large cohort study [27] found no association between bedtime and the risk of dementia, although that study only classified bedtime as early or later than 11 PM. Dementia patients reportedly go to bed early [28], and thus, the effect of bedtime on cognition warrants further examination.

The present study has several strengths. First, we used a cohort study design, which is preferable for detecting a causal association. Second, this study had a high participation rate at baseline (90.4%) and an acceptable follow-up rate (72.9%). Finally, the information regarding participant lifestyle was obtained and confirmed through interviews during home visits by experienced nurses. There are also some limitations in this study. First, we obtained the participants’ sleep-related information through interviews by trained nurses, but the information was based on their self-report. Therefore, there is a possible misclassification bias, which might have led to underestimation of associations between predictors and outcomes. Second, we did not collect information on naptime, although the timing of naps is also an important factor related to cognitive function [24]. Naptime, as well as nap duration, could influence sleep quality at night, which in turn could affect cognitive function.

Conclusion

Short daytime napping (<30 min) reduces the risk of 5-year cognitive decline in community-dwelling older adults. A future study will need to determine whether or not short naps decrease the risk of clinically diagnosed dementia.

Abbreviations

HDS-R: Hasegawa’s dementia scale

ORs: Odds Ratios

SD: Standard Deviation

CI: Confidence interval

Declarations

- **Ethics approval and consent to participate**

This study was approved by the Ethics Committee of Niigata University. Informed consent was obtained from all participants.

- **Consent for publication**

Not applicable.

- **Availability of data and material**

Data are available to researchers who meet the criteria for access to confidential data. We cannot provide individual data because informed consent to provide data to anyone outside the research group was not obtained from participants. Please contact the corresponding author (principal investigator: Dr. K Nakamura) regarding any requests for access to confidential data.

- **Competing interests**

The authors have no conflicts of interest to report.

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- **Authors' contributions**

All authors contributed to the study conception and design. KK contributed to design and conceptualization, analyzing data, drafting the manuscript, and revising the manuscript for intellectual content. KN contributed to design and conceptualization, analyzing data, and revising the manuscript for intellectual content. YW and TS contributed to revising the manuscript for intellectual content. CT, NH, and HS contributed to design and conceptualization and data collection. All authors read and approved the final manuscript.

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Tables

TABLE 1. Participant characteristics at baseline.

Characteristics	Men (n=159)		Women (n=230)		P value
Age (years)					
65-69	39	-24.50%	58	-25.20%	0.9955
70-79	83	-52.20%	117	-50.90%	
80-89	35	-22.00%	52	-22.60%	
90-99	2	-1.30%	3	-1.30%	
Area of residence					
Heisei-cho	40	-25.20%	63	-27.40%	0.8174
Matto	67	-42.10%	98	-42.60%	
Katakai	52	-32.70%	69	-30.00%	
Family environment					
Living with family	153	-96.20%	206	-89.60%	0.0155
Living alone	6	-3.80%	24	-10.40%	
Job status					
Employed	84	-52.80%	52	-22.60%	<0.0001
Unemployed	75	-47.20%	178	-77.40%	
History of hypertension					
Absent	82	-51.60%	116	-50.40%	0.8254
Present	77	-48.40%	114	-49.60%	
History of cerebrovascular disease					
Absent	150	-94.30%	224	-97.40%	0.1244
Present	9	-5.70%	6	-2.60%	
History of diabetes					
Absent	146	-91.80%	210	-91.30%	0.8565
Present	13	-8.20%	20	-8.70%	
Alcohol consumption*(*gou*/wk)					
Non-drinker	41	-25.80%	167	-72.60%	<0.0001
<7	21	-13.20%	37	-16.10%	
7-13	36	-22.60%	22	-9.60%	

14-20	41	-25.80%	3	-1.30%	
≥21	20	-12.60%	1	-0.40%	
Smoking					
Non-smoker	53	-33.30%	224	-97.40%	<0.0001
Past smoker	60	-37.70%	2	-0.90%	
Current smoker	46	-28.90%	4	-1.70%	
Bedtime					
-8:59 p.m.	27	-17.00%	18	-7.80%	<0.0001
9:00-9:59 p.m.	62	-39.00%	54	-23.50%	
10:00-10:59 p.m.	39	-24.50%	79	-34.30%	
11:00 p.m.-	31	-19.50%	79	-34.30%	
Duration of nighttime sleep (hr)					
<6	23	-14.50%	48	-20.90%	0.1437
6-6.9	38	-23.90%	65	-28.30%	
7-7.9	52	-32.70%	73	-31.70%	
8-8.9	35	-22.00%	32	-13.90%	
≥9	11	-6.90%	12	-5.20%	
Duration of daytime nap (min)					
0	52	-32.70%	101	-43.90%	0.0098
1-29	35	-22.00%	63	-27.40%	
30-59	39	-24.50%	35	-15.20%	
≥60	33	-20.80%	31	-13.50%	

*Equivalent to Japanese *sake* (1 *gou* of *sake* is equivalent to 180 mg *sake* or 27g ethanol)

TABLE 2. Cumulative incidence and odds ratios (ORs) for cognitive decline* according to levels of predictor variables

Predictors	Cumulative incidence	Unadjusted OR (95% CI)	Adjusted OR** (95% CI)
Age (years)		P for trend<0.0001	
65-69	12/97 (12.4%)	1 (Ref)	-
70-79	46/200 (23.0%)	2.12 (1.06-4.21)	-
80-89	45/87 (51.7%)	7.59 (3.63-15.85)	-
90-99	3/5 (60.0%)	10.62 (1.61-70.22)	-
Sex			
Men	46/159 (28.9%)	1 (Ref)	1 (Ref)
Women	60/230 (26.1%)	0.87 (0.55-1.36)	0.80 (0.49-1.29)
Area of residence			
Heisei-cho	30/103 (29.1%)	1 (Ref)	1 (Ref)
Matto	37/165 (22.4%)	0.70 (0.40-1.23)	0.70 (0.39-1.27)
Katakai	39/121 (32.2%)	1.16 (0.65-2.05)	1.14 (0.62-2.09)
Family environment			
Living with family	94/359 (26.2%)	1 (Ref)	1 (Ref)
Living alone	12/30 (40.0%)	1.88 (0.87-4.05)	1.81 (0.81-4.03)
Job status			
Employed	23/136 (16.9%)	1 (Ref)	1 (Ref)
Unemployed	83/253 (32.8%)	2.40 (1.43-4.03)	1.78 (1.03-3.07)
History of hypertension			
Absent	44/198 (22.2%)	1 (Ref)	1 (Ref)
Present	62/191 (32.5%)	1.68 (1.07-2.64)	1.23 (0.76-1.99)
History of cerebrovascular disease			
Absent	101/374 (27.0%)	1 (Ref)	1 (Ref)
Present	5/15 (33.3%)	1.35 (0.45-4.05)	1.23 (0.40-3.80)
History of diabetes			
Absent	99/356 (27.8%)	1 (Ref)	1 (Ref)

Present	7/33 (21.2%)	0.70 (0.29-1.66)	0.72 (0.29-1.77)
Alcohol consumption*** (*gou*/wk)		P for trend=0.3590	P for trend=0.7898
Non-drinker	64/208 (30.8%)	1 (Ref)	1 (Ref)
<7	13/58 (22.4%)	0.65 (0.33-1.29)	0.71 (0.34-1.45)
7-13	11/58 (19.0%)	0.53 (0.26-1.08)	0.70 (0.33-1.48)
14-20	11/44 (25.0%)	0.75 (0.36-1.58)	0.95 (0.43-2.09)
≥21	7/21 (33.3%)	1.13 (0.43-2.92)	1.88 (0.68-5.18)
Smoking		P for trend=0.2706	P for trend=0.0563
Non-smoker	72/277 (26.0%)	1 (Ref)	1 (Ref)
Past smoker	17/62 (27.4%)	1.08 (0.58-2.00)	1.31 (0.67-2.56)
Current smoker	17/50 (34.0%)	1.47 (0.77-2.79)	1.94 (0.97-3.87)
Bedtime		P for trend=0.0698	P for trend=0.1472
-8:59 p.m.	13/45 (28.9%)	1 (Ref)	1 (Ref)
9:00-9:59 p.m.	38/116 (32.8%)	1.20 (0.57-2.54)	1.28 (0.58-2.85)
10:00-10:59 p.m.	33/118 (28.0%)	0.96 (0.45-2.04)	0.93 (0.42-2.09)
11:00 p.m.-	22/110 (20.0%)	0.62 (0.28-1.36)	0.71 (0.30-1.65)
Duration of nighttime sleep (hr)		P for trend=0.0284	P for trend=0.2737
<6	17/71 (23.9%)	1.00 (0.50-1.97)	1.16 (0.57-2.36)
6-6.9	24/103 (23.3%)	0.96 (0.52-1.78)	1.03 (0.54-1.94)
7-7.9	30/125 (24.0%)	1 (Ref)	1 (Ref)
8-8.9	26/67 (38.8%)	2.01 (1.06-3.81)	1.67 (0.84-3.32)
≥9	9/23 (39.1%)	2.04 (0.80-5.17)	1.73 (0.63-4.76)
Duration of daytime nap (min)		P for trend=0.1085	P for trend=0.8387
None	44/153 (28.8%)	1 (Ref)	1 (Ref)
1-29	15/98 (15.3%)	0.45 (0.23-0.86)	0.46 (0.23-0.90)
30-59	21/74 (28.4%)	0.98 (0.53-1.82)	0.83 (0.43-1.59)
≥60	26/64 (40.6%)	1.70 (0.92-3.12)	1.11 (0.57-2.15)
Sleep disturbance			
Absent	91/338 (26.9%)	1 (Ref)	1 (Ref)

Present	14/50 (28.0%)	1.06 (0.54-2.05)	1.20 (0.60-2.41)
Use of sleeping pills			
No	81/308 (26.3%)	1 (Ref)	1 (Ref)
Yes	25/81 (30.9%)	1.25 (0.73-2.14)	1.13 (0.64-2.00)

*DHDS-R ≤3

**Adjusted for age and baseline HDS-R score

***Equivalent to Japanese *sake* (1 *gou* of *sake* is equivalent to 180 ml *sake* or 27g ethanol)

Figures

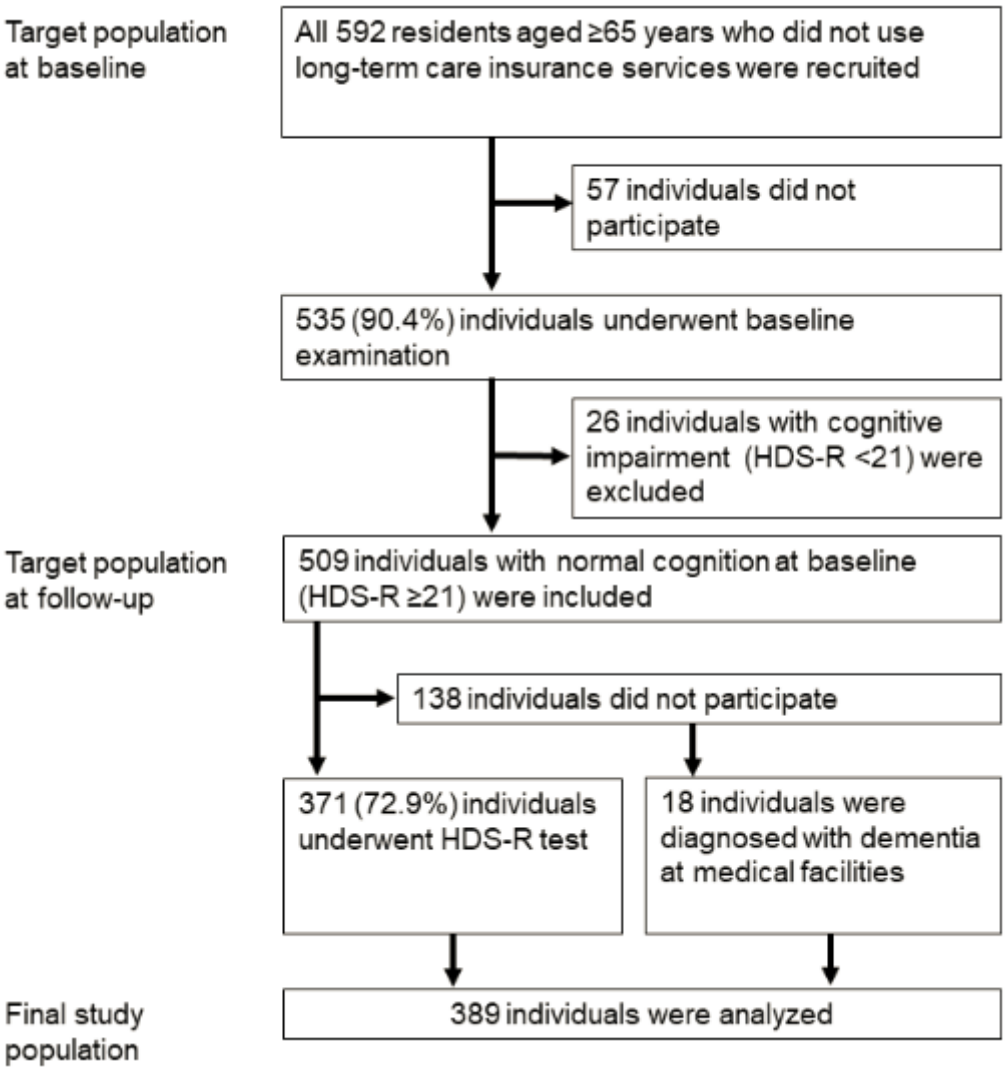

Figure 1

Flow chart of participant enrollment.

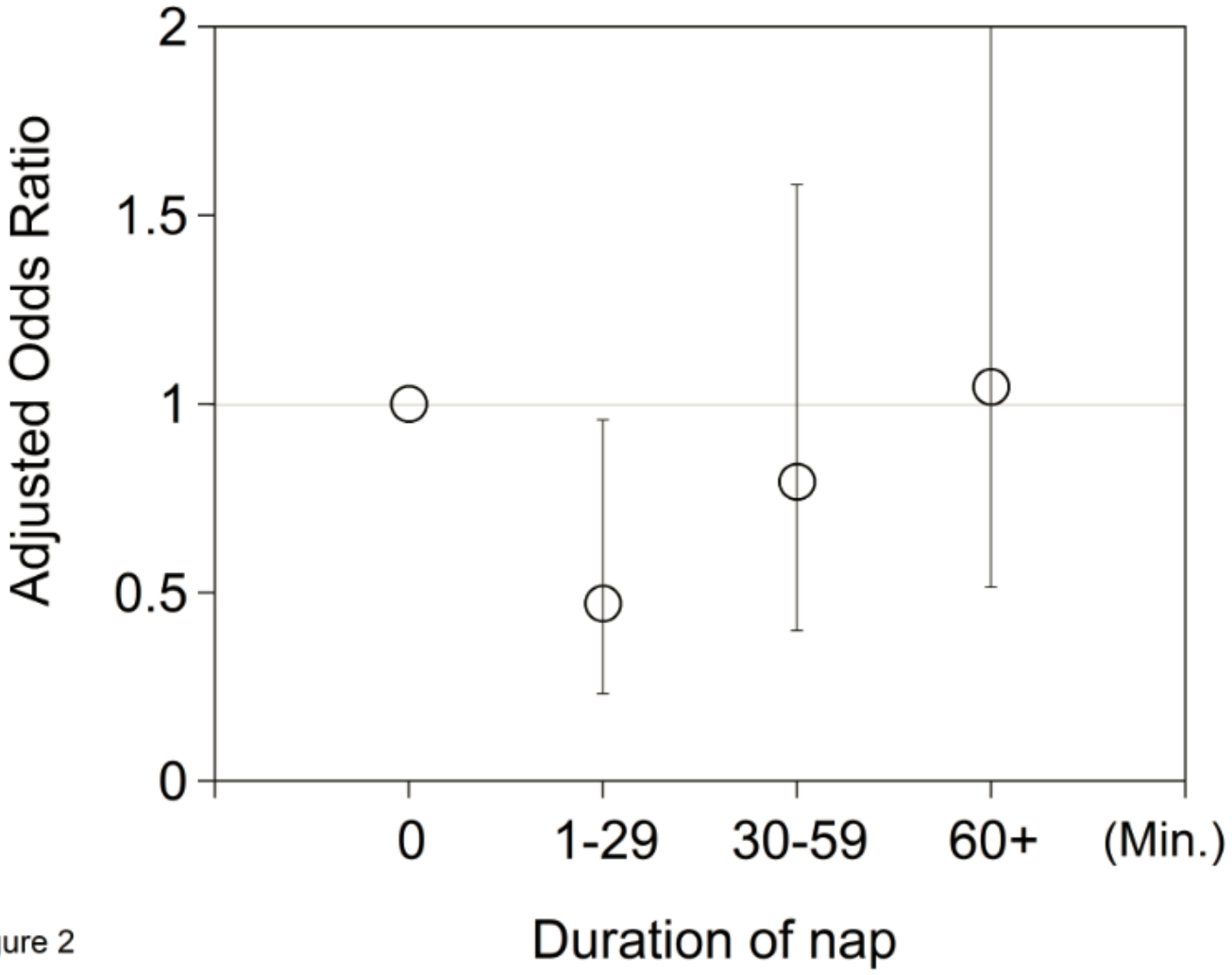

Figure 2

Figure 2

Odds ratios (ORs) for cognitive decline (ΔHDS-R ≤3) over 5 years according to the duration of daytime nap. Individuals taking naps 1-29 minutes in duration had a significantly lower risk of cognitive decline.