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Research Article

# Living Alone and Depressive Symptoms Among Older Japanese: Do Urbanization and Time Period Matter?

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## Abstract

**Objectives:** Previous research has suggested cross-national differences in the association between living alone and well-being among older adults. This study examined whether the association varied across social contexts within the country, Japan, in terms of varying degree of urbanization and differential time periods.

**Methods:** Data were obtained from a nine-wave nationwide longitudinal survey with a probability sample of Japanese adults aged 60 years and over. Respondents belonged to one of the three periods (around 1990, 2000, and 2015) according to the year they commenced participation. As many as 4,655 individuals from 575 municipalities provided 9,016 observation sets of two consecutive waves ($t - 1$ and $t$). Within a framework of the Hierarchical Generalized Linear Model, depressive symptoms at $t$ were predicted based on changes in living arrangements from $t - 1$ to $t$ and their cross-level interactions with gender, level of urbanization, and time period, controlling for various covariates at $t - 1$.

**Results:** In general, older adults living alone continuously as well as those who started living alone between the waves showed more depressive symptoms than those coresiding with someone continuously. However, this tendency was more prominent among rural residents than their urban counterparts, especially for men. Moreover, the effect of continuously living alone on depressive symptoms became smaller in Period 2015 than that in Period 1990, because of the increase in depressiveness in coresident older adults.

**Discussion:** Our findings indicate that living alone has a differential effect on older adults' well-being depending on the social context where residents' preferences for living arrangements and availability of formal services could vary.

**Keywords:** Gender differences, Living arrangement, Longitudinal study, Moderating effect, Social change

Substantial amounts of research have focused on the subjective well-being of older adults in single households, including their loneliness (Greenfield & Russell, 2011; Gu et al., 2019), quality of life (Henning-Smith, 2016), life satisfaction (Gu et al., 2019; Mao & Han, 2018; Park & Lee, 2017), and depressive symptoms or other mental health indicators (Henning-Smith, 2016; Park et al., 2013). In general, older adults living alone tend to show lower levels of well-being than their counterparts who live with someone, especially with a spouse or partner (Greenfield & Russell, 2011; Hawkley et al., 2019; Henning-Smith, 2016). However, cross-national studies in Europe revealed

a higher prevalence of loneliness in Southern European countries where familism is more prevalent and the rate of older individuals living alone is lower, compared with those in "individualistic" Northern European countries where the rate of living alone is higher (Dykstra, 2009; Jylhä & Jokela, 1990). A similar pattern was reported for Eastern versus Western European countries (de Jong Gierveld & Tesch-Römer, 2012). These results suggest the importance of the social context of living alone.

As Reher and Requena (2018, p. 428) described, "The living arrangements of the elderly, and more specifically living alone, are the result of the preferences and resources people have, together with the constraints they face as they age". These preferences are generated within the context of prevailing cultural norms (Reher & Requena, 2018), which are closely connected to individualism and attitudes toward marriage and intergenerational support. The resources may include good financial and health status which enable older adults to choose to live independently, as well as the availability of kin. In addition, public policies and social welfare programs can affect the living arrangements of older adults. For example, in countries where the public-pension system is underdeveloped and/or the availability of formal care services is very low, older adults need to live with adult children to receive support from them. Thus, there is a general trend toward a high rate of older adults living alone in developed countries (Reher & Requena, 2018; United Nations, 2020).

Because living arrangements are the results of constraints as well as preferences, actual living arrangements are sometimes different from preferred ones. Loneliness, one of the most studied indicators of well-being in older adults, is defined as the subjective and unpleasant experience caused by a discrepancy between one's desired and achieved level of social relations (Perlman & Peplau, 1981). Similarly, a discrepancy between the actual and preferred (or desired) living arrangement could have a negative effect on older adults' well-being. Thus, older adults who live alone, despite their preference for intergenerational coresidence, would be more likely to feel distressed.

Dykstra (2009) suggested that there are three possible reasons for the cross-national differences in loneliness, which are not mutually exclusive. First, the distribution of individual characteristics (i.e., population composition) that affect loneliness differs across countries. Second, country-level characteristics, such as cultural systems, economic organization, and policy arrangements, have a direct effect on loneliness. Third, there is an interaction between individual- and country-level characteristics. Namely, some kinds of country-level characteristics moderate the effect of individual characteristics on loneliness and, consequently, the importance of a particular individual-level predictor varies across countries. Thus, living alone may lead to greater distress in countries where high expectations for filial obligations exist, compared with countries where independence is highly valued.

However, differences in individual and community characteristics and their interactions may exist not only among nations but also across regions or historical time periods within a given nation. In addition, Dykstra's (2009) insight could be extended to more general subjective well-being rather than loneliness, which reflects a subjective inadequacy of social relations. We examined depressive symptoms as a measure of subjective well-being because negative emotional well-being (i.e., depression), rather than positive emotional well-being (i.e., happiness) or life satisfaction, is considered to be more suitable for evaluating potential psychological distress in those living alone. Thus, we focused on how the link between living alone and depressive symptoms in older Japanese people varied by social context (i.e., the third reason), for which empirical studies are very limited. Social context included areas with varying degrees of urbanization, and three time periods between 1987 and 2017, when family norms and policies changed in Japan.

## Living Arrangements and Social Changes in Japan in the Past Three Decades

The aged population (65 years or older) in Japan exceeded 7% in 1970, 14% in 1993, and has continued to increase to 28.8% in 2020, becoming the world's most aged population (Cabinet Office, 2021a). Japan experienced a rapid economic growth from 1955 to 1973, and the public pension and health insurance systems were expanded to cover all citizens in the early 1960s. In addition, the public long-term care insurance system (LTCI) was introduced in 2000 in response to population aging and the transitions in family structure and values.

In 2021, among Japanese people aged 65 years or older, 19.4% lived alone, 39.9% lived only with a spouse, 36.2% lived with their children (including those living with a child and others, such as a spouse), and 4.4% lived with other relatives or nonrelatives (Ministry of Health, Labour and Welfare, 2022). Although Japan is an economically developed country with an advanced social security system, the percentage of older adults living alone is much lower than that of many developed countries in Europe and North America (United Nations, 2020). The relatively high rate of intergenerational coresidence and the resulting lower rate of living alone in Japan might be attributable to traditional family norms valuing filial piety, influenced by Confucian ideology, as in other East Asian societies (Park & Chesla, 2007). Nevertheless, compared with 1986, the percentages of people "living alone" and "with spouse only" increased almost twofold, whereas the percentage of "coresidence with a child" shrank by nearly half over three decades (Ministry of Health, Labour and Welfare, 2022). Traditionally, older Japanese adults tended to live with their eldest son and daughter-in-law, and often with grandchildren (Ochiai, 1997). However, coresidence with a married child remarkably declined from 46.7% (1986) to 9.5% (2021), indicating a decrease in the number of traditional

three-generation households. The decline in coresidence with a married child is partly due to the declining fertility rate (i.e., fewer children per couple) (Ochiai, 1997) and the tendency of late marriage or staying unmarried among younger generations (Tsuya, 2017). Consequently, coresidence with an unmarried child increased over the same period (17.6%–26.8%).

The preference for intergenerational coresidence among older Japanese has also been changing. According to an international comparative survey that has been conducted every 5 years (Cabinet Office, 2021b), the percentage of Japanese adults aged ≥60 years who chose "always live with children and grandchildren" as the most ideal intergenerational relationship decreased steadily from 59.4% in 1980 to 18.8% in 2020, whereas those who chose "meet them occasionally for a meal and to talk" as the ideal increased from 30.1% to 56.8%. In contrast, the preference in older Americans remained stable, with over 60% of them choosing "meet occasionally" at every time point between 1980 and 2020.

Cohort replacement might account for the changes in family values: Older cohorts who were born and educated under the pre-World War II Civil Code dictating the stem family system have been replaced by new cohorts that were educated after the war. A previous study reported that the positive association between coresidence with a child and life satisfaction was significant in earlier cohorts (born 1901–1924), but not in recent cohorts (1925–1949), among older Japanese women (Kobayashi et al., 2015).

The most radical policy reform in Japan over the past three decades was the introduction of the LTCI in 2000. Although it is unclear how this policy reform affected family norms, because intergenerational coresidence and its preference began to decline before the LTCI was introduced, some research has suggested its effect (Tsutsui et al., 2014). Taken together, older adults' preference for intergenerational coresidence has declined with an increase in the availability of formal care services through implementation of the LTCI in the past three decades in Japan. These changes might allow older adults to live alone more comfortably than previously. Hence, we expected that the tendency for well-being to be lower in older adults living alone in Japan compared with those living with someone would have recently become weaker than before.

## Regional Differences: Urbanization as a Moderator

The level of urbanization has been recognized as one of the key regional-level characteristics. Previous studies, not restricted to older people, have generally shown that urban residents are more likely to have worse mental health than their rural counterparts (Chen et al., 2015, China data; Dekker et al., 2008, German data; Peen et al., 2010, a meta-analysis using studies from various countries), although some Chinese studies reported the opposite association (He et al., 2020; Wang et al., 2018). Fewer studies have focused on the moderating role of urbanization. Urban–rural comparative studies in China showed that living alone was negatively associated with life satisfaction (Mao & Han, 2018), and living with grandchildren was positively associated with life satisfaction (Wu, 2022) only among rural older adults.

We hypothesized that the lower the urbanization level (i.e., more rural), the stronger would be the effect of living alone on depressive symptoms, based on the following reasons. First, compared with urban residents, rural residents are assumed to prefer and hold traditional family values, including the belief that being married and living in a multigenerational household are keys to a happy life, which might lead to distress in such older adults living alone. This preference might be linked to the practical significance of intergenerational coresidence, because the succession of family businesses and land, such as on farms, is a significant issue for people living in agricultural communities. Second, urban residents usually have advantages in terms of accessibility of shops, restaurants, and other facilities necessary for daily living. In addition, although the LTCI and the health insurance system are nationwide policies in Japan, the available options for long-term care and medical services are more likely to be limited in rural than in urban areas due to there being fewer service providers. Thus, it would be easier for urban older adults to live without help from kin than for their rural counterparts.

## Changes in Living Arrangements and Gender Differences

According to the study by Brown et al. (2002), which analyzed nine-year longitudinal data, living arrangements among older Japanese remained quite stable. However, starting to live alone should be distinguished from continuously living alone when assessing their associations with well-being, because the cause of starting to live alone in old age is often spousal death. Using the Health and Retirement Study in the United States, Domingue et al. (2021) showed that depressive symptoms exhibited a sharp increase following spousal death, but were attenuated within a year after the loss. Although there is a considerable variability among older individuals in their adjustment to bereavement (King et al., 2019; Szabó et al., 2020), it is considered that people who continuously live alone have a longer time for adjustment to living alone than those newly widowed or divorced.

Thus, whereas most prior studies cross-sectionally examined the association between living arrangements and well-being, we examined changes in living arrangements to clarify whether older adults continuously living alone, as well as those who start living alone, show lower levels of well-being compared with those who continuously live with someone. Moreover, we predicted that the moderating effects of time period and level of urbanization would be

observed for the association with continuously living alone rather than starting to live alone because the latter is assumed to include an acute response to bereavement, which is a very stressful life event regardless of time period and level of urbanization.

Another consideration involves gender differences. It is widely documented that men benefit more from marriage than women, in terms of their health and well-being (Coombs, 1991; Wang et al., 2020), although reports on whether widowers show more emotional vulnerability than widows are somewhat inconsistent (Perrig-Chiello et al., 2016; Sasson & Umberson, 2014; Umberson et al., 1992). Moreover, compared with living with only a spouse, living alone was more strongly associated with lower levels of well-being among older men than women in both the United States (Greenfield & Russell, 2011) and Japan (Raymo et al., 2008).

### The Present Study

Although previous cross-national studies have indicated that social context might moderate the association between living alone and well-being in old age (e.g., Dykstra, 2009), the evidence is limited for the diverse social context within the same country, especially in Japan. The present study fills this gap by focusing on the moderating role of urbanization and time period as the social context, in conjunction with gender as an individual-level moderator, using three-decade longitudinal data obtained from a nationwide probability sample of older Japanese. Another unique feature of this study is that it examined the effects of changes in living arrangements on depressive symptoms, which allows us to differentiate older adults who recently started living alone from those continuously living alone. We hypothesized that higher levels of urbanization and more recent time periods would weaken the effect of continuously living alone on depressive symptoms.

## Method

### Sample and Data

Data were obtained from the National Survey of the Japanese Elderly (NSJE), a nine-wave longitudinal survey with a nationwide representative sample of older Japanese. The NSJE was started in 1987 with 2,200 people aged ≥60 years who participated in a face-to-face interview, and subsequently added 404 respondents aged 60–62 years in 1990 (Wave 2), 976 aged 60–65 years in 1996 (Wave 4), 1,635 aged ≥70 years in 1999 (Wave 5), and 1,450 aged 60–92 years in 2012 (Wave 8). The response rate was 67% in 1987, and 70%, 81%, 83%, and 59% for the added cohort in 1990, 1996, 1999, and 2012, respectively. Participants were randomly selected from the basic resident register using a two-stage stratified sampling method, in which stratification was performed based on geographic region and population size of municipalities, and 192 census enumeration districts were selected in the first stage of sampling. More information on the survey is available elsewhere (Japanese Aging and Health Dynamics Study, n.d.).

Participants were divided into three groups according to the year they commenced participation and the three periods were constructed accordingly (Table 1). Participants in Period A were those who entered the survey in either 1987 or 1990, and their responses between 1987 and 1996 were used. Similarly, the 1996–2006 data of participants who entered in 1996 or 1999 were used for Period B, and the 2012 and 2017 data of those who entered in 2012 were used for Period C.

We restricted the study sample to participants who self-responded in two consecutive waves in the same municipality. Among 6,193 self-respondents from various waves of entry (Wave 1, 2, 4, 5, or 8), 1,538 participants were excluded from analyses due to dropout before the first follow-up because of death ($n = 458$), relocation ($n = 101$), or other reasons ($n = 979$, including proxy responses). Thus, 4,655 participants (Table 1, Level 2) provided one to three observation sets of two consecutive waves, yielding 9,016 observation sets in total (Level 1). Regarding Period C, the number of respondents and their observations were relatively small, because only the 2012 cohort with a single follow-up was available and their response rate in 2012 was lower than that of earlier cohorts. For the regional level (Level 3), the unit of analysis was the municipality where the selected census enumeration district was located, because we could not determine which specific districts the participants resided in. Participants resided in 190–193 municipalities for each period, with 575 municipalities in total. Although many of the municipalities were duplicated across the periods, we treated them as different cities/towns with different urbanization levels, as observed in the 1990, 2000, and 2015 Population Census.

### Measures

#### Depressive symptoms

Nine items from the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977) were evaluated in all the survey waves in the NSJE, including the eight-item version of the CES-D (Karim et al., 2015), and an additional item "my appetite was poor." Because factors of positive affect (e.g., I was happy) did not substantially correlate with other factors in terms of depressive symptoms in the Japanese sample (Yatomi et al., 1993), two positive affect items were excluded, and the remaining seven negative symptoms (e.g., I felt lonely, sleep was restless) were analyzed. Participants were asked how often they had felt these symptoms during the past week. There were three response categories (rarely or none, sometimes, often) in

**Table 1.** Participants and Data Structure

| Period | Year of entry to NSJE | Waves used for analysis (years of data collection) | Level 1: Number of observation sets; Wave ($t$-1) and Wave ($t$) | Level 2: Number of respondents | Level 3: Number of municipalities |
|---|---|---|---|---|---|
| A: Around 1990 | 1987, 1990 | Waves 1–4 (1987–1996) | 4,635 ($t$ = 2, 3, or 4) | 2,030 | 192 |
| B: Around 2000 | 1996, 1999 | Waves 4–7 (1996–2006) | 3,527 ($t$ = 5, 6, or 7) | 1,771 | 193 |
| C: Around 2015 | 2012 | Waves 8–9 (2012–2017) | 854 ($t$ = 9) | 854 | 190 |
| Total | | Waves 1–9 | 9,016 | 4,655 | 575 |

*Notes*: NSJE = National Survey of the Japanese Elderly. The years under "Period" (1990, 2000, and 2015) were based on the year of the Population Census used for municipality data.

Waves 1–4 and four categories (rarely or none, little of the time [1–2 days], occasionally [3–4 days], most or all of the time [5–7 days]) in Waves 5–9. Thus, we treated "rarely or none" as 0 and the other categories were grouped as 1 to count the number of depressive symptoms (0–7). Cronbach's alpha was 0.78 and 0.79 at $t$ – 1 and $t$, respectively, showing high internal consistency for the seven items.

### Changes in living arrangements

Changes in living arrangements from Wave ($t$ – 1) to Wave ($t$) consisted of four categories: continuous coresidence (lived with someone in both waves), continuously lived alone (lived alone in both waves), started living alone (lived with someone at $t$ – 1 but alone at $t$), and started coresidence (lived alone at $t$ –1 but with someone at $t$). To check variability among the cohabitants, we performed supplementary analyses to examine the changes in marital status and those in coresidence with a child from $t$ – 1 to $t$.

### Level of urbanization and time periods

Densely inhabited districts (DIDs) represent areas designated as urban areas, based on the Population Census of Japan using two criteria regarding population density and population in the targeted and adjacent districts (Statistics Bureau of Japan, n.d.). The level of urbanization was defined as DID population ratio (DID-PR), that is, the percentage of the population living in DIDs relative to the total population (0–100). The DID-PR was obtained for each municipality based on the 1990, 2000, and 2015 Census for Periods A, B, and C, hereafter referred to as Periods 1990, 2000, and 2015, respectively. Since the time periods correspond to the years of the Census, not only the level of urbanization but also the period was treated as a regional-level attribute in analyses.

### Gender and Covariates

Gender (female = 1, male = 0) was one of the key variables in this study. The following sociodemographic, social network, and health-related characteristics, which were assumed to correlate with both living arrangements and depressive symptoms, were controlled for: Age, years of education, annual income (including spouse's, if married), working status, self-rated health (ranging from 1: not at all healthy to 5: perfectly healthy), functional limitations, frequency of contact with children living apart, including contact by telephone and e-mail, and frequency of meeting friends and neighbors. Functional limitations represented the number of activities participants could not do independently (0–9) among three items of instrumental activities of daily living and six items of physical activities (e.g., using the telephone, traveling by bus or train, climbing stairs, walking a few blocks, etc.). For both frequency of contact with children living apart and frequency of meeting friends and neighbors, responses of "more than twice a week," "once a week," "2–3 times a month," "once a month," "less than once a month," and "none" were coded from 6 to 1. The frequency of "none" included cases without such relationships (e.g., having no children living apart). These covariates, excluding education, were time-varying covariates measured at $t$ – 1, that is, the wave before the dependent variable was measured ($t$). In addition to contact with children living apart at $t$ – 1, we included changes in child contact from $t$ – 1 to $t$, because changes in living arrangements due to the child leaving home or starting coresidence increase or decrease the number of non-coresident children. Moreover, depressive symptoms at $t$ – 1 and drop-out status were controlled. Drop-out status, a time-invariant covariate regarding whether participants did not respond to the survey during each period and its reason (death, relocation, and others), was introduced to control for potential attrition bias.

## Analysis

Due to the multilevel structure of data (Table 1) and the nature of the dependent variable, analyses were performed within a framework of Hierarchical Generalized Linear Models (HGLM) for count data using the Poisson

distribution (Raudenbush & Bryk, 2002). The Level-1 equation is denoted as follows:

$$\begin{aligned}\text{Level 1}: \quad \ln(L_{tij}) =& \pi_{0ij} + \pi_{1ij}(\text{cont. live-alone})_{tij} \\ &+ \pi_{2ij}(\text{start live-alone})_{tij} \\ &+ \pi_{3ij}(\text{start co-residence})_{tij} \\ &+ \Sigma\pi_{pij}X_{p(t-1)ij}\end{aligned}$$

where $L_{tij}$ is the expected number of depressive symptoms at $t$ for individual $i$ in municipality $j$.

The three dummy variables represent changes in living arrangements from $t-1$ to $t$, omitting continuous coresidence as a reference category. The variable $X_{p(t-1)ij}$ refers to time-varying covariates at $t-1$, including changes in contact with children living apart from $t-1$ to $t$. The intercept $\pi_{0ij}$ varies randomly as a function of Level-2 variables (gender, education, and drop-out status), and Level-3 variables (urbanization, period) according to the following equations:

$$\begin{aligned}\text{Level 2}: \quad \pi_{0ij} =& \beta_{00j} + \beta_{01j}(\text{female}) + \beta_{02j}(\text{education}) \\ &+ \beta_{03j}(\text{drop\_death}) \\ &+ \beta_{04j}(\text{drop\_relocation}) \\ &+ \beta_{05j}(\text{drop\_other}) + e_{0ij}\end{aligned}$$

$$\begin{aligned}\text{Level 3}: \quad \beta_{00j} =& \gamma_{000} + \gamma_{001}\,(\text{DID-PR}) \\ &+ \gamma_{002}\,(\text{Period 2000}) \\ &+ \gamma_{003}\,(\text{Period 2015}) + r_{00j}\end{aligned}$$

Meanwhile, the Level-1 slopes ($\pi_{1ij}$, $\pi_{2ij}$, and $\pi_{3ij}$) for living arrangements vary as a function of gender and the Level-3 variables, when examining cross-level interactions. These equations are denoted as follows if $p$ = 1, 2, or 3:

$$\text{Level 2}: \quad \pi_{pij} = \beta_{p0j} + \beta_{p1j}(\text{female})$$

$$\begin{aligned}\text{Level 3}: \quad \beta_{p0j} =& \gamma_{p00} + \gamma_{p01}(\text{DID-PR}) \\ &+ \gamma_{p02}(\text{Period 2000}) + \gamma_{p03}\,(\text{Period 2015})\end{aligned}$$

We did not include random errors in the slope equations due to the failure of convergence of the estimating algorithm. In addition, we checked whether the moderating effects of gender ($\beta_{p1j}$) might vary according to any of the Level-3 variables. Estimations were made based on the population-average model using penalized quasi-likelihood. Noncategorical explanatory variables were centered around the grand mean.

There were no missing values for changes in living arrangements. Income had 13.6% missing values and other variables had less than 2%, which were imputed via multiple imputation method (number of datasets = 5). HLM 8.00 software was used for HGLM, and all other analyses were performed using IBM SPSS Statistics 23.

## Results

Descriptive statistics for explanatory variables are shown in Table 2. Regarding changes in living arrangements, 7,751 (86%) of 9,016 observation sets of two consecutive waves were categorized as continuous coresidence, and 842 (9.3%), 323 (3.6%), and 100 (1.1%) were categorized as continuously lived alone, started living alone, and started coresidence, respectively. As shown in Supplementary Tables 1 and 2, among continuous coresidence observation sets, 74% were married and 57% lived with a child in both waves, whereas 75% of those who continuously lived alone were widowed in both waves. For those who started living alone, 54% became widowed and 34% experienced a child leaving home between the waves, and for those who started coresidence, 75% started coresidence with a child. Although not shown in the tables, of 4,655 Level-2 individuals, 1.8% were never-married and 5.5% were childless, both of which were small proportions, but increased in more recent periods (never-married: 1.3%–2.6%; childless: 4.6%–7.3%).

According to Model 1 in Table 3 or the main effect model, continuously lived alone as well as started living alone respondents showed significantly higher levels of depressive symptoms than continuous coresident respondents, after controlling for all covariates described previously (see Supplementary Table 3 for the covariate coefficients). In addition, being woman and recent time periods (2000 and 2015) were associated with more depressive symptoms, whereas the level of urbanization had no main effect. Evaluation of focal cross-level interactions in Model 2 indicated significant interactions of continuously living alone with gender, urbanization, and period, as expected. However, further analysis revealed that the moderating effect of gender varied by the level of urbanization in those who continuously lived alone (Model 3). Although a significant three-way interaction between started coresidence, gender and Period 2015 was also observed, the result seemed to be unreliable because the sample size of "started coresidence" in Period 2015 was very small ($n$ = 12). Thus, Model 3 was regarded as the final model.

Figure 1 illustrates interactions between changes in living arrangements, gender, and urbanization. The logarithm of the expected number of depressive symptoms was estimated based on Model 3, assuming that the period and covariates had values of zero, namely a reference category for categorical variables (1990 for the period) or a mean value for mean-centered covariates. Next, the exponent was obtained to transform the log link back to the expected counts. In the graph, we regarded 25% for DID-PR as "rural" and 97% as "urban," which corresponded to the 20th and 80th percentiles in the DID-PR distribution of the 575 municipalities. Differences between the predicted values for continuous coresidence and those for the other three categories at a DID-PR of 25 and 97, respectively, were tested using a technique recommended by Aiken and West (1991; pp. 132–133) (see also Supplementary Table 4). Compared with continuous coresidence, respondents who continuously lived alone, as well as those who started living alone, showed significantly higher levels of depression, except for urban women who continuously lived alone.

**Table 2.** Descriptive Statistics for Explanatory Variables

| Variables | Min–Max | Proportion (%)/Mean (SD) |
|---|---|---|
| Level-1 variables ($n$ = 9,016) | | |
| Changes in living arrangements [$t$ – 1 to $t$]: | | |
| Continuous coresidence (ref.) | – | 86.0 |
| Continuously lived alone | 0–1 (dummy) | 9.3 |
| Started living alone | 0–1 (dummy) | 3.6 |
| Started coresidence | 0–1 (dummy) | 1.1 |
| Age (years) [$t$ – 1] | 60–95 | 69.8 (6.45) |
| Annual income [$t$ – 1]: <1.2 million yen (ref.) | – | 22.5 |
| 1.2 to <3 million yen | 0–1 (dummy) | 39.5 |
| 3 to <5 million yen | 0–1 (dummy) | 25.6 |
| 5 million yen and over | 0–1 (dummy) | 12.4 |
| Working [$t$ – 1] | 0–1 (dummy) | 34.7 |
| Functional limitations [$t$ – 1] | 0–9 | 0.65 (1.53) |
| Self-rated health [$t$ – 1] | 1–5 | 3.58 (1.00) |
| Freq. contact with children living apart [$t$ – 1] | 1–6 | 3.87 (1.78) |
| Changes in contact with children living apart [$t$ – 1 to $t$] | –5 – +5 | –0.03 (1.57) |
| Freq. meetings with friends and neighbors [$t$ – 1] | 1–6 | 3.90 (1.78) |
| Depressive symptoms [$t$ – 1] | 0–7 | 0.99 (1.58) |
| Level-2 variables ($n$ = 4,655) | | |
| Gender: Female | 0–1 (dummy) | 55.8 |
| Education (years) | 0–17 (17 = 17 or more) | 9.66 (2.80) |
| Drop-out status: remained (ref.) | – | 70.4 |
| Death | 0–1 (dummy) | 8.4 |
| Relocation | 0–1 (dummy) | 2.0 |
| Other reasons | 0–1 (dummy) | 19.2 |
| Level-3 variables ($n$ = 575) | | |
| Level of urbanization: DID-PR (%) | 0–100 | 60.9 (35.1) |
| Period (census year): around 1990 (ref.) | – | 33.4 |
| Around 2000 | 0–1 (dummy) | 33.6 |
| Around 2015 | 0–1 (dummy) | 33.0 |

*Notes*: DID-PR = percentage of population living in Densely Inhabited Districts. All Level-1 explanatory variables except those for "Changes" were measured at $t$ – 1.

The negative coefficient for the interaction between continuously lived alone and woman (–0.336, $p < .001$ in Table 3) suggested that older adults continuously living alone reported more depressive symptoms than those continuously living with someone, and this association was stronger among men than women. However, as Figure 1 shows, this does not necessarily mean that men who continuously lived alone had more depressive symptoms than their female counterparts, because the average depression level in women was higher than in men, and continuously coresident women had more depressive symptoms than their male counterparts. Moreover, rural residents who continuously lived alone reported more depressive symptoms than their urban counterparts, and this tendency was more prominent in men (i.e., a significant interaction of continuously living alone × female × urbanization). A similar pattern was observed for started living alone in Figure 1, but none of the interactions with started living alone reached the 0.05 significance level (Table 3). Starting coresidence enhanced depressive symptoms compared to continuous coresidence for men, but not for women (started coresidence × female).

Model 3 interactions regarding period are illustrated in Figure 2, assuming a mean level of urbanization and considering other covariates as zero. Estimates for starting coresidence appeared to be accelerated in more recent periods in the graph, although with no statistically significant interaction between starting coresidence and period due to large standard errors (Table 3). Compared with Period 1990, differences in depressive symptoms between continuous coresidence and continuously lived alone became smaller in Period 2015 (continuously lived alone × Period 2015). However, this significant interaction was not caused by an improvement in depression among people living alone, but by an increase in depression among those with continuous coresidence. As shown in Figure 2 and in Supplementary Table 5, in women, those continuing or starting to live alone showed significantly higher levels of depressive symptoms than continuously coresident women in Period 1990, but the differences were not significant in Period 2015.

**Table 3.** Estimated Fixed Effects for Depressive Symptoms Based on Hierarchical Generalized Linear Models

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Explanatory variables | Coefficient (SE) | Coefficient (SE) | Coefficient (SE) |
| Intercept | −0.296 (0.060)*** | −0.325 (0.061)*** | −0.325 (0.061)*** |
| Changes in living arrangements | | | |
| Continuous coresidence (ref.) | | | |
| Continuously lived alone | 0.219 (0.048)*** | 0.525 (0.120)*** | 0.529 (0.116)*** |
| Started living alone | 0.358 (0.073)*** | 0.662 (0.155)** | 0.648 (0.162)*** |
| Started coresidence | 0.142 (0.119) | 0.587 (0.278)* | 0.602 (0.262)* |
| Gender: Female | 0.305 (0.036)*** | 0.347 (0.037)*** | 0.348 (0.037)*** |
| Level of urbanization | −0.000 (0.001) | 0.000 (0.001) | 0.000 (0.001) |
| Period: 1990 (ref.) | | | |
| 2000 | 0.131 (0.053)* | 0.141 (0.057)* | 0.139 (0.057)* |
| 2015 | 0.398 (0.056)*** | 0.436 (0.059)*** | 0.434 (0.059)*** |
| Cross-level interactions | | | |
| Continuously lived alone | | | |
| × Female | – | −0.330 (0.104)** | −0.336 (0.104)** |
| × Urbanization | – | −0.002 (0.001)* | −0.007 (0.002)** |
| × Period 2000 | – | −0.033 (0.100) | −0.035 (0.100) |
| × Period 2015 | – | −0.283 (0.121)* | −0.268 (0.121)* |
| × Female × urbanization | | – | 0.005 (0.002)* |
| Started living alone | | | |
| × Female | – | −0.281 (0.153) | −0.257 (0.165) |
| × Urbanization | – | −0.002 (0.002) | −0.005 (0.003) |
| × Period 2000 | – | −0.155 (0.155) | −0.172 (0.155) |
| × Period 2015 | – | −0.300 (0.163) | −0.313 (0.163) |
| × Female × urbanization | | – | 0.005 (0.004) |
| Started coresidence | | | |
| × Female | – | −0.686 (0.240)** | −0.709 (0.232)** |
| × Urbanization | – | −0.003 (0.003) | −0.002 (0.004) |
| × Period 2000 | – | 0.155 (0.246) | 0.165 (0.240) |
| × Period 2015 | – | 0.113 (0.389) | 0.119 (0.391) |
| × Female × urbanization | | – | −0.001 (0.006) |
| Random effects | Variance component | Variance component | Variance component |
| Intercept, Level-2 residuals | 0.589*** | 0.586*** | 0.587*** |
| Intercept, Level-3 residuals | 0.188*** | 0.187*** | 0.188*** |

*Notes*: SE = robust standard errors. Controlled for Level-1 covariates at $t - 1$ (age, income, working status, functional limitations, self-rated health, frequency of contact with children living apart, frequency of meeting friends and neighbors, and depressive symptoms), changes in child contact from $t - 1$ to $t$, and Level-2 covariates (education and drop-out status). Noncategorical explanatory variables were centered around the grand mean.
$p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

To consider the variability of coresidence (i.e., with whom the person continued/started/quit coresiding), we conducted a supplementary analysis to examine how changes in marital status and child coresidence affected depressive symptoms in a subsample who continued coresiding. As seen in Supplementary Table 6, older adults who continuously lived with someone but experienced widowhood between the waves showed higher levels of depressive symptoms than those continuously married, and this effect was smaller in Period 2000 than in 1990 (married to widowed × Period 2000). The effect of continuously unmarried (widowed/divorced/never married in both waves) was not significant in the main effect model, but was significant in the interaction model, suggesting that being continuously unmarried enhanced depressive symptoms in men (i.e., female = 0). Although not coresiding with a child in either wave (vs. coresiding continuously) was associated with more depressive symptoms regardless of gender and period, starting coresidence with a child was more likely to depress men and people in Period 2015 compared with their counterparts (significant interactions for started coresidence with gender and Period 2015). Meanwhile, the child leaving home did not significantly affect the parents' depressive level. Even after considering these changes in marital status and coresident children, older coresident adults in Period 2015, and to a lesser extent in Period 2000, had more depressive symptoms than those in Period 1990.

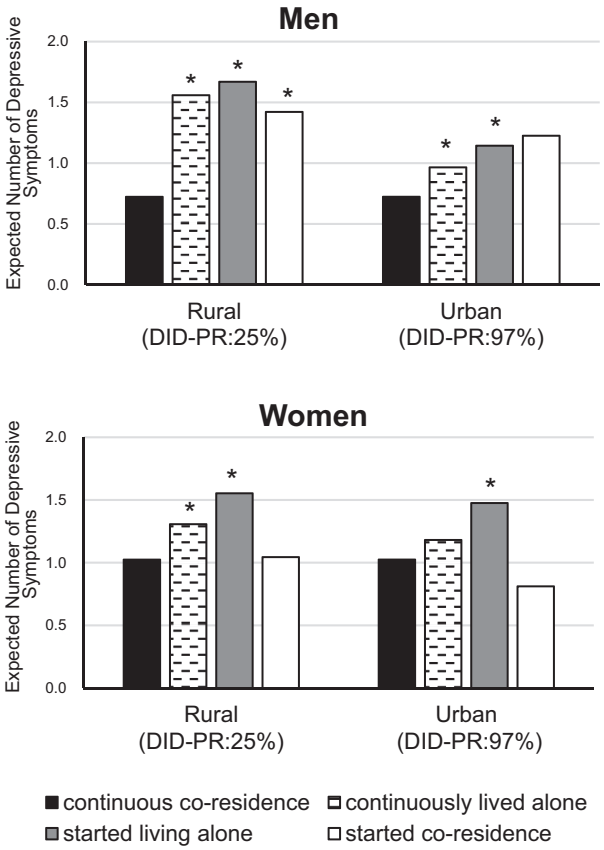


**Figure 1.** Expected number of depressive symptoms by gender and level of urbanization. DID-PR = Percentage of population living in Densely Inhabited Districts. Estimation was made based on Model 3 in Table 3, assuming that the period was 1990 and other covariates were their reference category or mean value. The asterisks (*) represent a significant difference ($p<.05$) vs. "continuous coresidence" at the same level of urbanization, based on the results in Supplementary Table 4.

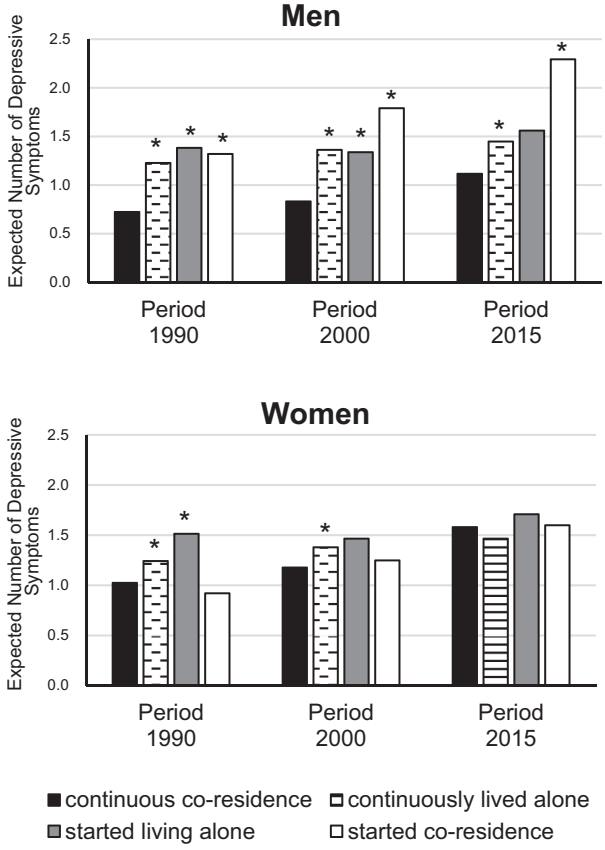


**Figure 2.** Expected number of depressive symptoms by gender and time period. Estimation was made based on Model 3 in Table 3, assuming that level of urbanization and other covariates were their reference category or mean value. Because the sample size for starting coresidence was small, their estimates should be interpreted with caution. The asterisks (*) represent a significant difference ($p<.05$) from "continuous coresidence" in the same period, based on the results in Supplementary Table 5.

## Discussion

European research has suggested cross-national differences in the association between living alone and well-being among older adults (de Jong Gierveld & Tesch-Römer, 2012; Dykstra, 2009). This study further revealed that the association varied across social contexts within the same country, in terms of varying degrees of urbanization and different historical periods, using longitudinal data of older Japanese adults. We also found that not only starting to live alone, over half the cases of which were induced by widowhood, but also continuously living alone was associated with higher levels of depressive symptoms in general, compared to continuously living with someone. The results indicate that living alone might be a chronic stressor for older adults and, hence, mitigation of its negative effect is an important issue.

Nevertheless, it is worth noting that gender substantially moderates the effect of living alone on depressive symptoms. The difference in depressive tendency between continuously living alone and continuous coresidence was larger for men than women, consistent with previous research reporting a greater effect of marital status on health and well-being among men (Coombs, 1991; Wang et al., 2020). Our results also suggested that rural men were more vulnerable to depression when living alone than urban men, whereas the moderating effect of urbanization was less prominent in women. There are two possible reasons for this. First, we assume that the high availability of commercial services, including shops and restaurants, in urban areas, is more helpful for men living alone than their female counterparts, because there is a huge gender gap in Japan in terms of housework; on average, men spent 44 min/day on housework-related activities in 2016 (it was 24 min in 1996), whereas women spent approximately 210 min/day in 1996–2016 (Statistics Bureau of Japan, 2017). This assumption is consistent with a report that the stress associated with household management is the critical mechanism linking widowhood to depression among men (Umberson et al., 1992). Second, in the traditional Japanese stem family

system or "*ie*" system, which was legally supported until the Civil Code was revised in 1947, the family business and property were passed on to only the eldest son, along with the responsibility of taking care of his aged parents. Continuity is an essential feature of the *ie*, according to which the house (*ie*) must continue even after the death of the current members (Hendry, 2013, pp. 23–40). Residents in rural agricultural areas are more likely to adhere to values rooted in the *ie* system (Tsuya & Martin, 1992). Thus, compared with women and urban men, rural men might feel more distress in living alone due to their inability to transfer family property to the next generation.

Moreover, the effect of continuously living alone on depressive symptoms became smaller in Period 2015 than in Period 1990. Especially, the level of depression in women who lived alone was not significantly different from that in coresident women in Period 2015. However, the reason was not as we had expected. The average level of depressive symptoms in coresident older adults increased, despite our hopeful expectation that a decrease in preference for intergenerational coresidence, along with an increase in the availability of formal care services, would enable older adults to live alone more comfortably. The supplementary analysis (Supplementary Table 6) indicated that changes in family structure over the decades (e.g., decrease in coresidence with children) did not fully account for the increase in depressive symptoms among older coresident adults. The downturn in the Japanese economy due to the low economic growth over the past three decades (The World Bank, n.d.) might have affected individual mental health, although social changes making single lives easier might have somewhat offset this negative effect in older adults living alone. Studies in other nations suggested that the increase in negative emotions in older adults is not necessarily a general trend. Studies in China reported an increase in depressive symptoms and loneliness among older adults from late 1980s to early 2010s (Shao et al., 2013; Yan et al., 2014), whereas there was no evidence of an increase in loneliness among older U.S. adults (Hawkley et al., 2019). In contrast, a Dutch study reported that later-born cohorts were less lonely (Suanet & van Tilburg, 2019). Thus, further studies in the Japanese population are necessary to clarify the robustness and reasons for the increase in depressive symptoms among older adults living with someone.

There are some limitations to this study. First, we do not know to what extent family values or norms contributed to the moderating effects of urbanization and period, due to the unavailability of measured values, including preferences for living arrangements, in the NSJE. Second, the focus on changes in living arrangements did not allow us to adequately consider variability within coresidence. Although we revealed a substantial variability depending on cohabiting with a spouse or child (Supplementary Table 6), the well-being of older adults might also be affected by the gender and marital status of the coresident child (Oshio, 2012), as well as coresidence with grandchildren or family members who need nursing care.

Third, our analyses and interpretations were limited by the relatively small number of people with changes in living arrangements, along with the small sample size in Period 2015. The low response rate in the 2012 survey might cause some bias: Compared with the same-age population in the 2010 Census, the ratios of males and married individuals were higher in the 2012 respondents by 3.9% and 5.3%, respectively (Kobayashi et al., 2015), which could reduce the number of respondents who were unmarried and living alone. In addition, exclusion of respondents who relocated from the original municipality might have underestimated the number of those starting to live alone/coreside. In particular, old parents who relocated to their child's house were likely to be excluded. Although the moderating effects of urbanization and period were statistically significant only for those who continuously living alone in accordance with our expectation, the coefficient of the interaction between starting to live alone and Period 2015 was even larger than that with continuously living alone (Table 3).

The result that older adults, especially men, who started coresidence, appeared to become more depressed in more recent periods (Figure 2) should be interpreted with caution because of the small sample size. However, we would like to note that this observation was in line with our observation that starting coresidence with a child was more likely to depress men and people in Period 2015 among those who continued coresidence (Supplementary Table 6). Similarly, a European study reported that adult children's return to their parents' home had a negative effect on the parents' well-being (Tosi & Grundy, 2018). Further empirical studies focusing on starting coresidence with a child are required, because older adults' values of independence and filial piety, as well the children's purposes for coresidence, would affect their reactions to starting coresidence, which will alter the effectiveness of policies encouraging intergenerational coresidence in old age.

## Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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## Conflict of Interest

None declared.

## Ethical Approval

This study was approved by the Institutional Review Board of the Tokyo Metropolitan Institute of Gerontology (approved as R21-008).

## Author Contributions

E. Kobayashi planned the study, performed the data analysis, and wrote the paper. K. Harada and S. Okamoto helped to plan the study and contributed to revising the paper. J. Liang planned the longitudinal study and contributed to revising the paper.

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