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# Spouse's functional disability and mortality: The Ohsaki Cohort 2006 Study

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**Aim:** Caregiver burden is known to negatively affect a partner's health. Given the important role of physical and mental stress in mortality, a higher caregiver burden might be associated with an increased incidence of fatal events. However, previous studies of the effects of the partner's caregiving on mortality have shown inconsistent results. Thus, the purpose of the present longitudinal study was to determine if there is an association between a spouse's functional disability and mortality in the older Japanese population.

**Methods:** A baseline survey was carried out with 7598 participants in 2006. Information on the date of functional disability, death or emigration was retrieved from the Ohsaki City government. Functional disability was defined as receiving a certification for long-term care insurance in Japan. After a follow-up period of a maximum of 87 months, 1316 of the participants died and Cox regression analysis with adjustment for confounding factors was used to assess mortality after the incidence of functional disability in a spouse.

**Results:** The multivariate adjusted hazard ratio for mortality was 1.78 (95% confidence interval 1.52–2.08, $P < 0.01$) in those whose spouses had functional disabilities compared with those with spouses who did not have functional disabilities. The mortality was consistently higher, irrespective of age group or sex.

**Conclusions:** These results imply that caregiver burden might increase stress responses and lead to increased mortality; therefore, enhancement of support systems, including long-term care, housing and livelihood support services, for those with disability and their spouses might be important for preventing deaths. **Geriatr Gerontol Int 2019; 19: 774–779**.

**Keywords:** functional disability, longitudinal study, mortality, spouse.

## Introduction

Currently, Japan has the highest population aging rate among developed countries (Japan 26.7%, Italy 22.4%, Germany 21.2%),[1] and 17.8% of Japanese older adults (aged ≥65 years) have functional disabilities and require assistance with activities of daily living.[2] Caregivers of those with disability experience high burden,[3] and the main caregiver for these elderly patients is their spouse.[2] Furthermore, disability or hospitalization of the partner adds to this burden, and can negatively affect the partner's health conditions, including mortality.[4,5] Such perceived caregiver burden is conceptualized as problems encountered by the caregiver with their own health, psychological well-being, finances, social life, and the relationship between the caregiver and ill family member.[6] Furthermore, caregiver burden is known to lead to poor health.[7]

In Japan, more than half of the caregivers who live with care recipients are aged ≥65 years.[2] Long-term care of older adults by the older adults has been a social issue, wherein caring for older adult patients with disability is carried out by older adults, and the psychological burden of these older adult caregivers is known to be arguably heavier.[8] In contrast, although women have been the main caregivers in the past in Japan, nearly 30% of the caregivers are currently men.[2] Men lack experience with personal care, and compared with women, they are less likely to provide assistance with tasks related to personal care.[9] However, if they cannot get enough support, they might experience more psychological distress related to caregiving than that experienced by women. Therefore, the burden of caring for older adults might have different impacts depending on age and sex.

Previous studies of the effects of a partner's caregiving on mortality have shown inconsistent results. Some studies have shown

an association with all-cause mortality and cardiovascular disease (CVD) risks,[4,10–13] whereas others have not found any such association.[14–17] The impact of the caregiving burden on mortality might differ between age and sex based on the caregiving burden differences between the two factors. In addition, a previous study has reported that mortality in partners was much higher early in the course of a partner's illness, implying that duration of the disability might also affect mortality.[4] Determination of these differences would strengthen our understanding of the enhancement of the support systems that can reduce the impact of caregiving burden on mortality.

The purpose of the present study was to determine the association between a spouse's functional disability and mortality in the older Japanese population. We hypothesized that a spouse's functional disability was associated with an increased mortality. The present study also sought to determine the effects of the differences by age group and sex on this association.

## Methods

### *Study design, setting and participants*

The design of the Ohsaki Cohort 2006 Study has been described elsewhere in detail.[18] Ohsaki City is a typical rural area, and the main industry is agriculture. The population density in this area was 167.4 people/km$^2$ (340.8 people/km$^2$ in Japan), and the population aging rate was 27.0% (26.7% in Japan) in 2015.[1] In brief, the source population for the baseline survey comprised 77 235 men and women living in Ohsaki City, in northeastern Japan, as on 1 December 2006.

The baseline survey was carried out between 1 December 2006 and 15 December 2006 through questionnaires that were distributed to individuals in households by the heads of the individual administrative districts and collected by mail. Of the eligible 77 235 respondents, 49 855 provided valid responses and formed the study cohort. We defined spouses as follows, using the information on participants' relationship with the householder: head of household-wife, head of household-husband, mother of head of household-father of head of household and mother of spouse-father of spouse. Through this matching process, we identified 29 410 potential participants (14 705 pairs). We excluded participants who were aged <65 years, participants who did not provide written consent for a review of their long-term care insurance (LTCI) information, participants who had already been certified as having a disability by the LTCI at the time of the baseline survey, and participants who had died or moved away before the starting date of follow up; their spouses were also excluded. Finally, data from 7598 participants (3799 pairs) were analyzed in this study. During the 87-month follow-up period, just 110 participants were lost to follow up, providing a follow-up rate of 98.6%. Among 610 564 person-months, the number of all-cause deaths was 1316 (Fig. S1).

### *Measurements*

The questionnaire administered to participants aged ≥65 years requested the following information: frailty checklist (Japanese-language Kihon Checklist),[19] history of disease, health status during the last year, smoking status, alcohol consumption status, dietary habits, bodyweight and height, general health status, pain, daily activities, sports and exercise, psychological distress, educational background, social support, participation in community activities, and dental status.

### *Spouse's functional disability (the LTCI system in Japan)*

In the present study, functional disability was defined as certification for the LTCI, a form of mandatory social insurance intended to assist the frail and elderly in their daily activities, in Japan, which uses a nationally uniform standard of functional disability.[20] When a person applies to the municipal government for benefits, a care manager visits his or her home to assess the degree of functional disability using a questionnaire developed by the Japanese Ministry of Health, Labor and Welfare. Next, the municipal government calculates the standardized scores for physical and mental functions based on the questionnaire, and classifies the applicant as eligible or ineligible for LTCI benefits (certification). If a person is deemed eligible for benefits, the Municipal Certification Committee provides one of seven levels of support, including Support Levels and Care Levels. LTCI certification has previously been used as a measure of functional disability in older adults.[5]

**Table 1** Baseline characteristics based on functional disability among spouses

| Characteristic | Spouses without functional disability | Spouses with functional disability |
|---|---|---|
| No. participants | 5920 | 1678 |
| Age at baseline, years (%) | | |
| 65–74 | 66.5 | 42.9 |
| 75–84 | 31.6 | 52.5 |
| ≥85 | 1.9 | 4.7 |
| Sex (%) | | |
| Male | 52.6 | 40.9 |
| Female | 47.4 | 59.1 |
| Smoking status (%) | | |
| Non-smoking | 76.3 | 76.6 |
| Currently smoking | 12.1 | 8.6 |
| Unknown | 11.6 | 14.8 |
| Alcohol consumption (%) | | |
| Non-drinking | 53.2 | 57.9 |
| Currently drinking | 37.2 | 28.3 |
| Unknown | 9.6 | 13.8 |
| Education duration (%) | | |
| ≤15 years | 26.0 | 30.9 |
| 16–18 years | 42.2 | 37.4 |
| ≥19 years | 26.9 | 25.7 |
| Unknown | 4.9 | 6.0 |
| Community activity (%) | | |
| More than once a month | 27.3 | 23.4 |
| Less than once a month | 61.7 | 62.5 |
| Unknown | 11.0 | 14.1 |
| Social support (%) | | |
| Sufficient | 86.2 | 82.1 |
| Lack | 10.5 | 13.3 |
| Unknown | 3.3 | 4.6 |
| Self-rated health (%) | | |
| Good | 31.8 | 30.8 |
| Fair | 50.0 | 49.4 |
| Poor | 17.4 | 18.4 |
| Unknown | 0.9 | 1.4 |
| Body mass index (%) | | |
| <18.5 | 3.7 | 5.2 |
| 18.5–24.9 | 56.5 | 54.5 |
| ≥25.0 | 26.9 | 25.4 |
| Unknown | 12.9 | 14.9 |
| Kihon Checklist (mean ± SD) | | |
| | 4.1 ± 3.5 | 4.8 ± 3.6 |

SD, standard deviation.

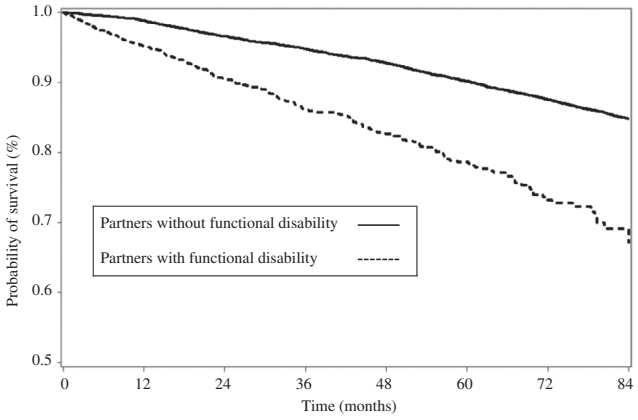


**Figure 1** Kaplan–Meier curves of mortality according to functional disability among spouses.

### *Follow up and case ascertainment*

We obtained information on the date of LTCI certification (incidence of functional disability), death or emigration from the Ohsaki City government and data were transferred, once a year in December, according to an agreement related to epidemiological research and privacy protection.

The primary outcome was all-cause mortality. We followed up with the participants for mortality and emigration by reviewing the residential registry record of Ohsaki City from 16 December 2006 to 31 March 2014. The National Vital Statistics Database of Japan was used to determine the cause of death in deceased participants with permission from the Japanese Ministry of Health, Labor and Welfare, and the causes of death were classified according to the International Classification of Diseases, 10th revision (ICD-10). Death due to CVD was identified as ICD-10: I00–I99, and death due to other causes was identified as ICD-10: other than I00–I99.

We calculated person-months of follow up for each participant from 16 December 2006 until the date of the incidence of functional disability, death, emigration or the end of the study period (31 March 2014), whichever occurred first. The exposure variable (incidence of functional disability) was considered as a time-dependent variable; thus, person-time before the spouse's functional disability was counted as unexposed, whereas person-time after the spouse's functional disability was counted as exposed. Exposed person-time was further categorized based on duration of follow up since date of the incidence of functional disability (<12 months, 12–35 months and 36–87 months).[21]

### *Ethical issues*

We considered the return of a completed questionnaire to imply consent to participate in the study, which involved baseline survey data and a subsequent follow up of death and emigration. We also confirmed information regarding LTCI certification statuses after obtaining written consent from the participants. The ethics committee of Tohoku University Graduate School of Medicine (Sendai, Japan) reviewed and approved the study protocol.

### *Statistical analysis*

The Kaplan–Meier survival curves were used to obtain estimates of survival at 87 months, and the log–rank test was used to test for significant differences among survival curves derived based on the categories of functional disability among spouses (spouses with and without functional disability). Cox regression analysis was used to assess the all-cause and CVD mortality after the incidence of functional disability in a spouse. The hazard ratio (HR) and 95% confidence interval (CI) for mortality after having experienced functional disability in a spouse was compared with that for mortality without having experienced functional disability in a spouse. In a sensitivity analysis of HR of mortality for the functional disability according to time since entry, we divided the follow-up period as <12 months, 12–35 months and 36–87 months, and then examined HR in these three intervals of follow up.

In addition, stratified analyses according to age group (65–-74 years, ≥75 years) or sex (male, female) were carried out based on the association between a spouse's functional disability and mortality. Furthermore, the participants were divided into four categories based on the spouse's functional disability (i.e. spouses with and without functional disability), age group or sex, and then classified into groups based on age group as follows: (i) spouses without functional disability AND aged 65–74 years; (ii) spouses without functional disability AND aged ≥75 years; (iii) spouses with functional disability AND aged 65–74 years; and (iv) spouses with functional disability AND aged ≥75 years. A similar grouping based on sex was as follows: (i) spouses without functional disability AND female; (ii) spouses without functional disability AND male; (iii) spouses with functional disability AND female; and (iv) spouses with functional disability AND male. Such a grouping enabled us to fit the Cox regression model while allowing for interactions between the spouse's functional disability and mortality. In addition, we also carried out propensity score

**Table 2** Multivariate hazard rations and 95% confidence intervals of all-cause mortality according to functional disability among spouses in three intervals of follow up after the spouse's functional disability: <12 months, 12–35 months and 36–87 months of follow up

| | Spouses without functional disability | Spouses with functional disability |
|---|---|---|
| Person-months of follow up (mean/median) | 552 704 (73/87) | 57 860 (34/30) |
| No. deaths | 1076 | 240 |
| Multivariate HR (95% CI) | 1.00 (Ref.) | 1.78 (1.52–2.08) |
| *P*-value | – | <0.01 |

| | Spouses without functional disability | Spouses with functional disability | | |
|---|---|---|---|---|
| | | <12 months of follow up | 12–35 months of follow up | 36–87 months of follow up |
| Person-months of follow-up (mean/median) | 552 704 (73 / 87) | 17 653 (11 / 12) | 23 440 (18/24) | 16 768 (24/23) |
| No. deaths | 1076 | 73 | 97 | 70 |
| Multivariate HR (95% CI) | 1.00 (Ref.) | 2.87 (2.09–3.94) | 1.98 (1.54–2.55) | 1.73 (1.30–2.29) |
| *P*-value | – | <0.01 | <0.01 | <0.01 |

Multivariate hazard ratio (HR) was adjusted for age (65–74, 75–84 or ≥85 years), sex (male or female), smoking status (non-smoking, currently smoking or unknown), alcohol consumption (non-drinking, currently drinking or unknown), education duration (≤15, 16–18, ≥19 years or unknown), community activity (more than once a month, less than once a month or unknown), social support (sufficient, lack or unknown), self-rated health (good, fair, poor or unknown), body mass index (<18.5, 18.5–24.9, ≥25.0 or unknown) and Kihon Checklist (continuous variable). Time since entry into the study was used as the time scale. CI, confidence interval.

matching analysis. The propensity scores were calculated using multivariate regression with spouses with and without functional disability as dependent variables, and age, sex, smoking status, alcohol consumption, education duration, community activity, social support, self-rated health, body mass index and the Kihon checklist as independent variables. Additional information is provided in the Supporting Doc 1.

Statistical analyses were carried out using the software SAS, version 9.4 (SAS Institute, Cary, NC, USA), and SPSS version 23 (IBM, Armonk, NY, USA). Differences with a *P*-value of <0.05 were considered as statistically significant.

## Results

### *Baseline characteristics by functional disability among spouses*

Among the 7598 participants enrolled, 1678 (22.1%) participants had spouses with functional disabilities, whereas the remaining 5920 (77.9%) did not. As shown in Table 1, participants with spouses who had functional disabilities were older, and more likely to be women and to have a higher mean Kihon checklist score compared with participants with spouses who did not have functional disabilities.

### *Mortality according to functional disability among spouses*

The Kaplan–Meier survival curves showed that those whose spouses with functional disabilities were associated with a higher mortality compared with those with spouses without functional disabilities ($P < 0.01$; Fig. 1). Table 2 shows the HR (95% CI) for mortality according to the functional disability among spouses. There was a statistically significant association between a spouse's functional disability and mortality. Compared with those whose spouses did not have functional disabilities, the multivariate adjusted HR for mortality was 1.78 (95% CI 1.52–2.08, $P < 0.01$) for those whose spouses had functional disabilities. Sensitivity analysis of mortality due to spouse functional disability based on time since entry showed that the above-mentioned increase in the mortality was attributable to an increase in mortality from 12 months of follow up. The multivariate adjusted HR for mortality were 2.87 (95% CI 2.09–3.94, $P < 0.01$) at <12 months of follow up, 1.98 (95% CI 1.54–2.55, $P < 0.01$) for 12–35 months of follow up and 1.73 (95% CI 1.30–2.29, $P < 0.01$) for 36–87 months of follow up.

Table 3 shows the multivariate HR and 95% CI of all-cause mortality according to functional disability among spouses stratified by age group or sex. The increase in mortality with those with disability spouses was independent of age group or sex (Table 3). There was no difference across the age group tested (*P* for interaction = 0.66); likewise, sex did not have a significant effect modification (*P* for interaction = 0.15). Furthermore, Table 4 shows the multivariate adjusted HR (95% CI) for mortality, categorized based on a combination of the spouse's functional disability and age group or sex. The present results also identified that the mortality among those whose spouses had functional disabilities was consistently increased, irrespective of age class or sex. Additional information is provided in the Supporting Doc 2 (Table S1, S2).

**Table 3** Multivariate hazard ratios and 95% confidence intervals of all-cause mortality according to functional disability among spouses stratified by age group or sex

| | Spouses without functional disability | Spouses with functional disability |
|---|---|---|
| Age group (65–74 years) | | |
| Person-months of follow up (mean/median) | 363 425 (78/87) | 12 825 (46/46) |
| No. deaths | 443 | 17 |
| Multivariate HR 1 (95% CI) | 1.00 (Ref.) | 2.01 (1.23–3.30) |
| *P*-value | – | < 0.01 |
| Age group (≥75 years) | | |
| Person-months of follow up (mean/median) | 189 280 (64/81) | 45 035 (32/25) |
| No. deaths | 633 | 223 |
| Multivariate HR 1 (95% CI) | 1.00 (Ref.) | 2.02 (1.72–2.38) |
| *P*-value | – | <0.01 |
| Female | | |
| Person-months of follow up (mean/median) | 282 069 (74/87) | 36 328 (37/32) |
| No. deaths | 256 | 71 |
| Multivariate HR 2 (95% CI) | 1.00 (Ref.) | 1.49 (1.11–2.00) |
| *P*-value | – | <0.01 |
| Male | | |
| Person-months of follow up (mean/median) | 270 636 (71/87) | 21 532 (31/25) |
| No. deaths | 820 | 169 |
| Multivariate HR 2 (95% CI) | 1.00 (Ref.) | 1.91 (1.59–2.30) |
| *P*-value | – | <0.01 |

Multivariate hazard ratio (HR) 1 was adjusted for sex (male or female), smoking status (non-smoking, currently smoking or unknown), alcohol consumption (non-drinking, currently drinking or unknown), education duration (≤15, 16–18, ≥19 years or unknown), community activity (more than once a month, less than once a month or unknown), social support (sufficient, lack or unknown), self-rated health (good, fair, poor or unknown), body mass index (<18.5, 18.5–24.9, ≥25.0 or unknown) and Kihon Checklist (continuous variable). Multivariate HR 2 was adjusted for age (65–74, 75–84 or ≥85 years), smoking status (non-smoking, currently smoking or unknown), alcohol consumption (non-drinking, currently drinking or unknown), education duration (≤15, 16–18, ≥19 years or unknown), community activity (more than once a month, less than once a month or unknown), social support (sufficient, lack or unknown), self-rated health (good, fair, poor or unknown), body mass index (<18.5, 18.5–24.9, ≥25.0 or unknown) and Kihon Checklist (continuous variable). Time since entry into the study was used as the time scale. Age group or sex as a confounding factor between spouse's functional disability and mortality was tested by adding cross-product terms to the multivariate adjusted model (age; *P* for interaction = 0.66, sex; *P* for interaction = 0.15). CI, confidence interval.

## Discussion

In the present population-based, prospective, cohort study in Japan, our results showed that those with disabled spouses were at an increased risk of mortality. We also identified that mortality among those whose spouses had functional disabilities was consistently higher, irrespective of age group or sex.

In agreement with the present results, previous studies of mortality in caregivers with disabled partners also found a significantly higher risk.[4,10–13] However, other studies have not shown any such associations.[14–17] There are several possible reasons for this discrepancy in results. First, although the age range of our study population was 65–95 years (mean age 73.6 years), the age range of the participants in the previous studies was relatively lower at 47–61 years,[14] ≥25 years[16] or ≥45 years.[17] Therefore, the physiological effects of the caregiving burden on mortality might be lower among the middle-aged partners. Second, although a previous study has reported a higher mean age of participants than ours, approximately half of the participants were not living with the care recipient.[15] In contrast, we have defined spouses as a male

**Table 4** Multivariate hazard ratios and 95% confidence intervals of mortality by category, as a combination of functional disability among spouses (spouses without functional disability or spouses with functional disability) and either age group or sex

| Functional disability among spouses × age group | Spouses without functional disability × 65–74 years | Spouses without functional disability × ≥75 years | Spouses with functional disability × 65–74 years | Spouses with functional disability × ≥75 years |
|---|---|---|---|---|
| Person-months of follow up (mean/median) | 363 425 (78/87) | 189 280 (64/81) | 12 825 (46/46) | 45 035 (32/25) |
| No. deaths | 443 | 633 | 17 | 223 |
| Multivariate HR 1 (95% CI) | 1.00 (Ref.) | 2.04 (1.80–2.32) | 2.00 (1.22–3.25) | 4.12 (3.48–4.89) |
| *P*-value | – | <0.01 | <0.01 | <0.01 |
| Functional disability among spouses × sex | Spouses without functional disability × female | Spouses without functional disability × male | Spouses with functional disability × female | Spouses with functional disability × male |
| Person-months of follow up (mean/median) | 282 069 (74/87) | 270 636 (71/87) | 36 328 (37/32) | 21 532 (31/25) |
| No. deaths | 256 | 820 | 71 | 169 |
| Multivariate HR 2 (95% CI) | 1.00 (Ref.) | 2.93 (2.50–3.44) | 1.52 (1.16–1.99) | 5.59 (4.46–7.02) |
| *P*-value | – | <0.01 | <0.01 | <0.01 |

Multivariate hazard ratio (HR) 1 was adjusted for sex (male or female), smoking status (non-smoking, currently smoking or unknown), alcohol consumption (non-drinking, currently drinking or unknown), education duration (≤15, 16–18, ≥19 years or unknown), community activity (more than once a month, less than once a month or unknown), social support (sufficient, lack or unknown), self-rated health (good, fair, poor or unknown), body mass index (<18.5, 18.5–24.9, ≥25.0 or unknown) and Kihon Checklist (continuous variable). Multivariate HR 2 was adjusted for age (65–74, 75–84 or ≥85 years), smoking status (non-smoking, currently smoking or unknown), alcohol consumption (non-drinking, currently drinking or unknown), education duration (≤15, 16–18, ≥19 years or unknown), community activity (more than once a month, less than once a month or unknown), social support (sufficient, lack or unknown), self-rated health (good, fair, poor or unknown), body mass index (<18.5, 18.5–24.9, ≥25.0 or unknown) and Kihon Checklist (continuous variable). Time since entry into the study was used as the time scale. CI, confidence interval.

and female couple living at the same address, and this might be a contributing factor for the observed inconsistency with the previous study.

In Japan, caregiving is traditionally a woman's role, and men lack relevant experience with personal care; therefore, they are less likely to provide assistance with tasks related to personal care than women.[9] Some studies have reported that the association between psychological distress and ischemic heart disease mortality stratified by sex, and high levels of distress in men increased mortality.[22,23] However, the present findings show that those with disabled spouses had a greater mortality, independent of sex. Caregivers experience a high burden, and might not have sufficient personal time.[3] Consequently, they might not be able to participate in physical and social activities or manage their health condition, irrespective of sex. Thus, the impact of caregiving burden on mortality might be greater than sex differences.

We showed that caregivers with spouses with a disability were at a significantly higher risk of mortality. The following mechanism has been proposed to explain this association between a spouse's functional disability and mortality. Because caregiving itself can be burdensome,[3] a higher caregiver burden has been associated with poor mental health.[7] Physiological conditions, such as stressful physical or mental situations, affect the activity of the hypothalamic–pituitary–adrenocortical axis and the sympathetic–adrenal–medullary system, a major stress response mechanism. The activation of the hypothalamic–pituitary–adrenocortical axis exacerbates poor mental health,[24] and poor mental health leads to an increased mortality.[25] In addition, as catecholamines work in concert with the autonomic nervous system to exert regulatory effects on the cardiovascular systems, the sympathetic–adrenal–medullary system activity contributes to the development of CVD through effects of catecholamines.[26,27]

The present results also show that the increase in mortality occurred in the first year of follow up. During the early stages of care, caregivers might not be appropriately supported by family members, relatives and/or public support systems. Caregiver burden might increase in the early stages of care, because caregiving can influence the behavior and daily life of the partner.[28] Furthermore, previous studies have documented that the partner's mortality increased in the early stages of hospitalization.[4] Thus, enhancing the community care systems is important for supporting not only those with disability, but also their partners, in the early stages of care.

Perceived burden was conceptualized as problems encountered in the relationship between the caregiver and ill family member.[6] Strategies to reduce caregiver burden are important, because caregiver burden is significantly associated with increased mortality in older adults. In Japan, each municipal government has provided healthcare, long-term care, prevention, housing and livelihood support services as part of the Integrated Community Care system. Enhancing the Integrated Community Care system might be useful for reducing the caregiving burden.

The present study had some limitations. First, the lifestyle habits or health conditions among the study participants might have been altered positively or negatively at the time of exposure. However, we had only baseline data and no information on confounding variables on such changes. Thus, the present results could have been overestimated. Second, the actual degree of total caregiver burden in their family would be essential to the results. However, we did not obtain information on the proportion of total caregiver burden in their family, as well as on the types and usage of long-term care services, or the hours of care provided to the spouse. In Japan, approximately 50.0% of caregivers devote >2 h per day to their partners, and 25.2% of caregivers provide care for most of the day.[2] Furthermore, intense caregiving is known to be associated with increased burden on the caregivers.[29] The main caregiver among disabled patients in Japan is a spouse,[2] and spouses might experience a high caregiver's burden. Therefore, the quality of such a burden might differ with the types and usage of long-term care services or caregiving intensity. The long-term care services might reduce mortality among partners of disabled patients, because using long-term care services reduces caregiver burden.[30] Thus, further studies with respect to the

above-mentioned factors will be required. Additional information is provided in the Supporting Doc 3.

The present study investigated the association between a spouse's functional disability and mortality in the Japanese population aged >65 years. Our findings showed that those with disabled spouses had significantly higher mortality rates, and that this was independent of age and sex. The enhancement of support systems for such patients and their caregivers might be important for preventing deaths.

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## Disclosure statement

The authors declare no conflict of interest.

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## Supporting information

Additional supporting information may be found in the online version of this article at the publisher's website:

**Supporting Doc 1** Covariates.
**Supporting Doc 2** Supplementary results.
**Supporting Doc 3** Supplementary limitation.
**Table S1** Multivariate hazard ratios and 95% confidence intervals of cause-specific mortality according to functional disability among spouses.
**Table S2** Hazard ratios and 95% confidence intervals of all-cause mortality according to functional disability among spouses using propensity score matching.
**Figure S1** Flowchart of the study participants.

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