Types of Elder Abuse and Dementia Onset among Older Adults in Japan: A 6-year Longitudinal Study from the Japan Gerontological Evaluation Study

Chie Koga a, *, Taishi Tsuji b, Masamichi Hanazato a, Tomo Takasugi c, Katsunori Kondo a, d

a Center for Preventive Medical Sciences, Chiba University, Chiba 260-8670, Japan
b Department of Community Health and Preventive Medicine, Hamamatsu University School of Medicine, Shizuoka, Japan
c Faculty of Health and Sport Sciences, University of Tsukuba
d Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, 474-8511 Japan

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ABSTRACT

Objectives: Elder abuse is a growing global public health concern. Previous studies have reported that elder abuse increases the risk of dementia; however, to the best of our knowledge, no studies have investigated the association between different types of abuse and dementia onset yet. This study, therefore, investigated the association between physical, psychological, and financial abuses and dementia onset in independent older adults in Japan.

Methods: A 6-year prospective cohort data from the Japan Gerontological Evaluation Study (JAGES) were collected in 2010 through a mail survey conducted among 5,674 men and 6,562 women aged ≥65 years across Japan. Dementia was assessed using the nationally standardized dementia scale proposed by the Ministry of Health, Labor and Welfare. Poisson regression analysis was performed separately for each type of abuse to calculate the incidence rate ratios and 95% confidence intervals.

Results: During follow-up, 552 (9.7%) men and 728 (11.1%) women developed dementia. After adjusting for potential confounders, participants who experienced financial abuse were 1.53 (1.09–2.16) times more likely to develop dementia than those who did not. On the other hand, participants who experienced physical abuse were 1.53 (0.92–2.56) times more likely and those who experienced psychological abuse were 0.98 (0.82–1.17) times less likely to develop dementia than participants who did not experience such abuses. However, the difference was not significant.

Conclusion: Financial abuse may promote dementia among older adults in Japan, suggesting that preventing this abuse may help prevent dementia onset. However, further studies with larger data sets are warranted.

Introduction

Elder abuse is a growing global public health concern. (Pillemer, Burns, Riffin, & Lachs, 2016; Yon, Mikton, Gassoumis, & Wilber, 2017) The United Nations has published a policy brief that warns of the disturbing increase in the abuse of older adults during the coronavirus pandemic (COVID-19). (United Nations, 2020) Thus, evaluating the impact of elder abuse on the health of older adults is an urgent issue, given that identifying the underlying factors may help develop preventive strategies against such abuse. Although longitudinal studies on this subject are limited, previous evidence suggests that elder abuse increases the risks of negative health outcomes such as depression and suicide. (Koga, Tsuji, Hanazato, Suzuki, & Kondo, 2020; Lee & Atteraya, 2019) Moreover, another study reported that financial abuse was associated with decline in physical and psychological health. (Waite, 2017) Elder abuse has been classified into several types: physical, sexual, financial, and emotional/psychological abuses as well as neglect. (Johannesen & Logiudice, 2013) However, studies investigating the association between elder abuse and health have combined all types of abuse, with very few studies investigating each type of abuse separately. Furthermore, limited studies have included independent older adults as the target population and used longitudinal data to evaluate the association of elder abuse with health outcomes such as dementia.

Dementia is one of the various causes of disability and dependency among older adults, with estimates showing that 50 million individuals already have dementia and nearly 10 million new cases are reported...
Table 1 Characteristics of study participants.

|                          | Total   | Dementia, n | Cumulative incidence |
|--------------------------|---------|-------------|----------------------|
| Physical abuse           |         |             |                      |
| No abuse                 | 8,331   | 68.1%       | 859                  |
| Abuse                    | 109     | 0.9%        | 16                   |
| Missing                  | 3,796   | 31.0%       | 405                  |
| Psychological abuse      |         |             |                      |
| No abuse                 | 7,169   | 58.6%       | 733                  |
| Abuse                    | 1,239   | 10.1%       | 135                  |
| Missing                  | 3,828   | 31.3%       | 412                  |
| Financial abuse          |         |             |                      |
| No abuse                 | 8,500   | 69.5%       | 880                  |
| Abuse                    | 224     | 1.8%        | 34                   |
| Missing                  | 3,512   | 28.7%       | 366                  |
| Depression               |         |             |                      |
| No depression            | 7,524   | 61.5%       | 614                  |
| Mild or severe depressives | 2,701  | 22.1%       | 375                  |
| Missing                  | 2,011   | 16.4%       | 291                  |
| Sex                      |         |             |                      |
| Male                     | 5,674   | 46.4%       | 552                  |
| Female                   | 6,562   | 53.6%       | 728                  |
| Age                      |         |             |                      |
| 65–69                    | 3,374   | 27.6%       | 81                   |
| 70–74                    | 3,679   | 30.1%       | 192                  |
| 75–79                    | 2,829   | 22.1%       | 347                  |
| 80–84                    | 1,630   | 13.3%       | 390                  |
| ≥85                      | 724     | 5.9%        | 270                  |
| Education attainment     |         |             |                      |
| ≤9                       | 5,911   | 48.3%       | 694                  |
| ≥10                      | 6,014   | 49.2%       | 507                  |
| Missing                  | 311     | 2.5%        | 79                   |
| Equivalent income        |         |             |                      |
| Low(<199)                | 4,982   | 40.7%       | 510                  |
| Mid(200–399)             | 3,901   | 31.9%       | 334                  |
| High(≥400)               | 1,157   | 9.5%        | 87                   |
| Missing                  | 2,196   | 17.9%       | 349                  |
| Living arrangement       |         |             |                      |
| Living with someone      | 9,933   | 81.2%       | 973                  |
| Living alone             | 1,362   | 11.3%       | 158                  |
| Missing                  | 921     | 7.5%        | 149                  |
| Marital status           |         |             |                      |
| Married                  | 8,601   | 70.3%       | 718                  |
| Widowed                  | 2,676   | 21.9%       | 440                  |
| Separated                | 396     | 3.2%        | 36                   |
| Unmarried                | 249     | 2.0%        | 31                   |
| Missing                  | 314     | 2.6%        | 55                   |
| BMI                       |         |             |                      |
| <18.5                    | 884     | 7.2%        | 142                  |
| 18.5–24.9                | 8,251   | 67.4%       | 762                  |
| 25.0–29.9                | 2,358   | 19.1%       | 197                  |
| ≥30                      | 763     | 6.2%        | 179                  |
| Longest job held         |         |             |                      |
| Professional/technical   | 1,619   | 13.2%       | 138                  |
| Administrative            | 640     | 5.2%        | 41                   |
| Clerical                 | 1,629   | 13.3%       | 153                  |
| Sales/service            | 1,577   | 12.9%       | 131                  |
| Skilled/labor            | 1,383   | 11.3%       | 116                  |
| Agriculture/forestry/fishery | 1,181 | 9.7%       | 128                  |
| Others                   | 1,426   | 11.7%       | 170                  |
| No occupation            | 619     | 5.1%        | 93                   |
| Missing                  | 2,162   | 17.7%       | 310                  |
| Alcohol consumption      |         |             |                      |
| Drinker                  | 3,869   | 31.6%       | 309                  |
| Stop drinking            | 398     | 3.3%        | 62                   |
| Non-drinker              | 7,066   | 57.7%       | 797                  |
| Missing                  | 903     | 7.4%        | 112                  |
| Smoking                  |         |             |                      |
| Never smoker             | 6,524   | 53.3%       | 673                  |
| Former smoker            | 2,560   | 20.9%       | 271                  |
| Smoker                   | 1,762   | 14.4%       | 156                  |
| Missing                  | 1,390   | 11.4%       | 180                  |
| Frequency of meeting friends |       |             |                      |
| 4 times or more than a week | 1,661 | 13.6%       | 152                  |

The association between different types of elder abuse (i.e., physical, psychological, and financial abuses) and dementia onset in older women revealed no association between violence, such as being pushed, grabbed, hit, and forced to participate in unwanted sexual activity, and dementia. (Cations, Keage, Laver, Byles, & Loxton, 2020) The risk of dementia incidence associated with elder abuse has been scarcely evaluated, and previous studies on dementia have reported inconsistent findings. A case-control study showed that women with Alzheimer’s disease reported a history of interpersonal violence (IPV) four times more frequently than their healthy counterparts (Leung, Thompson, & Weaver, 2006). Furthermore, a longitudinal study that investigated the association between IPV and dementia incidence in older women revealed no association between violence, such as being pushed, grabbed, hit, and forced to participate in unwanted sexual activity, and dementia. (Cations, Keage, Laver, Byles, & Loxton, 2020)

Dementia has strongly associated with depression (Bennett & Thomas, 2014; Diniz, Butters, Albert, Dew, & Reynolds, 2013). Because depression and elder abuse have a bidirectional relationship, the association between elder abuse and dementia is worth investigating (Koga, Tsuji, et al., 2020). Our hypothesis was that elder abuse is a risk factor for dementia onset. Because studies that investigated the association between different types of elder abuse and dementia onset are sparse, we investigated the association between different types of elder abuse (i.e., physical, psychological, and financial abuses) and dementia onset in independent older adults in Japan.
Table 2
Results of Poisson regression analysis between the types of elder abuse and dementia onset.

| Days of Follow-up | Dementia Onset Within 500 Days | Dementia Onset Within 1,000 Days | Dementia Onset Within 1,500 Days | Dementia Onset Within 2,000 Days | Entire Follow-Up Period |
|-------------------|-------------------------------|---------------------------------|---------------------------------|---------------------------------|------------------------|
| Physical Abuse     |                               |                                 |                                 |                                 |                        |
| No Abuse           | 319                           | 1.00                            | 684                             | 1.00                            | 1057                   | 1.00                   |
| Abuse              | 48                            | 2.11                            | 94                              | 1.91                            | 166                   | 2.69                   |
| Psychological Abuse |                               |                                 |                                 |                                 |                        |
| No Abuse           | 319                           | 1.00                            | 693                             | 1.00                            | 1083                   | 1.00                   |
| Abuse              | 48                            | 2.11                            | 94                              | 1.91                            | 166                   | 2.69                   |
| Financial Abuse    |                               |                                 |                                 |                                 |                        |
| No Abuse           | 319                           | 1.00                            | 693                             | 1.00                            | 1083                   | 1.00                   |
| Abuse              | 48                            | 2.11                            | 94                              | 1.91                            | 166                   | 2.69                   |

IRR: Incidence rate ratio
CI: Confidence interval

Methods

Study design and respondents

This study used longitudinal cohort data from the Japan Gerontological Evaluation Study (JAGES) collected through a mail survey. (Kondo & Rosenberg, 2018) The baseline survey was conducted in 2010 and involved participants from 16 municipalities across Japan. This population-based study included independent older adults aged ≥65 years who had no physical or cognitive disabilities. The participants were not eligible for public long-term care insurance benefits. The municipalities included in JAGES data were urban, suburban, and rural communities from the northern- to southernmost prefectures in Japan. Although the municipalities were not selected randomly, the data covered a wide range and size of community populations. However, participants within a municipality were selected randomly. Among the 56,587 eligible participants, 54,539 (96.2%) were successfully associated with the records of dementia over a follow-up period of 6 years from August 2010 to December 2016. Among the 54,539 respondents, 52,061 had valid information regarding identification number, sex, age, and dependence status in terms of activities of daily living (ADL). For the present study, the abuse item was randomly sampled from one-fifth of the JAGES participants in 2010, covering the data of 12,236 individuals.

Measurements

Dementia Outcome

Dementia incidence during the follow-up period from 2010 to 2016 was ascertained through associating the participants with the standardized in-home assessment and medical examination data obtained from the public long-term care insurance registry in Japan (Tamiya et al., 2011) Under this system, the certification board of each municipality sends trained surveyors to the applicant’s home to assess (1) physical function, (2) ADL, (3) cognitive function, (4) mental and behavioral disorders, (5) adaptation to social life, and (6) previous medical treatment (Ministry of Health, 2009) and the applicant’s eligibility to receive the benefits of long-term care insurance, such as home assistance or day care. Moreover, their primary care physician also submitted a written judgment. After the assessment, the investigators classified the applicants into one of the eight dementia categories according to the severity of their cognitive impairment (Hikichi, Kondo, Takeda, & Kawachi, 2017) A validation study has revealed strong associations with the Mini Mental State Examination (Hisano, 2009) Our study defined patients with dementia as those who obtained Level II or higher scores on the dementia scale (Takasugi, Tsuji, Nagamine, Miyaguni, & Kondo, 2019; Tani, Fujiwara, & Kondo, 2020)

Elder Abuse

Elder abuse based on three dimensions, namely, physical, psychological, and financial abuses, was measured at baseline using a self-reported questionnaire. (Koga, Hanazato, Tsuji, Suzuki, & Kondo, 2020; Koga, Tsuji, et al., 2020) For physical abuse, the respondents answered the following question: In the past year, did you ever experience physical violence such as being hit, kicked, having objects thrown at you, or being shut in a room? For psychological abuse, they answered the following question: In the past year, did you ever experience an act that harmed your self-esteem such as verbal abuse, cutting remarks, or being ignored for long periods? Answers to both questions were rated on a 4-point scale: 1, never; 2, once or twice; 3, occasionally; and 4, frequently. Those who answered 1 (never) were considered nonabused, whereas those who answered 2–4 were considered abused. Concerning financial abuse, the respondents answered the following question: Does anyone, including your family members, take or use your savings or pension benefits without your consent? Answers were recorded as either yes or no, with the former indicating abuse and the latter indicating nonabuse. These questionnaires were designed through the collective effort of...
several researchers, including medical doctors, social epidemiology researchers, and social workers. Owing to the lack of an official and established definition, clarifying the criteria for determining the type, frequency, and duration of behaviors that constitute elder abuse remains challenging. Questionnaires were designed to identify specific actions that respondents had endured, such as being hit, harm to their self-esteem, and being prevented from accessing their savings/pension benefits, to verify the presence or absence of abuse.

**Covariates**

In accordance with previous studies that investigated elder abuse and dementia, the present study included basic demographic information such as sex (men or women), age (65–69, 70–74, 75–79, 80–84, or ≥85 years), education level (<9 or ≥10 years), equivalent income (low, ≤1,999,999 yen; middle, 2,000,000–3,999,999 yen; or high, ≥4,000,000 yen), marital status (married, widowed, divorced, unmarried, or others), and living arrangements (living alone, with family members, or other facilities). (Koga, Hanazato, et al., 2020; Kondo & Rosenberg, 2018; Takasugi et al., 2019) Depressive symptoms were also measured using the 15-item Geriatric Depression Scale, which defines mild and severe depression as ≥5 and >10 points, respectively. (Haseda et al., 2017; M. Saito et al., 2017) The following factors were also included based on previous studies investigating the risk of dementia: body mass index (18.5, 18.5–24.9, 25.0–29.9, and ≥30), job they had for the longest duration (professional/technical, administrative, clerical, sales/service, skilled/labor, agriculture/forestry/fishery, others, and no occupation), alcohol consumption (drinker, stopped drinking, or others), and living arrangements (living alone, with family members, or other facilities). (Koga, Hanazato, et al., 2020; Kondo & Rosenberg, 2018; Takasugi et al., 2019) Depressive symptoms were also measured using the 15-item Geriatric Depression Scale, which defines mild and severe depression as ≥5 and >10 points, respectively. ([Haseda et al., 2017; M. Saito et al., 2017])

**Statistical analysis**

Descriptive analysis was used to summarize the characteristics of the participants. Furthermore, owing to that lack of some variables in this analysis, such as abuse, multiple imputations were performed. A total of 20 multiple imputed datasets, including all measurement variables, were created using the multivariate normal imputation method under a “missing at random” assumption, after which the estimated parameters were combined using Rubin’s combination methods. Because proportional hazard assumption was not permitted on the basis of Kaplan–Meier curve, Cox proportional-hazards model was not used. We performed Poisson regression analysis separately for each type of abuse to calculate the incidence rate ratios (IRRs) and 95% confidence intervals (CIs) for dementia onset after adjusting for all covariates. The analysis was performed by increasing the follow-up period every 500 days, which resulted in the following follow-up points: <500 days, <1,000 days, <1,500 days, <2,000 days, and the entire follow-up period. All statistical analyses were performed using Stata 16/IC (StataCorp, College Station, TX, USA).

**Results**

Table 1 presents the characteristics of the 12,236 respondents. Among all included respondents, 5,674 (46.4%) and 6,562 (53.6%) were men and women, respectively; among them, 552 (9.7%) men and 728 (11.1%) women had dementia. A total of 109 (0.9%) participants experienced physical abuse; among participants who experienced physical abuse, 16 (14.7%) developed dementia during the follow-up period. In total, 1239 participants experienced psychological abuse, and 135 (10.9%) developed dementia during the follow-up period. Furthermore, 224 (1.8%) participants experienced financial abuse; among them, 34 (15.2%) developed dementia during the follow-up period.

**Discussion**

The present study investigated the association between types of abuse, such as physical, psychological, and financial abuses, and dementia onset among independent older adults in Japan. Our results showed that financial abuse is significantly associated with a higher risk of developing dementia during the follow-up period, whereas physical and psychological abuses showed no such association. To the best of our knowledge, this is the first longitudinal study to investigate the association between different types of elder abuse and dementia onset in older adults in Japan.

The present study found a positive association between financial abuse and dementia onset in older adults in Japan. This might be because of the level of involvement in social relationships. A previous study revealed an association between a lower risk of elder abuse and the higher levels of social capital. (Koga, Hanazato, et al., 2020) Some studies have also reported an association between a lower perceived social support and a higher risk of financial exploitation. (Beach & Schulz, 2016; Liu, Wood, Xi, Berger, & Wilber, 2017) Moreover, social relationship or social participation is known to potentially protect against dementia. (Fujihara et al., 2019; Nemoto et al., 2017; T. Saito, Murata, Saito, Takeda, & Kondo, 2018) For example, a study on dementia pathway by a previous study stated that cognitive stimulation by social relationship may prevent cognitive decline and, eventually, dementia onset. (Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000) Financial abuse may also result in reduced social activities because of economic restrictions. Thus, low social relationships may be attributed to an increased risk of dementia onset. However, a study on dementia-free participants reported that decreased scam awareness is associated with the incidence of Alzheimer’s disease. Older age, lower cognitive functioning, and lower literacy skills have also been reported to be associated with a higher susceptibility to scams. (Boyle, Yu, Schneider, Wilson, & Bennett, 2019; Peter A, Lichtenberga, Grossb, & Fickerc, 2020) Although we did not measure the scam perception, our analysis targeted independent older adults and included a question on whether paying bills was possible as part of the IADL questionnaire. We
found a significant association, and even after excluding these effects at baseline, the association remained. Therefore, dementia onset due to cognitive decline at baseline may not in this case.

This study found no association between physical abuse and dementia onset. One of the reasons might be the small number of cases that occurred. During the 6-year follow-up period, only 109 participants had dementia onset. In a previous study, no association was noted between physical violence such as being pushed, grabbed, kicked, or hit and dementia. (Cations et al., 2020) However, physical abuse might have led to brain damage if the violence was targeted at the face or head. Our analysis included a question on whether the respondents had ever been hit, kicked, or been thrown at with any objects. Although this study did not specify the body part that was hit, previous studies have suggested that brain damage from being hit during boxing or traumatic brain injury can cause dyskinesia, cognitive impairment, and behavioral disorders in later life. (Barnes et al., 2018; Jordan, 2000) In future, studies with large samples are necessary to ascertain the impact of physical abuse on dementia.

Similarly, no significant association was found between psychological abuse and dementia onset in our study population, suggesting that psychological abuse itself does not directly contribute to the development of dementia. A previous study reported that psychological interpersonal violence is significantly associated with mental health consequences, including depression, in both men and women. (Coker et al., 2002) whereas an observational study suggested that older adults with poor psychological conditions had a higher risk of dementia. (Takeda, Kondo, & Hirai, 2010) In our study, participants who had mild or severe depression were 1.23 (95% CI = 1.08–1.39) times more likely to develop dementia for the entire follow-up period. Hence, although depression resulting from continued psychological abuse may possibly increase the risk of dementia, it is unlikely that psychological abuse directly contributes to the risk of developing dementia. The content of the cutting remarks cannot be mentioned in this study, but it may have affected retraf activities of the older adults, for example, if a participant is told that they see their friends too often or go out too much, that cause them to refrain from social interaction. Furthermore, in psychological abuse, whether it is considered abuse or not may vary depending on the perception of the individual, and there may be more variability in its measurement than in that of physical or financial abuse.

The present study has some limitations. First, this study did not assess dementia using clinical diagnostic criteria, which might have introduced misclassification of dementia among the participants. However, the scale criteria utilized herein had been validated in accordance with other assessments such as the Mini Mental State Examination. (Hisanou, 2009) Second, missing data of nonrespondents might have introduced selection bias. Moreover, participants suffering from severe abuse might not have responded to the questionnaire, and this might have led to underestimating the results. Third, we excluded participants with marked ADL dysfunction and those on public long-term care insurance benefits because evidence suggests that ADL-dependent respondents are more likely to be abused. (Johannesen & Logiadice, 2013) Fourth, abuse in this study was measured using a self-administered questionnaire that had not been validated previously; therefore, its validity in accurately measuring elder abuse should be investigated in future studies. In addition, given that our sample targeted only Japanese older adults, studies on other populations should be conducted to confirm reproducibility. At present, studies that investigated the association between elder abuse and dementia onset are limited. To promote policy interventions, multifaceted analyses should be performed using cohort data as such that used in the present study. Fifth, the body parts of the victims that were hit during physical abuses could not be determined. Finally, because the outcome is less likely to occur, validation with a larger sample should be conducted. Despite the aforementioned limitations, this study provides important insights into the association between various types of elder abuse and dementia onset in older adults in Japan.

Conclusions

The present study investigated the association between physical, psychological, and financial abuses and dementia onset in independent older adults in Japan. The results showed a significant association between financial abuse and dementia onset over the 6-year follow-up period. Thus, preventing financial abuse may help prevent dementia. However, more studies with larger data sets are warranted.

Statement of Ethics

The Japan Gerontological Evaluation Study protocol was reviewed and approved by the Ethics Committee on Human Research of the Nihon Fukushi University (approval No. 10-05) and the Ethics Committee at the Chiba University Faculty of Medicine (approval No. 2493). Informed consent was obtained from all participants.

CRediT authorship contribution statement

Chie Koga: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft. Taishi Tsugi: Writing – review & editing, Funding acquisition. Masamichi Hanazato: Funding acquisition, Writing – review & editing, Resources. Tomo Takasugi: Writing – review & editing, Katsunori Kondo: Data curation, Funding acquisition, Resources, Supervision, Project administration.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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### Appendix

Results of Poisson regression analysis between types of elder abuse and dementia with all variables.

| Physical abuse | Psychological abuse | Financial abuse | Depression | Sex | Age (years) | Education attainment | Equivalent income | Living arrangement | Marital status | BMI | Longest job held |
|----------------|---------------------|-----------------|------------|-----|-------------|----------------------|-------------------|-------------------|----------------|-----|------------------|
| No abuse       | No abuse            | No abuse        | No depression | Male | 65–69       | Low (<199)          | 2.00              | 1.00              | Married        | 8.601 | 1.619            |
| 8,331          | 1.00                | 7,169           | 5,911       | 1.00 | 1.00        | 1.00                 | 1.00              | 1.00              | Widowed        | 2,676 | 0.66             |
| 109            | 1.71                | 1,239           | 2,701       | 1.00 | 70–74       | 3.679               | 3.679             | 3.679             | Separated      | 396   | 0.99             |
| 10             | 0.37                | 0.75            | 0.90        | 0.90 | 70–74       | 2.829               | 2.829             | 2.829             | Living with someone | 9,933 | 1.00          |
| 1,000          | 0.53                | 0.73            | 0.60        | 0.60 | 70–74       | 1,630               | 1.630             | 1.630             | Living alone   | 1,382 | 0.74             |
| 5,59           | 0.84                | 0.73            | 0.79        | 0.79 | 70–74       | 1,08           | 1.08              | 1.08              | Married        | 8,601 | 1.00          |
| 1.00           | 0.41                | 1.56            | 0.92        | 0.92 | ≥85         | 724                 | 724               | 724               | Widowed        | 2,676 | 0.64          |
| 1.00           | 0.77                | 1.32            | 0.79        | 0.79 | ≥85         | 115                 | 1.15              | 1.15              | Separated      | 396   | 0.95             |
| 1.00           | 1.31                | 0.96            | 0.74        | 0.74 | ≥85         | 1,33                 | 1.55              | 1.55              | Living with someone | 9,933 | 1.00          |
| 1.00           | 0.63                | 1.10            | 0.81        | 0.81 | ≥85         | 0.55                 | 0.55              | 0.55              | Living alone   | 1,382 | 0.69             |
| 1.00           | 0.77                | 1.32            | 0.81        | 0.81 | ≥85         | 1.55                 | 0.55              | 0.55              | Married        | 8,601 | 1.00          |
| 1.00           | 0.80                | 1.16            | 0.76        | 0.76 | ≥85         | 0.55                 | 0.55              | 0.55              | Widowed        | 2,676 | 0.64          |
| 1.00           | 0.82                | 1.24            | 0.79        | 0.79 | ≥85         | 1.55                 | 0.55              | 0.55              | Separated      | 396   | 0.95             |
| 1.00           | 0.84                | 1.10            | 0.76        | 0.76 | ≥85         | 0.55                 | 0.55              | 0.55              | Living with someone | 9,933 | 1.00          |
| 1.00           | 0.86                | 1.13            | 0.81        | 0.81 | ≥85         | 1.55                 | 0.55              | 0.55              | Living alone   | 1,382 | 0.69             |
| 1.00           | 0.97                | 1.00            | 0.79        | 0.79 | ≥85         | 0.55                 | 0.55              | 0.55              | Married        | 8,601 | 1.00          |
| 1.00           | 0.94                | 1.00            | 0.79        | 0.79 | ≥85         | 0.55                 | 0.55              | 0.55              | Widowed        | 2,676 | 0.64          |
| 1.00           | 0.87                | 1.00            | 0.79        | 0.79 | ≥85         | 0.55                 | 0.55              | 0.55              | Separated      | 396   | 0.95             |
| 1.00           | 0.81                | 1.00            | 0.79        | 0.79 | ≥85         | 0.55                 | 0.55              | 0.55              | Living with someone | 9,933 | 1.00          |
| 1.00           | 0.78                | 1.00            | 0.79        | 0.79 | ≥85         | 0.55                 | 0.55              | 0.55              | Living alone   | 1,382 | 0.69             |
| 1.00           | 0.91                | 1.00            | 0.79        | 0.79 | ≥85         | 0.55                 | 0.55              | 0.55              | Married        | 8,601 | 1.00          |
| 1.00           | 0.74                | 1.00            | 0.79        | 0.79 | ≥85         | 0.55                 | 0.55              | 0.55              | Widowed        | 2,676 | 0.64          |
| 1.00           | 0.69                | 1.00            | 0.79        | 0.79 | ≥85         | 0.55                 | 0.55              | 0.55              | Separated      | 396   | 0.95             |

(continued on next page)
### Appendix (continued)

|                                      | Dementia onset within <500 days of follow-up | Dementia onset within <1,000 days of follow-up | Dementia onset within <1,500 days of follow-up | Dementia onset within <2,000 days of follow-up | Dementia onset within the entire follow-up period |
|-------------------------------------|---------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|--------------------------------------------------|
|                                     | (n = 12,236) IRR p 95%CI                     | (n = 12,236) IRR p 95%CI                       | (n = 12,236) IRR p 95%CI                       | (n = 12,236) IRR p 95%CI                       | (n = 12,236) IRR p 95%CI                           |
| No occupation                       | 619 0.63 0.07 0.38 1.03                      | 1,097 0.62 0.77 1.54                         | 1,100 0.52 0.83 1.44                         | 1,057 0.68 0.83 1.32                         | 1,070 0.54 0.86 1.33                               |
| Alcohol consumption                 |                                             |                                               |                                               |                                               |                                                 |
| Drinker                            | 3,869 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| Non-drinker                        | 7,966 0.82 0.27 0.57 1.17                    | 0.94 0.61 0.73 1.20                         | 0.94 0.53 0.78 1.14                         | 0.97 0.70 0.83 1.13                         | 0.98 0.83 0.85 1.14                               |
| Smoking                            |                                             |                                               |                                               |                                               |                                                 |
| Never smoker                       | 6,524 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| Former smoker                      | 2,560 1.42 0.12 0.92 2.18                  | 1.01 0.93 0.76 1.35                         | 1.08 0.51 0.86 1.35                         | 1.13 0.20 0.94 1.36                         | 1.10 0.27 0.92 1.32                               |
| Smoker                             | 1,762 1.28 0.35 0.77 2.12                  | 0.98 0.91 0.70 1.38                         | 1.08 0.57 0.83 1.41                         | 1.08 0.48 0.87 1.35                         | 1.08 0.48 0.87 1.33                               |
| Frequency of meeting friends       |                                             |                                               |                                               |                                               |                                                 |
| 4 times or more than a week        | 1,661 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| 2-3 times a week                   | 2,638 1.39 0.27 0.77 2.49                  | 1.10 0.61 0.76 1.59                         | 0.95 0.73 0.73 1.25                         | 0.99 0.91 0.80 1.22                         | 0.98 0.85 0.80 1.20                               |
| Occupational status                |                                             |                                               |                                               |                                               |                                                 |
| Worker                             | 2,604 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| Retired                            | 6,428 1.70 0.10 0.91 3.17                  | 1.45 0.04 1.02 2.06                         | 1.21 0.15 0.94 1.57                         | 1.27 0.03 1.03 1.57                         | 1.29 0.02 1.05 1.58                               |
| Never worked                       | 1,575 2.43 0.01 1.24 4.76                  | 1.44 0.09 0.94 2.21                         | 1.31 0.09 0.96 1.80                         | 1.40 0.01 1.08 1.82                         | 1.40 0.01 1.09 1.80                               |
| Daily walking time(minutes)        |                                             |                                               |                                               |                                               |                                                 |
| <30                                | 3,884 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| 30-59                              | 3,883 0.87 0.40 0.64 1.20                  | 0.80 0.05 0.64 1.00                         | 0.86 0.09 0.73 1.02                         | 0.90 0.17 0.79 1.04                         | 0.92 0.22 0.80 1.05                               |
| 60-89                              | 1,785 0.58 0.05 0.34 1.01                  | 0.63 0.01 0.44 0.89                         | 0.75 0.02 0.59 0.95                         | 0.82 0.04 0.67 0.99                         | 0.82 0.04 0.68 0.99                               |
| Hypertension                       |                                             |                                               |                                               |                                               |                                                 |
| No                                 | 4,579 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| Yes                                | 4,728 0.77 0.08 0.58 1.03                  | 0.84 0.09 0.69 1.03                         | 0.80 0.01 0.68 0.93                         | 0.83 0.01 0.73 0.94                         | 0.83 0.01 0.74 0.94                               |
| Stroke                             |                                             |                                               |                                               |                                               |                                                 |
| No                                 | 9,149 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| Yes                                | 158 2.15 0.04 1.04 4.46                   | 1.59 0.10 0.91 2.80                         | 1.50 0.08 0.95 2.39                         | 1.55 0.02 1.07 2.26                         | 1.52 0.02 1.06 2.19                               |
| Diabetes                           |                                             |                                               |                                               |                                               |                                                 |
| No                                 | 7,814 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| Yes                                | 1,493 1.30 0.18 0.88 1.93                 | 1.23 0.14 0.94 1.60                         | 1.24 0.03 1.02 1.52                         | 1.20 0.03 1.02 1.42                         | 1.21 0.02 1.04 1.41                               |
| Hearing                            |                                             |                                               |                                               |                                               |                                                 |
| No                                 | 8,393 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| Yes                                | 914 0.97 0.89 0.64 1.47                   | 1.09 0.54 0.83 1.43                         | 0.99 0.93 0.80 1.23                         | 1.03 0.73 0.86 1.23                         | 1.02 0.85 0.85 1.21                               |
| Instrumental activities of daily livingIADL |     |                                               |                                               |                                               |                                                 |
| Independent                        | 8963 1.00                                 | 1.00                                          | 1.00                                          | 1.00                                          | 1.00                                             |
| Dependent                          | 2290 2.03 <0.01 1.49 2.77                  | 2.06 <0.01 1.68 2.54                         | 1.86 <0.01 1.58 2.18                         | 1.63 <0.01 1.43 1.87                         | 1.56 <0.01 1.37 1.77                               |

IRR: incidence rate ratio  
CI: confidence interval
