ABSTRACT

Background: There is little longitudinal evidence on the impact of specific living arrangements (ie, who individuals live with) on mental health among older adults, and no studies have examined the modifying effect of residential social cohesion level on this association. We aimed to examine the association between living arrangements and depressive symptoms and whether this association varies with residential neighborhood social cohesion level among 19,656 men and 22,513 women aged 65 years and older in Japan.

Methods: We analyzed the association between baseline living arrangements in 2010 and depressive symptoms in 2013. We calculated gender-specific odds ratios (ORs) of living arrangements for depressive symptoms using a logistic regression and conducted subgroup analyses by neighborhood social cohesion level.

Results: Among men (but not women), living alone (OR 1.43; 95% confidence intervals [CI], 1.18–1.73) and living with spouse and parent (OR 1.47, 95% CI, 1.09–1.98) were associated with increased odds of depressive symptoms compared with living with a spouse only. Living with spouse and child was a risk for men in the young age group but a protective factor for women. We also identified that the negative impact of living arrangements on depressive symptoms was attenuated in neighborhoods with higher levels of social cohesion.

Conclusions: Living arrangements are associated with risk of depressive symptoms among men and women; these associations differ by gender and neighborhood social cohesion level. Our results suggest the need to pay more attention to whether individuals live alone, as well as who individuals live with, to prevent depressive symptoms among older adults.

Key words: living arrangement; depressive symptoms; Japan; aged; social cohesion

INTRODUCTION

Major depressive disorder is a primary cause of disability, as measured by years lived with disabilities.1 Depression in later life decreases individuals’ quality of life in terms of both psychological and physical health2 and increases the risk of premature death.3 In Japan, the number of older people with mood disorder and depression has substantially increased in recent years.4 Moreover, the population is rapidly aging, and it has been predicted that one in three Japanese people will be aged ≥65 years by 2030.5 Therefore, there needs to be a greater focus on mental health among older adults to reduce the individual and social burden of these diseases.

Previous studies have reported an association between living arrangement and mental health6–12 and agree that older adults living alone are at higher risk of experiencing deteriorations in mental health. Most studies conducted in Western countries on living arrangements among older adults have focused on whether individuals live alone or not. Studies in Asian countries (including Japan) have also examined detailed living arrangement (ie, who individuals live with) and depressive symptoms.6,8 However, to the best of our knowledge, there are few longitudinal studies on the association between variation in living arrangements and risk of developing depressive symptoms among older adults, and no such studies in Asia.
Living with someone has both advantages and disadvantages. Receiving various types of social support through cohabitants may positively impact their mental health, while relational conflicts and extra duties and responsibilities for cohabitants may negatively affect their mental health. In addition, impact of living arrangements could differ by gender, particularly in societies characterized by strong gender role norms (i.e., the male breadwinner model). In such societies, women are generally more likely to adopt the role of providing various types of social support for family members at home compared to men. Thus, we hypothesized that types of living arrangement affect people’s mental health differently, and the impact could differ by gender.

Social capital, defined as the resources that individuals access through their social networks, has been identified as a crucial social determinant of health. These social resources comprise trust between people in a network, the exchange of information, instrumental support, emotional support, and social reinforcement. Several studies have examined the effect of social capital on mental health among older adults, but few have investigated the interactive effect of social capital and other social factors. One study examined the interactive effect of marital status on the association between neighborhood disorder and depression among older adults and demonstrated that social factors. One study examined the interactive effect of marital status on the association between neighborhood disorder and social factors. One study examined the interactive effect of marital status on the association between neighborhood disorder and social capital.

In other words, social capital and other social factors. One study examined the interactive effect of marital status on the association between neighborhood disorder and social capital.

The objectives of this study were to investigate the associations of living arrangements (living alone; with spouse only; with spouse and parent(s); with spouse and child; with spouse, parent(s), and child; with parent(s) and/or child without spouse; or other arrangements) with depressive symptoms over a follow-up period among older Japanese adults. We aimed to answer the following specific research questions:

1) Does the risk of developing depressive symptoms differ according to the level of neighborhood social cohesion? To measure neighborhood social cohesion, we used a validated neighborhood social cohesion scale derived from Saito et al. The GDS is a well-known instrument to measure depression among older adults and has been extensively validated and used for healthy older adults in community setting; the GDS score was found to have a sensitivity of 88%–92% and specificity of 62%–81% compared with a structured interview for depression. Following previous research, those with a score of ≥5 on the GDS in 2013 were considered to have newly developed depressive symptoms during the follow-up period.

2) Is the association between depressive symptoms and living arrangements modified by gender? For the subgroup analysis, we created a neighborhood social cohesion variable using a validated neighborhood social cohesion scale derived from Saito et al. Briefly, school district was defined as level of neighborhood and a measure of neighborhood social capital was generated using factor analysis. The analysis produced three social capital components, one of which was social cohesion. Social cohesion was measured by summing up the scores on three questions about community trust, reciprocity, and community attachment for each school district, following our previous studies. The total number of school districts was 525 in this study. For the subgroup analysis, we created two social cohesion groups using the median: high and low. We did not calculate a social cohesion score for school districts with a small sample size.

3) Is the association between depressive symptoms and living arrangements modified by the level of neighborhood social cohesion?

MATERIALS AND METHODS

Study population

This study used longitudinal data from the Japan Gerontological Evaluation Study (JAGES) conducted in 2010 and 2013. Details of the study procedure have been described elsewhere. Briefly, the baseline sample in 2010 comprised 92,272 participants (response rate: 65%). Among them, 77,714 participants were targeted in the follow-up survey after the exclusion of participants who had died, received benefits from public long-term care insurance, or moved to another municipality during the follow-up period. Approximately 80% of the participants (n = 62,438) completed the follow-up self-report questionnaire in 2013.

Of these 62,438 men and women, we excluded the following: those who reported limitations in activities of daily living (defined as inability to walk, bathe, or use the toilet without assistance in 2010 or missing information on activities of daily living; n = 2,007), those with depressive symptoms (defined as a score of ≥5 on the Geriatric Depression Scale [GDS] at baseline; n = 15,125), those with missing information about depressed mood in 2010 and/or 2013 (n = 1,871), and those with missing information about living arrangements in 2010 (n = 1,149). We included the remaining 19,656 men and 22,513 women as our final study population.

The JAGES protocol was approved by the Ethics Committee on Research of Human Subjects at Nihon Fukushi University (No. 10-05). Use of the data for this study was approved by the Ethics Committee of the University of Tokyo, Faculty of Medicine (No. 10555).

Primary predictor: living arrangements

Living arrangements were assessed using a self-reported baseline questionnaire. Participants responded to the question “Who do you live with” by choosing all the applicable options from the following: (a) living alone, (b) spouse, (c) child, (d) child-in-law, (e) grandchild, (f) parent(s), (g) parent(s)-in-law, (h) siblings, and (i) others. Based on the responses, we created seven types of living arrangement: (1) living with spouse only; (2) living alone; (3) living with spouse and parent(s); (4) living with spouse and child; (5) living with spouse, child, and parent(s); (6) living with parent(s) and/or child but not spouse; and (7) other living arrangements.

Outcome: depressive symptoms

Participants were followed up to 2013. The endpoint of this study was depressive symptoms assessed with the Japanese short version of the GDS (the GDS-15) using a simple yes/no format suitable for self-administration. The GDS is a well-known instrument to measure depression among older adults and has been extensively validated and used for healthy older adults in community setting; the GDS score was found to have a sensitivity of 88%–92% and specificity of 62%–81% compared with a structured clinical interview for depression. Following previous research, those with a score of ≥5 on the GDS in 2013 were considered to have newly developed depressive symptoms during the follow-up period.

Modifying factor: neighborhood social cohesion level

For the subgroup analysis, we created a neighborhood social cohesion variable using a validated neighborhood social cohesion scale derived from Saito et al. Briefly, school district was defined as level of neighborhood and a measure of neighborhood social capital was generated using factor analysis. The analysis produced three social capital components, one of which was social cohesion. Social cohesion was measured by summing up the scores on three questions about community trust, reciprocity, and community attachment for each school district, following our previous studies. The total number of school districts was 525 in this study. For the subgroup analysis, we created two social cohesion groups using the median: high and low. We did not calculate a social cohesion score for school districts with a small sample size.

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number of households (less than 25; \( n = 368 \)) but treated these as missing data for this variable.

**Covariates**

Age (years), GDS score at baseline, age group (60–74 years, 75 years and older), years of educational attainment (9 years or less, 10–12 years, 13 years or more), equivalent household income groups (0–1.99 million yen, 2–3.99 million yen, and 4 million yen and more per year), employment status (working, retired, or never worked), receiving treatment for any disease (yes/no), poor self-rated health (yes/no), time spent walking per day, and residential area (municipality; \( n = 24 \)) at baseline were treated as confounding factors.

Social support exchange was hypothesized to be a mediating factor. Social support was assessed using the following questions: “Is there someone who listens to your concerns and complaints?” (Emotional support receipt), “Is there someone whose concerns and complaints you listen to?” (Emotional support provision), “Is there someone who helps and takes care of you when you are sick in bed?” (Instrumental support receipt), and “Is there someone who you help and take care of when s/he is sick in bed?” (Instrumental support provision). Responses to each question were classified as “Yes” or “No.”

**Statistical analysis**

Proportions and mean values of GDS score, age, sociodemographic factors, and other covariates were calculated by gender as well as by living arrangements. We estimated gender-specific multivariable odds ratios (ORs) and 95% confidence intervals (CIs) for depressive symptoms according to living arrangements using men and women who lived with a spouse only as the reference group. We tested statistical interaction using cross-product terms for living arrangement and gender. Subgroup analysis by age (60–74 years group or 75 years and older group) was also performed. To examine if the identified associations were modified by the level of neighborhood social cohesion, we conducted subgroup analysis by neighborhood social cohesion level among those aged 65–74 years. We further included social support variables in the model in order to examine if social support could explain the impact of neighborhood social cohesion on the associations. Analyses were performed using SAS, version 9.4 (SAS Institute, Inc., Cary, NC, USA).

**RESULTS**

During the mean follow-up period of 2.6 years, 2,577 men (13.0%) and 2,897 women (12.5%) developed depressive symptoms (Table 1). The proportions of women living alone and living with child and/or parent without spouse were higher than those of men. The proportion of men living with spouse and child was higher than that of women. The distributions of depressive symptoms differed by living arrangements. Moreover, the distribution of educational attainment level, household equivalent income level, working status, receiving treatment for any disease, poor self-rated health, time spent walking per day, social support exchange, mean age, and mean GDS score at baseline differed according to living arrangements among both men and women.

Table 2 shows the gender-specific multivariable ORs of depressive symptoms according to living arrangements with living with spouse only as a reference. Among men, living alone (OR 1.43; 95% CI, 1.18–1.73) and living with spouse and parent(s) (OR 1.47; 95% CI, 1.09–1.98) were associated with increased odds of developing depressive symptoms; however, no such associations were identified among women (the \( P \)-values for the gender interaction were 0.07 and 0.09, respectively). Living with spouse and child had a protective effect for women (OR 0.84; 95% CI, 0.74–0.95) but not for men (OR 1.08; 95% CI, 0.97–1.20) (the \( P \)-value for the gender interaction was 0.18). Compared with women living with spouse and child, women living alone showed increased odds of having depressive symptoms (OR 1.19; 95% CI, 1.06–1.35; not shown in the table).

We identified associations between living arrangements and depressive symptoms among both men and women in the younger age group, but found no statistically significant associations in the older age group (Table 3). In particular, men living with spouse and child was a significant risk of depressive symptoms for men aged 65–74 years. Thus, we decided to use only the younger age group (65–74 years old) for further subgroup analysis.

Table 4 shows the gender-specific ORs for depressive symptoms according to living arrangements by neighborhood social cohesion level in men and women in the younger age group (65–74 years old). The negative impact of living arrangements on depressive symptoms was attenuated in neighborhoods with higher levels of social cohesion among men and women aged 65–74 years, although the multiplicative interaction was not significant (\( P \)-value for the interaction of social cohesion level = 0.66). The ORs of living alone for men were 2.01 (95% CI, 1.44–2.82) in the less socially cohesive neighborhood group and 1.46 (95% CI, 0.98–2.18) in the more socially cohesive neighborhood group. In addition, the OR of living alone for men in the less socially cohesive neighborhood group was significantly reduced by adjusting for social support variables (OR 1.54; 95% CI, 1.04–2.30).

**DISCUSSION**

In this study of Japanese older adults, living arrangements were significantly associated with risk of depressive symptoms. Our results indicated that the association between living arrangements and depressive symptoms differs by gender. We found that men living alone and living with a spouse and parent(s) had higher odds of developing depressive symptoms than those living with their spouse only; however, no such association was identified among women. In contrast, women living with a spouse and child had lowered odds of developing depressive symptoms compared with those living with a spouse only, whereas increased odds were identified among men in the younger age group. Moreover, our results suggest that neighborhood social cohesion level may affect the associations between living arrangements and depressive symptoms. The increased odds of depressive symptoms for those living alone were slightly attenuated in those living in neighborhoods with greater social cohesion.

There is good evidence that living alone is a risk factor for depressive symptoms among older adults. However, to the best of our knowledge, there are few longitudinal studies on specific living arrangements and depressive symptoms among older adults. A cross-sectional study in South Korea reported that older men and women living with spouse only were the least likely to have depressive symptoms; however, living with other family members in addition to a spouse, as well as living alone, were associated with higher odds of depressive symptoms among...
men and women. Another cross-sectional study in Japan also indicated that living with family members other than a spouse was associated with increased odds of psychological distress among men and women aged 65–74 years.

Our results are partly consistent with these previous results; living alone was significant risk of developing depressive symptoms. However, while previous studies showed no gender differences in the association between living arrangement and depressive symptoms, we identified clear gender difference in the effect of living with spouse and living with child/parent. Living with a spouse only was beneficial for mental health among men, but it was not necessarily true for women. For women, living with a spouse and child was most beneficial factor, but it seemed to be a risk for men at least in the younger age group. In addition, living with a spouse and parent(s) was risk for depressive symptoms for men but not for women. Our results suggested that who an individual lives with, not just whether they live with a spouse and child, is important for mental health among older adults, who an individual lives with, not just whether they live with a spouse and child. Furthermore, the gender differences in the association between living arrangements and depressive symptoms among older Japanese adults.

The gender differences identified may be a result of differences in the expected social roles of men and women in Japanese society, which is characterized by strong gender role norms.

### Table 1. Characteristics of subjects in the longitudinal samples of older Japanese men (n = 19,656) and women (n = 22,513) according to living arrangement

| Living arrangement | MEN (n = 19,656) | With spouse only (n = 9,468, 48%) | With spouse and parents (n = 4,472, 2%) | Living alone (n = 9,868, 5%) | With spouse and child (n = 6,683, 32%) | With spouse and child and parent(s) (n = 4,403, 2%) | Child only, parent(s) only, or child and parent(s) only (n = 1,786, 9%) | Others (n = 218, 1%) | P-value for difference of living arrangement |
|---------------------|-----------------|---------------------------------|--------------------------------------|-----------------------------|-------------------------------------|-----------------------------------------------|-------------------------------------------------|-----------------|-----------------------------------------------|
| n                   | %               | n                               | %                                    | n                           | n                                   | n                                             | n                                               | n               | <0.0001                                       |
| Years of education attainment |                  | 65–74 years old | 13,090 | 67 | 6,341 | 67 | 566 | 58 | 412 | 92 | 4,330 | 68 | 373 | 93 | 933 | 54 | 135 | 62 | <0.0001                                       |
| 13 years and more | 5,121 | 26 | 2,764 | 29 | 250 | 25 | 165 | 37 | 1,507 | 24 | 121 | 30 | 284 | 16 | 30 | 14 | <0.0001                                       |
| 10–12 years | 6,849 | 35 | 3,469 | 37 | 310 | 32 | 168 | 38 | 2,220 | 35 | 147 | 36 | 480 | 28 | 55 | 25 | <0.0001                                       |
| 9 years and less | 7,547 | 38 | 3,140 | 33 | 402 | 41 | 109 | 24 | 2,597 | 35 | 129 | 32 | 945 | 54 | 125 | 57 | <0.0001                                       |
| Household equivalent income |                  | 4 million yen and higher | 8,303 | 42 | 4,004 | 42 | 414 | 42 | 235 | 53 | 2,847 | 45 | 169 | 42 | 577 | 33 | 57 | 26 | <0.0001                                       |
| 3.99 million yen | 8,303 | 42 | 4,004 | 42 | 414 | 42 | 235 | 53 | 2,847 | 45 | 169 | 42 | 577 | 33 | 57 | 26 | <0.0001                                       |
| 4 million yen and lower |                  | 1.99 million yen and higher | 7,221 | 37 | 4,099 | 43 | 302 | 31 | 136 | 30 | 658 | 38 | 107 | 49 | 0.0002                                       |
| Missing | 1,622 | 8 | 517 | 6 | 166 | 17 | 20 | 4 | 568 | 9 | 26 | 6 | 268 | 15 | 39 | 18 | <0.0001                                       |
| Working status |                  | Working | 6,070 | 31 | 3,111 | 63 | 90 | 18 | 1,712 | 34 | 143 | 28 | 582 | 29 | 29 | 14 | <0.0001                                       |
| Retired | 11,872 | 60 | 6,016 | 63 | 599 | 61 | 246 | 55 | 3,694 | 58 | 148 | 30 | 572 | 27 | 56 | 27 | 0.05                                           |
| Never work | 592 | 3 | 283 | 3 | 58 | 6 | 6 | 1 | 152 | 2 | 5 | 1 | 79 | 5 | 9 | 4 | <0.0001                                       |
| Disease treatment |                  | No | 5,301 | 27 | 2,452 | 26 | 284 | 29 | 157 | 35 | 11,576 | 28 | 121 | 30 | 467 | 27 | 64 | 29 | <0.0001                                       |
| Missing | 1,303 | 7 | 645 | 7 | 84 | 9 | 17 | 4 | 391 | 6 | 149 | 27 | 21 | 7 | 12 | 10 | <0.0001                                       |
| Poor self-rated health |                  | No | 17,535 | 89 | 8,442 | 89 | 890 | 90 | 420 | 94 | 5,689 | 89 | 362 | 90 | 1,536 | 88 | 196 | 90 | 0.05                                           |
| Missing | 1,992 | 10 | 990 | 10 | 87 | 9 | 27 | 6 | 642 | 10 | 38 | 9 | 186 | 11 | 22 | 10 | <0.0001                                       |
| Walking time period per day |                  | Missing | 129 | 1 | 54 | 1 | 6 | 1 | 0 | 52 | 1 | 1 | 1 | 14 | 1 | 0 | 0 | <0.0001                                       |
| Emotional social support receipt |                  | No | 1,045 | 5 | 410 | 4 | 183 | 19 | 13 | 3 | 255 | 4 | 9 | 2 | 145 | 8 | 30 | 14 | <0.0001                                       |
| Missing | 1,645 | 90 | 8,627 | 91 | 727 | 74 | 417 | 93 | 5,852 | 92 | 377 | 94 | 1,446 | 85 | 179 | 82 | 0.05                                           |
| Emotional social support provision |                  | No | 975 | 5 | 359 | 4 | 171 | 17 | 13 | 3 | 242 | 4 | 11 | 3 | 150 | 9 | 29 | 13 | <0.0001                                       |
| Missing | 17,735 | 90 | 8,866 | 92 | 748 | 76 | 417 | 93 | 5,873 | 92 | 376 | 93 | 1,461 | 84 | 174 | 80 | <0.0001                                       |
| Instrumental social support receipt |                  | No | 946 | 5 | 449 | 5 | 73 | 7 | 17 | 4 | 276 | 4 | 14 | 7 | 125 | 7 | 15 | 7 | <0.0001                                       |
| Instrumental social support provision |                  | No | 488 | 2 | 85 | 1 | 280 | 28 | 2 | 1 | 39 | 1 | 2 | 65 | 4 | 15 | 7 | <0.0001                                       |
| Missing | 18,379 | 94 | 9,045 | 95 | 643 | 65 | 430 | 96 | 6,113 | 96 | 386 | 96 | 1,568 | 90 | 192 | 88 | <0.0001                                       |
| GDS score in 2010 |                  | Mean | 72.6 | 5.5 | 72.6 | 5.2 | 73.8 | 6.1 | 69.0 | 3.6 | 72.4 | 5.5 | 68.7 | 3.6 | 74.6 | 6.3 | 73.6 | 5.8 | <0.0002                                       |
Continued.

Under such gendered norms, men may feel role conflicts when they cannot fulfill their role responsibility, such as provision of financial support for family members, when they retire. In contrast, because women are expected to take care of their family members, this may shape their identity within the family; living with their child or parent(s) only, or child and parent(s) only, provides a range of social support to their spouse under such social norms. Therefore, for men, living with a spouse may mean that they have someone to take care of them; for women, living with a spouse may mean that they have someone who needs their care. These different roles may be the basis of the identified gender differences in the associations between living arrangements and depressive symptoms.

Another explanation for these findings may be differences in how men and women construct and maintain social networks. Older adults are likely to be vulnerable to social isolation because they are more likely to lose their social ties. However, women living alone are not necessarily socially isolated and often show better psychological health compared with those living with a spouse. Constructing social relationships is beneficial for mental health among older adults. Women are likely to maintain their active social networks with their friends, immediate family, and other relatives and experience more social support regardless of their marital status, whereas older men tend to mainly have relationships with their spouses. We found that living in socially cohesive neighborhoods may prevent the occurrence of depressive symptoms among people.
### Table 2. Gender-specific adjusted odds ratios of living arrangement for depressive symptoms

| Living arrangement                      | ALL n = 42,169 | P-value for interaction of gender |
|-----------------------------------------|----------------|----------------------------------|
|                                         | Men (n = 19,656) | Women (n = 22,513) |
|                                         | n | n of case | OR* | 95% CI   | n | n of case | OR* | 95% CI   |
| With spouse only                        | 9,468 | 1,144 | 1.00 | 7,805 | 915 | 1.00 |
| Living alone                            | 983 | 174 | 1.43 | (1.18, 1.73) | 3,555 | 471 | 1.04 | (0.91, 1.18) |
| With spouse and parent(s)               | 447 | 60 | 1.47 | (1.09, 1.98) | 227 | 21 | 0.82 | (0.51, 1.32) |
| With spouse and child                   | 6,383 | 797 | 1.08 | (0.97, 1.20) | 5,232 | 548 | 0.84 | (0.74, 0.95) |
| With spouse, child and parent(s)        | 403 | 31 | 0.72 | (0.49, 1.06) | 177 | 19 | 0.95 | (0.57, 1.58) |
| Child only, parent(s) only, or child and parent(s) only | 1,736 | 253 | 1.12 | (0.96, 1.32) | 5,294 | 726 | 0.95 | (0.84, 1.07) |
| Others                                  | 218 | 31 | 0.97 | (0.65, 1.46) | 423 | 67 | 1.11 | (0.83, 1.48) |

CI, confidence interval; GDS, Geriatric Depression Scale; OR, odds ratio.
*Adjusted by all variables in the table. Residential area was also adjusted using a fixed model (ie, using 23 dummy variables).

### Table 3. Gender-specific adjusted odds ratios of living arrangement for depressive symptoms

| Living arrangement                      | ALL n = 42,169 | P-value for interaction of age group |
|-----------------------------------------|----------------|----------------------------------|
|                                         | Men (n = 19,656) | Women (n = 22,513) |
|                                         | n | n of case | OR* | 95% CI   | n | n of case | OR* | 95% CI   |
| Age 65–74 years                         |                           |                          |
| With spouse only                        | 6,341 | 663 | 1.00 | 5,983 | 663 | 1.00 |
| Living alone                            | 566 | 107 | 1.79 | (1.40, 2.29) | 1,788 | 253 | 1.16 | (0.98, 1.37) |
| With spouse and parent(s)               | 412 | 56 | 1.68 | (1.23, 2.30) | 216 | 20 | 0.86 | (0.53, 1.41) |
| With spouse and child                   | 4,330 | 496 | 1.19 | (1.04, 1.36) | 3,915 | 375 | 0.81 | (0.71, 0.94) |
| With spouse, child and parent(s)        | 373 | 25 | 0.68 | (0.44, 1.05) | 163 | 19 | 1.08 | (0.64, 1.80) |
| Child only, parent(s) only, or child and parent(s) only | 933 | 110 | 1.08 | (0.86, 1.35) | 2,544 | 304 | 0.96 | (0.82, 1.13) |
| Others                                  | 135 | 18 | 1.05 | (0.62, 1.79) | 224 | 41 | 1.48 | (1.02, 2.16) |

CI, confidence interval; OR, odds ratio.
*Adjusted by GDS score in 2010, age, age group, years of education attainment, household income, working status, disease treatment, poor self-rated health, and walking time period per day. Residential area was also adjusted using a fixed model (ie, using 23 dummy variables).
living alone. One possible explanation for this is that cohesive communities may provide more social support for residents, which may reduce the likelihood of social isolation and social exclusion among community members. As social isolation and social exclusion are risks for depressive symptoms, community cohesiveness may reduce the risk of depressive symptoms among people living alone. Indeed, the results of our mediating analysis indicated that the increased odds of depressive symptoms in individuals living alone in less socially cohesive neighborhoods could be explained by less social support exchange among people in those areas. Our results indicate that interventions to improve aspects of social cohesion may help to prevent depressive symptoms among older individuals.

This is one of the few longitudinal investigations to examine the association between living arrangements and risk of depressive symptoms. However, several limitations should be mentioned. First, we did not account for changes in our primary predictor or in other variables during the follow-up period. Second, this was an observational study and selection bias could not be ruled out. Unfortunately, we have no demographic information on those who did not participate in this cohort study, so no information on the direction of this selection bias was available. Third, residual confounding could have occurred from unmeasured confounding variables, such as family history of mental health. Fourth, measurement errors could also occur. Measurement error of our outcome was assumed to be non-differential and might have reduced the reliability of our result. Fifth, although it was a strength of our study design to have data on depressive symptoms at baseline and follow-up, our study population was limited to those who responded to both questionnaires, which may introduce some selection bias. Those who did not respond to the following survey was likely to be older, have lower socioeconomic conditions, and poorer self-rated health, and to live with parent(s) and/or child but not spouse, compared to our study population, which did not indicate clear direction of this bias.

Although these cautions are necessary to interpret, our results suggest that public health practitioners and policy makers should pay more attention to whether individuals live alone, as well as who individuals live with. It also support that interventions to strengthen community social cohesion may work; for example, by creating more opportunities of social informal gathering, such as “community salons”.

| Social cohesion level | Model 1 | Model 2 | P-value for interaction of social cohesion level |
|-----------------------|---------|---------|-----------------------------------------------|
| Model 1: adjusted by GDS score in 2010, age, years of education attainment, household income, working status, disease treatment, poor self-rated health, and walking time period per day. Residential area was also adjusted using a fixed model (ie, using 23 dummy variables). Model 2: Model 1 + emotional support receipt, emotional support provision, instrumental support receipt, and instrumental support provision. | Model 1: Model 1+ emotional support receipt, emotional support provision, instrumental support receipt, and instrumental support provision. | Model 2: Model 1+ emotional support receipt, emotional support provision, instrumental support receipt, and instrumental support provision. |

Table 4. Gender-specific adjusted odds ratios of living arrangement for depressive symptoms by social cohesion level among men and women aged 65–74 years
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