Types of social participation and psychological distress in Japanese older adults: A five-year cohort study

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Abstract

Introduction

The most effective type of social participation against psychological distress in older adults is not well documented. The aim of this study was to examine whether different types of social participation are associated with changes in psychological distress level in older men and women in Japan.

Methods

Two thousand seven hundred community-dwelling older adults (aged 65–74 years, 50\% women) were randomly selected from the resident registry of three cities. Of these, participants who reported social participation and psychological distress level in the baseline survey in 2010 were followed up. Psychological distress was evaluated based on K6 scales at baseline and follow-up (in 2015). Social participation level was examined using question items from the National Health and Nutrition Survey in Japan. Exploratory factor analysis was used to derive the underlying factor structure. Multiple linear regression analysis was used to examine the association between social participation and changes in psychological distress level after adjusting for covariates stratified by both gender and age group or living arrangement.

Results

Data from 825 community-dwelling older adults (45.3\% women) were analyzed. Social participation was categorized into two types using factor analysis: community involvement (volunteer activities, community events, clubs for the elderly) and individual relationship (friendship, communication with family and friends, hobbies). During the 5-year follow-up, 29.5\% of participants reported a deterioration in psychological distress. Higher community involvement was independently associated with lower risk of psychological distress for older women ($\beta = 0.099$, $p = 0.047$), whereas there were no associations with individual relationship for either gender. Furthermore, in older women living with others, higher community involvement was also associated with lower risk of psychological distress ($\beta = 0.110$, $p = 0.048$).
Conclusion

Community involvement provides older women with mental health benefits regardless of individual relationship level. Promoting community involvement may be an effective strategy for healthy mental aging.

Introduction

Psychological distress is generally defined as a state of emotional suffering characterized by depressive symptoms and anxiety [1, 2]. Several studies have shown associations between psychological distress and increased risk of mortality [3–6], cardiovascular disease [7, 8], and hypertension [9]. The Global Burden of Disease (GBD) Study 2010 ranked major mental disorders as a leading cause of burden [10, 11]. In Japan, the number of older adult patients (≥65 years old) with mood or anxiety disorders has been increasing with the growing proportion of older adults, reaching 340,000 in 2014 (men: 102,000, women: 238,000) [12]. Despite both individual and social burdens of psychological distress, there is still limited information identifying its potential causes and interventions that may help in preventing psychological distress in older adults.

Social participation is a key component of successful and healthy aging in response to concerns about population aging. Previous studies have shown that older adults’ social participation is associated beneficially with mental health [13, 14], as well as quality of life (QOL) [15], cognitive functioning [16], lower mortality [17] and morbidity [18]. Several studies have found that active engagement in volunteering, religious activities, and clubs are associated with better mental health and reduced levels of depressive symptoms [14, 19–21]. Furthermore, it is reported that the impact of social participation on mental health differs by gender [22–24]; one study, for example, indicates that frequent participation at church is related to low prevalence of depressive symptoms in older women, while the opposite relationship was found in older men [22]. Another study in a Japanese population suggested that lack of participation in community sports or exercise activities was negatively associated with psychological distress in older women, but not associated in older men [24]. Since limited types of social participation have been focused on, comprehensive research related to social participation is needed.

Many similar concepts such as social engagement, social involvement, social capital, social network, social integration, and social gathering have been used interchangeably with social participation [25]. In addition to there being no agreed upon definition, social participation has included a variety of activities such as individual-based (e.g. hobby, neighborhood relationship) or community-based (e.g. local event, volunteer, senior center, religious) activities [25]. Therefore, the most effective type of social participation against poor mental health, especially for psychological distress in older adults, is not well documented. We examined whether different types of social participation were associated with changes in psychological distress level in community-dwelling Japanese older men and women.

Methods

Participants and data collection

This population-based, cohort study was conducted using a postal survey in 2010 (baseline) and 2015 (follow-up). We included three Japanese cities of various population densities; Bunkyo city, Fuchu city and Oyama city. Bunkyo is an urban city in the Tokyo metropolitan area,
Fuchu is a suburban city of Tokyo within commuting distance to the central business district, and Oyama in Shizuoka prefecture is a typical small rural city located about 80 km west of Tokyo. The study sample aged 65 to 74 years (N = 2,700) was randomly selected from the resident register of each municipality, which contains all individual information of residents in each city. The details of the sampling process for the 2010 survey and the locations, areas, population sizes, and population densities of each area are described in a previous study [26].

Ethical approval for the study was obtained from the Tokyo Medical University Ethics Committee prior to the survey in 2010 (No. 1273) and in 2015 (No. 2898). All participants signed the consent form before answering the questionnaire.

Fig 1 is a flow diagram of participant enrollment. Of 2,700 older adults invited to participate, 2,045 people returned the questionnaire at baseline (response rate 75.7%) and 1,314 of them agreed to complete the survey. We provided 1,314 potential participants advance notification of the intention to send a questionnaire one month before the survey at follow-up. In this process, we excluded 104 people because of refusal (n = 6), address unknown (n = 93) and death (n = 5). Therefore, we sent a questionnaire to 1,210 participants at follow-up. Though 988 of them returned the questionnaire at follow-up, we included 927 respondents who had answered the questionnaire by themselves. Then, we excluded 102 due to missing data of psychological distress level (n = 36 at baseline and n = 34 at follow-up) and missing data of social participation and other variables (n = 52). Therefore, there were 825 (451 men, 374 women) final participants.
Measures

**Dependent variable.** Psychological distress was measured using the Kessler 6 (K6) scale [27] at both baseline and follow-up. The scale assesses how often respondents had experienced the following depressive symptoms over the last 30 days: feeling nervous, hopeless, restless or fidgety, so depressed that nothing could cheer you up, everything was an effort, and worthless [27]. Each of the six items are scaled from 0 (none of the time) to 4 (all of the time), and the total score (0–24) is used as an index of psychological distress level (i.e. higher scores represented more severe psychological distress). Good validity and reliability for screening serious mental illness in the general population [27, 28] have been demonstrated and the K6 has been translated into Japanese [29].

In the present study, deterioration in psychological distress was defined as any change from the baseline score to the score at follow-up. This was calculated by subtracting the baseline K6 score (0–24) from the follow-up K6 score (0–24), where the calculated value indicated -24 to -1: improvement, 0: unchanged, 1 to 24: deterioration, respectively (i.e. a lower value represents improvement of psychological distress).

**Independent variables.** Social participation level was examined at baseline using question items from the National Health and Nutrition Survey in Japan in 2006. Social participation included six types of activities: hobby, friendship, clubs for the elderly, volunteer activities, community events and communication with family members and friends. Each social participation level ranged from 1 to 3 points (1: frequently, 2: sometimes, 3: seldom).

**Covariates.** Information about age, gender, and residential area were obtained from the resident registry of each municipality. The following factors acquired through using self-reported questionnaires were relevant confounders for statistical control: living arrangement, working status, Body Mass Index (BMI), physical health, smoking, and drinking. Physical functioning was measured with one item from the Short Form-8 (SF-8) [30], which is commonly used to assess physical health: “during the past 4 weeks, how much did physical health problems limit your usual physical activities (such as transfers or going places)?” The answers were categorized into “good” (not at all, very little, and somewhat) and “bad” (quite a lot and could not do physical activities). Smoking and drinking status was examined using question items from the National Health and Nutrition Survey in Japan.

**Statistical analyses**

A chi-squared test was conducted to determine whether there was a significant association between categorical variables. For the continuous variables, data comparisons between genders were tested with Mann-Whitney U tests. To identify types of social participation, we then conducted exploratory factor analysis with principal axis extraction and varimax Kaiser normalization. Cronbach’s alpha was calculated to examine the scale’s internal consistency. We used eigenvalues greater than one in the factor analysis to retain factors. Multiple regression analysis was used to examine the association between social participation level and change in psychological distress, calculating the adjusted $\beta$ (standardized coefficients) and 95% confidence intervals (CIs) of $\beta$, stratified by gender. Additionally, multiple regression analyses stratified by age and living arrangement were performed. Each categorical covariate was classified as follows; residential area: “Bunkyo”, “Fuchu”, or “Oyama”; living arrangement: “with others” or “alone”, working status: “working with income” or “not working”, physical health: “good” or “bad”, smoking: “yes” or “no” and drinking: “yes” or “no”. We also conducted multiple regression analyses where only older adults without psychological distress (<5 points) at baseline were included based on a recommended cutoff point for screening mood/anxiety disorder in the general population [31, 32].
Three models were performed by gender, simultaneously controlling for potential confounders; model 1: age, area, living arrangement, and working, model 2: BMI, physical functioning, smoking, and drinking were added to model 1, and model 3: each type of social participation generated after the factor analysis was mutually adjusted (i.e. entering all variables). All covariates were entered into the model at the same time since there was no multicollinearity (Variance Inflation Factor). The significance level was set at p < 0.05. All statistical analyses were conducted using IBM SPSS Statistics version 21 (SPSS Inc., Tokyo, Japan).

Results

Participant characteristics

The mean age at baseline was 69.3 ± 2.9 years in men and 69.3 ± 2.9 years in women. Fewer than half of the respondents were women (45.3%), and most of the study population was living with others (men: 92.2%, women: 86.9%) and had good physical functioning (men: 97.1%, women: 93.6%) (Table 1). The median (25%, 75%) K6 scores at baseline were 1.0 (0.0, 3.0) in men and 1.0 (0.0, 4.0) in women. There were statistically significant baseline group differences in living arrangement, working, smoking, drinking, physical functioning, BMI, and individual relationship level (p < 0.05). During the 5-year follow-up, 29.5% (men: 27.7%, women: 31.6%) of participants reported worsening of psychological distress, while 33.9% (men: 33.3%, women: 34.8%) improved and 36.6% (men: 39.0%, women: 33.7%) did not change (results are not shown in the table). There was no significant gender difference in pattern of change in K6 score (chi-squared test, p = 0.151).

Result of the factor analysis

As a result of the factor analysis, two social participation types were derived with eigenvalues greater than one: community involvement (volunteer activities, community events, clubs for the elderly) (Cronbach’s α = 0.63), and individual relationship (hobby, friendship, communication with family members and friends) (Cronbach’s α = 0.54). The rotated factor loadings are presented in Table 2.

Results of the multiple regression analysis

In the multiple regression analysis, there were no statistically significant associations between social participation and risk of psychological distress in model 1 and 2 for both genders (Table 3). However, in model 3 (i.e. fully adjusted model), higher community involvement level was independently associated with lower risk of psychological distress for older women ($\beta = 0.099$, $95\%$CI = 0.003–0.443, p = 0.047), whereas individual relationship level was not related to either gender. These results did not change when participants who had K6 scores ≥5 points at baseline were excluded from the analyses. There was no significant interaction between men and women, or younger and elderly. The impacts of covariates on psychological distress in older adults by age group are shown in S1 Table.

Table 4 represents the adjusted $\beta$ for change of psychological distress level by living arrangement. In older women living alone, higher individual relationship was associated with lower risk of psychological distress ($\beta = 0.258$, $95\%$CI = 0.052–1.396, p = 0.035) and this association remained significant after adjustment for community involvement ($\beta = 0.249$, $95\%$CI = 0.033–1.363, p = 0.040). On the other hand, in older women living with others, higher community involvement was independently associated with lower risk of psychological distress ($\beta = 0.110$, $95\%$CI = 0.002–0.468, p = 0.048). S2 Table provides the impacts of covariates on psychological distress in older adults by living arrangement.
|                          | Men (n = 451) | Women (n = 374) | p-value |
|-------------------------|--------------|-----------------|---------|
| Age                     |              |                 | 0.716a  |
| 65–69 years             | 239 (53.0)   | 201 (53.7)      |         |
| 70–74 years             | 212 (47.0)   | 173 (46.3)      |         |
| Area                    |              |                 | 0.104a  |
| Bunkyo                  | 144 (31.9)   | 130 (34.8)      |         |
| Fuchu                   | 159 (35.3)   | 106 (28.3)      |         |
| Oyama                   | 148 (32.8)   | 138 (36.9)      |         |
| Living arrangement      |              |                 | 0.015a  |
| with others             | 416 (92.2)   | 325 (86.9)      |         |
| alone                   | 35 (7.8)     | 49 (13.1)       |         |
| Working with income     |              |                 | <0.001a |
| yes                     | 245 (54.3)   | 123 (32.9)      |         |
| no                      | 206 (45.7)   | 251 (67.1)      |         |
| Smoking                 |              |                 | <0.001a |
| yes                     | 104 (23.1)   | 18 (4.8)        |         |
| no                      | 347 (76.9)   | 356 (95.2)      |         |
| Drinking                |              |                 | <0.001a |
| yes                     | 319 (70.7)   | 104 (27.8)      |         |
| no                      | 132 (29.3)   | 270 (72.2)      |         |
| Physical functioning    |              |                 | 0.018a  |
| good                    | 438 (97.1)   | 350 (93.6)      |         |
| bad                     | 13 (2.9)     | 24 (6.4)        |         |
| Body Mass Index (BMI)   |              |                 | <0.005a |
| < 25 (kg/m²)            | 345 (76.5)   | 316 (84.5)      |         |
| ≥ 25 (kg/m²)            | 106 (23.5)   | 58 (15.5)       |         |
| Psychological distress (K6) score | 0.058a   |                   |
| < 5 (point)             | 379 (84.0)   | 295 (78.9)      |         |
| ≥ 5 (point)             | 72 (16.0)    | 79 (21.1)       |         |
| Social participation level (3–9 points) |       |                   |
| individual relationship (lower score: frequently) | 5.5 (4.4, 6.6) | 4.9 (3.8, 6.0) | <0.001b |
| community involvement (lower score: frequently) | 7.8 (6.3, 8.7) | 7.6 (6.3, 8.6) | 0.223b |

aP-value was calculated using chi-squared tests.
bP-value was calculated using Mann-Whitney U tests.

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Table 2. Rotated factor loadings (varimax rotation).

| Variables                          | Men          |           | Women        |           |
|------------------------------------|--------------|-----------|--------------|-----------|
|                                    | Factor 1     | Factor 2  | Factor 1     | Factor 2  |
|                                    | community involvement | individual relationship | community involvement | individual relationship |
| Clubs for the elderly              | 0.698        | -0.016    | 0.738        | -0.083    |
| Volunteer activities               | 0.801        | 0.201     | 0.606        | 0.354     |
| Community events                   | 0.742        | 0.125     | 0.791        | 0.080     |
| Hobby                              | 0.131        | 0.610     | 0.027        | 0.746     |
| Friendship                         | 0.101        | 0.747     | 0.196        | 0.569     |
| Communication with family and friends | 0.022    | 0.717     | -0.022       | 0.647     |

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Table 3. Association of social participation level with psychological distress in community-dwelling older adults by age group.

|                | Model 1 | Model 2 | Model 3 |
|----------------|---------|---------|---------|
|                | β       | 95%CI   | p-value | β       | 95%CI   | p-value | β       | 95%CI   | p-value |
| **Men** Community involvement |         |         |         |         |         |         |         |         |         |
| total          | -0.021  | -0.217  | 0.141   | 0.680   | 0.013   | -0.144  | 0.189   | 0.790   | 0.033   | -0.119  | 0.237   | 0.518   |
| 65–69 years    | -0.012  | -0.254  | 0.213   | 0.861   | 0.014   | -0.198  | 0.247   | 0.826   | 0.020   | -0.201  | 0.270   | 0.775   |
| 70–74 years    | -0.014  | -0.304  | 0.253   | 0.856   | 0.007   | -0.242  | 0.267   | 0.923   | 0.043   | -0.198  | 0.360   | 0.567   |
| **Individual relationship** |         |         |         |         |         |         |         |         |         |
| total          | -0.089  | -0.360  | 0.008   | 0.061   | -0.050  | -0.276  | 0.077   | 0.267   | -0.053  | -0.291  | 0.084   | 0.277   |
| 65–69 years    | -0.062  | -0.341  | 0.117   | 0.338   | -0.035  | -0.288  | 0.160   | 0.574   | -0.019  | -0.265  | 0.198   | 0.775   |
| 70–74 years    | -0.121  | -0.562  | 0.038   | 0.087   | -0.060  | -0.417  | 0.156   | 0.370   | -0.083  | -0.492  | 0.134   | 0.261   |
| **Women** Community involvement |         |         |         |         |         |         |         |         |         |
| total          | 0.050   | -0.128  | 0.352   | 0.359   | 0.082   | -0.025  | 0.392   | 0.084   | 0.099   | 0.003   | 0.443   | 0.047   |
| 65–69 years    | 0.057   | -0.220  | 0.511   | 0.434   | 0.045   | -0.197  | 0.423   | 0.472   | 0.048   | -0.216  | 0.457   | 0.481   |
| 70–74 years    | 0.032   | -0.274  | 0.408   | 0.699   | 0.087   | -0.126  | 0.488   | 0.247   | 0.112   | -0.088  | 0.555   | 0.154   |
| **Individual relationship** |         |         |         |         |         |         |         |         |         |
| total          | -0.067  | -0.404  | 0.085   | 0.199   | -0.013  | -0.237  | 0.178   | 0.428   | -0.029  | -0.292  | 0.155   | 0.548   |
| 65–69 years    | -0.079  | -0.491  | 0.133   | 0.259   | -0.003  | -0.268  | 0.255   | 0.559   | -0.007  | -0.307  | 0.273   | 0.809   |
| 70–74 years    | -0.051  | -0.529  | 0.269   | 0.521   | -0.014  | -0.385  | 0.313   | 0.738   | -0.023  | -0.431  | 0.310   | 0.749   |

*Model 1: Adjusted for age, area (Bunkyo/Fuchu/Oyama), living arrangement (with others/alone), working (yes/no)*
*Model 2: Adjusted for age, area (Bunkyo/Fuchu/Oyama), living arrangement (with others/alone), working (yes/no), BMI, physical functioning (good/bad), smoking (yes/no), drinking (yes/no)*
*Model 3: Adjusted for age, area (Bunkyo/Fuchu/Oyama), living arrangement (with others/alone), working (yes/no), BMI, physical functioning (good/bad), smoking (yes/no), drinking (yes/no), community involvement or individual relationship

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Table 4. Association of social participation level with psychological distress in community-dwelling older adults by living arrangement.

|                | Model 1 | Model 2 | Model 3 |
|----------------|---------|---------|---------|
|                | β       | 95%CI   | p-value | β       | 95%CI   | p-value | β       | 95%CI   | p-value |
| **Men** Community involvement |         |         |         |         |         |         |         |         |         |
| living with others | -0.014  | -0.208  | 0.157   | 0.784   | 0.007   | -0.160  | 0.185   | 0.886   | 0.024   | -0.140  | 0.228   | 0.640   |
| living alone     | 0.032   | -0.545  | 0.655   | 0.853   | 0.055   | -0.433  | 0.622   | 0.716   | 0.016   | -0.598  | 0.653   | 0.928   |
| **Individual relationship** |         |         |         |         |         |         |         |         |         |
| living with others | -0.114  | -0.420  | -0.040  | 0.018   | -0.048  | -0.283  | 0.088   | 0.300   | -0.046  | -0.288  | 0.103   | 0.352   |
| living alone     | 0.068   | -0.471  | 0.694   | 0.699   | 0.086   | -0.373  | 0.656   | 0.577   | 0.078   | -0.484  | 0.739   | 0.671   |
| **Women** Community involvement |         |         |         |         |         |         |         |         |         |
| living with others | 0.017   | -0.232  | 0.294   | 0.597   | 0.065   | -0.080  | 0.357   | 0.213   | 0.110   | 0.002   | 0.468   | 0.048   |
| living alone     | 0.139   | -0.545  | 1.308   | 0.411   | 0.200   | -0.199  | 1.300   | 0.146   | 0.185   | -0.212  | 1.229   | 0.162   |
| **Individual relationship** |         |         |         |         |         |         |         |         |         |
| living with others | -0.165  | -0.613  | -1.134  | 0.002   | -0.078  | -0.394  | 0.043   | 0.116   | -0.102  | -0.473  | 0.009   | 0.059   |
| living alone     | 0.169   | -0.372  | 1.323   | 0.265   | 0.258   | 0.052   | 1.396   | 0.035   | 0.249   | 0.033   | 1.363   | 0.040   |

*Model 1: Adjusted for age, area (Bunkyo/Fuchu/Oyama), working (yes/no)*
*Model 2: Adjusted for age, area (Bunkyo/Fuchu/Oyama), working (yes/no), BMI, physical functioning (good/bad), smoking (yes/no), drinking (yes/no)*
*Model 3: Adjusted for age, area (Bunkyo/Fuchu/Oyama), working (yes/no), BMI, physical functioning (good/bad), smoking (yes/no), drinking (yes/no), community involvement or individual relationship

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Discussion

Our study explores the associations between different types of social participation and changes in psychological distress level in community-dwelling Japanese older adults. Higher community involvement was independently associated with lower risk of psychological distress in community-dwelling Japanese older women. However, both community involvement and individual relationship were not related to risk of psychological distress in older men.

In terms of gender differences, previous studies have indicated a gender difference in the relationship between social participation and mental health [22, 23, 33–35]. Our result was consistent with some studies suggesting that women gain more benefit from their social participation [22, 23, 34, 35]. In the current study, we found community involvement was associated beneficially with psychological distress for older women. Our findings correspond to Kuriyama et al.’s report that no participation in community activities was negatively associated with mental health in older women (≥65 years) [24]. This is probably because community involvement provides a sense of meaning in people’s lives as well as fulfillment and opportunity for social support [36–39]. A previous study showed, for example, that volunteering improved mental health by enhancing the participants’ range of social networks [38]. Atkins et al. reported that lower levels of social support were related to higher psychological distress [40]. Moreover, women, more than men, tend to build relationships from their wide and diverse networks, and women may be inclined to receive positive benefits from community involvement. Norton et al. reported that frequent religious engagement was related to a reduced prevalence of depression; our findings partly support Norton et al.’s argument [22] because religious involvement is considered to be one type of community involvement.

In the present study, individual relationship did not have a favorable association on psychological distress in overall older men and women although previous studies have reported the link between fewer close relationship and depressive symptoms [36, 41]. Older adults who have higher level of personal relationships with others (e.g. family, relatives, friends, and neighbors) may be more likely to face problems and traumatic/stressful events such as death of a loved one and someone’s death from disease, and thus these predispose them to feel emotionally close and depressive [36]. As our finding shows, individual relationship which is fundamental of social participation [25] may be more important for older women living alone, who are likely to have less income and to be in poor health compared to those living with others [42]. A previous study by Victor et al. [43] showed that older women living alone were more likely than those with others to experience feeling of social isolation partly because of a lack of social network including emotional support. Improved social relationships were connected with reduced level of loneliness [43] which was associated with depression [44, 45]. Compared to community involvement, individual relationship is more informal and therefore older women living alone can be dependent principally on individual relationship for emotional support. Individual relationship may have had a protective role against psychological distress in older women living alone.

Strengths and limitations

Our study has several strengths. First, to our knowledge, this is the first cohort study to examine the association between social participation and change of psychological distress level in community-dwelling older adults. Our study permits a causal interpretation of our findings based on its follow-up design. Second, we performed the random sampling of participants from each included city at baseline. Third, older adults from cities with different population densities were included in this study.
Some limitations of our study should be considered. First, some respondents were excluded from our analysis due to missing data. Generally, missing responses and data may tend to be higher in older adults with more severe psychological stress and lower social participation level, which may have biased the findings. Second, the generalization of the results of our study to other populations may be somewhat difficult. Third, we cannot deny the possibility of residual confounding factors as there could have been some unmeasured variables that influenced the association between social participation and changes in psychological distress level. For example, our study did not examine whether participants had a social role in social organizations. Takagi et al. reported that older men who occupied leadership positions in organizations rated better mental health [34]; therefore, additional adjustment for social role may change this association. In addition, it is possible that certain personality traits are connected with both social participation and the occurrence of mental health [41]. Finally, social participation and psychological distress level were evaluated using self-reported information and thus the measurements themselves may have reporting bias. In present analyses, we included participants who had different physiological distress level, and thus individuals with high K6 score compared to those with low one might have tended to make more negative interpretation of social participation level [46].

Conclusion
Change in psychological distress level was found to be associated with certain types of social participation in older adults. Community involvement provides older women with mental health benefits regardless of individual relationship level. Promoting community involvement may be an effective strategy for healthy mental aging.

Supporting information
S1 Table. Impacts of covariates on psychological distress in older adults by age group. (DOCX)
S2 Table. Impacts of covariates on psychological distress in older adults by living arrangement. (DOCX)

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Conceptualization: SA SI.
Data curation: SA NF HK SI.
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Investigation: SA NF HK KO TT YO SI.
Methodology: SI KO.
Project administration: SI.
Resources: SI NF.
Supervision: SI NF KO.
Visualization: SA SI.
Writing – original draft: SA.
Writing – review & editing: SA NF HK TT YO SI.

References
1. Mirowsky John, Ross CE. Measurement for a Human Science. Journal of Health and Social Behavior. 2002; 43(2):152–70. PMID: 12096697
2. Drapeau A, Marchand A, Beaulieu-Prévost D. Epidemiology of psychological distress. In: Luciano LA, editor. [Mental Illnesses—Understanding, prediction and control]2011.
3. Russ TC, Stamatakis E, Hamer M, Starr JM, Kivimaki M, Batty GD. Association between psychological distress and mortality: individual participant pooled analysis of 10 prospective cohort studies. BMJ (Clinical research ed). 2012; 345:e4933. Epub 2012/08/02. PubMed Central PMCID: PMCPmc3409083.
4. Huppert FA, Whittington JE. Symptoms of psychological distress predict 7-year mortality. Psychological medicine. 1995; 25(5):1073–86. Epub 1995/09/01. PMID: 8588004
5. Robinson KL, McBeth J, Macfarlane GJ. Psychological distress and premature mortality in the general population: a prospective study. Annals of epidemiology. 2004; 14(7):467–72. Epub 2004/08/11. https://doi.org/10.1016/s1047-2797(04)00095-7
6. Rosness TA, Strand BH, Bergem AL, Nafstad P, Langballe EM, Engedal K, et al. Association of psychological distress late in life and dementia-related mortality. Aging & mental health. 2016; 20(6):603–10. Epub 2015/04/15.
7. Brotman DJ, Golden SH, Wittstein IS. The cardiovascular toll of stress. Lancet (London, England). 2007; 370(9592):1089–100. Epub 2007/09/08.
8. Hamer M, Molloy GJ, Stamatakis E. Psychological distress as a risk factor for cardiovascular events: pathophysiological and behavioral mechanisms. The American Journal of Cardiology. 2008; 52(25):2156–62. Epub 2008/12/20. https://doi.org/10.1016/j.ajcc.2008.08.057 PMID: 19095133
9. Ojike N, Sowers JR, Seixas A, Ravenell J, Rodriguez-Figueroa G, Awadallah M, et al. Psychological Distress and Hypertension: Results from the National Health Interview Survey for 2004–2013. Cardiorenal medicine. 2016; 6(3):198–208. Epub 2016/06/09. PubMed Central PMCID: PMCPmc4886035. https://doi.org/10.1159/000439333 PMID: 27275156
10. Ferrari AJ, Charlson FJ, Norman RE, Flaxman AD, Patten SB, Vos T, et al. The epidemiological modeling of major depressive disorder: application for the Global Burden of Disease Study 2010. PloS one. 2013; 8(7):e69637. Epub 2013/08/08. PubMed Central PMCID: PMCPmc3726670. https://doi.org/10.1371/journal.pone.0069637 PMID: 23922765
11. Whiteford HA, Degenhardt L, Rehm J, Baxter AJ, Ferrari AJ, Erskine HE, et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet (London, England). 2013; 382(9904):1575–86. Epub 2013/09/03.
12. Ministry of Health, Labour and Welfare. The patient survey 2014 [cited 2016 8.3]. Available from: http://www.mhlw.go.jp/toukei/saikin/hw/kanja/14/.
13. Croesen S, Avendano M, Burdorf A, van Lenthe FJ. Social participation and depression in old age: a fixed-effects analysis in 10 European countries. American journal of epidemiology. 2015; 182(2):168–76. Epub 2015/05/31. PubMed Central PMCID: PMCPmc4493978. https://doi.org/10.1093/aje/kwv015 PMID: 26025236
14. Chiao C, Weng LJ, Botticello AL. Social participation reduces depressive symptoms among older adults: an 18-year longitudinal analysis in Taiwan. BMC public health. 2011; 11:292. Epub 2011/05/17. PubMed Central PMCID: PMCPmc3103460. https://doi.org/10.1186/1471-2458-11-292 PMID: 21569285
15. Levasseur M, Desrosiers J, St-Cyr Tribble D. Subjective Quality-of-Life Predictors for Older Adults with Physical Disabilities. American journal of physical medicine & rehabilitation / Association of Academic Physiatrists. 2008; 87(10):830–41. Epub 2008/09/23.
16. Tomioka K, Kurumatani N, Hosoi H. Social Participation and Cognitive Decline Among Community-dwelling Older Adults: A Community-based Longitudinal Study. The journals of gerontology Series B, Psychological sciences and social sciences. 2016. Epub 2016/05/20.
17. Glass TA, de Leon CM, Marottoli RA, Berkman LF. Population based study of social and productive activities as predictors of survival among elderly Americans. BMJ (Clinical research ed). 1999; 319 (7208):478–83. Epub 1999/08/24. PubMed Central PMCID: PMCPmc28199.
24. Kuriyama S, Nakaya N, Ohmori-Matsuda K, Shimazu T, Kikuchi N, Kakizaki M, et al. Factors associated with self-rated health in the general population of Japan: evidence from a national longitudinal study of late-middle-aged Japanese. The journals of gerontology Series B, Psychological sciences and social sciences. 2006; 61(3):P129–36. Epub 2006/05/04. PMID: 16670181

25. Inoue S, Ohya Y, Odagiri Y, Takamiya T, Kamada M, Okada S, et al. Perceived neighborhood environment and walking for specific purposes among elderly Japanese. Journal of epidemiology / Japan Epidemiological Association. 2009; 19(6):294–302. Epub 2009/09/15. PubMed Central PMCID: PMCPmc3924098.

26. Norton MC, Skoog I, Franklin LM, Corcoran C, Tschanz JT, Zandi PP, et al. Gender differences in the association between religious involvement and depression: the Cache County (Utah) study. The journals of gerontology Series B, Psychological sciences and social sciences. 2006; 61(3):P129–36. Epub 2006/05/04. PMID: 16670181

27. Kessler RC, Green JG, Gruber MJ, Sampson NA, Bromet E, Cuitan M, et al. Screening for serious mental illness in the general population with the K6 screening scale: results from the WHO World Mental Health (WMH) survey initiative. International journal of methods in psychiatric research. 2010; 19 Suppl 1:4–22. Epub 2010/06/08. PubMed Central PMCID: PMCPmc3659799.

28. Gill SC, Butterworth P, Rodgers B, Mackinnon A. Validity of the mental health component scale of the 12-item Short-Form Health Survey (MCS-12) as measure of common mental disorders in the general population. Psychiatry research. 2007; 152(1):63–71. Epub 2007/03/31. https://doi.org/10.1016/j.psychres.2006.11.005 PMID: 17395272

29. Furukawa TA, Kawakami N, Saitoh M, Ono Y, Nakane Y, Nakamura Y, et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. International journal of methods in psychiatric research. 2008; 17(3):152–8. Epub 2008/09/04. https://doi.org/10.1002/mpr.257 PMID: 18763695

30. Tokuda Y, Okubo T, Ohde S, Jacobs J, Takahashi O, Omata F, et al. Assessing items on the SF-8 Japanese version for health-related quality of life: a psychometric analysis based on the nominal categories model of item response theory. Value in health: the journal of the International Society for Pharmacoeconomics and Outcomes Research. 2009; 12(4):568–73. Epub 2008/09/12.

31. Schmitz N, Lesage A, Wang J. Should psychological distress screening in the community account for self-perceived health status? Canadian journal of psychiatry Revue canadienne de psychiatrie. 2009; 54(8):526–33. Epub 2009/09/04. https://doi.org/10.1177/070674370905400805 PMID: 19726005

32. Sakurai K, Nishi A, Kondo K, Yanagida K, Kawakami N. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. Psychiatry and clinical neurosciences. 2011; 65(5):434–41. Epub 2011/08/20. https://doi.org/10.1111/j.1440-1819.2011.02236.x PMID: 21851452

33. Sugihara Y, Sugisawa H, Shibata H, Harada K. Productive roles, gender, and depressive symptoms: evidence from a national longitudinal study of late-middle-aged Japanese. The journals of gerontology Series B, Psychological sciences and social sciences. 2008; 63(4):P227–p34. Epub 2008/08/12. PMID: 18689764

34. Takagi D, Kondo K, Kawachi I. Social participation and mental health: moderating effects of gender, social role and rurality. BMC public health. 2013; 13:701. Epub 2013/08/02. PubMed Central PMCID: PMCPmc3734410. https://doi.org/10.1186/1471-2458-13-701 PMID: 23902596
35. Kendler KS, Myers J, Prescott CA. Sex differences in the relationship between social support and risk for major depression: a longitudinal study of opposite-sex twin pairs. The American journal of psychiatry. 2005; 162(2):250–6. Epub 2005/01/29. https://doi.org/10.1176/appi.ajp.162.2.250 PMID: 15677587

36. Kawachi I, Berkman LF. Social ties and mental health. Journal of urban health: bulletin of the New York Academy of Medicine. 2001; 78(3):458–67. Epub 2001/09/21. PubMed Central PMID: PMCPmc3455910.

37. Levasseur M, St-Cyr Tribble D, Desrosiers J. Meaning of quality of life for older adults: importance of human functioning components. Archives of gerontology and geriatrics. 2009; 49(2):e91–100. Epub 2008/11/04. https://doi.org/10.1016/j.archger.2008.08.013 PMID: 18977542

38. Moen Phyllis, Dempster-McClain Donna, Williams J Robin M. Successful Aging: A Life-Course Perspective on Women's Multiple Roles and Health,. American Journal of Sociology. 1992; 97(6).

39. Demura S, Sato S. Relationships between depression, lifestyle and quality of life in the community dwelling elderly: a comparison between gender and age groups. Journal of physiological anthropology and applied human science. 2003; 22(3):159–66. Epub 2003/06/17. https://doi.org/10.1016/j.archger.2008.08.013 PMID: 12808229

40. Atkins J, Naismith SL, Luscombe GM, Hickie IB. Psychological distress and quality of life in older persons: relative contributions of fixed and modifiable risk factors. BMC psychiatry. 2013; 13:249. Epub 2013/10/10. PubMed Central PMID: PMCPMC3852717. https://doi.org/10.1186/1471-244X-13-249 PMID: 24103220

41. Barnett PA, Gotlib IH. Psychosocial functioning and depression: distinguishing among antecedents, concomitants, and consequences. Psychological bulletin. 1988; 104(1):97–126. Epub 1988/07/01. PMID: 3043529

42. Kasper J, Pearson J. Living arrangements, social integration, and personal control: Correlates of life satisfaction among older people. Journal of Mental Health and Aging. 1995; 1(1):21–34.

43. Victor CR, Bowling A. A longitudinal analysis of loneliness among older people in Great Britain. The Journal of psychology. 2012; 146(3):313–31. Epub 2012/05/12. https://doi.org/10.1080/00223980.2011.609572 PMID: 22574423

44. Zebhauser A, Baumer J, Emeny RT, Ronel J, Peters A, Ladwig KH. What prevents old people living alone from feeling lonely? Findings from the KORA-Age-study. Aging & mental health. 2015; 19 (9):773–80. Epub 2014/11/20.

45. Domenech-Abella J, Lara E, Rubio-Valera M, Olaya B, Moneta MV, Rico-Uribe LA, et al. Loneliness and depression in the elderly: the role of social network. Social psychiatry and psychiatric epidemiology. 2017. Epub 2017/02/06.

46. Kircanski K, Joormann J, Gotlib IH. Cognitive Aspects of Depression. Wiley interdisciplinary reviews Cognitive science. 2012; 3(3):301–13. Epub 2012/12/15. PubMed Central PMID: PMCPMC3518852. PMID: 23240069