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

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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 $\leq 20$ 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 $\leq -3$ to detect the presence of cognitive decline, referring to the cutoff of DMMSE $\leq -3$ (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 $\chi^2$ 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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References

1. International WHOaAsD. (2012). Dementia: a public health priority. World Health Organization. Geneva (Switzerland).

2. Livingston, G., Sommerlad, A., Orgeta, V., et al. (2017). Dementia prevention, intervention, and care. The Lancet, 390(10113), 2673-2734.

3. Kim, H. B., Myung, S. K., Lee, S. M., & Park, Y. C. (2016). Longer Duration of Sleep and Risk of Cognitive Decline: A Meta-Analysis of Observational Studies. Neuroepidemiology, 47(3-4), 171-180.

4. Wu, L., Sun, D., & Tan, Y. (2018). A systematic review and dose-response meta-analysis of sleep duration and the occurrence of cognitive disorders. Sleep Breath, 22(3), 805-814.

5. Liang, Y., Qu, L. B., & Liu, H. (2019). Non-linear associations between sleep duration and the risks of mild cognitive impairment/dementia and cognitive decline: a dose-response meta-analysis of observational studies. Aging Clin Exp Res, 31(3), 309-320.

6. Wennberg, A. M. V., Wu, M. N., Rosenberg, P. B., & Spira, A. P. (2017). Sleep Disturbance, Cognitive Decline, and Dementia: A Review. Semin Neurol, 37(4), 395-406.

7. Shi, L., Chen, S. J., Ma, M. Y., et al. (2018). Sleep disturbances increase the risk of dementia: A systematic review and meta-analysis. Sleep Med Rev, 40, 4-16.

8. Keage, H. A., Banks, S., Yang, K. L., Morgan, K., Brayne, C., & Matthews, F. E. (2012). What sleep characteristics predict cognitive decline in the elderly? Sleep Med, 13(7), 886-892.

9. Cross, N., Terpening, Z., Rogers, N. L., Duffy, S. L., Hickie, I. B., Lewis, S. J., & Naismith, S. L. (2015). Napping in older people ‘at risk’ of dementia: relationships with depression, cognition, medical burden and sleep quality. J Sleep Res, 24(5), 494-502.

10. Lin, J. F., Li, F. D., Chen, X. G., et al. (2018). Association of postlunch napping duration and night-time sleep duration with cognitive impairment in Chinese elderly: a cross-sectional study. BMJ Open, 8(12), e023188.

11. Owusu, J. T., Wennberg, A. M. V., Holingue, C. B., Tzuan, M., Abeson, K. D., & Spira, A. P. (2019). Napping characteristics and cognitive performance in older adults. Int J Geriatr Psychiatry, 34(1), 87-96. doi:10.1002/gps.4991

12. Nakamura, K., Kitamura, K., Watanabe, Y., Shinoda, H., Sato, H., & Someya, T. (2016). Rural-urban differences in the prevalence of cognitive impairment in independent community-dwelling elderly residents of Ojiya city, Niigata Prefecture, Japan. Environ Health Prev Med, 21(6), 422-429. doi:10.1007/s12199-016-0542-2

13. Ministry of Health, Labour, and Welfare. (2015) Ethical Guidelines for Medical and Health Research Involving Human Subjects. https://www.mhlw.go.jp/le/06-Seisakujouhou-10600000-Daijinkanboukouseikagakuka/0000080278.pdf.

14. Imai YH, K. (1994). The Revised Hasegawa's Dementia Scale (HDS-R)-Evaluation of Its Usefulness as a Screening Test for Dementia. Hong Kong Journal of Psychiatry, 4(Suppl 2), 20-24.
15. Jeong, J. W., Kim, K. W., Lee, D. Y., et al. (2007). A normative study of the Revised Hasegawa Dementia Scale: comparison of demographic influences between the Revised Hasegawa Dementia Scale and the Mini-Mental Status Examination. *Dement Geriatr Cogn Disord, 24*(4), 288-293.

16. Rosli, R., Tan, M. P., Gray, W. K., Subramanian, P., & Chin, A. V. (2016). Cognitive assessment tools in Asia: a systematic review. *Int Psychogeriatr, 28*(2), 189-210.

17. Kim, K. W., Lee, D. Y., Jhoo, J. H., et al. (2005). Diagnostic accuracy of mini-mental status examination and revised hasegawa dementia scale for Alzheimer's disease. *Dement Geriatr Cogn Disord, 19*(5-6), 324-330.

18. Hensel, A., Angermeyer, M. C., & Riedel-Heller, S. G. (2007). Measuring cognitive change in older adults: reliable change indices for the Mini-Mental State Examination. *J Neurol Neurosurg Psychiatry, 78*(12), 1298-1303.

19. Taniguchi, Y., Yoshida, H., Fujiwara, Y., Motohashi, Y., & Shinkai, S. (2012). A prospective study of gait performance and subsequent cognitive decline in a general population of older Japanese. *J Gerontol A Biol Sci Med Sci, 67*(7), 796-803.

20. Yamamoto, N., Yamanaka, G., Ishikawa, M., et al. (2009). Cardio-ankle vascular index as a predictor of cognitive impairment in community-dwelling elderly people: four-year follow-up. *Dement Geriatr Cogn Disord, 28*(2), 153-158.

21. Asada, T., Motonaga, T., Yamagata, Z., Uno, M., & Takahashi, K. (2000). Associations between retrospectively recalled napping behavior and later development of Alzheimer's disease: association with APOE genotypes. *Sleep, 23*(5), 629-634.

22. Lovato, N., & Lack, L. (2010). The effects of napping on cognitive functioning. *Prog Brain Res, 185*, 155-166.

23. Faraut, B., Andrillon, T., Vecchierini, M. F., & Leger, D. (2017). Napping: A public health issue. From epidemiological to laboratory studies. *Sleep Med Rev, 35*, 85-100.

24. Milner, C. E., & Cote, K. A. (2009). Benefits of napping in healthy adults: impact of nap length, time of day, age, and experience with napping. *J Sleep Res, 18*(2), 272-281.

25. Machado, A., Herrera, A. J., de Pablos, R. M., et al. (2014). Chronic stress as a risk factor for Alzheimer’s disease. *Rev Neurosci, 25*(6), 785-804.

26. Greenberg, M. S., Tanev, K., Marin, M. F., & Pitman, R. K. (2014). Stress, PTSD, and dementia. *Alzheimers Dement, 10*(3 Suppl), S155-165.

27. Bokenberger, K., Strom, P., Dahl Aslan, A. K., Johansson, A. L., Gatz, M., Pedersen, N. L., & Akerstedt, T. (2017). Association Between Sleep Characteristics and Incident Dementia Accounting for Baseline Cognitive Status: A Prospective Population-Based Study. *J Gerontol A Biol Sci Med Sci, 72*(1), 134-139.

28. Harris, M., & Grando, V. (2014). When is nighttime? A description of bedtime in persons with dementia in the nursing home. *Geriatr Nurs, 35*(6), 474-478.

Tables
TABLE 1. Participant characteristics at baseline.
| Characteristics                        | Men (n=159) | Women (n=230) | P value |
|---------------------------------------|-------------|---------------|---------|
| Age (years)                           |             |               |         |
| 65-69                                 | 39          | 58            | -24.50% | 0.9955 |
|                                       | -25.20%     | -25.20%       |         |
| 70-79                                 | 83          | 117           | -52.20% |         |
|                                       | -50.90%     | -50.90%       |         |
| 80-89                                 | 35          | 52            | -22.00% |         |
|                                       | -22.60%     | -22.60%       |         |
| 90-99                                 | 2           | 3             | -1.30%  |         |
|                                       | -1.30%      | -1.30%        |         |
| Area of residence                     |             |               |         |
| Heisei-cho                            | 40          | 63            | -25.20% | 0.8174 |
|                                       | -27.40%     | -27.40%       |         |
| Matto                                 | 67          | 98            | -42.10% |         |
|                                       | -42.60%     | -42.60%       |         |
| Katakai                               | 52          | 69            | -32.70% |         |
|                                       | -30.00%     | -30.00%       |         |
| Family environment                    |             |               |         |
| Living with family                    | 153         | 206           | -96.20% | 0.0155 |
|                                       | -89.60%     | -89.60%       |         |
| Living alone                          | 6           | 24            | -3.80%  |         |
|                                       | -10.40%     | -10.40%       |         |
| Job status                            |             |               |         |
| Employed                              | 84          | 52            | -52.80% | <0.0001|
|                                       | -22.60%     | -22.60%       |         |
| Unemployed                            | 75          | 178           | -47.20% |         |
|                                       | -77.40%     | -77.40%       |         |
| History of hypertension               |             |               |         |
| Absent                                | 82          | 116           | -51.60% | 0.8254 |
|                                       | -50.40%     | -50.40%       |         |
| Present                               | 77          | 114           | -48.40% |         |
|                                       | -49.60%     | -49.60%       |         |
| History of cerebrovascular disease    |             |               |         |
| Absent                                | 150         | 224           | -94.30% | 0.1244 |
|                                       | -97.40%     | -97.40%       |         |
| Present                               | 9           | 6             | -5.70%  |         |
|                                       | -2.60%      | -2.60%        |         |
| History of diabetes                   |             |               |         |
| Absent                                | 146         | 210           | -91.80% | 0.8565 |
|                                       | -91.30%     | -91.30%       |         |
| Present                               | 13          | 20            | -8.20%  |         |
|                                       | -8.70%      | -8.70%        |         |
| Alcohol consumption* (gou/wk)          |             |               |         |
| Non-drinker                           | 41          | 167           | -25.80% | <0.0001|
|                                       | -72.60%     | -72.60%       |         |
| <7                                    | 21          | 37            | -13.20% |         |
|                                       | -16.10%     | -16.10%       |         |
| 7-13                                  | 36          | 22            | -22.60% |         |
|                                       | -9.60%      | -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)                      |                      |                        |                        |
| 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 | Alcohol consumption*** (gou/wk) | 7/33 (21.2%) | 0.70 (0.29-1.66) | 0.72 (0.29-1.77) |
|----------------|---------|---------------------------------|---------------|------------------|------------------|
| 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        | 72/277 (26.0%) | 1 (Ref)         | 1 (Ref)       |                  |                  |
| Non-smoker     | 17/62 (27.4%)  | 1.08 (0.58-2.00) | 1.31 (0.67-2.56) |                  |                  |
| Past smoker    | 17/50 (34.0%)  | 1.47 (0.77-2.79) | 1.94 (0.97-3.87) |                  |                  |
| Current smoker | 13/45 (28.9%)  | 1 (Ref)         | 1 (Ref)       |                  |                  |
| Bedtime        | 38/116 (32.8%) | 1.20 (0.57-2.54) | 1.28 (0.58-2.85) |                  |                  |
| -8:59 p.m.     | 11/44 (25.0%)  | 0.96 (0.45-2.04) | 0.93 (0.42-2.09) |                  |                  |
| 9:00-9:59 p.m. | 22/110 (20.0%) | 0.62 (0.28-1.36) | 0.71 (0.30-1.65) |                  |                  |
| Duration of nighttime sleep (hr) | 26/67 (38.8%) | 2.01 (1.06-3.81) | 1.67 (0.84-3.32) |                  |                  |
| <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%)  | 2.04 (0.80-5.17) | 1.73 (0.63-4.76) |                  |                  |
| ≥ 9            | 9/23 (39.1%)   | 2.04 (0.80-5.17) | 1.73 (0.63-4.76) |                  |                  |
| Duration of daytime nap (min) | 44/153 (28.8%) | 1 (Ref)         | 1 (Ref)       |                  |                  |
| None           | 15/98 (15.3%)  | 0.45 (0.23-0.86) | 0.46 (0.23-0.90) |                  |                  |
| 1-29           | 21/74 (28.4%)  | 0.98 (0.53-1.82) | 0.83 (0.43-1.59) |                  |                  |
| 30-59          | 26/64 (40.6%)  | 1.70 (0.92-3.12) | 1.11 (0.57-2.15) |                  |                  |
| Sleep disturbance | 91/338 (26.9%) | 1 (Ref)         | 1 (Ref)       |                  |                  |

**Note:** P for trend refers to the statistical significance of the trend across categories. The values in parentheses represent the 95% confidence intervals.
| Use of sleeping pills | Present | 14/50 (28.0%) | 1.06 (0.54-2.05) | 1.20 (0.60-2.41) |
|-----------------------|---------|----------------|-----------------|-----------------|
| 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)