

Panel Data Research Center, Keio University

PDRC Discussion Paper Series

【Discussion Paper Series by ESRC-JSPS Research Project on Japan and the UK】

**How did the COVID-19 pandemic affect the well-being of
older people living alone in Japan?**

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**9 March, 2024
revised: November, 2024**

DP2023-004

<https://www.pdrc.keio.ac.jp/en/publications/dp/9001/>



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JEL Classification: D1; I31

Keywords: living alone; happiness; unconditional quantile regression with fixed effects

Abstract

The spread of coronavirus disease 2019 (COVID-19) has serious adverse effects on our daily lives. The impact may be highly significant for older people, particularly those living alone, because they lose the opportunity to meet friends and family owing to going out restrictions. However, studies examining the impact of living arrangements on older people during the pandemic are limited. Hence, this study uses data from Japan, the world's first super-aging society, to examine the association between living arrangements and older adults' well-being, measured by happiness, before and after the COVID-19 pandemic. The differences-in-differences estimation that controls for individual fixed effects provides three findings. First, the happiness of older men living alone decreased during the COVID-19 pandemic, but we did not find a significant impact of living alone among older women. Second, we used the quantile regression model to examine how the effect of living alone varied based on the happiness distribution. We found that the decline in happiness was most pronounced among older men with high happiness, but no significant effects were found in any quantile of the distribution for older women. Third, only the happiness of men living alone worsened when we used the detailed living arrangements variables. Overall, significant gender differences in the effect of living alone were found.

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Acknowledgement: Data from the Japan Household Panel Survey were provided by the Panel Data Research Center at Keio University. This work was supported by JSPS Grants-in-Aid for Scientific Research (KAKENHI) in Japan (22H04911, JPJSJRP20211706).

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Acknowledgments: Data from the Japan Household Panel Survey were provided by the Panel Data Research Center at Keio University.

Statements & Declarations

Financial interests: The authors have no relevant financial or non-financial interests to disclose.

Funding: This work was supported by JSPS Grants-in-Aid for Scientific Research (KAKENHI) in Japan (22H04911, JPJSJRP20211706).

Competing Interest: The Panel Data Research Center at Keio University provided the microdata to graduate students and researchers from universities and national, public, or private research institutes, given that it is used for nonprofit and academic purposes. Therefore, when replicating the results of this study, please submit an application form to the office of the Panel Data Research Center at Keio University to borrow the data.

Conflict of Interest: The Panel Data Research Center at Keio University provided the microdata to graduate students and researchers from universities and national, public, or private research institutes, given that it is used for nonprofit and academic purposes. Therefore, when replicating the results of this study, please submit an application form to the office of the Panel Data Research Center at Keio University to borrow the data.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Kazuma Sato. The first draft of the manuscript was written by Kazuma Sato and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Disclosure of potential conflicts of interest

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Research involving Human Participants and/or Animals

Permission to use the data used in this paper was obtained from the participants for academic purposes and on the condition that the data be anonymized.

Informed consent

This paper is not applicable.

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Abstract

The spread of coronavirus disease 2019 (COVID-19) has serious adverse effects on our daily lives. The impact may be highly significant for older people, particularly those living alone, because they lose the opportunity to meet friends and family owing to going out restrictions. However, studies examining the impact of living arrangements on older people during the pandemic are limited. Hence, this study uses data from Japan, the world's first super-aging society, to examine the association between living arrangements and older adults' well-being, measured by happiness, before and after the COVID-19 pandemic. The differences-in-differences estimation that controls for individual fixed effects provides three findings. First, the happiness of older men living alone decreased during the COVID-19 pandemic, but we did not find a significant impact of living alone among older women. Second, we used the quantile regression model to examine how the effect of living alone varied based on the happiness distribution. We found that the decline in happiness was most pronounced among older men with high happiness, but no significant effects were found in any quantile of the distribution for older women. Third, only the happiness of men living alone worsened when we used the detailed living arrangements variables. Overall, significant gender differences in the effect of living alone were found.

Keywords: living alone, happiness, COVID-19, unconditional quantile regression with fixed effects

JEL classification codes: D1, I31,

1. Motivation

The spread of coronavirus disease 2019 (COVID-19) has sparked a public health crisis worldwide. The World Health Organization (WHO) declared the COVID-19 outbreak a public health emergency of international concern on January 30, 2020, and many lives have been lost due to COVID-19. Many governments have implemented countermeasures, such as stay-at-home policies, full lockdowns, and public place closures, to control the spread of infection. Although these policies effectively reduced the spread of COVID-19, they also restricted face-to-face communication, leading to social isolation, which can affect well-being. Social isolation could negatively affect well-being because social relationships critically impact our well-being (Hwang et al., 2020; Brodeur et al., 2021; Henssler et al., 2021). In addition, the extent of the impact of social isolation may depend on two factors. The first factor is people's age. As older adults are vulnerable to social isolation (WHO 2020), the negative impact of COVID-19 could be highly significant for these age groups. The second factor is living arrangements. As face-to-face communication declined because of the spread of COVID-19, the importance of who people usually live with has increased. Particularly, people living alone who lost the opportunity to talk with others could be negatively affected. Considering these points, the adverse impact of a decline in face-to-face communication because of the spread of COVID-19 may be substantial for older adults living alone. This study examines this point using Japanese panel data obtained from two special surveys conducted in May–June and October–November 2020.

Increasing studies using data from EU countries have examined the impact of the COVID-19 pandemic on the well-being of older people. However, this study focuses on the case of Japan because the household structure for older people in this country has changed in recent decades. Moreover, the number of older people living alone has increased. According to the Comprehensive Survey of Living Conditions conducted by the Ministry of Health, Labor, and Welfare, the ratio of one-person households among those with persons aged 65 and over was 13% in 1985. This ratio has increased gradually and reached 29% in 2019. Based on this result, several older people live alone and are expected to be affected by the spread of COVID-19. We empirically examine how the well-being of older people living alone varied during the first and second waves of the COVID-19 pandemic relative to the pre-COVID-19 period.

The literature examining the effect of the COVID-19 pandemic on well-being has been rapidly growing. Studies have reported that the spread of COVID-19 has deteriorated the well-being of people (Vindegård & Benros, 2020; Wang et al., 2020; Xiong et al., 2020). In addition, the number of studies focusing on the association between the COVID-19 pandemic and the well-being of older people has recently increased. For example, Mendez-Lopez et al. (2022) examined how the mental health of people over 50 years changed during the COVID-19 pandemic based on the stringency of pandemic responses and protection. They showed that the mental health of people in countries with great stringency of physical distancing decreased. However, the decline in the mental health of people in countries with high social protection expenditures was alleviated. García-Prado et al. (2022) investigated the causal association between the well-being of

people over 50 years old and lockdown policies. They revealed that insomnia, anxiety, and depression deteriorated because of the lockdown policies. They also found a heterogeneous impact of lockdown policies and showed that the negative effect was strong for women, those aged between 50 and 65, and people living alone. Litwin and Levinsky (2021) examined the relationship between social networks and the mental health of people over 50 years. They reported that although face-to-face communication was positively related to mental health, electronic communication had adverse effects.

Although some studies focused on the effect of living arrangements of older people on their well-being during the COVID-19 pandemic, the number of studies is limited. Berniell et al. (2023) examined the impact of the COVID-19 pandemic on the well-being of people over 50 years varied based on their living arrangements and housing conditions. Using data from European countries, they showed that older people living alone or living only with a spouse experienced worsening depression, loneliness, and trouble sleeping in the first wave of the pandemic. Meanwhile, having children in the same building improved those symptoms. Atzendorf and Gruber (2021) analyzed the impact of individual attributes and macroindicators using the Oxford COVID-19 Government Response Tracker on the mental health of older adults, including retired respondents over 60 years. Their study, which used data from European countries, showed that although macroindicators and individual attributes deteriorated mental health, the magnitude of individual attributes was more substantial than the former. In addition, they found that the mental health of older adults declined when they lived alone after the first wave of the COVID-19 pandemic. Ryu et al. (2022) investigated changes in social relationships and mental health of older adults living alone before and after the pandemic. Their study, which used data from South Korea, revealed that although social activity and interaction with neighbors declined, interaction with family members improved. In addition, they found that depression and suicide ideation did not significantly change during the pandemic. Meanwhile, Noguchi et al. (2023) examined the association between living alone and depressive symptoms in older people over 65 years in Japan. They focused on the moderating effect of nonface-to-face social interactions, including phone calls or emails with families or friends. Empirical analysis indicated that although living alone worsened depressive symptoms, nonface-to-face social interactions alleviated the adverse effects of living alone. The aim of their study coincides with that of the present study. However, their study employed data from one city in Japan, Minokamo City, and there is a risk that the analysis is based on data that are not representative. In addition, their study did not control for the individual fixed effect (FE), which may lead to biased estimates.

This study extends our understanding of the effects of living alone during the COVID-19 pandemic on older adults' well-being, measured by happiness. The study has three contributions to the literature. First, this study broadens the existing studies about the effect of living alone by focusing on Japan, the world's first super-aging society. The proportion of people aged 65 and over in Japan's total population in 2020 was 28.8%. In addition, the rate of people living alone has been on the rise. Thus, the impact of the COVID-19 pandemic may be more widespread in Japan than in other countries. Chijiki et al.

(2022) pointed out that the health of older Japanese people has been seriously affected during the pandemic owing to restrictions on going out. They revealed that the number of older adults experiencing not only a decline in physical function owing to lack of exercise but also forgetfulness owing to few opportunities to meet people has increased. These symptoms may be highly severe for those living alone and impact their well-being. The present study focuses on the effect on well-being using the Japan Household Panel Survey (JHPS)/Keio Household Panel Survey (KHPS), a representative panel survey conducted before the COVID-19 pandemic.

Second, this study explores the heterogeneous effects of living alone in different quantiles of happiness distribution using unconditional quantile regression (UQR) with person FEs (Firpo et al. 2009; Borgen 2016). Recently, increasing studies have examined the varying effects of the determinants on well-being distribution using quantile regression models (Binder and Coad 2011; Binder 2015; Fang and Sakellariou 2016; Fang 2017; Yuan and Golpelwar 2013). These studies have demonstrated that the effects of several determinants, such as income and health, change depending on the part in the distribution. The impact of living alone during the pandemic may similarly differ across the happiness distribution. Hence, this study uses a quantile regression model in addition to the ordinary least squares (OLS).

Third, we examine the effect of living arrangements other than living alone, mainly cohabitation, on the happiness of older people. Although this study focuses on the impact of living alone on well-being, research on the effects of detailed cohabitation status during the pandemic is gradually increasing (Berniell et al. 2023; Cansel et al. 2021; Choi et al. 2022; Evans et al. 2020; Hendriksen et al. 2021; Mari et al. 2020). These studies have examined how the impact of cohabitation varies based on who the survey respondents live with. However, as these studies provided mixed results, accumulating further knowledge on this issue is necessary. Therefore, following Berniell et al. (2023), we examine the effect of detailed living arrangements, including living alone, living together as a couple, a couple living with others, and living without a spouse but with others, on the well-being of older people.

The differences-in-differences (DID) estimation that controls for individual FEs provides three findings. First, the happiness of older men living alone decreased during the COVID-19 pandemic. However, we did not find a significant impact of living alone among older women. Second, when we examined how the impact of living alone varied depending on the happiness distribution, the decline in happiness was most pronounced among older men with higher happiness. Conversely, no significant effects were found in any quantile of the distribution for older women. Third, only the happiness of men living alone worsened when we used the detailed living arrangements variables.

The remainder of this paper is organized as follows. Section 2 explains the data, and Section 3 describes the empirical strategy. Finally, Section 4 discusses the estimation results, and Section 5 concludes the study.

2. Data

The JHPS/KHPS data integrate the Keio Household Panel Survey (KHPS) and the Japan Household Panel Survey (JHPS) conducted by the Panel Data Research Center at Keio University. The KHPS started in 2004 and covers 4,000 men and women aged 20–69 years. The JHPS survey began in 2009 and covered 4,000 men and women aged 20 years. Both data are surveyed annually, and the survey targets are selected using a stratified two-stage random sampling method. Both surveys had high similarities in survey items and survey methods and were conducted by the same research institution; therefore, they were merged in 2014 and renamed JHPS/KHPS. JHPS/KHPS has a questionnaire about education, well-being, health, and medical care, including economic and employment status¹.

As the ordinal survey period of JHPS/KHPS is January each year, the latest survey before the spread of COVID-19 is January 2020. JHPS/KHPS conducted two special surveys in May–June (special survey 1) and October–November (special survey 2) 2020 to investigate the impact of the COVID-19 pandemic. In special surveys, changes related to COVID-19 and shortened regular survey items were asked.

The first confirmed COVID-19 case in Japan was announced in January 2020, and the first death occurred in February 2020. The first wave of the COVID-19 pandemic was from March to June 2020, and the second wave was from July to October 2020. The JHPS/KHPS 2020 survey was conducted just before the spread of COVID-19, and special survey 1 was conducted during the first wave. Special survey 2 corresponds to the second wave period. Additionally, in Japan, the government declared a state of emergency from April to May 2020, requiring people to refrain from going out unless necessary, requiring restaurants to close, and restricting the use of schools and welfare facilities. With the rapid increase in the number of infected people, together with the declaration of a state of emergency during the first wave of the COVID-19 pandemic, people's stress and anxiety are expected to increase.

This study mainly focuses on men and women over 65 years old.² The estimations are conducted by gender because some previous studies, such as García-Prado et al. (2022) and Pierce et al. (2020), have reported gender differences in the impact of the COVID-19 pandemic. We use happiness as measures of well-being. We use the data from 2014, when the JHPS/KHPS started. The study samples are men and women over 65 in 2014–2020, special survey 1 (May–June 2020), and special survey 2 (October–November 2020). The wave-person observations for men are 5,603, and the sample size for women is 5,989.

3. Estimation method and variables

3.1 FE OLS

This study aims to examine the effect of living arrangements, particularly living alone, on the well-being of older adults during the COVID-19 pandemic. We estimate the following FE OLS to investigate this

¹ The survey details can be found on the following website (<https://www.pdrc.keio.ac.jp/en/paneldata/datasets/jhpskhps/>).

² Elderly persons are usually defined as individuals aged 65 and over by institutions such as the OECD and WHO. Following this definition, we analyze a sample of people over 65.

association.

$$H_{it} = \alpha L_{it} + \beta COVID_{it} + \gamma L_{it} * COVID_{it} + \delta X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where H_{it} indicates happiness of individual i at time t . L_{it} indicates the living alone dummy and $COVID_{it}$ is assigned a value of 1 for the wave of special survey 1 and special survey 2, and 0 otherwise. $L_{it} * COVID_{it}$ is an interaction term between the living alone dummy and the COVID-19 period dummy to examine how the impact of living alone on the well-being of older adults changed before and after the COVID-19 pandemic. This process is a simple DID estimation. The estimated coefficient γ is the primary focus of this analysis. A positive γ indicates that older adults living alone had better well-being during the COVID-19 pandemic. Meanwhile, a negative γ indicates that older adults living alone had worse well-being during the COVID-19 pandemic. We estimate this coefficient using FE OLS and determine the outcome. X_{it} indicates individual attributes, including age, subjectively rated health, marriage, children, working status, and type of housing. μ_i shows the individual FE, and ε_{it} is the error term.

In this analysis, the reverse causality between well-being and living arrangements may be a concern. Although we assume that living arrangements affect the well-being of older adults, well-being may impact the type of housing people choose. For example, if people with worse well-being tend to select living alone, the coefficient of living alone can be negatively overestimated. However, the prime interest of this study is the change in the effect of living arrangements before and after the COVID-19 pandemic, which is unexpected and considered a natural experiment. In addition, this study employs an FE model that can control for individual FEs. Therefore, the impact of reverse causality may be mitigated.

3.2 Well-being outcomes

We use happiness as measures of well-being. The following question measures happiness: *Please provide answers as to how your feeling of happiness was during the following periods, on a scale of 0 to 10, with 0 being "having no feeling of happiness at all," and 10 being "having a feeling of complete happiness."* The respondents answered this question from 0 to 10, where a high number indicates better happiness. The mean happiness for men is 6.190, and for women, it is 6.329, showing slight gender differences.

3.3 Living arrangements and individual attributes

For the living arrangements variable, we use a living alone dummy, which is assigned a value of 1 if respondents live alone and 0 if otherwise. In addition, our analysis uses age, subjectively rated health, marriage, children, working status, and type of housing as individual attributes. Age dummies are categorized as 65–69, 70–79, and over 80 years. Subjectively rated health is the variable evaluating the respondent's health from 1 = bad to 5 = good. The marriage dummy is assigned a value of 1 if the respondent is married and 0 if otherwise. The having children dummy is assigned a value of 1 if the respondent has

any children and 0 if otherwise. The working status is the dummy variable, which is assigned a value of 1 if the respondent is employed and 0 if otherwise. Dummies of types of housing show the kind of housing where the respondents presently live and are categorized as detached houses, semi-detached houses, steel/concrete condos, and wooden apartments.

Notably, special surveys 1 and 2 did not investigate living arrangements and the type of housing. However, these surveys asked the respondents whether they had moved since the last survey, and approximately 98% of respondents did not move.³ Therefore, most respondents remained in similar living conditions at the time of the JHPS/KHPS2020 survey. Hence, we inputted the value of JHPS/KHPS 2020 into those in special surveys 1 and 2. In addition, we deleted the samples that moved in during special surveys 1 and 2 to ensure the accuracy of variables. Table 1 shows the summary statistics of the variables by gender.

3.4 UQR with fixed effect

Equation (1) uses OLS, which analyzes the effect of living alone on the mean distribution of well-being. Although this method is appropriate for examining the effect, OLS cannot shed light on the impact of living alone on the upper and lower areas of the distribution of well-being. Several empirical studies have recently used the quantile regression model to explore how the effect of the determinants of well-being varies in the distribution of well-being. Binder and Coad (2011) were the first to study this field. Their analysis showed that the impact of income, health status, and social factors declined along with quantiles of happiness. Binder (2015) examined the effect of volunteering on well-being using a fixed effects quantile regression approach proposed by Canay (2011). Binder found that its impact decreased at the upper parts of the distribution. Then, Yuan and Golpelwar (2013) explored how the impact of several determinants varied in the parts of well-being distribution. They showed that house tenure, financial balance, social participation, social trust, loneliness, and social alienation significantly impacted each quantile of the well-being distribution. However, the effects of marriage and education were statistically significant only in part of the distribution. Fang and Sakellariou (2016) compared the effect of determinants on well-being using OLS and UQR. They found that income and health status have positive impacts, whereas work hours have adverse effects. However, these effects decreased as quantiles of well-being increased. Fang (2017) employed a panel quantile regression model and found that the positive impact of income varies across the distribution area. The effect of income on the least happy 10% group was twice as great as that on the happiest 10% group. In addition, the negative impact of unemployment disappeared at the top of the distribution. These results indicate the heterogeneous effects of determinants at different quantiles of the well-being distribution and emphasize the importance of broadening the horizons beyond the mean.

³ Of the respondents in special survey 1, 1.39% have moved since the JHPS/KHPS 2020, and of respondents in special survey 2, 1.21% have moved since special survey 1.

The effects of living alone may similarly change depending on the distribution of well-being. However, no studies have examined this point. Suppose the impact of living alone differs in areas other than the mean of the distribution. The OLS analysis may not have adequately captured that impact in that case. In addition, if the effect of living alone changes depending on the distribution, then changes in the disparity in happiness may also exist.⁴ A strong impact of living alone at the top of the distribution may reduce the differences in well-being. However, observing such effects at the bottom of the distribution could worsen the happiness gap. We also analyzed the UQR model with FEs to address these issues (Firpo et al. 2009; Borgen 2016). UQR with FEs allows us to control for individual FEs and assess the impact of living alone on well-being for each quantile.⁵

The procedure for the UQR is as follows: First, we convert the dependent variable into a recentered influence function (RIF). Then, we estimate a regression of the transformed dependent variables on independent variables. As UQR with FEs is a linear FE OLS that replaces the dependent variable with RIF (Borgen 2016), the estimated coefficients show the marginal effect, allowing us to interpret the results intuitively. The estimated econometric model is presented below as Eq. (2).

$$RIF(H_{it}; q_{\tau}) = \theta_{\tau} + \alpha_{\tau}L_{it} + \beta_{\tau}COVID_{it} + \gamma_{\tau}L_{it} * COVID_{it} + \delta_{\tau}X_{it} + \mu_i + \varepsilon_{it}, \quad (2)$$

where $RIF(H_{it}; q_{\tau})$ indicates RIF, where H_{it} is the dependent variable, happiness, and q_{τ} is the value of happiness at the given quantile τ . Other independent variables are the same variables as in Eq. (1). In this model, we are mainly interested in the coefficients γ_{τ} , which represents the effects of living alone during the pandemic at a given quantile of the distribution of well-being. γ_{τ} is estimated for the 10th, 25th, 50th, 75th, and 90th quantiles, and the robust standard errors are calculated.

3.5 Descriptive statistics of happiness before and after the COVID-19 pandemic

Figure 1 shows the change in happiness before and after the COVID-19 pandemic by gender. Figure 1 (a) shows the results for men, and Figure 1 (b) are the results for women. As shown in Figure 1 (a), the happiness of older men differs by living arrangement. Compared with older men living with others, the average happiness of older men living alone was lower than that before the spread of COVID-19 and substantially declined during special survey 1 when the COVID-19 cases rapidly increased. The happiness of older men living alone recovered during special survey 2. The result of Figure 1 (a) indicates that the difference in happiness by living arrangements magnified, particularly during the first wave of the COVID-19 pandemic. Figure 1 (b) shows that average happiness for women was almost similar for those living

⁵ Increasing empirical studies have recently used the UQR (Killewald and Bearak 2014; England et al. 2016; Glauber 2018). Although the conditional quantile regression (CQR) model is also available in the quantile regression models, UQR is increasingly being used because UQR provides us with the marginal impact of an independent variable on the quantile of the unconditional distribution of the outcome.

alone and others before and after the COVID-19 pandemic. In the case of women, there are no differences in happiness depending on the living arrangements.

Figure 1 shows that the differences in happiness based on the living arrangement were distinct, mainly for men. This result leads us to expect that the negative impact of living alone will be substantial for men and not women.

4. Estimation results

4.1 The effect of living alone on the happiness of older people estimated by FE OLS

Table 2 shows the results of the FE OLS. Columns (1) indicate the men's results, and columns (2) show the women's results. Happiness is used as the dependent variable. In the analysis, all individual attributes are used in addition to the variables shown in Table 2. The primary interest in Table 2 is the coefficients of the interaction term between living alone and the COVID-19 period dummy. In the men's results, the coefficient of the interaction term is negatively significant for happiness, which indicates that the happiness of older men living alone decreases during the COVID-19 pandemic. Meanwhile, in the results for women, we cannot find significant coefficients of the interaction term. This result indicates that women living alone during the COVID-19 pandemic did not experience significant changes in well-being.

Table 3 indicates the result of splitting the COVID-19 dummy into two-period dummies: the special survey 1 (May–Jun 2020) and special survey 2 (Oct–Nov 2020) dummies. The result is almost the same as that in Table 2, and the interaction terms between living alone and COVID-19 dummies are negatively significant only for men's happiness. Both interaction terms are negatively significant, revealing that the happiness of older men living alone deteriorates in special surveys 1 and 2. The magnitude of the coefficient is larger for the special survey 1 period, showing a substantial decline in the happiness of older men during the first wave of the pandemic when the number of infected people increased rapidly. Meanwhile, for women, all coefficients of the interaction terms between living alone and COVID-19 dummies were not statistically significant, indicating that the well-being of older women living alone did not change for both special survey periods.

The results in Tables 2 and 3 indicate the gender difference in the effect of living alone during the COVID-19 pandemic. The negative impact of living alone is significant only for men. This result is interesting because some previous studies have pointed out the opposite effect, which means a more substantial negative impact of living alone for women than men (García-Prado et al. 2022; Pierce et al. 2020). Why is there such a difference? The reason may be that older men in Japan living alone tend to have lower well-being and higher mortality rates (Ishikawa 1990; Matsuura & Ma 2022), and their social networks with the community and friends are weaker than women (Kino et al., 2023; Raymo 2015). Older men living alone, who already have vulnerable social networks, are thought to have become even more isolated because of the spread of COVID-19, worsening their well-being. Meanwhile, older Japanese women are likely to feel happy when they live alone (Matsuura & Ma, 2022). The reason is that a sense of

gender division of labor still exists in Japan, and women have a heavy burden of housework. However, living alone allows them to escape this burden. Older women living alone were also expected to experience a decline in communication with others during the COVID-19 pandemic, but the actual negative impact of restricted communication was slight. One of the reasons may be that they compensated for the decrease in contact by means such as telephone and email. As Noguchi et al. (2023) pointed out, the decline in well-being of older Japanese over 65 years who live alone was low when they used communication tools, including telephone and email. Older women living alone might have frequently used the phone and email to contact friends or family, preventing a decrease in well-being.

4.2 Robustness check

We conduct three robustness checks. First, we exclude subjectively rated health from independent variables because subjectively rated health is one of the well-being indicators and may cause bias in the estimate owing to the correlation with the dependent variable. Columns (1)–(2) of Table 4 present the estimated results. The result of the interaction term between living alone and the COVID-19 period dummy is the same as that in Table 2, indicating a significant decline in well-being only in the case of men’s happiness. Second, we use another dependent variable to assess whether the impact of living alone changes. We use life satisfaction, which is one of the representative well-being indicators. Life satisfaction is measured from 0 to 10, showing that the higher the value, the higher the satisfaction. Columns (3)–(4) of Table 4 show the estimated results. We find results similar to those in Table 2, showing that the interaction term between living alone and the COVID-19 period dummy is negatively significant only for men’s life satisfaction. Finally, we changed the age range for the analysis sample to check whether the impact of living alone during the COVID-19 pandemic varied. We estimate the FE OLS by changing the age range to three years before and after 65 years. Table 5 shows the results, and the trend of the result hardly changes with respect to Table 2. In addition, notably, the magnitude of the coefficients of the interaction term between living alone and the COVID-19 dummy in men’s happiness slightly increases with age. This result indicates that the older a man lives alone, the greater his decline in happiness during the COVID-19 pandemic.

4.3 Effect of living alone on the happiness of older people estimated by UQR with FEs

The analysis examined the effect of living alone using OLS. Although this method is standard for investigating the effect on well-being, the results have mainly been limited to estimating the impact on the mean of happiness distribution. Hence, we use the UQR with FEs to address this issue. This method can provide heterogeneous effects on the upper and lower areas of happiness distribution.

Table 6 shows the estimated interaction coefficients between living alone and the COVID-19 dummy using UQR with FEs. Panel (A) shows the result for men, and Panel (B) presents the result for women. The result for men demonstrates that most coefficients of interaction terms are negatively significant, and the magnitude of the coefficient is large in the upper layers of the distribution. This

result indicates that the spread of COVID-19 negatively affected older men living alone, and its impact was substantial for older men with relatively high happiness. Meanwhile, the result for women shows that all coefficients of the interaction terms are not statistically significant. For women, living alone during the COVID-19 pandemic did not significantly change happiness levels, even when looking at each quartile of happiness.⁶

The results of Table 6 showed that the negative impact of living alone during the COVID-19 pandemic on well-being was substantial for older men. Moreover, its effect was highly prominent for older men with high happiness levels. This result is interesting because previous studies examining the impact of individual attributes on well-being using quantile regression models indicated that the effects of some covariates, such as income and health, decreased at the upper quantiles (Binder and Coad 2011; Fang and Sakellariou 2016). The impact of living alone for older men contrasts with those findings. Moreover, strong adverse effects at the top of the distribution may lead to changes in happiness inequality, with a narrowing of the happiness gap.

4.4 Analysis using the detailed living arrangements variables

We also examine how living arrangements other than living alone affect the well-being of older people during the COVID-19 pandemic. The analysis has examined the effect of living alone. However, the impact of living arrangements other than living alone has not been fully explored. Some previous studies have investigated the effects of living arrangements other than living alone, mainly cohabitation, during the pandemic, with mixed results. In other words, some studies found a positive effect of increased well-being, whereas others found a negative impact of decreasing well-being. Evans et al. (2020) found that Australian parents of children under 18 years experienced mental health difficulties and strained family relationships during the lockdown. Then, Cansel et al. (2021) showed that living with others during the pandemic in Turkey increased stress. From another aspect, Mari et al. (2020) revealed that cohabitation with children or partners in lockdown positively affected the emotions of Italian people. In addition, Hendriksen et al. (2021) indicated that although the mood of those living alone and together in the Netherlands decreased during the lockdown, the increase in loneliness was relatively minor for those living together. Choi et al. (2022) also showed that, in the United States, avoiding close contact with co-residents deteriorated loneliness, and its impact was high for men.

These studies showed that the impact of living together during the pandemic varies depending on the country, and no uniform conclusions have been reached. Thus, accumulating further empirical results is desirable. In this section, we analyze the variables of detailed living arrangements to provide additional empirical results. Following Berniell et al. (2023), four living arrangements dummies,

namely, living alone, living together as a couple, a couple living with others, and living without a spouse but with others, were used as independent variables.⁷

Table 7 shows the estimated results using the FE OLS. Column (1) presents the results for men, and column (2) shows the results for women. In this analysis, we are interested in the interaction terms between living arrangements dummies and COVID-19 period dummies. In column (1), only the interaction term between living alone and the COVID-19 period dummy is negatively significant. This result is in line with the findings in Table 2. Meanwhile, other interaction terms are not statistically significant, which indicates that older men living with someone during the pandemic did not experience a decline in happiness. This result demonstrates that living with someone mitigates loneliness and prevents the decrease in happiness. Moreover, living with someone may have a protective effect on well-being among older Japanese men. For them, interpersonal connections and bonding with cohabitants, such as wives or children, may have alleviated the impact of the harsh environment caused by the pandemic. In Japan, a strong sense of gender division of labor exists (Lee & Ono 2008), with women spending more time doing housework than men. Therefore, the family life benefits of marriage are relatively greater for men than women, and this effect may have become highly apparent during the pandemic.

Women's results in Table 7 show no significant coefficients between living arrangements and COVID-19 period dummies. This result indicates that living arrangements did not affect the well-being of older women even during the COVID-19 pandemic. However, notably, the coefficients of the COVID-19 period dummy are negatively significant, indicating that women's well-being declined during the COVID-19 pandemic. In other words, although the well-being of all older women declined during the pandemic, substantial differences in well-being did not occur depending on living arrangements.

The results in Table 7 show the distinct gender differences in the effect of living arrangements. Older men living alone are negatively affected by the spread of COVID-19, whereas older women are intact in the same situation. These results in women are intriguing as previous studies have found a conspicuously negative impact of living arrangements on women. In Japan, the use of remote communication tools, such as phone and email, by older people may cover the decrease in the opportunity to contact others, preventing the effects of living arrangements (Noguchi et al. 2023).

5. Conclusion

This study investigated the relationship between living arrangements and the well-being of older adults during the COVID-19 pandemic. Although research examining the effect of the spread of COVID-19 has been increasing, studies investigating the impact of living arrangements on older adults are limited. In

⁷ The reference group of the living arrangement dummies is the dummy for living without a spouse but with others. The composition ratio of living arrangement dummies for men is as follows: living alone (12.0%), living together as a couple (51.3%), a couple living with others (33.3%), and living without a spouse but with others (3.4%). In addition, the composition ratio of living arrangements dummies for women is as follows: living alone (21.8%), living together as a couple (40.1%), a couple living with others (21.0%), and living without a spouse but with others (17.1%).

addition, regarding Japanese research, there are issues with the representativeness of data. We analyze the effect of living arrangements using Japanese panel data by addressing these issues. The analysis using the FE models generates three findings. First, the happiness of older men living alone deteriorated during the spread of COVID-19, whereas the well-being of older women did not change significantly regardless of whether they lived alone. Second, the estimates using UQR with fixed effects revealed that the decrease in happiness was most pronounced among older men living alone with a high happiness level. Meanwhile, statistically significant changes in happiness were not found for women even when using the UQR model. Third, the estimates using the detailed living arrangements variables showed that although the men's well-being worsened when living alone, the women's well-being did not vary significantly for either living arrangement.

The overall analysis shows distinct gender differences in the impact of living alone. The adverse effects of living alone were highly pronounced for men in the older age groups. The result of substantial adverse effects for older men is intriguing, as previous studies using European countries have shown a considerable negative impact on older women. The gap in the results may be caused by the fact that older Japanese men tend to be socially isolated (Kino et al., 2023). Older Japanese men were likely to be socially isolated before the pandemic, and this social isolation could have deepened further due to COVID-19. These differences in the environment surrounding older people between countries may have led to differences in the effects of living alone.

The findings of this study lead to policy implications in the context of COVID-19. Social isolation because of the COVID-19 pandemic was an issue, and its impact was expected to be substantial for older people. Although this expectation was reasonable, the negative impact was highly prominent in older men. Therefore, providing care that focuses on older men living alone is essential. Although COVID-19's impact is almost limited at this point, the spread of similar infectious diseases in the future may restrict daily life activities. In that case, policy intervention for older men living alone will be necessary.

This study has several strengths, such as the representativeness of the data, its longitudinal nature, which can compare the same respondents before and after the COVID-19 pandemic, the use of representative well-being indicators, and the employing of both OLS and quantile regression models. However, the study has some limitations. First, the data used in this study do not survey the mental health measures, such as depression, loneliness, and trouble sleeping, which are employed in European studies. Therefore, making strict comparisons with the results of previous studies is difficult. Furthermore, this study examined the impact of COVID-19 in 2020 and failed to analyze the changes in the impact since then. Whether the effects of the COVID-19 pandemic will be long-lasting is a critical issue, and research using long-term data is needed.

References

- Atzendorf, J., & Gruber, S., The Mental Well-Being of Older Adults after the First Wave of Covid-19 (March 15, 2021). MEA Discussion Paper no. 04-2021, Available at SSRN: <https://ssrn.com/abstract=3808100> or <http://dx.doi.org/10.2139/ssrn.3808100>
- Becchetti, L., Massari, R., & Naticchioni, P. (2014). The drivers of happiness inequality: Suggestions for promoting social cohesion. *Oxford Economic Papers*, 66(2), 419–442.
- Berniell, I., Laferrère, A., Mira, P., & Pronkina, E. (2023). Robinson Crusoe: Less or more depressed? With whom and where to live in a pandemic if you are above 50. *Review of Economics of the Household*, 21(2), 435–459. <https://doi.org/10.1007/s11150-022-09624-8>
- Binder, M., Coad, A. (2011). From Average Joe's happiness to Miserable Jane and Cheerful John: Using quantile regressions to analyze the full subjective well-being distribution. *J. econ. behav. organ*, 79(3), 275–290.
- Binder, M. (2015). Volunteering and life satisfaction: a closer look at the hypothesis that volunteering more strongly benefits the unhappy. *Applied Economics Letters*, 22(11), 874–885.
- Borgen, N. T. (2016). Fixed effects in unconditional quantile regression. *The Stata Journal*, 16 (2), 403–415.
- Brodeur, A., Clark, A. E., Fleche, S., & Powdthavee, N. (2021). COVID-19, lockdowns and well-being: Evidence from google trends. *Journal of Public Economics*, 193, 104346. <https://doi.org/10.1016/j.jpubeco.2020.104346>
- Cansel, N., Ucuz, İ., Arslan, A. K., Kayhan Tetik, B., Colak, C., Melez, Ş. N. İ., Şule Gümüstakım, R., Ceylan, S., Zeren Öztürk, G., Kılıç Öztürk, Y., Cadırcı, D., & Semra Demir Akca, A. (2021). Prevalence and predictors of psychological response during immediate COVID-19 pandemic. *International journal of clinical practice*, 75(5), e13996. <https://doi.org/10.1111/ijcp.13996>
- Canay, I. A. (2011) A simple approach to quantile regression for panel data, *The Econometrics Journal*, 14, 368–86.
- Chijiki, S., Tanabe, K., Tsukao, A., & Kuno, S. (2023). A Structural Analysis of the Effects on the Lifestyle and Health Status of Exercise Class Participants Owing to COVID-19 Prevention Measures. *American journal of health behavior*, 47(1), 40–46. <https://doi.org/10.5993/AJHB.47.1.5>
- Choi, E. Y., Farina, M. P., Wu, Q., & Ailshire, J. (2022). COVID-19 Social Distancing Measures and Loneliness Among Older Adults. *The journals of gerontology. Series B, Psychological sciences and social sciences*, 77(7), e167–e178. <https://doi.org/10.1093/geronb/gbab009>
- Clark, A. E., Fle`che, S., & Senik, C. (2014). The Great happiness moderation: Well-being inequality during episodes of income growth. In A. E. Clark & C. Senik (Eds.), *Happiness and economic growth: Lessons from developing countries*. Oxford: Oxford University Press.
- Clark, A. E., Fle`che, S., & Senik, C. (2016). Economic growth evens out happiness: Evidence from six surveys. *Review of Income and Wealth*, 62(3), 405–419.

- England, P., Bearak, J., Budig, M. J., Hodges, M. J., 2016. Do highly paid, highly skilled women experience the largest motherhood penalty? *American Sociological Review*, 81, 1161–1189.
- Evans, S., Mikocka-Walus, A., Klas, A., Olive, L., Sciberras, E., Karantzas, G., & Westrupp, E. M. (2020). From "It Has Stopped Our Lives" to "Spending More Time Together Has Strengthened Bonds": The Varied Experiences of Australian Families During COVID-19. *Frontiers in psychology*, 11, 588667. <https://doi.org/10.3389/fpsyg.2020.588667>
- Fang, Z., Sakellariou, C., 2016. Social Insurance, Income and Subjective Well-Being of Rural Migrants in China—An Application of Unconditional Quantile Regression. *Journal of Happiness Studies*, 17, 1635–1657.
- Firpo, S. P., N. M. Fortin, and T. Lemieux. 2009. Unconditional quantile regressions. *Econometrica* 77: 953-973.
- García-Prado, A., González, P., & Rebollo-Sanz, Y. F. (2022). Lockdown strictness and mental health effects among older populations in Europe. *Economics and Human Biology*, 45, 101116. <https://doi.org/10.1016/j.ehb.2022.101116>
- Glauber, R., 2018. Trends in the motherhood wage penalty and fatherhood wage premium for low, middle, and high earners. *Demography*, 55, 1663–1680.
- Hendriksen, P. A., Kiani, P., Garssen, J., Bruce, G., & Verster, J. C. (2021). Living Alone or Together During Lockdown: Association with Mood, Immune Fitness and Experiencing COVID-19 Symptoms. *Psychology research and behavior management*, 14, 1947–1957. <https://doi.org/10.2147/PRBM.S332853>
- Henssler, J., Stock, F., van Bohemen, J., Walter, H., Heinz, A., & Brandt, L. (2021). Mental health effects of infection containment strategies: Quarantine and isolation-a systematic review and meta-analysis. *European Archives of Psychiatry and Clinical Neuroscience*, 271(2), 223–234. <https://doi.org/10.1007/s00406-020-01196-x>
- Horita, N., & Moriguchi, S. (2022, March 1). Trends in suicide in Japan following the 2019 coronavirus pandemic. *JAMA Network Open*, 5(3), e224739. <https://doi.org/10.1001/jamanetworkopen.2022.4739>, PubMed: 35348713, PubMed Central: PMC8965634
- Hwang, T. J., Rabheru, K., Peisah, C., Reichman, W., & Ikeda, M. (2020). Loneliness and social isolation during the COVID-19 pandemic. *International Psychogeriatrics*, 32(10), 1217–1220. <https://doi.org/10.1017/S1041610220000988>
- Ishikawa, A. (1999). Marital life table: 1995. *Journal of Population Problems*, 55(1), 35–60. in Japanese.
- Killewald, A., Bearak, J., 2014. Is the motherhood penalty larger for low-wage women? A comment on quantile regression. *Am. Sociol. Rev*, 79, 350–357.
- Kino, S., Stickley, A., Arakawa, Y., Saito, M., Saito, T., & Kondo, N. (2023). Social isolation,

- loneliness, and their correlates in older Japanese adults. *Psychogeriatrics*, 23(3), 475–486. <https://doi.org/10.1111/psyg.12957>
- Lee, K. S., & Ono, H. (2008). Specialization and happiness in marriage: A U.S.–Japan comparison, *Social Science Research*, 37(4), 1216–1234. <https://doi.org/10.1016/j.ssresearch.2008.02.005>
- Litwin, H., & Levinsky, M. (2022). Social networks and mental health change in older adults after the Covid-19 outbreak. *Aging and Mental Health*, 26(5), 925–931. <https://doi.org/10.1080/13607863.2021.1902468>
- Mari, E., Frascchetti, A., Lausi, G., Pizzo, A., Baldi, M., Paoli, E., Giannini, A. M., & Avallone, F. (2020). Forced Cohabitation during Coronavirus Lockdown in Italy: A Study on Coping, Stress and Emotions among Different Family Patterns. *Journal of clinical medicine*, 9(12), 3906. <https://doi.org/10.3390/jcm9123906>
- Matsuura, T., & Ma, X. (2022). Living Arrangements and Subjective Well-being of the Elderly in China and Japan. *Journal of Happiness Studies*, 23(3), 903–948. <https://doi.org/10.1007/s10902-021-00430-0>
- Mendez-Lopez, A., Stuckler, D., McKee, M., Semenza, J. C., & Lazarus, J. V. (2022). The mental health crisis during the COVID-19 pandemic in older adults and the role of physical distancing interventions and social protection measures in 26 European countries. *SSM – Population Health*, 17, 101017. <https://doi.org/10.1016/j.ssmph.2021.101017>
- Niimi, Y. (2018). What Affects Happiness Inequality? Evidence from Japan. *Journal of Happiness Studies*, 19, 521–543.
- Noguchi, T., Hayashi, T., Kubo, Y., Tomiyama, N., Ochi, A., & Hayashi, H. (2023, January). Living alone and depressive symptoms among older adults in the COVID-19 pandemic: Role of non-face-to-face social interactions. *Journal of the American Medical Directors Association*, 24(1), 17–21.e4. <https://doi.org/10.1016/j.jamda.2022.10.014>. Epub October 28, 2022.
- Ott, J. (2005). Level and inequality of happiness in nations: Does greater happiness of a greater number imply greater inequality in happiness? *Journal of Happiness Studies*, 6(4), 397–420.
- Ovaska, T., & Takashima, R. (2010). Does a rising tide life all the boats? Explaining the national inequality of happiness. *Journal of Economic Issues*, 44(1), 205–223.
- Pierce, M., Hope, H., Ford, T., Hatch, S., Hotopf, M., John, A., Kontopantelis, E., Webb, R., Wessely, S., McManus, S., & Abel, K. M. (2020). Mental health before and during the COVID-19 pandemic: A longitudinal probability sample survey of the UK population. *The Lancet Psychiatry*, 7(10), 883–892. [https://doi.org/10.1016/S2215-0366\(20\)30308-4](https://doi.org/10.1016/S2215-0366(20)30308-4).
- Raymo, J. M. (2015). Living alone in Japan: Relationships with happiness and health. *Demographic Research*, 32, 1267–1298. <https://doi.org/10.4054/DemRes.2015.32.46>
- Ryu, S. I., Park, Y. H., Kim, J., Huh, I., Chang, S. J., Jang, S. N., & Noh, E. Y. (2022, July 6). Impact of COVID-19 on the social relationships and mental health of older adults living alone: A two-year

- prospective cohort study. *PLOS ONE*, 17(7), e0270260.
<https://doi.org/10.1371/journal.pone.0270260>
- Stevenson, B., & Wolfers, J. (2008). Happiness inequality in the United States. *Journal of Legal Studies*, 37(S2), S33–S79.
- Veenhoven, R. (2005). Return of inequality in modern society? Test by dispersion of life-satisfaction across time and nations. *Journal of Happiness Studies*, 6(4), 457–487.
- Vindegaard, N., & Benros, M. E. (2020). COVID-19 pandemic and mental health consequences: Systematic review of the current evidence. *Brain, Behavior, and Immunity*, 89, 531–542.
<https://doi.org/10.1016/j.bbi.2020.05.048>
- Wang, Y., Kala, M. P., & Jafar, T. H. (2020). Factors associated with psychological distress during the coronavirus disease 2019 (COVID-19) pandemic on the predominantly general population: A systematic review and meta-analysis. *PLOS ONE*, 15(12), article e0244630.
<https://doi.org/10.1371/journal.pone.0244630>
- World Health Organization. (2020). *Mental health and psychosocial considerations during COVID-19 outbreak*. WHO/2019-nCoV/MentalHealth/2020.1. DOI
- Xiong, J., Lipsitz, O., Nasri, F., Lui, L. M. W., Gill, H., Phan, L., Chen-Li, D., Iacobucci, M., Ho, R., Majeed, A., & McIntyre, R. S. (2020). Impact of COVID-19 pandemic on mental health in the general population: A systematic review. *Journal of Affective Disorders*, 277, 55–64.
<https://doi.org/10.1016/j.jad.2020.08.001>

Table 1 Summary statistics

Variables	Men		Women	
	Mean	SD	Mean	SD
Happiness	6.190	2.123	6.329	2.133
Living alone	0.107	0.309	0.213	0.409
COVID	0.152	0.359	0.139	0.346
COVID*Living alone	0.016	0.125	0.028	0.165
Age 65-69	0.377	0.485	0.359	0.480
Age 70-79	0.524	0.499	0.549	0.498
Age 80+	0.099	0.299	0.092	0.289
Subjective rated health	3.241	0.950	3.254	0.922
Marriage	0.871	0.335	0.648	0.478
Having children	0.705	0.456	0.728	0.445
Working	0.411	0.492	0.304	0.460
Type of housing: detached house	0.830	0.376	0.837	0.370
Type of housing: semi-detached house	0.026	0.160	0.019	0.137
Type of housing: steel/concrete condo	0.120	0.324	0.118	0.323
Type of housing: wooden apartment	0.024	0.154	0.026	0.160
Observations	5,603		5,989	

Figure 1 (a) Happiness: men

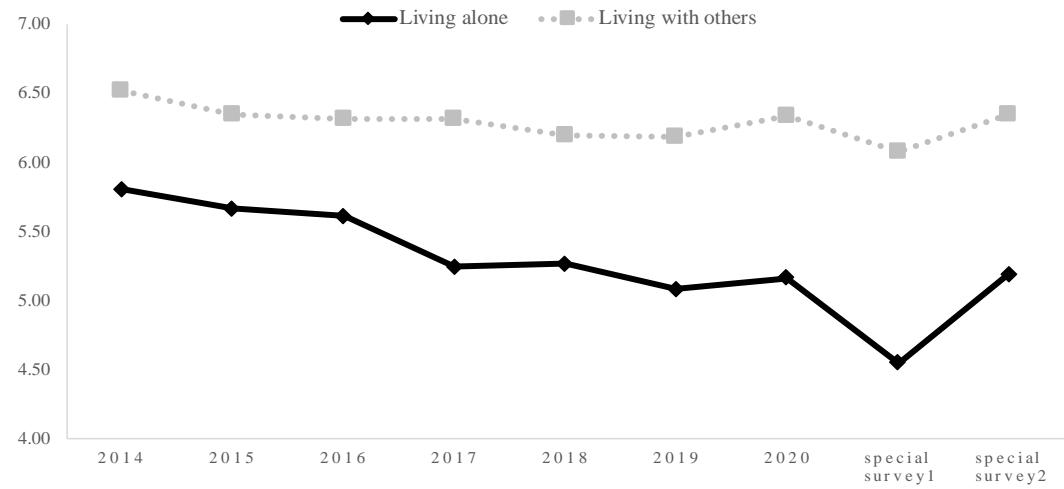


Figure 1 (b) Happiness: women

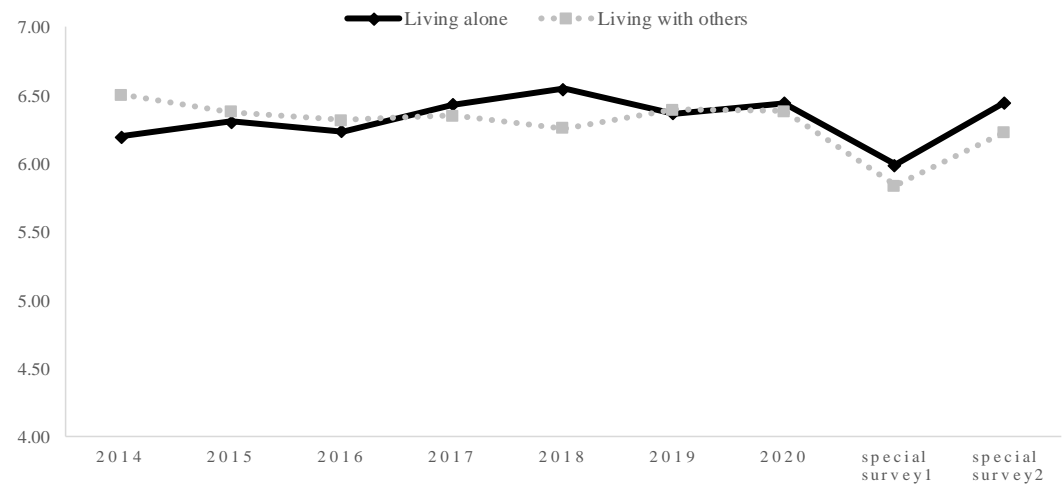


Table 2 Effect of living alone on the well-being of older adults

	(1)	(2)
Dependent variable: happiness	Men	Women
Living alone×COVID	-0.645** (0.256)	0.213 (0.168)
Living alone	-0.116 (0.330)	0.092 (0.250)
COVID	-0.290*** (0.071)	-0.572*** (0.076)
Estimation method	FE OLS	FE OLS
Observations	5,603	5,989
R-squared	0.033	0.037

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses. Individual attributes such as age, subjectively rated health, marriage, children, working status, and types of housing are also used as independent variables.

Table 3 Effect of living alone on the well-being of older adults using the split COVID-19 period dummies

	(1)	(2)
Dependent variable: happiness	Men	Women
Living alone×COVID(May-Jun)	-0.718** (0.319)	0.222 (0.191)
Living alone×COVID(Oct-Nov)	-0.565** (0.264)	0.199 (0.200)
Living alone	-0.117 (0.328)	0.085 (0.251)
COVID(May-Jun)	-0.390*** (0.080)	-0.754*** (0.094)
COVID(Oct-Nov)	-0.187** (0.084)	-0.375*** (0.085)
Estimation method	FE OLS	FE OLS
Observations	5,603	5,989
R-squared	0.034	0.040

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses. Individual attributes such as age, subjectively rated health, marriage, children, working status, and types of housing are also used as independent variables.

Table 4 Robustness check for the effect of living alone on the well-being of older adults

	(1)	(2)	(3)	(4)
	Excluding the subjective rated health		Using life satisfaction	
Dependent variable: happiness	Men	Women	Men	Women
Living alone×COVID	-0.624** (0.261)	0.181 (0.171)	-0.449* (0.249)	0.147 (0.156)
Living alone	-0.092 (0.341)	0.113 (0.254)	0.155 (0.319)	0.143 (0.203)
COVID	-0.209*** (0.071)	-0.491*** (0.076)	-0.269*** (0.067)	-0.598*** (0.074)
Estimation method	FE OLS	FE OLS	FE OLS	FE OLS
Observations	5,603	5,989	5,603	5,989
R-squared	0.016	0.018	0.025	0.051

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses. Individual attributes such as age, marriage, children, working status, and types of housing are also used as independent variables.

Table 5 Robustness check using samples aged 3 and 65 years before and after the pandemic

Panel (A) Men						
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: happiness	age>=62	age>=63	age>=64	age>=66	age>=67	age>=68
Living alone×COVID	-0.522** (0.229)	-0.596** (0.241)	-0.591** (0.247)	-0.660** (0.268)	-0.730** (0.293)	-0.759** (0.328)
Living alone	-0.145 (0.287)	-0.240 (0.308)	-0.349 (0.331)	0.044 (0.282)	-0.007 (0.313)	-0.020 (0.335)
COVID	-0.286*** (0.064)	-0.293*** (0.065)	-0.272*** (0.067)	-0.299*** (0.073)	-0.277*** (0.077)	-0.292*** (0.080)
Estimation method	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS
Observations	6,800	6,412	6,020	5,161	4,713	4,297
R-squared	0.028	0.031	0.031	0.031	0.033	0.034
Panel (B) Women						
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: happiness	age>=62	age>=63	age>=64	age>=66	age>=67	age>=68
Living alone×COVID	0.253 (0.160)	0.243 (0.161)	0.202 (0.163)	0.145 (0.171)	0.169 (0.177)	0.199 (0.180)
Living alone	0.022 (0.224)	0.112 (0.237)	0.126 (0.246)	0.173 (0.249)	0.085 (0.263)	0.201 (0.290)
COVID	-0.565*** (0.068)	-0.570*** (0.070)	-0.570*** (0.073)	-0.599*** (0.079)	-0.597*** (0.081)	-0.624*** (0.084)
Estimation method	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS
Observations	7,173	6,787	6,397	5,588	5,151	4,703
R-squared	0.034	0.035	0.037	0.040	0.039	0.041

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses. Individual attributes such as age, subjectively rated health, marriage, children, working status, and types of housing are also used as independent variables.

Table 6 Effect of living alone on the well-being of older adults using UQR with FEs

Panel (A) Men					
	(1)	(2)	(3)	(4)	(5)
Percentile of happiness	10th	25th	50th	75th	90th
Living alone×COVID	0.056 (0.631)	-0.454** (0.227)	-0.722* (0.410)	-0.476* (0.266)	-0.996* (0.551)
Living alone	-0.131 (0.806)	-0.193 (0.207)	-0.147 (0.495)	0.025 (0.281)	-0.866 (0.897)
COVID	-0.035 (0.149)	-0.097* (0.056)	-0.255* (0.136)	-0.267*** (0.089)	-0.674*** (0.173)
Estimation method	UQR with FE				
Observations	5,603				
R-squared	0.015	0.017	0.014	0.015	0.017
Panel (B) Women					
	(1)	(2)	(3)	(4)	(5)
Percentile of happiness	10th	25th	50th	75th	90th
Living alone×COVID	0.818 (0.501)	0.103 (0.133)	0.550 (0.368)	0.012 (0.173)	0.060 (0.294)
Living alone	-0.104 (0.826)	0.121 (0.179)	0.447 (0.445)	0.206 (0.246)	-0.018 (0.454)
COVID	-0.474** (0.231)	-0.163*** (0.059)	-0.865*** (0.186)	-0.541*** (0.095)	-0.752*** (0.140)
Estimation method	UQR with FE				
Observations	5,989				
R-squared	0.012	0.013	0.019	0.023	0.014

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses. Individual attributes such as age, subjectively rated health, marriage, children, working status, and types of housing are also used as independent variables.

Table 7 Effect of living arrangements on the well-being of older adults

	(1)	(2)
Dependent variable: happiness	Men	Women
Living alone×COVID	-0.978** (0.384)	0.058 (0.234)
Living only with a couple ×COVID	-0.459 (0.313)	-0.175 (0.204)
couple living with others×COVID	-0.389 (0.323)	-0.064 (0.223)
Living alone	-0.240 (0.455)	0.470** (0.238)
Living only with a couple	0.126 (0.423)	0.225 (0.145)
couple living with others	-0.058 (0.435)	0.129 (0.134)
COVID	0.119 (0.303)	-0.466*** (0.179)
Estimation method	FE OLS	FE OLS
Observations	5,603	5,989
R-squared	0.032	0.036

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses. Individual attributes such as age, subjectively rated health, marriage, children, working status, and types of housing are also used as independent variables.