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How did the COVID-19 pandemic affect the well-being of people living alone in Japan? A comparison of older adults and their characteristics

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Abstract

This study examines the association between living arrangements and older adults' well-being measured by happiness and K6 levels before and after the coronavirus disease 2019 (COVID-19) pandemic using Japanese panel data. The data used in this study are from the Japan Household Panel Survey, which are representative panel data. The study conducts surveys before and after the spread of COVID-19. The differences-in-differences estimation that controls for individual fixed effects generates three findings. First, the happiness of older men living alone decreased during the spread of COVID-19. However, we did not find a significant impact of living alone among older women. Second, when we used the detailed living arrangements variables, including living alone, living together as a couple, a couple living with others, and living without a spouse but with others, the well-being of men living alone or living together as a couple worsened. Meanwhile, the well-being of women did not vary significantly for either living arrangement. Last, additional analysis, including the sample of other age groups, such as those under 39 years and 40–64 years, revealed that the mental health of women under 39 years deteriorated when they lived alone during the COVID-19 pandemic. The overall analysis shows distinct gender differences in the impact of living alone, and the adverse effects of living alone were substantial for older men and younger women.

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 (Vindegaard & 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. They focused on the moderating effect of non-face-to-face social interactions, including phone calls or emails with families or friends. Empirical analysis using Japanese data indicated that although living alone worsened depressive symptoms, non-face-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 examines the association between living arrangements and older adults' well-being measured by happiness and K6 levels before and after the COVID-19 pandemic using the Japan Household Panel Survey (JHPS/Keio Household Panel Survey (KHPS)). JHPS/KHPS is representative panel data conducted before the COVID-19 pandemic. The differences-in-differences (DID) estimation that controls for individual FEs generates 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 used the detailed living arrangements variables, including living alone, living together as a couple, a couple living with others, and living without a spouse but with others, the well-being of men living alone or living together as a couple worsened. Meanwhile, the well-being of women did not vary significantly for either living arrangement. Last, additional analysis, including the sample of other age groups, such as those under 39 years and 40–64 years, revealed that the mental health of women under 39 years deteriorated when they lived alone during the COVID-19 pandemic. The overall analysis shows the gender difference in the impact of living alone, that is, the adverse effects of living alone were substantial for older men.

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 status.

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.[1] The estimations are conducted by

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[1] 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.

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 and K6 as measures of well-being. As both variables are available after 2019, we restrict the sample of men and women over 65 in 2019 and 2020 in special survey 1 (May–June 2020) and special survey 2 (October–November 2020). The wave-person observations for men are 2,428, and the sample size for women is 2,583.

3. Estimation method and variables

3.1 Estimation method

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 ordinary least squares (OLS) to investigate this association.

$$MH_{it} = \alpha L_{it} + \beta COVID_{it} + \gamma L_{it} * COVID_{it} + \delta X_{it} + \mu_i + \varepsilon_{it} \tag{1}$$

where MH_{it} indicates happiness and k6 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 0 for special survey 2. $L_{it} * COVID_{it}$ 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 great 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, education, and working status. 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 and K6 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 great happiness. Regarding K6, respondents were asked the following questions: *During the past 30 days, how often did you feel nervous, hopeless, restless, or fidgety, so depressed that nothing could cheer you up, that everything was an effort, and worthless?* For each question, respondents select the answer from "1 = All of the time" to "5 = None of the time." We sum the answers to the six questions and use them as the dependent variable, showing that a high number indicates excellent mental health.

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, and working status 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. Table 1 shows the summary statistics of the variables by gender.

3.4 Descriptive statistics of well-being before and after the COVID-19 pandemic

Figure 1 shows the change in well-being before and after the COVID-19 pandemic by gender. Figure 1 (a) and (b) show the results for men, and Figure 1 (c) and (d) 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 a similar trend, that is, the mental health of men living alone was poor before the COVID-19 pandemic and deteriorated further at the time of special survey 1 and then recovered at the time of special survey 2. Different results can be found when we look at the figures for women. Figure 1 (c) shows that average happiness was almost similar in living arrangements before and after the COVID-19 pandemic. This case also is the same with the mental health results, as shown in Figure 1 (d), indicating that almost no differences exist between the women living alone and those living with others.

Figure 1 shows that the differences in well-being 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 Base result

Table 2 shows the results of the FE OLS. Columns (1) and (2) indicate the men's results, and columns (3) and (4) show the women's results. Happiness is used as the dependent variable in columns (1) and (3), and K6 is used as the dependent variable in columns (2) and (4). In the analysis, all individual attributes are used in addition to the variables shown in Table 1. 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, the interaction term is not statistically significant for K6, showing that the mental health of older men living alone does not significantly change during the COVID-19 pandemic. 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. Perhaps, older women living alone used the phone and email frequently 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)–(4) 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 other estimation methods. We use the FE ordered logit model because happiness and K6 are ordinal variables. Columns (5)–(8) 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 happiness. 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 Additional analysis

In this section, we conduct two additional analyses. First, we use the detailed living arrangement variables. Following Berniell et al. (2023), four living arrangements dummies, such as 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 to assess how living arrangements other than living alone affect the well-being of older people during the COVID-19 pandemic[2]. Table 6 shows the estimated results using the FE OLS and FE ordered logit models. Columns (1)–(4) present the results for men, and columns (5)–(8) show the results for women. In this analysis, we are interested in the interaction terms between living arrangements dummies and COVID-19 period dummies. In columns (1) and (2), using happiness as the dependent variable, only the interaction term between living alone and the COVID-19 period dummy is negatively significant. This

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[2] 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%).

result is in line with the findings in Table 2. Meanwhile, only the interaction term between living together as a couple and the COVID-19 period dummy is negatively significant, as shown in columns (3) and (4), using K6 as the dependent variable. This result indicates that older men living only with their spouses have worse mental health. This result is consistent with the findings of Berniell et al. (2023), who indicated that older people living together as a couple are more likely to be depressed, feel lonely, and have trouble sleeping. The reason for the adverse effects of living together as a couple may be that people spend less time going out owing to the spread of COVID-19, which increases stress as the couple spends more time alone. This interpretation contrasts with the prediction of Hamermesh (2020), who indicates a positive association between life satisfaction and time spent together by married individuals. However, it is considered appropriate when freedom of movement is restricted because of COVID-19. From another aspect, women's results show no significant coefficients between living arrangements and COVID-19 period dummies. This result indicates that the well-being of older women was not affected by living arrangements 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 epidemic. In other words, although the well-being of all older women decreased during the COVID-19 pandemic, substantial differences in well-being did not occur depending on living arrangements.

The results in Table 6 show the distinct gender differences in the effect of living arrangements. Older men living alone or with their spouses are negatively affected by the spread of COVID-19, whereas older women are intact in the same situation. These women's results are intriguing as previous studies have found a conspicuously negative impact of living arrangements on women. In Japan, using 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).

In the second additional analysis, we used other age groups to compare the impact of living alone. Two age groups, namely, young people under 39 years old and middle-aged people between 40 and 64 years old, were used in the estimate. Table 7 shows the results estimated using the FE OLS and FE ordered logit model. Panel (A) of Table 7 indicates the result of a sample less than 39 years old, and panel (B) of Table 7 shows that of 40–64 years old. In both panels, columns (1)–(4) show the results for men, and columns (5)–(8) indicate the results for women.

The results for men in panel (A) of Table 7 indicate no significant coefficients of the interaction term between living alone and the COVID-19 dummy. Meanwhile, the results of women in panel (A) of Table 7 show negatively significant coefficients of the interaction term with K6. This result indicates that women living alone under the age of 39 years have relatively worse mental health during the COVID-19 pandemic. This result contrasts with the finding of older women over 65, that is, living alone during the COVID-19 pandemic has no significant impact. The negative impact may be caused by the harsh conditions faced by young women. As younger women tend to work in nonregular employment and face economic instability during the COVID-19 pandemic, they are likely to experience stress. This stress could be magnified in

young women who lived alone and were likely to feel loneliness. In this regard, suicide statistics by the National Police Agency have reported that the suicide rate of young women has risen during the COVID-19 pandemic. The results of men in panel (B) of Table 7 indicate that middle-aged men living alone did not experience a change in well-being during the COVID-19 pandemic. Meanwhile, the interaction terms between living alone and the COVID-19 dummy show positively significant coefficients to K6 for women. This result indicates that middle-aged women living alone had great mental health during the COVID-19 pandemic.

The results in Table 7 show the distinct gender differences in the effect of living arrangements, as in Table 6. Although young and middle-aged men did not experience a change in well-being based on their living arrangements during the COVID-19 pandemic, the mental health of younger women living alone deteriorated. The negative impact on younger women may be attributed to economic instability owing to the COVID-19 pandemic, and this result coincides with a rise in the suicide rate among younger women.

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 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 the detailed living arrangements variables showed that although the men's well-being of living alone or living together as a couple worsened, the women's well-being did not vary significantly for either living arrangement. Last, additional analysis, including the sample of other age groups, such as those under 39 years and those 40–64 years, revealed that the mental health of women under 39 years deteriorated when they lived alone during the COVID-19 pandemic.

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 and women in the younger 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. By contrast, for young women living alone, economic insecurity owing to unstable employment environments caused a decline in well-being. The government's employment stabilization measures have effectively addressed this problem. Thus, differences exist in the necessary policies depending on age groups and gender, and this research contributes by clarifying this point.

This study has several strengths, such as the representativeness of data, its longitudinal nature, which can compare the same respondents before and after the COVID-19 pandemic, and the use of representative well-being indicators, such as happiness and K6. 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 because the effect of living alone can change depending on the indicators used in the study. 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

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

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

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

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.

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

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.

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

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.

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.

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

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	6.101	2.075	6.261	2.118
K6	26.499	3.671	25.863	4.003
Living alone	0.120	0.325	0.218	0.413
COVID	0.369	0.483	0.339	0.474
COVID*Living alone	0.039	0.194	0.067	0.251
Age 65-69	0.333	0.471	0.304	0.460
Age 70-79	0.536	0.499	0.568	0.496
Age 80+	0.131	0.337	0.129	0.335
Subjective rated health	3.312	0.967	3.329	0.929
Marriage	0.859	0.348	0.634	0.482
Having children	0.847	0.360	0.866	0.341
Working	0.437	0.496	0.318	0.466
N	2,428		2,583	

Figure 1 (a) Happiness: men
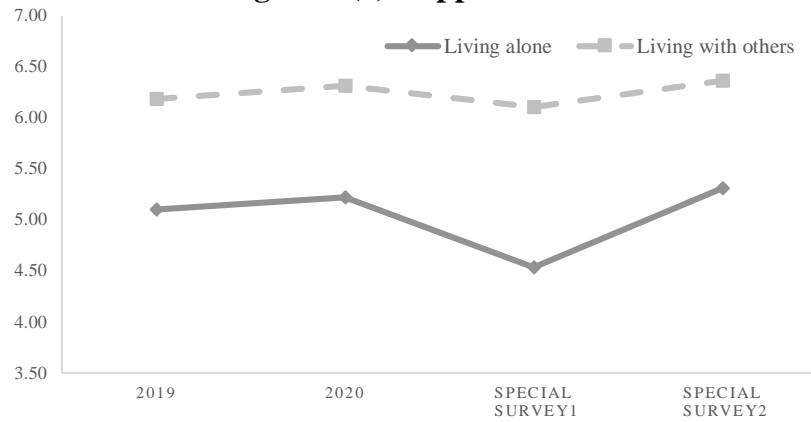
Figure 1 (b) K6: men
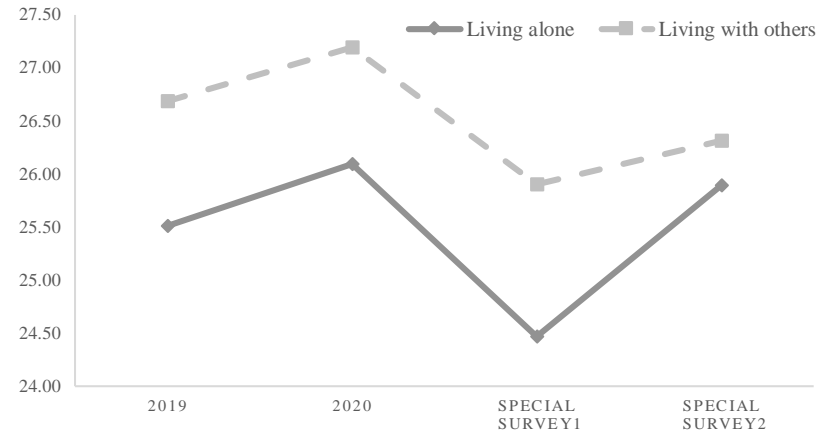
Figure 1 (c) Happiness: women
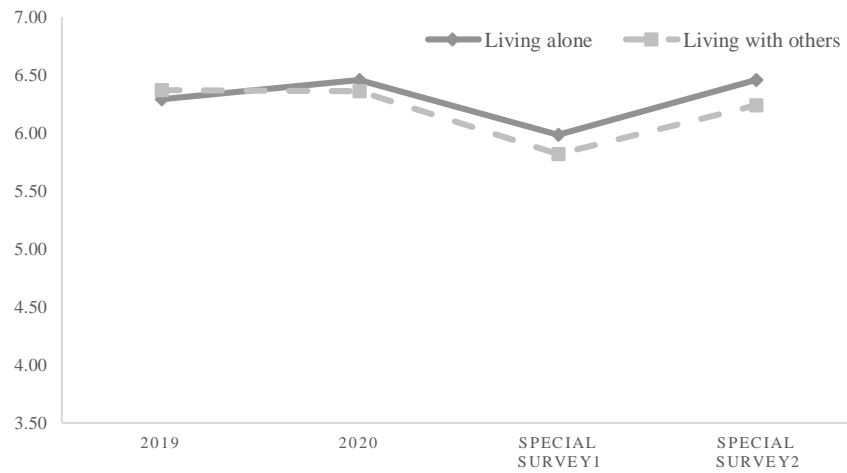
Figure 1 (d) K6: women
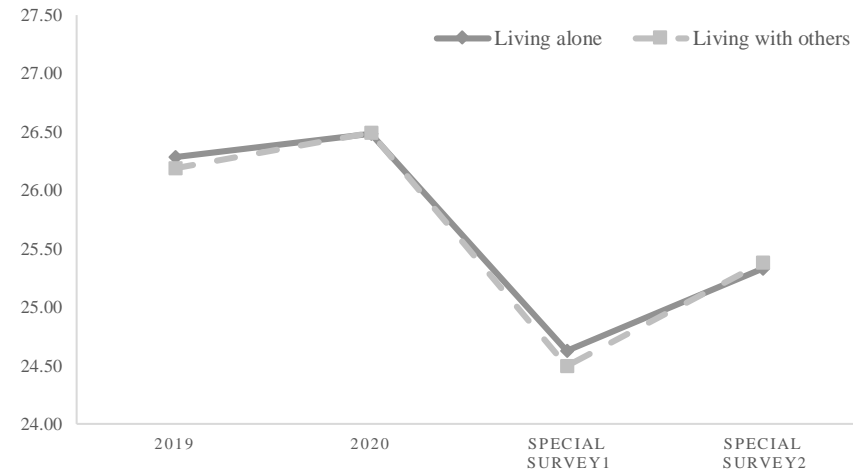
Table 2 Effect of living alone on the well-being of older adults

	(1)	(2)	(3)	(4)
	Men		Women	
	Happiness	K6	Happiness	K6
Living alone×COVID	-0.579**	0.126	0.176	0.191
	(0.242)	(0.499)	(0.186)	(0.391)
Living alone	0.176	1.779**	0.203	0.088
	(0.469)	(0.709)	(0.632)	(1.122)
COVID	-0.275***	-1.245***	-0.538***	-1.691***
	(0.076)	(0.151)	(0.084)	(0.181)
Estimation method	FE OLS	FE OLS	FE OLS	FE OLS
Observations	2,428	2,428	2,583	2,583
R-squared	0.039	0.077	0.043	0.097

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses.

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

	(1)	(2)	(3)	(4)
	Men		Women	
	Happiness	K6	Happiness	K6
Living alone×COVID(May-Jun)	-0.717**	-0.261	0.136	0.169
	(0.299)	(0.613)	(0.204)	(0.420)
Living alone×COVID(Oct-Nov)	-0.429*	0.546	0.204	0.183
	(0.253)	(0.488)	(0.216)	(0.458)
Living alone	0.153	1.720**	0.178	0.033
	(0.474)	(0.729)	(0.639)	(1.127)
COVID(May-Jun)	-0.375***	-1.450***	-0.725***	-2.121***
	(0.085)	(0.184)	(0.101)	(0.214)
COVID(Oct-Nov)	-0.168*	-1.025***	-0.331***	-1.212***
	(0.088)	(0.162)	(0.095)	(0.202)
Estimation method	FE OLS	FE OLS	FE OLS	FE OLS
Observations	2,428	2,428	2,583	2,583
R-squared	0.044	0.084	0.053	0.110

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses.

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Excluding the subjective rated health				Using FE ologit model			
	Men		Women		Men		Women	
	Happiness	K6	Happiness	K6	Happiness	K6	Happiness	K6
Living alone×COVID	-0.589**	0.109	0.138	0.109	-0.823**	0.203	0.280	0.148
	(0.240)	(0.498)	(0.189)	(0.398)	(0.337)	(0.410)	(0.287)	(0.297)
Living alone	0.151	1.737**	0.227	0.139	-0.254	1.613**	0.086	-0.107
	(0.466)	(0.779)	(0.640)	(1.161)	(0.780)	(0.760)	(0.916)	(0.653)
COVID	-0.196***	-1.114***	-0.471***	-1.546***	-0.450***	-1.092***	-0.829***	-1.230***
	(0.075)	(0.143)	(0.083)	(0.180)	(0.125)	(0.133)	(0.131)	(0.137)
Estimation method	FE OLS	FE OLS	FE OLS	FE OLS	FE Ologit	FE Ologit	FE Ologit	FE Ologit
Observations	2,428	2,428	2,583	2,583	1,905	2,000	1,933	2,175
R-squared	0.023	0.064	0.032	0.085				
Log conditional likelihood					-1625.201	-2795.516	-1679.408	-3290.275

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses.

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)	(7)	(8)	(9)	(10)	(11)	(12)
	age>=62	age>=63	age>=64	age>=66	age>=67	age>=68	age>=62	age>=63	age>=64	age>=66	age>=67	age>=68
	Happiness	Happiness	Happiness	Happiness	Happiness	Happiness	K6	K6	K6	K6	K6	K6
Living alone×COVID	-0.515**	-0.524**	-0.544**	-0.555**	-0.603**	-0.637**	0.193	0.193	0.148	0.290	0.007	-0.228
	(0.221)	(0.231)	(0.233)	(0.256)	(0.279)	(0.308)	(0.438)	(0.448)	(0.456)	(0.512)	(0.550)	(0.636)
Living alone	0.525	0.536	0.084	0.078	0.110	0.177	1.239**	1.288**	1.735**	1.725**	1.901**	2.050**
	(0.484)	(0.487)	(0.429)	(0.432)	(0.441)	(0.465)	(0.625)	(0.645)	(0.748)	(0.778)	(0.807)	(0.815)
COVID	-0.263***	-0.269***	-0.243***	-0.275***	-0.263***	-0.297***	-1.207***	-1.185***	-1.203***	-1.291***	-1.238***	-1.207***
	(0.066)	(0.068)	(0.070)	(0.076)	(0.080)	(0.084)	(0.137)	(0.140)	(0.144)	(0.158)	(0.164)	(0.170)
Estimation method	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS
Observations	2,876	2,737	2,596	2,272	2,103	1,958	2,876	2,737	2,596	2,272	2,103	1,958
R-squared	0.042	0.047	0.044	0.045	0.050	0.057	0.081	0.083	0.086	0.095	0.095	0.093

Panel (B) Women

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	age>=62	age>=63	age>=64	age>=66	age>=67	age>=68	age>=62	age>=63	age>=64	age>=66	age>=67	age>=68
	Happiness	Happiness	Happiness	Happiness	Happiness	Happiness	K6	K6	K6	K6	K6	K6
Living alone×COVID	0.194	0.172	0.120	0.104	0.097	0.066	0.192	0.138	0.052	-0.107	-0.112	-0.198
	(0.180)	(0.179)	(0.179)	(0.190)	(0.199)	(0.206)	(0.360)	(0.363)	(0.369)	(0.390)	(0.409)	(0.425)
Living alone	0.124	0.150	0.177	0.148	-0.064	-0.062	-0.019	0.108	0.194	-0.035	-0.412	-0.466
	(0.571)	(0.571)	(0.571)	(0.678)	(0.760)	(0.758)	(0.943)	(0.958)	(0.956)	(1.117)	(1.254)	(1.250)
COVID	-0.521***	-0.540***	-0.544***	-0.565***	-0.569***	-0.557***	-1.637***	-1.740***	-1.765***	-1.707***	-1.740***	-1.678***
	(0.075)	(0.077)	(0.081)	(0.087)	(0.090)	(0.093)	(0.160)	(0.165)	(0.174)	(0.186)	(0.197)	(0.207)
Estimation method	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS	FE OLS
Observations	3,074	2,905	2,748	2,457	2,306	2,149	3,074	2,905	2,748	2,457	2,306	2,149
R-squared	0.043	0.047	0.047	0.053	0.055	0.057	0.108	0.113	0.118	0.118	0.121	0.118

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses.

Table 6 Effect of living arrangements on the well-being of older adults

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Men				Women		
	Happiness	Happiness	K6	K6	Happiness	Happiness	K6	K6
Living alone×COVID	-0.946**	-1.347**	-0.970	-0.732	0.062	-0.011	0.383	0.313
	(0.459)	(0.630)	(0.806)	(0.674)	(0.259)	(0.350)	(0.483)	(0.371)
Living only with a couple	-0.543	-0.870	-1.224*	-1.133**	-0.150	-0.405	0.057	0.031
×COVID	(0.411)	(0.580)	(0.665)	(0.562)	(0.233)	(0.311)	(0.401)	(0.312)
couple living with others	-0.468	-0.660	-1.125	-0.905	-0.059	-0.232	0.712	0.576
×COVID	(0.421)	(0.586)	(0.690)	(0.578)	(0.249)	(0.338)	(0.521)	(0.379)
Living alone	0.125	-0.124	1.863	1.195	-0.038	-0.210	-1.287	-1.313
	(0.701)	(1.304)	(1.518)	(0.811)	(0.726)	(1.015)	(1.017)	(0.994)
Living only with a couple	0.441	0.419	0.238	-1.137	-0.879	-1.512	-3.828**	-2.373**
	(0.855)	(1.574)	(1.608)	(1.368)	(0.795)	(1.184)	(1.723)	(1.038)
couple living with others	0.352	0.536	0.370	-1.099	-0.996	-1.819	-3.670**	-2.396**
	(0.848)	(1.521)	(1.613)	(1.370)	(0.766)	(1.198)	(1.685)	(0.989)
COVID	0.217	0.291	-0.102	-0.090	-0.451**	-0.585**	-1.921***	-1.423***
	(0.403)	(0.559)	(0.641)	(0.540)	(0.205)	(0.246)	(0.337)	(0.261)
Estimation method	FE OLS	FE Ologit	FE OLS	FE Ologit	FE OLS	FE Ologit	FE OLS	FE Ologit
Observations	2,428	1,905	2,428	2,000	2,583	1,933	2,583	2,175
R-squared	0.036		0.079		0.044		0.104	
Log conditional likelihood		-1631.264		-2786.771		-1674.602		-3263.524

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses.

Table 7 Effect of living alone on the well-being of young and middle-aged people

Panel (A) under 39 years old

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Men				Women		
	Happiness	Happiness	K6	K6	Happiness	Happiness	K6	K6
Living alone×COVID	-0.373	-0.324	-0.660	-0.484	0.331	0.310	-1.938*	-0.935*
	(0.429)	(0.440)	(0.616)	(0.400)	(0.408)	(0.460)	(1.106)	(0.527)
Living alone	-1.069	-0.927	0.176	0.111	1.433**	2.043**	0.073	0.253
	(0.667)	(0.605)	(1.080)	(0.689)	(0.704)	(0.853)	(1.719)	(0.853)
COVID	-0.373**	-0.458**	-0.917***	-0.580***	-0.387***	-0.424***	-1.123***	-0.678***
	(0.151)	(0.183)	(0.300)	(0.180)	(0.142)	(0.157)	(0.272)	(0.169)
Estimation method	FE OLS	FE Ologit	FE OLS	FE Ologit	FE OLS	FE Ologit	FE OLS	FE Ologit
Observations	1,837	1386	1,837	1426	1,962	1578	1,962	1626
R-squared	0.020		0.027		0.026		0.038	
Log conditional likelihood		-1447.306		-2850.281		-1736.840		-3120.550

Panel (B) 40 to 64 years old

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Men				Women		
	Happiness	Happiness	K6	K6	Happiness	Happiness	K6	K6
Living alone×COVID	0.077	0.119	0.099	0.077	0.139	0.234	0.863*	0.605*
	(0.226)	(0.308)	(0.450)	(0.305)	(0.254)	(0.324)	(0.459)	(0.320)
Living alone	0.637	0.663	0.285	0.137	0.672	0.890	-0.382	-0.547
	(0.632)	(0.667)	(0.927)	(0.550)	(0.773)	(0.889)	(0.578)	(0.561)
COVID	-0.383***	-0.537***	-1.136***	-0.850***	-0.667***	-0.893***	-2.013***	-1.394***
	(0.092)	(0.133)	(0.171)	(0.133)	(0.084)	(0.115)	(0.166)	(0.117)
Estimation method	FE OLS	FE Ologit	FE OLS	FE Ologit	FE OLS	FE Ologit	FE OLS	FE Ologit
Observations	3,781	3043	3,781	3143	4,236	3459	4,236	3768
R-squared	0.019		0.038		0.052		0.087	
Log conditional likelihood		-2837.967		-5177.256		-3358.747		-6512.914

NOTES: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Heteroscedasticity robust standard errors are reported in parentheses.