Social isolation and its psychosocial factors in mild lockdown for the COVID-19 pandemic: a cross-sectional survey of the Japanese population

Nagisa Sugaya, Tetsuya Yamamoto, Naho Suzuki, Chigusa Uchiumi

ABSTRACT

Objective  This study investigated the sociodemographic, behavioural and psychological characteristics of socially isolated individuals during the ‘mild lockdown’ period of COVID-19 in Japan.

Design  A cross-sectional study.

Setting  The seven prefectures where the emergency declaration was first applied in Japan.

Participants  We collected data on 11 333 individuals (52.4% women, 46.3±14.6 years) living in the seven prefectures where the emergency declaration was first applied. The online survey was performed between 11 May and 12 May 2020, in the final phase of the state of emergency.

Primary outcome measures  Lubben Social Network Scale (LSNS-6)

Results  We found that male sex (95% CI 1.60 to 1.98), middle age (95% CI 1.55 to 1.93) and lower income (eg, annual household income <2.0 million: 95% CI 2.29 to 3.54) predicted social isolation; being a student was a protective factor against social isolation (95% CI 0.26 to 0.62). In the comparisons of each item of the LSNS-6 by sociodemographic characteristics, men were more likely to have fewer people to talk to about their personal problems (95% CI −0.37 to −0.28) and to seek help from (95% CI −0.39 to −0.30), and the middle-aged group had a lower social network of friends. Additionally, social isolation was associated with decreased online interaction with familiar people (95% CI −1.28 to −1.13) and decreased optimistic thinking under mild lockdown (95% CI −0.97 to −0.86).

Conclusions  We identified the sociodemographic and psychological characteristics associated with social isolation under mild lockdown. These results are expected to be a useful resource for identifying which groups may require intervention to improve their social interactions in order to preserve their mental health during the pandemic.

INTRODUCTION

COVID-19 has rapidly spread worldwide since its outbreak in December 2019. To deter the spread of COVID-19, many countries have imposed a lockdown with restrictions on outings, service closure, etc. The lockdown in most countries is mandatory, with penalties for violations. The lockdown can be expected to deter the spread of the infection, which if not stopped can cause economic damage and psychological distress.1-3

Lockdowns and ‘stay-at-home’ orders for COVID-19 announced internationally have led to physical and social distancing, with reports of many individuals experiencing social isolation and loneliness.1,4 Social isolation and loneliness are conceptually distinct, with social isolation generally defined in terms of objective availability of social contacts and frequency of contact with social network members, whereas loneliness referring to the perception that intimate and social needs are not being met.5,6 Social isolation has been reported to be inter-related with loneliness and is often a risk factor for loneliness.7 Sociodemographic characteristics that increase the likelihood of being socially isolated or lonely include being very old, single or widowed, living alone, having no education, low income or having financial burdens.8-10 Social isolation and loneliness have been reported to affect health and mortality risk,1,5,11 but the relationship is likely to be reciprocal. Previous research has suggested that chronic illness can also be a risk factor for social isolation.
and loneliness. In a previous report on the COVID-19 pandemic in Brazil, social interaction was the most affected aspect among people with higher education and income (45.8%), and financial problems caused a more significant impact (35%) among people with low income and education. Regarding loneliness, a previous study using cross-cohort analyses of data from adults in the UK conducted before and during the COVID-19 pandemic reported that loneliness levels were higher during the pandemic than before the pandemic, and being a student emerged as a higher risk factor for loneliness during lockdown than usual. Young adults, people living alone, people with lower education or income, the economically inactive women, ethnic minority groups and urban residents also had a higher risk of being lonely both before and during the pandemic. During stay-at-home orders in the USA, elevated loneliness was strongly associated with greater depression and suicidal ideation. Thus, social isolation and the resulting loneliness under stay-at-home orders for COVID-19 is a critical public health concern that must be considered.

The impact of ‘mild lockdown’ that occurred following the declaration of a state of emergency in Japan has attracted attention. On 7 April 2020, the Japanese government declared a state of emergency over the COVID-19 outbreak for seven prefectures. The state of emergency expanded nationwide on 16 April 2020, and was lifted in a phased manner starting on 14 May 2020. While many countries were in lockdown with penalties for violations, Japanese policy for COVID-19 was distinguished as the government having ‘requested’ people to refrain from going out except for emergencies, to work from home as much as possible, to reduce contact with people other than those living with them by 70%–80% and to temporarily close certain businesses without penalties for violations. The emergency declaration in Japan was a ‘request’ by the government, and thus it did not prohibit people from going out or meeting other households. On the other hand, most, but not all, schools were closed and online classes were held, and many universities banned students from entering the campus and closed the libraries and other facilities on campus. The mild lockdown in Japan had a diverse range of influences on people’s lives like other countries, such as changes in domestic circumstances due to teleworking or school closure and economic damage due to decreased income or job loss. This lockdown significantly transformed activity in Japan; for example, the number of monthly train users in April 2020 prominently decreased by 45.5% compared with the same month last year. Additionally, our epidemiological survey in the Japanese population under mild lockdown reported that the proportion of individuals with psychological distress was significantly higher when compared with the previous national survey data from 2010, 2013, 2016 and 2019. The degree of psychological distress was influenced by a specific interaction structure of risk factors such as high loneliness and COVID-19-induced negative influence, deterioration in interpersonal relationships, insomnia, anxiety, deterioration in family finances and work and academic difficulties. Thus, these voluntary restrictions on behaviour under mild lockdown during pandemics may lead to serious problems of social isolation among the Japanese.

In light of the above, the purpose of this study was to investigate the sociodemographic, behavioural and psychological characteristics of socially isolated individuals during the ‘mild lockdown’ period of COVID-19 in Japan.

**METHODS**

**Participants and data collection**

The survey was conducted online between 11 May and 12 May 2020, in the final phase of the state of emergency. We conducted an online survey of individuals living in the seven prefectures where the emergency declaration was first applied. The survey was designed to assess the psychological impact of the mild lockdown on participants for approximately 1 month from the start of ‘mild lockdown’. The exclusion criteria were as follows: (a) aged <18 years, (b) high school students and (c) living outside the seven prefectures. To sensitively detect the impact of the mild lockdown, participants were recruited only in the seven prefectures where the emergency declaration was first applied (Tokyo, Kanagawa, Osaka, Saitama, Chiba, Hyogo and Fukuoka). The number of people in each prefecture was determined according to the ratio of the number of people living in Tokyo (n=2783; 24.6%), Kanagawa (n=1863, 16.4%), Osaka (n=1794; 15.8%), Saitama (n=1484; 13.1%), Chiba (n=1263; 11.1%), Hyogo (n=1119; 9.9%) and Fukuoka (n=1027; 9.1%).

Through Macromill (Tokyo, Japan), a global marketing research company, approximately 80 000 registered people were recruited by email, and data were collected from 11 333 people on an online platform (target sample was n=11 000). Participants completed the online survey on the second day after receiving a link to the online survey. All participants voluntarily responded to the survey anonymously and provided informed consent online before the survey. Participants received a clear explanation of the survey procedure and could interrupt or terminate the survey at any time without needing a reason. The questionnaire format except the default items provided by Macromill (sex, age, occupation, annual household income, marital status and presence of children) did not allow participants to proceed to the next page if there were items they had not answered. All the participants received Macromill points for their participation, which constitute an original point service of Macromill, and participants can exchange these points for prizes or cash.

The data for this study were partly extracted from a database that contained data used in our published papers. The extracted data were secondarily reanalysed with different dependent and independent variables compared with those in the above-mentioned papers.
Patient and public involvement
No patient involved.

Measurements
Sociodemographic data
Participants' sociodemographic information including age, sex, employment status (employed, homemaker, student, unemployed or other), marital status and annual household income (<2.0 million, 2.0–3.9 million, 4.0–5.9 million, 6.0–7.9 million, ≥8.0 million or unknown) was collected. The details of the survey items are available on the open data platform (the Open Science Framework). To compare the impact on the group assumed to be vulnerable to the effects of lockdown in previous studies, information was collected on whether the individual or a family member was a healthcare worker, whether the individual was currently being treated for a mental condition or severe physical disease, and whether the individual had a history of treatment for a mental condition or severe physical disease.

Social isolation
We measured social networks since the declaration of the state of emergency using the Japanese version of the abbreviated Lubben Social Network Scale (LSNS-6). The LSNS-6 is a shortened version of the Lubben Social Network Scale that includes items on network size of relatives or friends who provide emotional and instrumental support. The LSNS-6 consists of three items related to the family network, three items related to the friendship network, as follows:
1. How many relatives do you see or hear from at least once a month?
2. How many relatives do you feel close to such that you can talk about private matters?
3. How many relatives do you feel at ease with that you could call on them for help?
4. How many of your friends do you see or hear from at least once a month?
5. How many friends do you feel close to that you can talk about private matters?
6. How many friends do you feel close to such that you could call on them for help?

The number of people in the network is calculated using a 6-point scale (0=none; 1=one; 2=two, 3=three or four; 4=five to eight; 5=nine or more) for each item. For each item, the score range from 0 to 5, with higher scores indicating higher levels of loneliness.

Lifestyle, coping behaviour and stressors related to mild lockdown
With extensive references to the literature on the COVID-19 pandemic, we developed eight lifestyle and coping behaviour items, and seven stressors were assumed to be associated with mild lockdown. We asked participants to rate the frequency of implementation and experience of these items from the start of the mild lockdown to the time of the survey on a scale of 1 (not at all) to 7 (extremely). All details of these items are described in our published article.

Statistical analyses
Data analyses were performed using SPSS V.25.0 (IBM, New York, USA). The χ² test was applied to compare sociodemographic data by the presence of social isolation (LSNS-6 <12). Binomial logistic regression analysis was conducted to examine the effect of sociodemographic characteristics on the presence of social isolation (LSNS-6 <12 or ≥12). We used the t-test and one-way analysis of variance (ANOVA) to compare each item of LSNS-6 between sociodemographic characteristics, and the post hoc t-test with Bonferroni correction was employed to test the difference between groups for the one-way ANOVA. The t-test was applied to compare lifestyle, coping behaviour and stressors related to COVID-19 by the presence of social isolation. The power analysis was performed using G*power V.3.1.9.4 (https://www.gpower.hhu.de/ arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower.html) to confirm if the sample size of the present study was appropriate.

RESULTS
Descriptive results
A total of 11 333 individuals participated in our study (52.4% women, mean age=46.3±14.6 years, range=18–89 years). In our dataset, although 1161 participants (10.2%) answered that they did not know their annual household income and 1707 participants (15.1%) did not provide an answer to the item about annual household income, there were no missing data for the other variables. The mean scores of the LSNS and UCLA were 10.56±6.17 and 23.46±5.70, respectively.

The sociodemographic characteristics are shown in table 1. The ‘unknown’ of annual household income in table 2 includes the missing values (n=1707).

The average statistical powers of the χ² test (effect size (w)=0.223–0.289, a=0.05, number of groups=2–5), t-test (effect size (d)=0.042–1.088, a=0.05, number of groups=2) and one-way ANOVA (effect size (f)=0.054–0.211, a=0.05, number of groups=3–5) were 1.000, 0.959 and 1.000, respectively.

Association between social isolation and sociodemographic factors
Table 2 shows the differences in sociodemographic data based on the presence of social isolation (LSNS-6 <12).
There were significant differences in the prevalence of LSNS <12 status between groups according to sex, age group, occupation, annual household income, marital status and the presence of children (p<0.05, Cramer’s V (or φ) was small (0.102–0.150)). Greater social isolation was prevalent in those who are male, middle-aged (40–64 years), employed, unemployed, other occupational status, lower income, unmarried and without children.

Table 3 indicates the results of the binomial logistic regression analysis between sociodemographic data and the presence of social isolation. No multicollinearity problems were found among the independent variables (all variance inflation factors <1.77). The risk factors that predicted social isolation included being male, middle-aged (40–64 years), lower income, unmarried and without children.

Regarding the results of the ANOVA that exceeded the lower limit of ‘small effect size’ (ie, η² >0.010), the results of multiple comparison analysis are shown below.

In the multiple comparison by age, the scores of items 3, 4, 5 and 6 in the middle-aged group (40–64 years) were significantly lower than those in the 18–39 years group and the over 65-year group. The score for item 4 in the 18–39 years group was significantly lower than that in patients aged >65 years. The score for item 5 in the over 65-year group was significantly lower than that in the 18–39 year group.

In the multiple comparison by occupational status, the scores of items 1, 2 and 3 in the employed group were significantly lower than those in the homemaker and student groups. The scores of those in the unemployed group were significantly lower than those in the employed, homemaker and student groups, and those in the other status group were significantly lower than those in the homemaker and student groups. Additionally, the scores of items 2 and 3 in the student group were significantly lower than those in the homemaker group. The results for the score of item 5 were similar to those of items 2 and 3, except that the score in the other status group was significantly lower than that of the employed group, and that in the homemaker group was significantly lower than that of the student group. The results for the score of item 6 were also similar to those of items 2 and 3.

### Comparison of each item of the LSNS-6 by sociodemographic characteristics

The results of the comparison of each item of the LSNS-6 by sociodemographic characteristics are shown in tables 4 and 5. All group differences were significant.

Regarding the results of the t-test that exceeded the lower limit of ‘small effect size’ (ie, Cohen’s d >0.200), male participants showed lower scores for items 2, 3, 5 and 6, and unmarried participants and participants without children had higher scores for items 1, 2 and 3.
3, except that there was no significant difference between the employed and homemaker groups.

Regarding the multiple comparisons by annual household income, all items showed lower scores for the group with lower annual household income. The differences in the scores of items 1 and 3 were significant between all annual household income groups, except between those in the 6.0–7.9 million Yen and over 8.0 million Yen groups. The difference in the score of item 2 was significant between all groups, except between those in the 6.0–7.9 and 4.0–5.9 or over 8.0 million Yen groups. The difference of the score of item 4 was significant between

| N (%) in each LSNS group | Group difference |
|--------------------------|------------------|
| LSNS <12 | LSNS ≥12 |
| **Overall** | | |
| 6337 | (55.9) | 4996 | (44.1) |
| **Sex** | | |
| 147.47 | 0.001 | 0.114 |
| Male | 3335 | (61.9) | 2056 | (38.1) |
| Female | 3002 | (50.5) | 2940 | (49.5) |
| **Age (years)** | | |
| 118.12 | 0.001 | 0.102 |
| 18–39 | 1950 | (50.2) | 1938 | (49.8) |
| 40–64 | 3654 | (60.7) | 2370 | (39.3) |
| ≥65 | 733 | (51.6) | 688 | (48.4) |
| **Occupation** | | |
| 161.82 | 0.001 | 0.119 |
| Employed | 4369 | (56.9) | 3316 | (43.1) |
| Homemaker | 866 | (48.0) | 940 | (52.0) |
| Student | 155 | (38.1) | 252 | (61.9) |
| Unemployed | 713 | (66.8) | 355 | (33.2) |
| Other | 234 | (63.8) | 133 | (36.2) |
| **Marital status** | | |
| 167.91 | 0.001 | 0.122 |
| Married | 3005 | (49.5) | 3067 | (50.5) |
| Unmarried | 3332 | (63.3) | 1929 | (36.7) |
| **The presence of child** | | |
| 219.18 | 0.001 | 0.139 |
| Yes | 6043 | (55.7) | 4808 | (44.3) |
| No | 294 | (61.0) | 188 | (39.0) |
| **Annual household income (JPY)** | | |
| 189.48 | 0.001 | 0.150 |
| <2.0 million | 466 | (73.6) | 167 | (26.4) |
| 2.0–3.9 million | 1253 | (63.0) | 737 | (37.0) |
| 4.0–5.9 million | 1278 | (57.7) | 936 | (42.3) |
| 6.0–7.9 million | 788 | (52.7) | 707 | (47.3) |
| ≥8.0 million | 1012 | (47.5) | 1118 | (52.5) |
| **Treatment of severe current physical diseases** | | |
| 5.27 | 0.022 | 0.002 |
| Yes | 294 | (61.0) | 188 | (39.0) |
| No | 6043 | (55.7) | 4808 | (44.3) |
| **Treatment of severe previous physical diseases** | | |
| 1.35 | 0.246 | 0.011 |
| Yes | 492 | (57.8) | 359 | (42.2) |
| No | 5845 | (55.8) | 4637 | (44.2) |
| **Treatment of current psychological problems** | | |
| 53.83 | 0.001 | 0.069 |
| Yes | 448 | (69.8) | 194 | (30.2) |
| No | 5889 | (55.1) | 4802 | (44.9) |
| **Treatment of previous psychological problems** | | |
| 62.63 | 0.001 | 0.074 |
| Yes | 900 | (65.9) | 466 | (34.1) |
| No | 5437 | (54.6) | 4530 | (45.4) |

Cramer’s V (or φ): 0.100–small; 0.300–medium; 0.600–large.
*Significant group difference found by residual analysis (absolute value of adjusted residual ≥1.96).
LSNS-6, Lubben Social Network Scale.
all groups, except between the 2.0–3.9 and the under 2.0 or 4.0–5.9 million Yen groups, and between the 4.0–5.9 and the 6.0–7.9 million Yen groups. The difference in the score of item 5 was significant between all groups, except between the 4.0–5.9 and the 2.0–3.9 or 6.0–7.9 million Yen groups. The difference in the score of item 6 was significant between all groups.

Table 3 shows a comparison of loneliness and items specific to mild lockdown between the LSNS-6 <12 group and the LSNS-6 ≥12 group. The LSNS-6 <12 group had a significantly higher UCLA-LS3 score than the LSNS-6 ≥12 group, and the effect size was large. Regarding items about lifestyle and coping behaviour during mild lockdown, the LSNS-6 <12 group showed significantly lower scores than the LSNS-6 ≥12 group for all items. The effect sizes in ‘online interaction with familiar people’ and ‘optimism’ were medium, and those in other items were small. Regarding items about stressors related to mild lockdown, although there were significant differences between groups in all items except ‘difficulties owing to the lack of daily necessities’, the effect sizes in these items except ‘deterioration of relationship with familiar people’ exceeded the lower limit of ‘small effect size’ (Cohen’s d >0.200).

**DISCUSSION**

As in other previous surveys during the period of the COVID-19 pandemic, the results of the present study indicate that it is evident that social isolation and loneliness are serious issues during this period. The severe loneliness among people with social isolation found in the present study is similar to the results that have been reported for some time. Compared to the previous studies before COVID-19 pandemic, our participants had a lower mean LSNS-6 score and a higher mean UCLA-LS3 score, suggesting an elevated severity of isolation during the COVID-19 mild lockdown.
Sociodemographic data that predicted social isolation were being male, middle-aged (40–64 years) and lower income. Regarding occupation status, being a student was found to be a protective factor for social isolation. While the association between lower income and social isolation in the present study is consistent with previous results during the COVID-19 pandemic,1 a previous study reported an association between female sex and younger age with loneliness.34 Given the severe loneliness among people with social isolation found in the present study, the previous results of loneliness in women and younger age groups did not support our results. However, previous studies prior to the COVID-19 pandemic have shown inconsistent results regarding sex differences, and several studies prior to the COVID-19 pandemic have shown that men are more likely to be socially isolated and lonely than women.35 36 Other studies have reported that women are more likely to be lonely than men, although this effect tends to disappear when other factors are controlled for in the analysis.8 9 Results regarding sex differences may be influenced by region and culture, and may be similar during the COVID-19 pandemic.

Changes in social conditions with respect to employment under the COVID-19 pandemic could be indirectly related to the association between lower income and social isolation found in the present study. Empirical studies prior to the COVID-19 pandemic have explored specific links between poverty and different aspects of social isolation, including living in a poor neighbourhood and access to social resources.37 38 Links have been established between low income, greater isolation and a lower sense of belonging, which also affect the perceptions and experiences of stigmatisation and isolation for those who live on a low income,39 and the effect of social resources and different norms on economic outcomes. 40 While these factors may have contributed to the severity of social isolation in this study, the social isolation of people in the unprecedented situation of the COVID-19 pandemic is clearly worse than that before the pandemic, and therefore, it is necessary to consider the social situation that the pandemic actually brought about. According to the Labour Force Survey by the Ministry of Internal Affairs and Communications in Japan,41 the unemployment rate (seasonally adjusted value) had remained at a low level.

### Table 4 Comparisons of each item of the LSNS-6 by sex, marital status and the presence of child

| LSNS-6 | Mean (SD) | Group difference | P value | Cohen's d |
|--------|-----------|-------------------|---------|-----------|
| Item 1 relatives: size | Male 1.99 (1.31) Female 2.18 (1.26) | Difference (95% CI) | <0.001 | 0.154 |
| Item 2 relatives: discuss private matters | Male 1.79 (1.28) Female 2.11 (1.21) | −0.32 (−0.37 to −0.28) | <0.001 | 0.259 |
| Item 3 relatives: call for help | Male 1.86 (1.28) Female 2.20 (1.21) | −0.35 (−0.39 to −0.30) | <0.001 | 0.277 |
| Item 4 friend: size | Male 1.25 (1.44) Female 1.42 (1.44) | −0.17 (−0.22 to −0.12) | <0.001 | 0.117 |
| Item 5 friend: discuss private matters | Male 1.45 (1.42) Female 1.84 (1.38) | −0.39 (−0.44 to −0.34) | <0.001 | 0.277 |
| Item 6 friend: call for help | Male 1.32 (1.38) Female 1.63 (1.38) | −0.31 (−0.36 to −0.26) | <0.001 | 0.224 |
| Total score | Male 9.65 (6.31) Female 11.38 (5.92) | −1.73 (−1.96 to −1.51) | <0.001 | 0.283 |

| LSNS-6 | Married | Not married | Difference (95% CI) | P value | Cohen's d |
|--------|---------|-------------|---------------------|---------|-----------|
| Item 1 relatives: size | Male 2.33 (1.22) Female 1.69 (1.30) | −0.64 (−0.69 to −0.59) | <0.001 | 0.508 |
| Item 2 relatives: discuss private matters | Male 2.19 (1.19) Female 1.57 (1.26) | −0.62 (−0.66 to −0.57) | <0.001 | 0.503 |
| Item 3 relatives: call for help | Male 2.25 (1.20) Female 1.69 (1.28) | −0.57 (−0.61 to −0.52) | <0.001 | 0.457 |
| Item 4 friend: size | Male 1.36 (1.45) Female 1.31 (1.43) | −0.06 (−0.11 to −0.01) | 0.032 | 0.042 |
| Item 5 friend: discuss private matters | Male 1.70 (1.39) Female 1.58 (1.43) | −0.12 (−0.18 to −0.07) | <0.001 | 0.088 |
| Item 6 friend: call for help | Male 1.52 (1.37) Female 1.41 (1.41) | −0.12 (−0.17 to −0.06) | <0.001 | 0.084 |
| Total score | Male 11.36 (5.96) Female 9.24 (6.27) | −2.12 (−2.36 to −1.89) | <0.001 | 0.347 |

| LSNS-6 | With child | Without child | Difference (95% CI) | P value | Cohen's d |
|--------|------------|---------------|---------------------|---------|-----------|
| Item 1 relatives: size | Male 2.45 (1.20) Female 1.67 (1.26) | −0.78 (−0.82 to −0.73) | <0.001 | 0.632 |
| Item 2 relatives: discuss private matters | Male 2.24 (1.19) Female 1.63 (1.24) | −0.61 (−0.65 to −0.56) | <0.001 | 0.499 |
| Item 3 relatives: call for help | Male 2.28 (1.20) Female 1.76 (1.26) | −0.53 (−0.57 to −0.48) | <0.001 | 0.427 |
| Item 4 friend: size | Male 1.42 (1.46) Female 1.26 (1.42) | −0.16 (−0.22 to −0.11) | <0.001 | 0.113 |
| Item 5 friend: discuss private matters | Male 1.71 (1.39) Female 1.59 (1.43) | −0.12 (−0.18 to −0.07) | <0.001 | 0.088 |
| Item 6 friend: call for help | Male 1.52 (1.37) Female 1.44 (1.41) | −0.08 (−0.13 to −0.03) | 0.002 | 0.057 |
| Total score | Male 11.62 (5.93) Female 9.34 (6.22) | −2.28 (−2.50 to −2.05) | <0.001 | 0.375 |

Cohen's d: 0.200~small; 0.500~medium; 0.800~large.
LSNS-6, Lubben Social Network Scale.
### Table 5  Comparisons of each item of the LSNS-6 by age group, occupational status and annual household income

| Item | 18–39 | 40–64 | ≥65 | Group difference |
|------|-------|-------|-----|------------------|
| 1. **Relative: size** | 2.15 (1.28) | 2.03 (1.29) | 2.19 (1.30) | 16.53 <0.001 0.003 |
| 2. **Discuss private matters** | 2.02 (1.24) | 1.86 (1.25) | 2.17 (1.26) | 44.32 <0.001 0.008 |
| 3. **Call for help** | 2.16 (1.25) | 1.91 (1.25) | 2.21 (1.25) | 63.07 <0.001 0.011 |
| 4. **Friend: size** | 1.43 (1.46) | 1.22 (1.39) | 1.64 (1.54) | 57.49 <0.001 0.011 |
| 5. **Discuss private matters** | 1.88 (1.43) | 1.50 (1.38) | 1.70 (1.40) | 90.76 <0.001 0.016 |
| 6. **Call for help** | 1.73 (1.44) | 1.32 (1.33) | 1.48 (1.39) | 90.39 <0.001 0.018 |
| **Total score** | 2.15 (1.28) | 2.03 (1.29) | 2.19 (1.30) | 16.53 <0.001 0.003 |

| Item | Employed | Homemaker | Student | Unemployed | Other | Group difference |
|------|----------|-----------|---------|------------|-------|------------------|
| 1. **Relative: size** | 2.05 (1.29) | 2.36 (1.24) | 2.37 (1.24) | 1.87 (1.32) | 1.90 (1.28) | 35.90 <0.001 0.013 |
| 2. **Discuss private matters** | 1.89 (1.25) | 2.36 (1.15) | 2.10 (1.21) | 1.75 (1.30) | 1.75 (1.30) | 70.39 <0.001 0.022 |
| 3. **Call for help** | 1.98 (1.26) | 2.41 (1.15) | 2.21 (1.26) | 1.83 (1.29) | 1.86 (1.30) | 60.72 <0.001 0.019 |
| 4. **Friend: size** | 1.34 (1.44) | 1.33 (1.41) | 1.99 (1.56) | 1.16 (1.44) | 1.29 (1.43) | 24.99 <0.001 0.009 |
| 5. **Discuss private matters** | 1.65 (1.41) | 1.77 (1.36) | 2.33 (1.44) | 1.29 (1.36) | 1.44 (1.38) | 46.57 <0.001 0.016 |
| 6. **Call for help** | 1.49 (1.39) | 1.54 (1.34) | 2.20 (1.50) | 1.08 (1.27) | 1.31 (1.38) | 52.90 <0.001 0.019 |
| **Total score** | 10.40 (6.16) | 11.77 (5.82) | 13.19 (5.90) | 8.99 (6.23) | 9.55 (6.13) | 58.08 <0.001 0.020 |

| Item | <2.0 million | 2.0–3.9 million | 4.0–5.9 million | 6.0–7.9 million | ≥8.0 million | Group difference |
|------|--------------|-----------------|-----------------|-----------------|-------------|------------------|
| 1. **Relative: size** | 1.41 (1.32) | 1.82 (1.32) | 2.08 (1.27) | 2.23 (1.24) | 2.35 (1.22) | 92.18 <0.001 0.043 |
| 2. **Discuss private matters** | 1.39 (1.33) | 1.79 (1.24) | 1.95 (1.24) | 2.06 (1.22) | 2.14 (1.22) | 52.56 <0.001 0.026 |
| 3. **Call for help** | 1.42 (1.32) | 1.90 (1.26) | 2.03 (1.23) | 2.16 (1.23) | 2.19 (1.22) | 52.45 <0.001 0.026 |
| 4. **Friend: size** | 1.07 (1.33) | 1.20 (1.37) | 1.27 (1.42) | 1.37 (1.45) | 1.55 (1.51) | 22.35 <0.001 0.011 |
| 5. **Discuss private matters** | 1.24 (1.36) | 1.49 (1.39) | 1.59 (1.39) | 1.69 (1.38) | 1.88 (1.44) | 35.29 <0.001 0.016 |
| 6. **Call for help** | 1.03 (1.31) | 1.32 (1.35) | 1.41 (1.36) | 1.53 (1.35) | 1.72 (1.42) | 41.97 <0.001 0.019 |
| **Total score** | 7.55 (6.36) | 9.52 (6.02) | 10.33 (5.96) | 11.05 (5.93) | 11.82 (6.20) | 74.70 <0.001 0.036 |

η²: 0.010–small; 0.060 medium; 0.140–large.
LSNS-6, Lubben Social Network Scale.
(low 2%) from 2018 to February 2020, but the unemployment rate (seasonally adjusted value) in May 2020 had worsened to 2.9%. Additionally, the number of active jobs (seasonally adjusted value) in May 2020 decreased by 8.6% month-over-month. On the other hand, ‘deterioration of household economy’, one of items specific to mild lockdown, was not found to be related to social isolation. It is possible that people fear financial struggle in the future even more as a result of unemployment or pay cuts, in the face of actual social conditions related to unemployment. Thus, these social conditions may preoccupy people, and may have worsened their mental health even if they were not actually laid off. We speculate that such preoccupation and poor mental health may have reduced their interaction with others. In addition, as shown in table 2, many participants in these two categories belonged to the LSNS-6 low score group, but there was no significant association in the logistic regression analysis. This may be due to the fact that middle age (many employed people were between 39 and 64 years of age) and low household income (many unemployed people in the low-income group) are related to social isolation.

We compared each item of the LSNS-6 by sociodemographic characteristics.

In terms of gender differences in social isolation, men were more likely to have fewer people to talk to about their personal problems and seek help, rather than just the number of relatives and friends they met and talked to. Those who were unmarried and without children scored lower on the three items related to ‘relatives’ in the LSNS-6 than those who were married and/or had children. However, there was no significant difference in the social network related to ‘friends’. It is not surprising that there are differences in items affected by the number of people in the household between those who are married/with children versus those who are single/without children, and it is difficult to say that this finding is the result of the mild lockdown. However, as noted above, this feature in these groups may have been more severe under mild lockdown because the number of people who
actually met the criteria for social isolation in the LSNS-6 was significantly higher than in previous studies. In the present study, the middle-aged group (40–64 years) had a lower social network of friendships. One possible reason for this result is that the middle-aged group includes a large number of people who work in offices, and it is possible that working remotely has reduced their interaction with their colleagues. Regarding occupational status, except for the number of friends that they could meet and talk to, the social network of the students was enhanced. Younger people are more likely to interact online and are able to maintain communication with many people to some extent even when they cannot meet in person. In terms of annual household income, the lower the income, the lower the social network was for all LSNS-6 items, so the characteristics of each LSNS-6 item were not clear.

Regarding items specific to mild lockdown, the LSNS-6 <12 group showed decreased ‘online interaction with familiar people’ and ‘optimism’. These results are consistent with previous results indicating the association between loneliness and lower contact with relatives or lower positive emotions by Losada-Baltar et al. Online communication has been reported to be beneficial for decreasing loneliness and increasing social contact among older adults in assisted and independent living communities. Additionally, the association between social isolation and being able to think positively about the future even under mild lockdown is consistent with the results of previous studies (eg, Garner et al) that have shown an association between social support and optimism.

This study had several limitations. First, since we employed a cross-sectional design, we could not compare the results during the mild lockdown with that before the COVID-19 pandemic. However, social isolation and loneliness in our participants prominently increased compared with previous results before the pandemic, and were correlated with items relating to COVID-19 and mild lockdown. Thus, the effect of mild lockdown was considered to be indicated in the present study. Second, although we asked about marital status and the presence of a child, we did not investigate the number of family members living together. Living alone was previously reported to be one of the risk factors for loneliness. In particular, being a parent and living with a child could affect social isolation and loneliness. Third, we did not assess the quality of relationships with relatives and friends. Even if the network size is small, mental health may be good if the quality of the relationships is sufficient. Fourth, we did not exclude people who did not stay in mild lockdown for any reason (eg, work) and people who were affected by COVID-19, and we could not adjust for their effect on the results of the present study. In the future, it would be useful to investigate whether the participants were in an environment affected by mild lockdown or COVID-19. Fifth, we collected the data for this study through an online survey and were not able to conduct random sampling, so we cannot guarantee the representativeness of the sample; the sample we collected could not be matched to the proportions of each age group and gender group in each region.

CONCLUSION

We explored in detail the factors that contribute to social isolation, which were exacerbated during a mild lockdown in the unprecedented global crisis of the COVID-19 pandemic. In the present study, male sex, middle age and lower income predicted social isolation; student as an occupational status was the protective factor of social isolation. In the comparisons of each item of the LSNS-6 by sociodemographic characteristics, men were more likely to have fewer people to talk to about their personal problems and seek help from, and the middle-aged group had a lower social network of friendships. Additionally, regarding lifestyle, coping behaviour and stressors specific to mild lockdown, social isolation was associated with decreased online interaction with familiar people and decreased optimism. In this study, we identified the sociodemographic and psychological characteristics associated with social isolation. These results are expected to be a useful resource for identifying social networks of people who may need intervention in order to improve their mental health under the pandemic.

Contributors Conceived and designed the study: TY, CU, NSuz. Performed the study: TY, NSuz. Analyzed the data: NSug. Wrote the paper, contributed to and approved the final manuscript: NSug, TY, CU, NSuz.

Funding This work was supported by Japan Society for the Promotion of Science (grant numbers 18K13323, 19K11771 and 20K10883) and the Project for Creative Research of the Faculty of Integrated Science, Tokushima University.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval This study was approved by the Research Ethics Committee at the Graduate School of Social and Industrial Science and Technology, Tokushima University (acceptance number 212), and was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. All data of the items except each item of the LSNS-6 are available on the Open Science Framework platform.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iDs Nagisa Sugaya http://orcid.org/0000-0002-4803-3907
Tetsuya Yamamoto http://orcid.org/0000-0003-4241-532X

REFERENCES

1 Bu F, Steptoe A, Fancourt D. Who is Lonely in lockdown? Cross-cohort analyses of predictors of loneliness before and during the COVID-19 pandemic. Public Health 2020;186:31–4.  
Sugaya N, et al. BMJ Open 2021;11:e048380. doi:10.1136/bmjopen-2020-048380

2 Cerbara L, Ciancimino G, Crescimbene M, et al. A nation-wide survey on emotional and psychological impacts of COVID-19 social distancing. *Eur Rev Med Pharmacol Sci* 2020;24:7155–63.

3 Cooke JE, Einrich R, Racine N, et al. Prevalence of posttraumatic and general psychological stress during COVID-19: a rapid review and meta-analysis. *Psychiatry Res* 2020;292:113347.

4 Li LZ, Wang S. Prevalence and predictors of general psychiatric disorders and loneliness during COVID-19 in the United Kingdom. *Psychiatry Res* 2020;291:113267.

5 Courten E, Knapp M. Stigma during, loneliness and health in old age: a scoping review. *Health Soc Care Community* 2017;25:799–812.

6 Peplau LA, Perlman D. Loneliness: a sourcebook of current theory, research, and therapy. New York: Wiley, 1982.

7 Hawkley LC, Cacioppo JT. Loneliness matters: a theoretical and empirical review of loneliness consequences and mechanisms. *Ann Behav Med* 2010;40:218–27.

8 Cohen-Mansfield J, Hazan H, Lerman Y, et al. Correlates and predictors of loneliness in older adults: a review of quantitative results informed by qualitative insights. *Int Psychogeriatr* 2016;28:557–76.

9 Gierveld JdeL. A review of loneliness: concept and definitions, determinants and consequences. *Rev Clin Gerontol* 1998;8:73–80.

10 Pinquart M, Sorensen S. Influences on loneliness in older adults: a meta-analysis. *Basic Appl Soc Psych* 2001;23:245–66.

11 Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: a meta-analytic review. *PLoS Med* 2010;7:1–20.

12 Barlow MA, Liu SY. Chronic illness and loneliness in older adulthood: the role of self-protective control strategies. *Health Psychol* 2015;34:929–33.

13 Mick P, Kawachi I, Lin FR. The association between hearing loss and social isolation in older adults. *Otalaryngol Head Neck Surg* 2014;150:378–84.

14 Bezerra ACV, Silva C, Soares FRG. Factors associated with people’s behavior in social isolation during the COVID-19 pandemic. *Cien Saude Colet* 2020;25:2411–21.

15 Killigore WDS, Cloonan SA, Taylor EC, et al. Loneliness: a signature mental health concern in the era of COVID-19. *Psychiatry Res* 2020;290:113117.

16 Paig Y, Shrivastava A, Ring L, et al. The loneliness pandemic: loneliness and other concomitants of depression, anxiety and their comorbidity during the COVID-19 outbreak. *J Affect Disord* 2020;275:109–11.

17 Ministry of Health, Labour and Welfare. The number of people tested positive for COVID-19 number of PCR tests (from 15 January 2020 to 6 April 2020). Available: https://www.mhlw.go.jp/content/10906000/000619755.pdf [Accessed 20 Nov 2020].

18 Ministry of Land, Infrastructure, Transport and Tourism. Monthly report of the statistical survey on Railway transport. Available: https://www.mlit.go.jp/k-toukei/saishintoukeiyouhu.html [Accessed Apr 2020].

19 Yamamoto T, Uchiumi C, Suzuki N, et al. The Psychological Impact of ‘Mild Lockdown’ in Japan during the COVID-19 Pandemic: A Nationwide Survey under a Declared State of Emergency. *Int J Environ Res Public Health* 2020;17:9382.

20 Sugaya N, Yamamoto T, Suzuki N, et al. A real-time survey on the psychological impact of mild lockdown for COVID-19 in the Japanese population. *Sci Data* 2020;7:372.

21 Yamamoto T, Uchiumi C, Suzuki N. The mental health impact of COVID-19 in Japan. *Open Sci Framew* 2020.

22 Brooks SK, Webster RK, Smith LE, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 2020;395:912–20.

23 Holmes EA, O’Connor RC, Perry VH, et al. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *Lancet Psychiatry* 2020;7:547–60.

24 Kisely S, Warren N, McMahon L, et al. Occurrence, prevention, and management of the psychological effects of emerging virus outbreaks on healthcare workers: rapid review and meta-analysis. *BMJ* 2020;369:m1642.

25 Mazzu C, Ricci E, Birindi S, et al. A nationwide survey of psychological distress among Italian people during the covid-19 pandemic: immediate psychological responses and associated factors. *Int J Environ Res Public Health* 2020;17:3165.

26 Kurimoto A, Awata S, Ohkubo T, et al. [Reliability and validity of the Losada-Verni version of the abbreviated Lubben Social Network Scale]. *Nihon Ronen Igakkai Zasshi* 2011;48:149–57.

27 Lubben JE. Assessing social networks among elderly populations. *Fam Community Health* 1988;11:42–52.

28 Lubben J, Bloizik E, Gillmann G, et al. Performance of an abbreviated version of the Lubben Network scale among three European community-dwelling older adult populations. *Gerontologist* 2006;46:503–13.

29 Arimoto A, Tadaka E. Reliability and validity of Japanese versions of the UCLA loneliness scale version 3 for use among mothers with infants and toddlers: a cross-sectional study. *BMC Women’s Health* 2019;19:105.

30 Russell DW. UCLA loneliness scale version (version 3 for use with among mothers with infants and toddlers: a cross-sectional study. *BMC Women’s Health* 2019;19:105.

31 Aloum M, Yu C, Czaja SJ. Loneliness and prevalent psychological distress during COVID-19: A nation-wide survey of quarantined Chinese university students. *J Affect Disord* 2020;274:1–7.

32 Fau I, Erdfelder E, Lang A-G, et al. G’Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods* 2007;39:175–91.

33 Noseda-Baltar A, Jiménez-González L, Gallego-Alberto L, et al. “We Are Staying at Home.” Association of Self-isolation and Loneliness With Psychological Distress During the Lock-Down Period of COVID-19. *J Gerontol B Psychol Sci Soc Sci* 2021;76:e10–16.

34 de Jong Gierveld J, Klevmark N, Fast JE. Determinants of loneliness among older adults in Canada. *Can J Aging* 2015;34:125–36.

35 Nicolaesin M, Thorsen K. Loneliness among men and women—a five-year follow-up study. *Aging Ment Health* 2014;18:194–206.

36 Tiggens LM, Brownie I, Green GP. Social isolation of the urban poor: race, class, and neighborhood effects on social resources. *Sociol Q* 1998:39:53–77.

37 Zavaleta D, Samuel K, Mills CT. Measures of social isolation. *Soc Indic Res* 2017;131:367–91.

38 Steward MJ, Makwarimba E, Reutter LI, et al. Poverty, sense of belonging and experiences of social isolation. *J Poverty* 2009;13:173–95.

39 Grootaert C. Social capital: The missing link? *Social Capital Initiative,* Washington, DC: The World Bank, 1998.

40 Statistics Bureau of Japan. Labor force survey, 2020. Available: https://www.stat.go.jp/english/data/roudou/results/month/index.html [Accessed 20 Nov 2020].

41 Barbosa Neves B, Fonseca JRS, Amaro F, et al. Social capital and Internet use in an age-comparative perspective with a focus on later life. *PloS One* 2018;13:e0192119.

42 Cotten SR, Anderson WA, McCullough BM. Impact of Internet use on loneliness and contact with others among older adults: cross-sectional analysis. *J Med Internet Res* 2013;15:e39.

43 Garner MJ, McGregor BA, Murphy KM, et al. Optimism and depression: a new look at social support as a mediator among women at risk for breast cancer. *Psychooncology* 2015;24:1708–13.