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Which psycho-social factors are associated with social isolation during the COVID-19 pandemic in the Japanese population?

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Abstract

Objective: This study investigated the characteristics of loneliness, sociodemographic factors, lifestyle, and stress, related to the 2019 coronavirus disease pandemic, in individuals experiencing social isolation during the “mild lockdown” under a declared state of emergency 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 inhabitants (52.4% women, 46.3 ± 14.6 years) living in the seven prefectures where the emergency declaration was first applied. The investigation was performed 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 (e.g. 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.

Keywords: the coronavirus disease 2019; mild lockdown; social isolation; loneliness

Strengths and Limitations of this study

The survey was conducted in real-time to minimize participants' recall bias.

The investigation dates of this study, 11 and 12 May 2020, were also in the final phase of the state of emergency when the effect of changes in life due to mild lockdown may be amplified.

Psychological questionnaires applied to this survey have been often used worldwide in psychological or psychiatric researches, and our data is comparable with the results in other countries with enforceable lockdowns for COVID-19.

Since we employed a cross-sectional design, we could not compare the results during the mild lockdown with that before the COVID-19 pandemic.

Introduction

The coronavirus disease 2019 (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 not only cause economic damage but also psychological distress.¹⁻³ Although “mild lockdown” with the declaration of a state of emergency in Japan was not enforced by law and was non-punitive, our epidemiological survey in the Japanese population under mild lockdown⁴ reported that the proportion of individuals with psychological distress was significantly higher when compared with the previous national survey.

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.^{1, 5} 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.⁶ Social isolation is reported to be interrelated with loneliness and is often a risk factor for loneliness.⁷ In a previous study using cross-cohort analyses of data from UK adults conducted before and during the pandemic,¹ loneliness levels were higher during the COVID-19 pandemic than before the, 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 United States, elevated loneliness was strongly associated with greater depression and suicidal ideation.^{8, 9} 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.

As mentioned above, Japan was in “mild lockdown” with the declaration of a state of emergency, and the impact attracted attention. On 7 April 2020, the Japanese government declared a state of emergency over the COVID-19 outbreak for seven prefectures.¹⁰ 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 and to temporarily close certain businesses without penalties for violations. 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.¹¹ Thus, these voluntary restrictions on behavior 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 characteristics of psycho-social factors including loneliness, sociodemographic factors, and lifestyle and stress relating to COVID-19 in individuals with social isolation 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 inhabitants 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). These prefectures were assumed to be susceptible to mild lockdown due to their large populations and the large number of COVID-19 cases reported in these areas. The number of people in each prefecture was determined according to the ratio of the number of people living in Tokyo (n = 2,783; 24.6%), Kanagawa (n = 1,863, 16.4%), Osaka (n = 1,794; 15.8%), Saitama (n = 1,484; 13.1%), Chiba (n = 1,263; 11.1%), Hyogo (n = 1,119; 9.9%), and Fukuoka (n = 1,027; 9.1%).

Through Macromill.inc. (Tokyo, Japan), approximately 80,000 people were recruited by e-mail, and data were collected on an online platform. 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.

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.

The data for this study were partly extracted from a database that contained data used in the following papers^{4, 12}:

Yamamoto T, Uchiumi C, Suzuki N, Yoshimoto J, Murillo-Rodriguez E. 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 (in press)

Sugaya N, Yamamoto T, Suzuki N, Uchiumi C. A real-time survey on the psychological impact of mild lockdown for COVID-19 in the Japanese population. *Sci. Data* 2020; 7: 372. doi: 10.1038/s41597-020-00714-9

The extracted data were reanalyzed with different dependent and independent variables compared to those in the abovementioned papers.

Patient and public involvement

No patient involved.

Measurements

Sociodemographic data

Participants' sociodemographic information including age, sex, employment status, marital status, and annual household income was collected. To compare the impact on the group assumed to be vulnerable to the effects of lockdown in previous studies,¹³⁻¹⁶ 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).¹⁷ 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 at ease with that you can talk about private matters?
3. How many relatives do you feel close to such 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 at ease with 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 six-point scale (0 = none; 1 = one; 2 = two, 3 = three or four; 4 = five to eight; 5 = nine or more) for each item.¹⁸ The total score ranges from 0 to 30 points, with higher scores indicating a larger social network and < 12 points indicating social isolation.

Loneliness

We measured loneliness since the declaration of the state of emergency on 7 April 2020 using the Japanese version of the UCLA loneliness scale version 3 (UCLA-LS3).¹⁹ The UCLA-LS3 consists of 10 items, each rated from 1 (never) to 4 (always).²⁰ The scores range from 10 to 40, with higher scores indicating higher levels of loneliness.

Lifestyle, coping behavior, and stressors related to mild lockdown

With extensive references to the literature on the COVID-19 pandemic,^{13, 15, 16, 21, 22} we developed eight lifestyle and coping behavior items, and seven stressors were assumed to be associated with mild lockdown.¹² 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).

Statistical analyses

Data analyses were performed using SPSS 25.0 (IBM Corp, NY, USA). The χ^2 test was applied to compare sociodemographic data by the presence of social isolation (LSNS-6 < 12). Multinomial logistic regression analysis was conducted to examine the effect of sociodemographic characteristics on the presence of social isolation (LSNS-6 < 12 or \geq 12). We used the *t*-test and one-way 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 behavior, and stressors related to COVID-19 by the presence of social isolation.

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 1,707 participants (15.1%) did not provide any data regarding 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 = 1,707).

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). The LSNS < 12 group included 6,337 participants (55.9%). 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 multinomial 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 absence of children. In contrast, the protective factor was being a student.

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” (i.e., 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.

Regarding the results of the ANOVA that exceeded the lower limit of “small effect size” (i.e., $\eta^2 > 0.010$), the results of multiple comparison analysis are shown below.

In the 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 year group and the over 65 year group. The score for item 4 in the 18–39 year 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 comparison by occupational status, the scores of items 1, 2, and 3 in the employed group were significantly lower than those in the home maker and student groups. The scores of those in the unemployed group were significantly lower than those in the employed, home maker, and student groups, and those in the other status group were significantly lower than those in the home maker and student groups. Additionally, the scores of items 2 and 3 in the student group were significantly lower than those in the home maker 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 home maker 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, except that there was no significant difference between the employed and home maker groups.

Regarding the comparison 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 between 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 4.0–5.9 million Yen and 6.0–7.9 million Yen groups, and those in the between 6.0–7.9 million Yen and over 8.0 million Yen groups. The difference of the score of item 4 was significant between all groups except between the under 2.0 million Yen and the 2.0–3.9 million Yen groups, between the 2.0–3.9 million Yen and 4.0–5.9 million groups, and between the 4.0–5.9 million Yen 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 2.0–3.9 million Yen and the 4.0–5.9 million Yen groups, and between the 4.0–5.9 million Yen and the 6.0–7.9 million Yen groups. The difference in the score of item 6 was significant between all groups.

Characteristics of loneliness, lifestyle, coping behavior, and stressors under mild lockdown in individuals with social isolation

Table 6 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 behavior 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,^{1, 5} 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.⁷ The mean scores of the LSNS-6 and UCLA-LS3 in our participants were higher than the previous results of these scores before the COVID-19 pandemic,^{17, 19} suggesting an elevated severity of isolation during the COVID-19 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,¹ the previous study reported the association of female sex and younger age with loneliness.^{1, 23} 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.

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. According to the Labour Force Survey by the Ministry of Internal Affairs and Communications in Japan,²⁴ the unemployment rate (seasonally adjusted value) had remained at a low level (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.

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 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 online²⁵ 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 items, so the characteristics of each LSNS 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 al²³. Online communication has been reported to be beneficial for decreasing loneliness and increasing social contact among older adults in assisted and independent living communities.²⁶ 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 (e.g. Garner et al²⁷) 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.¹ In particular, not only being a parent but also living with a child could affect social isolation and loneliness.

Conclusion

In the present study under mild lockdown, 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 behavior, 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.

Footnotes

Contributors

Conceived and designed the study: TY CU NS (Suzuki). Performed the study: TY NS (Suzuki). Analyzed the data: NS (Sugaya). Wrote the paper, contributed to and approved the final manuscript: NS (Sugaya) TY CU NS (Suzuki).

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Competing Interests

The authors declare that they have no competing interests.

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).

Patient consent for publication

Not applicable.

Data availability statement

All data of the items except each item of the LSNS-6 are available on the Open Science Framework platform.²⁸

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Table 1 Characteristics of participants

	N (%)		
	Total	Male	Female
Overall	11,333(100)	5,391(100)	5,942(100)
Age			
18-39	3,888(34.3)	1,077(20.0)	2,811(47.3)
40-64	6,024(53.2)	3,295(61.1)	2,729(45.9)
≥ 65	1,421(12.5)	1,019(18.9)	402(6.8)
Occupation			
Employed	7,685(67.8)	4,235(78.6)	3,450(58.1)
Homemaker	1,806(15.9)	25(0.5)	1,781(30.0)
Student	407(3.6)	122(2.3)	285(4.8)
Unemployed	1,068(9.4)	808(15.0)	260(4.4)
Other	367(3.2)	201(3.7)	166(2.8)
Annual household income (JPY)			
< 2.0 million	633(5.6)	308(5.7)	325(5.5)
2.0-3.9 million	1,990(17.6)	947(17.6)	1,043(17.6)
4.0-5.9 million	2,214(19.5)	1,150(21.3)	1,064(17.9)
6.0-7.9 million	1,495(13.2)	818(15.2)	677(11.4)
≥ 8.0 million	2,130(18.8)	1,247(23.1)	883(14.9)
Unknown	2,871(25.3)	921(17.1)	1,950(32.8)
Marital status (Married)	7,043(62.1)	3,492(64.8)	3,551(59.8)
The presence of child (Yes)	6,072(53.6)	3,091(57.3)	2,981(50.2)

Table 2 Comparison of sociodemographic data by the presence of social isolation

	N (%) in each LSNS group				Group difference		
	LSNS-6 < 12		LSNS-6 ≥ 12		χ^2	<i>p</i>	Cramer's <i>V</i> (φ)
Overall	6,337	(100)	4,996	(100)			
Sex (Male)	3,335	(52.6)	2,056	(41.2)	147.47	<0.001	0.114
Age					118.12	<0.001	0.102
18-39	1,950	(30.8)	1,938	(38.8)		*	
40-64	3,654	(57.7)	2,370	(47.4)		*	
≥65	733	(11.6)	688	(13.8)		*	
Occupation					161.82	<0.001	0.119
Employed	4,369	(68.9)	3,316	(66.4)		*	
Homemaker	866	(13.7)	940	(18.8)		*	
Student	155	(2.4)	252	(5.0)		*	
Unemployed	713	(11.3)	355	(7.1)		*	
Other	234	(3.7)	133	(2.7)		*	
Annual household income (JPY)					189.48	<0.001	0.150
< 2.0 million	466	(9.7)	167	(4.6)		*	
2.0-3.9 million	1,253	(26.1)	737	(20.1)		*	
4.0-5.9 million	1,278	(26.6)	936	(25.5)			
6.0-7.9 million	788	(16.4)	707	(19.3)		*	
≥ 8.0 million	1,012	(21.1)	1,118	(30.5)		*	
Marital status (Married)	3,606	(56.9)	3,437	(68.8)	167.91	<0.001	0.122
The presence of child (Yes)	3,005	(47.4)	3,067	(61.4)	219.18	<0.001	0.139

Cramer's *V* (or φ): 0.100~ small; 0.300~ medium; 0.600~ large

* Significant group difference found by residual analysis (adjusted residual > 1.96)

LSNS-6: the abbreviated Lubben Social Network Scale

Table 3 Results of multinomial logistic regression analysis between sociodemographic data and social isolation

Predictors	β (SE)	OR [95% CI]	<i>p</i>
Sex			
<i>Female (ref)</i>	0		
<i>Male</i>	0.58 (0.05)	1.78 [1.60-1.98]	<0.001
Age			
<i>18-39 (ref)</i>	0		
<i>40-64</i>	0.55 (0.06)	1.73 [1.55-1.93]	<0.001
<i>≥ 65</i>	-0.08 (0.09)	0.92 [0.77-1.10]	0.369
Occupation			
<i>Other (ref)</i>	0		
<i>Employed</i>	-0.20 (0.15)	0.82 [0.61-1.09]	0.175
<i>Homemaker</i>	-0.04 (0.16)	0.96 [0.70-1.32]	0.823
<i>Student</i>	-0.92 (0.22)	0.40 [0.26-0.62]	<0.001
<i>Unemployed</i>	0.11 (0.16)	1.11 [0.81-1.54]	0.515
Annual household income			
<i>≥ 8.0 million (ref)</i>	0		
<i>< 2.0 million</i>	1.05 (0.11)	2.85 [2.29-3.54]	<0.001
<i>2.0-3.9 million</i>	0.64 (0.07)	1.90 [1.65-2.18]	<0.001
<i>4.0-5.9 million</i>	0.46 (0.06)	1.58 [1.40-1.80]	<0.001
<i>6.0-7.9 million</i>	0.22 (0.07)	1.24 [1.09-1.43]	0.002
Marital status			
<i>Yes (ref)</i>	0		
<i>No</i>	0.17 (0.07)	1.19 [1.04-1.35]	0.010
The presence of child			
<i>Yes (ref)</i>	0		
<i>No</i>	0.59 (0.06)	1.80 [1.60-2.03]	<0.001

Note. $R^2 = 0.08$ (Cox-Snell), 0.10 (Nagelkerke). Model $\chi^2(13) = 685.62$, $p < 0.001$

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

		Mean (SD)				Group difference			
LSNS-6		Male		Female		Difference (95%CI)		<i>p</i>	Cohen's <i>d</i>
Item 1	Relatives: size	1.99	(1.31)	2.18	(1.26)	-0.20	(-0.25, -0.15)	<0.001	0.154
Item 2	Relatives: discuss private matters	1.79	(1.28)	2.11	(1.21)	-0.32	(-0.37, -0.28)	<0.001	0.259
Item 3	Relatives: call for help	1.86	(1.28)	2.20	(1.21)	-0.35	(-0.39, -0.30)	<0.001	0.277
Item 4	Friend: size	1.25	(1.44)	1.42	(1.44)	-0.17	(-0.22, -0.12)	<0.001	0.117
Item 5	Friend: discuss private matters	1.45	(1.42)	1.84	(1.38)	-0.39	(-0.44, -0.34)	<0.001	0.277
Item 6	Friend: call for help	1.32	(1.38)	1.63	(1.38)	-0.31	(-0.36, -0.26)	<0.001	0.224
Total score		9.65	(6.31)	11.38	(5.92)	-1.73	(-1.96, -1.51)	<0.001	0.283
LSNS-6		Married		Not married		Difference (95%CI)		<i>p</i>	Cohen's <i>d</i>
Item 1	Relatives: size	2.33	(1.22)	1.69	(1.30)	-0.64	(-0.69, -0.59)	<0.001	0.508
Item 2	Relatives: discuss private matters	2.19	(1.19)	1.57	(1.26)	-0.62	(-0.66, -0.57)	<0.001	0.503
Item 3	Relatives: call for help	2.25	(1.20)	1.69	(1.28)	-0.57	(-0.61, -0.52)	<0.001	0.457
Item 4	Friend: size	1.36	(1.45)	1.31	(1.43)	-0.06	(-0.11, -0.01)	0.032	0.042
Item 5	Friend: discuss private matters	1.70	(1.39)	1.58	(1.43)	-0.12	(-0.18, -0.07)	<0.001	0.088
Item 6	Friend: call for help	1.52	(1.37)	1.41	(1.41)	-0.12	(-0.17, -0.06)	<0.001	0.084
Total score		11.36	(5.96)	9.24	(6.27)	-2.12	(-2.36, -1.89)	<0.001	0.347
LSNS-6		With child		Without child		Difference (95%CI)		<i>p</i>	Cohen's <i>d</i>
Item 1	Relatives: size	2.45	(1.20)	1.67	(1.26)	-0.78	(-0.82, -0.73)	<0.001	0.632
Item 2	Relatives: discuss private matters	2.24	(1.19)	1.63	(1.24)	-0.61	(-0.65, -0.56)	<0.001	0.499
Item 3	Relatives: call for help	2.28	(1.20)	1.76	(1.26)	-0.53	(-0.57, -0.48)	<0.001	0.427
Item 4	Friend: size	1.42	(1.46)	1.26	(1.42)	-0.16	(-0.22, -0.11)	<0.001	0.113
Item 5	Friend: discuss private matters	1.71	(1.39)	1.59	(1.43)	-0.12	(-0.18, -0.07)	<0.001	0.088
Item 6	Friend: call for help	1.52	(1.37)	1.44	(1.41)	-0.08	(-0.13, -0.03)	0.002	0.057
Total score		11.62	(5.93)	9.34	(6.22)	-2.28	(-2.50, -2.05)	<0.001	0.375

Cohen's *d*: 0.200~ small; 0.500~ medium; 0.800~ large
LSNS-6: the abbreviated Lubben Social Network Scale

Table 5 Comparisons of each item of the LSNS-6 by age group, occupational status, and annual household income

LSNS-6		Mean (SD)						Group difference						
		18-39		40-64		≥65		<i>F</i>	<i>p</i>	η^2				
<i>Item 1</i>	<i>Relative: size</i>	2.15	(1.28)	2.03	(1.29)	2.19	(1.30)	16.53	<0.001	0.003				
<i>Item 2</i>	<i>Relative: discuss private matters</i>	2.02	(1.24)	1.86	(1.25)	2.17	(1.26)	44.32	<0.001	0.008				
<i>Item 3</i>	<i>Relative: call for help</i>	2.16	(1.25)	1.91	(1.25)	2.21	(1.25)	63.07	<0.001	0.011				
<i>Item 4</i>	<i>Friend: size</i>	1.43	(1.46)	1.22	(1.39)	1.64	(1.54)	57.49	<0.001	0.011				
<i>Item 5</i>	<i>Friend: discuss private matters</i>	1.88	(1.43)	1.50	(1.38)	1.70	(1.40)	90.76	<0.001	0.016				
<i>Item 6</i>	<i>Friend: call for help</i>	1.73	(1.44)	1.32	(1.33)	1.48	(1.39)	90.39	<0.001	0.018				
<i>Total score</i>		2.15	(1.28)	2.03	(1.29)	2.19	(1.30)	16.53	<0.001	0.003				
LSNS-6		Employed		Home maker		Student		Unemployed		Other		<i>F</i>	<i>p</i>	η^2
<i>Item 1</i>	<i>Relative: size</i>	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
<i>Item 2</i>	<i>Relative: discuss private matters</i>	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
<i>Item 3</i>	<i>Relative: call for help</i>	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
<i>Item 4</i>	<i>Friend: size</i>	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
<i>Item 5</i>	<i>Friend: discuss private matters</i>	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
<i>Item 6</i>	<i>Friend: call for help</i>	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
<i>Total score</i>		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
LSNS-6		< 2.0 million		2.0-3.9 million		4.0-5.9 million		6.0-7.9 million		≥ 8.0 million		<i>F</i>	<i>p</i>	η^2
<i>Item 1</i>	<i>Relative: size</i>	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
<i>Item 2</i>	<i>Relative: discuss private matters</i>	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
<i>Item 3</i>	<i>Relative: call for help</i>	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

Item 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
Item 5	Friend: 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
Item 6	Friend: 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

η^2 : 0.010~ small; 0.060 medium; 0.140~ large
LSNS-6: the abbreviated Lubben Social Network Scale

Table 6 Comparison of items specific to mild lockdown by the presence of social isolation

	Mean (SD)		Group difference		
	LSNS-6 < 12	LSNS-6 ≥ 12	Difference (95% CI)	<i>p</i>	Cohen's <i>d</i>
UCLA-LS3	25.86 (5.15)	20.42 (4.85)	5.44 (5.26, 5.63)	<0.001	1.088
Lifestyle and coping behavior during mild lockdown					
<i>Exercise</i>	3.83 (1.84)	4.60 (1.68)	-0.77 (-0.83, -0.70)	<0.001	0.435
<i>Healthy eating habits</i>	4.03 (1.59)	4.72 (1.42)	-0.69 (-0.74, -0.63)	<0.001	0.457
<i>Healthy sleep habits</i>	4.40 (1.83)	4.91 (1.70)	-0.51 (-0.58, -0.44)	<0.001	0.289
<i>Activity</i>	3.73 (1.70)	4.39 (1.57)	-0.66 (-0.72, -0.60)	<0.001	0.405
<i>Offline interaction with familiar people</i>	3.17 (1.81)	3.98 (1.86)	-0.81 (-0.88, -0.74)	<0.001	0.440
<i>Online interaction with familiar people</i>	2.74 (1.82)	3.94 (2.02)	-1.20 (-1.28, -1.13)	<0.001	0.626
<i>Preventive behaviors of COVID-19</i>	5.31 (1.81)	5.92 (1.39)	-0.61 (-0.67, -0.55)	<0.001	0.379
<i>Optimism</i>	3.65 (1.57)	4.57 (1.42)	-0.92 (-0.97, -0.86)	<0.001	0.614
Stressors related to mild lockdown					
<i>Deterioration of household economy</i>	3.85 (1.82)	3.73 (1.84)	0.12 (0.05, 0.19)	<0.001	0.065
<i>Deterioration of relationship with familiar people</i>	2.55 (1.58)	2.16 (1.47)	0.39 (0.33, 0.45)	<0.001	0.255
<i>Frustration</i>	3.41 (1.77)	3.18 (1.73)	0.23 (0.16, 0.29)	<0.001	0.131
<i>COVID-19-related anxiety</i>	4.00 (1.72)	4.09 (1.67)	-0.10 (-0.16, -0.03)	0.003	0.057
<i>COVID-19-related sleeplessness</i>	2.49 (1.54)	2.38 (1.53)	0.11 (0.06, 0.17)	<0.001	0.075
<i>Difficulties owing to the lack of daily necessities</i>	3.66 (1.86)	3.59 (1.84)	0.06 (-0.01, 0.13)	0.085	0.033
<i>Difficulties in work or schoolwork</i>	3.73 (2.03)	3.93 (2.07)	-0.20 (-0.27, -0.12)	<0.001	0.097

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Cohen’s *d*: 0.200~ small; 0.500~ medium; 0.800~ large
LSNS-6: the abbreviated Lubben Social Network Scale

For peer review only

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	7
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	6
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	7
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-8
		(b) Report category boundaries when continuous variables were categorized	7-8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Which psycho-social factors are associated with social isolation during the COVID-19 pandemic in the Japanese population?

Journal:	<i>BMJ Open</i>
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Secondary Subject Heading:	Epidemiology, Public health
Keywords:	COVID-19, MENTAL HEALTH, PUBLIC HEALTH

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Which psycho-social factors are associated with social isolation during the COVID-19 pandemic in the Japanese population?

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Abstract

Objective: This study investigated the sociodemographic, behavioral, and psychological characteristics of socially isolated individuals during the “mild lockdown” period of coronavirus disease 2019 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 investigation was performed between May 11 and May 12, 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 (e.g. 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.

Keywords: the coronavirus disease 2019; mild lockdown; social isolation; loneliness

Strengths and Limitations of this study

The survey was conducted in real-time to minimize participants' recall bias.

The investigation dates of this study, 11 and 12 May 2020, were also in the final phase of the state of emergency when the effect of changes in life due to mild lockdown may be amplified.

Psychological questionnaires applied to this survey have been often used worldwide in psychological or psychiatric researches, and our data is comparable with the results in other countries with enforceable lockdowns for COVID-19.

Since we employed a cross-sectional design, we could not compare the results during the mild lockdown with that before the COVID-19 pandemic.

Introduction

The coronavirus disease 2019 (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 not only cause economic damage but also 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 interrelated 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,^{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.^{12,13} 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.¹⁴ Regarding loneliness, a previous study using cross-cohort analyses of data from adults in UK conducted before and during the COVID-19 pandemic¹ 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 United States, elevated loneliness was strongly associated with greater depression and suicidal ideation.^{15,16} 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.¹⁷ 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 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. 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.¹⁸ Additionally, our epidemiological survey in the Japanese population under mild lockdown¹⁹ 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 behavior 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, behavioral, 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 = 2,783; 24.6%), Kanagawa (n = 1,863, 16.4%), Osaka (n = 1,794; 15.8%), Saitama (n = 1,484; 13.1%), Chiba (n = 1,263; 11.1%), Hyogo (n = 1,119; 9.9%), and Fukuoka (n = 1,027; 9.1%).

Through Macromill,inc. (Tokyo, Japan), a global marketing research company, approximately 80,000 registered people were recruited by e-mail, 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 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, Inc., and participants can exchange these points for prizes or cash.

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.

The data for this study were partly extracted from a database that contained data used in our published papers.^{19,20} The extracted data were secondarily reanalyzed with different dependent and independent variables compared to those in the abovementioned 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).²¹ To compare the impact on the group assumed to be vulnerable to the effects of lockdown in previous studies,^{22–25} 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).²⁶ The LSNS-6 is a shortened version of the Lubben Social Network Scale²⁷ 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 at ease with that you can talk about private matters?
3. How many relatives do you feel close to such 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 at ease with 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 six-point scale (0 = none; 1 = one; 2 = two, 3 = three or four; 4 = five to eight; 5 = nine or more) for each item.²⁸ The total score ranges from 0 to 30 points, with higher scores indicating a larger social network and < 12 points indicating social isolation.

Loneliness

We measured loneliness since the declaration of the state of emergency on 7 April 2020 using the Japanese version of the UCLA loneliness scale version 3 (UCLA-LS3).²⁹ The UCLA-LS3 consists of 10 items, each rated from 1 (never) to 4 (always).³⁰ The scores range from 10 to 40, with higher scores indicating higher levels of loneliness.

Lifestyle, coping behavior, and stressors related to mild lockdown

With extensive references to the literature on the COVID-19 pandemic,^{22,24,25,31,32} we developed eight lifestyle and coping behavior items, and seven stressors were assumed to be associated with mild lockdown.²⁰ 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.²⁰

Statistical analyses

Data analyses were performed using SPSS 25.0 (IBM Corp, NY, USA). The χ^2 test was applied to compare sociodemographic data by the presence of social isolation (LSNS-6 < 12). Multinomial logistic regression analysis was conducted to examine the effect of sociodemographic characteristics on the presence of social isolation (LSNS-6 < 12 or \geq 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 behavior, and stressors related to COVID-19 by the presence of social isolation. The power analysis was performed using G*power 3.1.9.4 (<https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower.html>) to confirm if the sample size of the present study was appropriate.³³

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 1,707 participants (15.1%) answered that they did not know 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 = 1,707).

The average statistical powers of the χ^2 test (effect size (w) = 0.223–0.289, α = 0.05, number of groups = 2–5), *t* test (effect size (d) = 0.042–1.088, α = 0.05, number of

groups = 2), and one-way ANOVA (effect size (f) = 0.054–0.211, α = 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). The LSNS < 12 group included 6,337 participants (55.9%). 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 multinomial 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 absence of children. In contrast, the protective factor was being a student.

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” (i.e., 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.

Regarding the results of the ANOVA that exceeded the lower limit of “small effect size” (i.e., η^2 > 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 year group and the over 65 year group. The score for item 4 in the 18–39 year 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 home maker and student groups. The scores of those in the unemployed group were significantly lower than

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those in the employed, home maker, and student groups, and those in the other status group were significantly lower than those in the home maker and student groups. Additionally, the scores of items 2 and 3 in the student group were significantly lower than those in the home maker 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 home maker 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, except that there was no significant difference between the employed and home maker 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 between 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 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.

Characteristics of loneliness, lifestyle, coping behavior, and stressors under mild lockdown in individuals with social isolation

Table 6 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 behavior 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,^{1,4} 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.⁷ The mean scores of the LSNS-6 and UCLA-LS3 in our participants were higher than the previous results of these scores before the COVID-19 pandemic,^{26,29} suggesting an elevated severity of isolation during the COVID-19 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.^{37,38} 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 neighborhood and access to social resources.^{39,40} Links have been established between low income, greater isolation, and a lower sense of belonging, which also affect the perceptions and experiences of stigmatization and isolation for those who live on a low income,⁴¹ and the effect of social resources and different norms on economic outcomes.⁴² 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

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brought about. According to the Labour Force Survey by the Ministry of Internal Affairs and Communications in Japan,⁴³ the unemployment rate (seasonally adjusted value) had remained at a low level (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 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 old) 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 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 online⁴⁴ 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 items, so the characteristics of each LSNS 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.³⁴ Online communication has been reported to be beneficial for decreasing loneliness and increasing social contact among older adults in assisted and independent living communities.⁴⁵ 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 (e.g. Garner et al⁴⁶) 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.¹ In particular, not only being a parent but also 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 (e.g., 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.

Conclusion

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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 behavior, 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.

Footnotes

Contributors

Conceived and designed the study: TY CU NS (Suzuki). Performed the study: TY NS (Suzuki). Analyzed the data: NS (Sugaya). Wrote the paper, contributed to and approved the final manuscript: NS (Sugaya) TY CU NS (Suzuki).

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Competing Interests

The authors declare that they have no competing interests.

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).

Patient consent for publication

Not applicable.

Data availability statement

All data of the items except each item of the LSNS-6 are available on the Open Science Framework platform.

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1 Table 1 Characteristics of participants

	N (%)		
	Total	Male	Female
Overall	11,333(100)	5,391(100)	5,942(100)
Age			
18-39	3,888(34.3)	1,077(20.0)	2,811(47.3)
40-64	6,024(53.2)	3,295(61.1)	2,729(45.9)
≥ 65	1,421(12.5)	1,019(18.9)	402(6.8)
Occupation			
Employed	7,685(67.8)	4,235(78.6)	3,450(58.1)
Homemaker	1,806(15.9)	25(0.5)	1,781(30.0)
Student	407(3.6)	122(2.3)	285(4.8)
Unemployed	1,068(9.4)	808(15.0)	260(4.4)
Other	367(3.2)	201(3.7)	166(2.8)
Annual household income (JPY)			
< 2.0 million	633(5.6)	308(5.7)	325(5.5)
2.0-3.9 million	1,990(17.6)	947(17.6)	1,043(17.6)
4.0-5.9 million	2,214(19.5)	1,150(21.3)	1,064(17.9)
6.0-7.9 million	1,495(13.2)	818(15.2)	677(11.4)
≥ 8.0 million	2,130(18.8)	1,247(23.1)	883(14.9)
Unknown	2,871(25.3)	921(17.1)	1,950(32.8)
Marital status (Married)	7,043(62.1)	3,492(64.8)	3,551(59.8)
The presence of child (Yes)	6,072(53.6)	3,091(57.3)	2,981(50.2)

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2 Table 2 Comparison of sociodemographic data by the presence of social isolation

	N (%) in each LSNS group				Group difference		
	LSNS<12		LSNS≥12		χ^2	<i>p</i>	Cramer's <i>V</i> or ϕ
Overall	6337	(55.9)	4996	(44.1)			
Sex					147.47	<0.001	0.114
<i>Male</i>	3335	(61.9)	2056	(38.1)			
<i>Female</i>	3002	(50.5)	2940	(49.5)			
Age					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
<i>Employed</i>	4369	(56.9)	3316	(43.1)		*	
<i>Homemaker</i>	866	(48.0)	940	(52.0)		*	
<i>Student</i>	155	(38.1)	252	(61.9)		*	
<i>Unemployed</i>	713	(66.8)	355	(33.2)		*	
<i>Other</i>	234	(63.8)	133	(36.2)		*	
Marital status					167.91	<0.001	0.122
<i>Married</i>	3606	(51.2)	3437	(48.8)			
<i>Unmarried</i>	2731	(63.7)	1559	(36.3)			
The presence of child					219.18	<0.001	0.139
<i>Yes</i>	3005	(49.5)	3067	(50.5)			
<i>No</i>	3332	(63.3)	1929	(36.7)			
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	0.022
<i>Yes</i>	294	(61.0)	188	(39.0)			
<i>No</i>	6043	(55.7)	4808	(44.3)			
Treatment of severe previous physical diseases					1.35	0.246	0.011
<i>Yes</i>	492	(57.8)	359	(42.2)			
<i>No</i>	5845	(55.8)	4637	(44.2)			

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6	Treatment of current psychological problems				53.83	<0.001		0.069
7	Yes	448	(69.8)	194	(30.2)			
8	No	5889	(55.1)	4802	(44.9)			
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10	Treatment of previous psychological problems				62.63	<0.001		0.074
11	Yes	900	(65.9)	466	(34.1)			
12	No	5437	(54.6)	4530	(45.4)			
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16 2 Cramer’s V (or ϕ): 0.100~ small; 0.300~ medium; 0.600~ large

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18 3 * Significant group difference found by residual analysis (absolute value of adjusted

19 4 residual ≥ 1.96)

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21 5 LSNS-6: the abbreviated Lubben Social Network Scale

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Table 3 Results of multinomial logistic regression analysis between sociodemographic data and social isolation

Predictors	β (SE)	OR [95% CI]	<i>p</i>
Sex			
<i>Female (ref)</i>	0		
<i>Male</i>	0.58 (0.05)	1.78 [1.60-1.98]	<0.001
Age			
<i>18-39 (ref)</i>	0		
<i>40-64</i>	0.55 (0.06)	1.73 [1.55-1.93]	<0.001
<i>≥ 65</i>	-0.08 (0.09)	0.92 [0.77-1.10]	0.369
Occupation			
<i>Other (ref)</i>	0		
<i>Employed</i>	-0.20 (0.15)	0.82 [0.61-1.09]	0.175
<i>Homemaker</i>	-0.04 (0.16)	0.96 [0.70-1.32]	0.823
<i>Student</i>	-0.92 (0.22)	0.40 [0.26-0.62]	<0.001
<i>Unemployed</i>	0.11 (0.16)	1.11 [0.81-1.54]	0.515
Annual household income			
<i>≥ 8.0 million (ref)</i>	0		
<i>< 2.0 million</i>	1.05 (0.11)	2.85 [2.29-3.54]	<0.001
<i>2.0-3.9 million</i>	0.64 (0.07)	1.90 [1.65-2.18]	<0.001
<i>4.0-5.9 million</i>	0.46 (0.06)	1.58 [1.40-1.80]	<0.001
<i>6.0-7.9 million</i>	0.22 (0.07)	1.24 [1.09-1.43]	0.002
Marital status			
<i>Yes (ref)</i>	0		
<i>No</i>	0.17 (0.07)	1.19 [1.04-1.35]	0.010
The presence of child			
<i>Yes (ref)</i>	0		
<i>No</i>	0.59 (0.06)	1.80 [1.60-2.03]	<0.001

Note. $R^2 = 0.08$ (Cox-Snell), 0.10 (Nagelkerke). Model $\chi^2(13) = 685.62$, $p < 0.001$

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

LSNS-6	Mean (SD)		Group difference		
	Male	Female	Difference (95%CI)	p	Cohen's d
Item 1 Relatives: size	1.99 (1.31)	2.18 (1.26)	-0.20 (-0.25, -0.15)	<0.001	0.154
Item 2 Relatives: discuss private matters	1.79 (1.28)	2.11 (1.21)	-0.32 (-0.37, -0.28)	<0.001	0.259
Item 3 Relatives: call for help	1.86 (1.28)	2.20 (1.21)	-0.35 (-0.39, -0.30)	<0.001	0.277
Item 4 Friend: size	1.25 (1.44)	1.42 (1.44)	-0.17 (-0.22, -0.12)	<0.001	0.117
Item 5 Friend: discuss private matters	1.45 (1.42)	1.84 (1.38)	-0.39 (-0.44, -0.34)	<0.001	0.277
Item 6 Friend: call for help	1.32 (1.38)	1.63 (1.38)	-0.31 (-0.36, -0.26)	<0.001	0.224
Total score	9.65 (6.31)	11.38 (5.92)	-1.73 (-1.96, -1.51)	<0.001	0.283
LSNS-6	Married	Not married	Difference (95%CI)	p	Cohen's d
Item 1 Relatives: size	2.33 (1.22)	1.69 (1.30)	-0.64 (-0.69, -0.59)	<0.001	0.508
Item 2 Relatives: discuss private matters	2.19 (1.19)	1.57 (1.26)	-0.62 (-0.66, -0.57)	<0.001	0.503
Item 3 Relatives: call for help	2.25 (1.20)	1.69 (1.28)	-0.57 (-0.61, -0.52)	<0.001	0.457
Item 4 Friend: size	1.36 (1.45)	1.31 (1.43)	-0.06 (-0.11, -0.01)	0.032	0.042
Item 5 Friend: discuss private matters	1.70 (1.39)	1.58 (1.43)	-0.12 (-0.18, -0.07)	<0.001	0.088
Item 6 Friend: call for help	1.52 (1.37)	1.41 (1.41)	-0.12 (-0.17, -0.06)	<0.001	0.084
Total score	11.36 (5.96)	9.24 (6.27)	-2.12 (-2.36, -1.89)	<0.001	0.347
LSNS-6	With child	Without child	Difference (95%CI)	p	Cohen's d
Item 1 Relatives: size	2.45 (1.20)	1.67 (1.26)	-0.78 (-0.82, -0.73)	<0.001	0.632
Item 2 Relatives: discuss private matters	2.24 (1.19)	1.63 (1.24)	-0.61 (-0.65, -0.56)	<0.001	0.499
Item 3 Relatives: call for help	2.28 (1.20)	1.76 (1.26)	-0.53 (-0.57, -0.48)	<0.001	0.427
Item 4 Friend: size	1.42 (1.46)	1.26 (1.42)	-0.16 (-0.22, -0.11)	<0.001	0.113
Item 5 Friend: discuss private matters	1.71 (1.39)	1.59 (1.43)	-0.12 (-0.18, -0.07)	<0.001	0.088
Item 6 Friend: call for help	1.52 (1.37)	1.44 (1.41)	-0.08 (-0.13, -0.03)	0.002	0.057
Total score	11.62 (5.93)	9.34 (6.22)	-2.28 (-2.50, -2.05)	<0.001	0.375

4 Cohen's d: 0.200~ small; 0.500~ medium; 0.800~ large
5 LSNS-6: the abbreviated Lubben Social Network Scale

Table 5 Comparisons of each item of the LSNS-6 by age group, occupational status, and annual household income

LSNS-6		Mean (SD)						Group difference						
		18-39		40-64		≥65		<i>F</i>	<i>p</i>	η^2				
<i>Item 1</i>	<i>Relative: size</i>	2.15	(1.28)	2.03	(1.29)	2.19	(1.30)	16.53	<0.001	0.003				
<i>Item 2</i>	<i>Relative: discuss private matters</i>	2.02	(1.24)	1.86	(1.25)	2.17	(1.26)	44.32	<0.001	0.008				
<i>Item 3</i>	<i>Relative: call for help</i>	2.16	(1.25)	1.91	(1.25)	2.21	(1.25)	63.07	<0.001	0.011				
<i>Item 4</i>	<i>Friend: size</i>	1.43	(1.46)	1.22	(1.39)	1.64	(1.54)	57.49	<0.001	0.011				
<i>Item 5</i>	<i>Friend: discuss private matters</i>	1.88	(1.43)	1.50	(1.38)	1.70	(1.40)	90.76	<0.001	0.016				
<i>Item 6</i>	<i>Friend: call for help</i>	1.73	(1.44)	1.32	(1.33)	1.48	(1.39)	90.39	<0.001	0.018				
<i>Total score</i>		2.15	(1.28)	2.03	(1.29)	2.19	(1.30)	16.53	<0.001	0.003				
LSNS-6		Employed		Home maker		Student		Unemployed		Other		<i>F</i>	<i>p</i>	η^2
<i>Item 1</i>	<i>Relative: size</i>	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
<i>Item 2</i>	<i>Relative: discuss private matters</i>	1.89	(1.25)	2.36	(1.15)	2.10	(1.21)	1.75	(1.30)	1.77	(1.30)	70.39	<0.001	0.022
<i>Item 3</i>	<i>Relative: call for help</i>	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
<i>Item 4</i>	<i>Friend: size</i>	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
<i>Item 5</i>	<i>Friend: discuss private matters</i>	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
<i>Item 6</i>	<i>Friend: call for help</i>	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
<i>Total score</i>		10.40	(6.16)	11.77	(5.82)	13.19	(5.90)	8.99	(6.23)	9.53	(6.13)	58.08	<0.001	0.020
LSNS-6		< 2.0 million		2.0-3.9 million		4.0-5.9 million		6.0-7.9 million		≥ 8.0 million		<i>F</i>	<i>p</i>	η^2
<i>Item 1</i>	<i>Relative: size</i>	1.41	(1.32)	1.82	(1.32)	2.08	(1.27)	2.23	(1.24)	2.33	(1.22)	92.18	<0.001	0.043
<i>Item 2</i>	<i>Relative: discuss private matters</i>	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
<i>Item 3</i>	<i>Relative: call for help</i>	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
<i>Item 4</i>	<i>Friend: size</i>	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

Item 5	Friend: 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
Item 6	Friend: 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)	11.80	(6.20)	74.70	<0.001	0.036

η^2 : 0.010~ small; 0.060 medium; 0.140~ large
LSNS-6: the abbreviated Lubben Social Network Scale

Table 6 Comparison of items specific to mild lockdown by the presence of social isolation

	Mean (SD)		Group difference		
	LSNS-6 < 12	LSNS-6 ≥ 12	Difference (95% CI)	<i>p</i>	Cohen's <i>d</i>
UCLA-LS3	25.86 (5.15)	20.42 (4.85)	5.44 (5.26, 5.63)	<0.001	1.088
Lifestyle and coping behavior during mild lockdown					
<i>Exercise</i>	3.83 (1.84)	4.60 (1.68)	-0.77 (-0.83, -0.70)	<0.001	0.435
<i>Healthy eating habits</i>	4.03 (1.59)	4.72 (1.42)	-0.69 (-0.74, -0.63)	<0.001	0.457
<i>Healthy sleep habits</i>	4.40 (1.83)	4.91 (1.70)	-0.51 (-0.58, -0.44)	<0.001	0.289
<i>Activity</i>	3.73 (1.70)	4.39 (1.57)	-0.66 (-0.72, -0.60)	<0.001	0.405
<i>Offline interaction with familiar people</i>	3.17 (1.81)	3.98 (1.86)	-0.81 (-0.88, -0.74)	<0.001	0.440
<i>Online interaction with familiar people</i>	2.74 (1.82)	3.94 (2.02)	-1.20 (-1.28, -1.13)	<0.001	0.626
<i>Preventive behaviors of COVID-19</i>	5.31 (1.81)	5.92 (1.39)	-0.61 (-0.67, -0.55)	<0.001	0.379
<i>Optimism</i>	3.65 (1.57)	4.57 (1.42)	-0.92 (-0.97, -0.86)	<0.001	0.614
Stressors related to mild lockdown					
<i>Deterioration of household economy</i>	3.85 (1.82)	3.73 (1.84)	0.12 (0.05, 0.19)	<0.001	0.065
<i>Deterioration of relationship with familiar people</i>	2.55 (1.58)	2.16 (1.47)	0.39 (0.33, 0.45)	<0.001	0.255
<i>Frustration</i>	3.41 (1.77)	3.18 (1.73)	0.23 (0.16, 0.29)	<0.001	0.131
<i>COVID-19-related anxiety</i>	4.00 (1.72)	4.09 (1.67)	-0.10 (-0.16, -0.03)	0.003	0.057
<i>COVID-19-related sleeplessness</i>	2.49 (1.54)	2.38 (1.53)	0.11 (0.06, 0.17)	<0.001	0.075
<i>Difficulties owing to the lack of daily necessities</i>	3.66 (1.86)	3.59 (1.84)	0.06 (-0.01, 0.13)	0.085	0.033
<i>Difficulties in work or schoolwork</i>	3.73 (2.03)	3.93 (2.07)	-0.20 (-0.27, -0.12)	<0.001	0.097

Cohen’s *d*: 0.200~ small; 0.500~ medium; 0.800~ large
LSNS-6: the abbreviated Lubben Social Network Scale

For peer review only

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	7
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	6
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	7
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-8
		(b) Report category boundaries when continuous variables were categorized	7-8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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

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

3
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Abstract

Objective: This study investigated the sociodemographic, behavioral, and psychological characteristics of socially isolated individuals during the “mild lockdown” period of coronavirus disease 2019 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 May 11 and May 12, 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 (e.g. 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.

Keywords: the coronavirus disease 2019; mild lockdown; social isolation; loneliness

Strengths and Limitations of this study

The survey was conducted in real-time to minimize participants' recall bias.

The investigation dates of this study, 11 and 12 May 2020, were also in the final phase of the state of emergency when the effect of changes in life due to mild lockdown may be amplified.

Psychological questionnaires applied to this survey have been often used worldwide in psychological or psychiatric researches, and our data is comparable with the results in other countries with enforceable lockdowns for COVID-19.

Since we employed a cross-sectional design, we could not compare the results during the mild lockdown with that before the COVID-19 pandemic.

Introduction

The coronavirus disease 2019 (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 not only cause economic damage but also 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 interrelated 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,^{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.^{12,13} 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.¹⁴ Regarding loneliness, a previous study using cross-cohort analyses of data from adults in UK conducted before and during the COVID-19 pandemic¹ 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 United States, elevated loneliness was strongly associated with greater depression and suicidal ideation.^{15,16} 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.¹⁷ 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.¹⁸ Additionally, our epidemiological survey in the Japanese population under mild lockdown¹⁹ 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 behavior 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, behavioral, 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 = 2,783; 24.6%), Kanagawa (n = 1,863, 16.4%), Osaka (n = 1,794; 15.8%), Saitama (n = 1,484; 13.1%), Chiba (n = 1,263; 11.1%), Hyogo (n = 1,119; 9.9%), and Fukuoka (n = 1,027; 9.1%).

Through Macromill.inc. (Tokyo, Japan), a global marketing research company, approximately 80,000 registered people were recruited by e-mail, 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, Inc. (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, Inc., and participants can exchange these points for prizes or cash.

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.

The data for this study were partly extracted from a database that contained data used in our published papers.^{19,20} The extracted data were secondarily reanalyzed with different dependent and independent variables compared to those in the abovementioned 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).²¹ To compare the impact on the group assumed to be vulnerable to the effects of lockdown in previous studies,^{22–25} 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).²⁶ The LSNS-6 is a shortened version of the Lubben Social Network Scale²⁷ 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 at ease with that you can talk about private matters?
3. How many relatives do you feel close to such 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 at ease with 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 six-point scale (0 = none; 1 = one; 2 = two, 3 = three or four; 4 = five to eight; 5 = nine or more) for each item.²⁸ The total score ranges from 0 to 30 points, with higher scores indicating a larger social network and < 12 points indicating social isolation.

Loneliness

We measured loneliness since the declaration of the state of emergency on 7 April 2020 using the Japanese version of the UCLA loneliness scale version 3 (UCLA-LS3).²⁹ The UCLA-LS3 consists of 10 items, each rated from 1 (never) to 4 (always).³⁰ The scores range from 10 to 40, with higher scores indicating higher levels of loneliness.

Lifestyle, coping behavior, and stressors related to mild lockdown

With extensive references to the literature on the COVID-19 pandemic,^{22,24,25,31,32} we developed eight lifestyle and coping behavior items, and seven stressors were assumed to be associated with mild lockdown.²⁰ 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.²⁰

Statistical analyses

Data analyses were performed using SPSS 25.0 (IBM Corp, NY, USA). The χ^2 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 \geq 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 behavior, and stressors related to COVID-19 by the presence of social isolation. The power analysis was performed using G*power 3.1.9.4 (<https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower.html>) to confirm if the sample size of the present study was appropriate.³³

Results

Descriptive results

A total of 11,333 individuals participated in our study (52.4% women, mean age = 46.3 \pm 14.6 years, range = 18–89 years). In our dataset, although 1,161 participants (10.2%) answered that they did not know their annual household income and 1,707 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 ($N = 1,707$).

The average statistical powers of the χ^2 test (effect size (w) = 0.223–0.289, $\alpha = 0.05$, number of groups = 2–5), t test (effect size (d) = 0.042–1.088, $\alpha = 0.05$, number of groups = 2), and one-way ANOVA (effect size (f) = 0.054–0.211, $\alpha = 0.05$, 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). The LSNS < 12 group included 6,337 participants (55.9%). 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 absence of children. In contrast, the protective factor was being a student.

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” (i.e., 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.

Regarding the results of the ANOVA that exceeded the lower limit of “small effect size” (i.e., $\eta^2 > 0.010$), 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 year group

1 and the over 65 year group. The score for item 4 in the 18-39 year 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.

2 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 home maker and student groups. The scores of those in the unemployed group were significantly lower than those in the employed, home maker, and student groups, and those in the other status group were significantly lower than those in the home maker and student groups. Additionally, the scores of items 2 and 3 in the student group were significantly lower than those in the home maker 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 home maker 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, except that there was no significant difference between the employed and home maker groups.

3 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 between 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 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.

4 **Characteristics of loneliness, lifestyle, coping behavior, and stressors under mild lockdown in individuals with social isolation**

5 Table 6 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 behavior 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,^{1, 4} 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.⁷ The mean scores of the LSNS-6 and UCLA-LS3 in our participants were higher than the previous results of these scores before the COVID-19 pandemic,^{26,29} suggesting an elevated severity of isolation during the COVID-19 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.^{37,38} 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 neighborhood and access to social resources.^{39,40} Links have been established between low income, greater isolation, and a lower sense of belonging,

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1 which also affect the perceptions and experiences of stigmatization and isolation for
2 those who live on a low income,⁴¹ and the effect of social resources and different norms
3 on economic outcomes.⁴² While these factors may have contributed to the severity of
4 social isolation in this study, the social isolation of people in the unprecedented
5 situation of the COVID-19 pandemic is clearly worse than that before the pandemic,
6 and therefore, it is necessary to consider the social situation that the pandemic actually
7 brought about. According to the Labour Force Survey by the Ministry of Internal
8 Affairs and Communications in Japan,⁴³ the unemployment rate (seasonally adjusted
9 value) had remained at a low level (low 2%) from 2018 to February 2020, but the
10 unemployment rate (seasonally adjusted value) in May 2020 had worsened to 2.9%.
11 Additionally, the number of active jobs (seasonally adjusted value) in May 2020
12 decreased by 8.6% month-over-month. On the other hand, “Deterioration of household
13 economy”, one of items specific to mild lockdown, was not found to be related to social
14 isolation. It is possible that people fear financial struggle in the future even more as a
15 result of unemployment or pay cuts, in the face of actual social conditions related to
16 unemployment. Thus, these social conditions may preoccupy people, and may have
17 worsened their mental health even if they were not actually laid off. We speculate that
18 such preoccupation and poor mental health may have reduced their interaction with
19 others. In addition, as shown in Table 2, many participants in these two categories
20 belonged to the LSNS low score group, but there was no significant association in the
21 logistic regression analysis. This may be due to the fact that middle age (many
22 employed people were between 39 and 64 years old) and low household income (many
23 unemployed people in the low-income group) are related to social isolation.

24 We compared each item of the LSNS-6 by sociodemographic characteristics.
25 In terms of gender differences in social isolation, men were more likely to have fewer
26 people to talk to about their personal problems and seek help, rather than just the
27 number of relatives and friends they met and talked to. Those who were unmarried and
28 without children scored lower on the three items related to “relatives” in the LSNS-6
29 than those who were married and/or had children. However, there was no significant
30 difference in the social network related to “friends. It is not surprising that there are
31 differences in items affected by the number of people in the household between those
32 who are married/with children versus those who are single/without children, and it is
33 difficult to say that this finding is the result of the mild lockdown. However, as noted
34 above, this feature in these groups may have been more severe under mild lockdown
35 because the number of people who actually met the criteria for social isolation in the
36 LSNS was significantly higher than in previous studies. In the present study, the

1 middle-aged group (40-64 years) had a lower social network of friendships. One
2 possible reason for this result is that the middle-aged group includes a large number of
3 people who work in offices, and it is possible that working remotely has reduced their
4 interaction with their colleagues. Regarding occupational status, except for the number
5 of friends that they could meet and talk to, the social network of the students was
6 enhanced. Younger people are more likely to interact online⁴⁴ and are able to maintain
7 communication with many people to some extent even when they cannot meet in
8 person. In terms of annual household income, the lower the income, the lower the social
9 network was for all LSNS items, so the characteristics of each LSNS item were not
10 clear.

11 Regarding items specific to mild lockdown, the LSNS-6 < 12 group showed
12 decreased "Online interaction with familiar people" and "Optimism". These results are
13 consistent with previous results indicating the association between loneliness and lower
14 contact with relatives or lower positive emotions by Losada-Baltar et al.³⁴ Online
15 communication has been reported to be beneficial for decreasing loneliness and
16 increasing social contact among older adults in assisted and independent living
17 communities.⁴⁵ Additionally, the association between social isolation and being able to
18 think positively about the future even under mild lockdown is consistent with the results
19 of previous studies (e.g. Garner et al⁴⁶) that have shown an association between social
20 support and optimism.

21 This study had several limitations. First, since we employed a cross-sectional
22 design, we could not compare the results during the mild lockdown with that before the
23 COVID-19 pandemic. However, social isolation and loneliness in our participants
24 prominently increased compared with previous results before the pandemic, and were
25 correlated with items relating to COVID-19 and mild lockdown. Thus, the effect of mild
26 lockdown was considered to be indicated in the present study. Second, although we
27 asked about marital status and the presence of a child, we did not investigate the number
28 of family members living together. Living alone was previously reported to be one of
29 the risk factors for loneliness.¹ In particular, not only being a parent but also living with
30 a child could affect social isolation and loneliness. Third, we did not assess the quality
31 of relationships with relatives and friends. Even if the network size is small, mental
32 health may be good if the quality of the relationships is sufficient. Fourth, we did not
33 exclude people who did not stay in mild lockdown for any reason (e.g., work) and
34 people who were affected by COVID-19, and we could not adjust for their effect on the
35 results of the present study. In the future, it would be useful to investigate whether the
36 participants were in an environment affected by mild lockdown or COVID-19. Fifth, we

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1 collected the data for this study through an online survey and were not able to conduct
2 random sampling, so we cannot guarantee the representativeness of the sample; the
3 sample we collected could not be matched to the proportions of each age group and
4 gender group in each region.

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Conclusion

9 We explored in detail the factors that contribute to social isolation, which were
10 exacerbated during a mild lockdown in the unprecedented global crisis of the COVID-
11 19 pandemic. In the present study, male sex, middle-age, and lower income predicted
12 social isolation; student as an occupational status was the protective factor of social
13 isolation. In the comparisons of each item of the LSNS-6 by sociodemographic
14 characteristics, men were more likely to have fewer people to talk to about their
15 personal problems and seek help from, and the middle-aged group had a lower social
16 network of friendships. Additionally, regarding lifestyle, coping behavior, and stressors
17 specific to mild lockdown, social isolation was associated with decreased online
18 interaction with familiar people and decreased optimism. In this study, we identified the
19 sociodemographic and psychological characteristics associated with social isolation.
20 These results are expected to be a useful resource for identifying social networks of
21 people who may need intervention in order to improve their mental health under the
22 pandemic.

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Footnotes

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Contributors

29 Conceived and designed the study: TY CU NS (Suzuki). Performed the study: TY
30 NS (Suzuki). Analyzed the data: NS (Sugaya). Wrote the paper, contributed to and
31 approved the final manuscript: NS (Sugaya) TY CU NS (Suzuki).

32
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Competing Interests

The authors declare that they have no competing interests.

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).

Patient consent for publication

Not applicable.

Data availability statement

All data of the items except each item of the LSNS-6 are available on the Open Science Framework platform.

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1 Table 1 Characteristics of participants

	N (%)		
	Total	Male	Female
Overall	11,333(100)	5,391(100)	5,942(100)
Age			
18-39	3,888(34.3)	1,077(20.0)	2,811(47.3)
40-64	6,024(53.2)	3,295(61.1)	2,729(45.9)
≥ 65	1,421(12.5)	1,019(18.9)	402(6.8)
Occupation			
Employed	7,685(67.8)	4,235(78.6)	3,450(58.1)
Homemaker	1,806(15.9)	25(0.5)	1,781(30.0)
Student	407(3.6)	122(2.3)	285(4.8)
Unemployed	1,068(9.4)	808(15.0)	260(4.4)
Other	367(3.2)	201(3.7)	166(2.8)
Annual household income (JPY)			
< 2.0 million	633(5.6)	308(5.7)	325(5.5)
2.0-3.9 million	1,990(17.6)	947(17.6)	1,043(17.6)
4.0-5.9 million	2,214(19.5)	1,150(21.3)	1,064(17.9)
6.0-7.9 million	1,495(13.2)	818(15.2)	677(11.4)
≥ 8.0 million	2,130(18.8)	1,247(23.1)	883(14.9)
Unknown	2,871(25.3)	921(17.1)	1,950(32.8)
Marital status (Married)	7,043(62.1)	3,492(64.8)	3,551(59.8)
The presence of child (Yes)	6,072(53.6)	3,091(57.3)	2,981(50.2)

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2 Table 2 Comparison of sociodemographic data by the presence of social isolation

	N (%) in each LSNS group				Group difference		
	LSNS<12		LSNS≥12		χ^2	<i>p</i>	Cramer's <i>V</i> or ϕ
Overall	6337	(55.9)	4996	(44.1)			
Sex					147.47	<0.001	0.114
<i>Male</i>	3335	(61.9)	2056	(38.1)			
<i>Female</i>	3002	(50.5)	2940	(49.5)			
Age					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
<i>Employed</i>	4369	(56.9)	3316	(43.1)		*	
<i>Homemaker</i>	866	(48.0)	940	(52.0)		*	
<i>Student</i>	155	(38.1)	252	(61.9)		*	
<i>Unemployed</i>	713	(66.8)	355	(33.2)		*	
<i>Other</i>	234	(63.8)	133	(36.2)		*	
Marital status					167.91	<0.001	0.122
<i>Married</i>	3606	(51.2)	3437	(48.8)			
<i>Unmarried</i>	2731	(63.7)	1559	(36.3)			
The presence of child					219.18	<0.001	0.139
<i>Yes</i>	3005	(49.5)	3067	(50.5)			
<i>No</i>	3332	(63.3)	1929	(36.7)			
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	0.022
<i>Yes</i>	294	(61.0)	188	(39.0)			
<i>No</i>	6043	(55.7)	4808	(44.3)			
Treatment of severe previous physical diseases					1.35	0.246	0.011
<i>Yes</i>	492	(57.8)	359	(42.2)			
<i>No</i>	5845	(55.8)	4637	(44.2)			

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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)		

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- 2 Cramer’s V (or ϕ): 0.100~ small; 0.300~ medium; 0.600~ large
- 3 * Significant group difference found by residual analysis (absolute value of adjusted
- 4 residual ≥ 1.96)
- 5 LSNS-6: the abbreviated Lubben Social Network Scale
- 6

Table 3 Results of binomial logistic regression analysis between sociodemographic data and social isolation

Predictors	β (SE)	OR [95% CI]	<i>p</i>
Sex			
<i>Female (ref)</i>	0		
<i>Male</i>	0.58 (0.05)	1.78 [1.60-1.98]	<0.001
Age			
<i>18-39 (ref)</i>	0		
<i>40-64</i>	0.55 (0.06)	1.73 [1.55-1.93]	<0.001
<i>≥ 65</i>	-0.08 (0.09)	0.92 [0.77-1.10]	0.369
Occupation			
<i>Other (ref)</i>	0		
<i>Employed</i>	-0.20 (0.15)	0.82 [0.61-1.09]	0.175
<i>Homemaker</i>	-0.04 (0.16)	0.96 [0.70-1.32]	0.823
<i>Student</i>	-0.92 (0.22)	0.40 [0.26-0.62]	<0.001
<i>Unemployed</i>	0.11 (0.16)	1.11 [0.81-1.54]	0.515
Annual household income			
<i>≥ 8.0 million (ref)</i>	0		
<i>< 2.0 million</i>	1.05 (0.11)	2.85 [2.29-3.54]	<0.001
<i>2.0-3.9 million</i>	0.64 (0.07)	1.90 [1.65-2.18]	<0.001
<i>4.0-5.9 million</i>	0.46 (0.06)	1.58 [1.40-1.80]	<0.001
<i>6.0-7.9 million</i>	0.22 (0.07)	1.24 [1.09-1.43]	0.002
Marital status			
<i>Yes (ref)</i>	0		
<i>No</i>	0.17 (0.07)	1.19 [1.04-1.35]	0.010
The presence of child			
<i>Yes (ref)</i>	0		
<i>No</i>	0.59 (0.06)	1.80 [1.60-2.03]	<0.001

Note. $R^2 = 0.08$ (Cox-Snell), 0.10 (Nagelkerke). Model $\chi^2(13) = 685.62$, $p < 0.001$

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7	2	Table 4	Comparisons of each item of the LSNS-6 by sex, marital status, and the					
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9	3	presence of child						
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11			Mean (SD)			Group difference		
12		LSNS-6	Male	Female		Difference (95%CI)	p	Cohen's d
13	Item 1	Relatives: size	1.99 (1.31)	2.18 (1.26)	-0.20	(-0.25, -0.15)	<0.001	0.154
14	Item 2	Relatives: discuss private matters	1.79 (1.28)	2.11 (1.21)	-0.32	(-0.37, -0.28)	<0.001	0.259
15	Item 3	Relatives: call for help	1.86 (1.28)	2.20 (1.21)	-0.35	(-0.39, -0.30)	<0.001	0.277
16	Item 4	Friend: size	1.25 (1.44)	1.42 (1.44)	-0.17	(-0.22, -0.12)	<0.001	0.117
17	Item 5	Friend: discuss private matters	1.45 (1.42)	1.84 (1.38)	-0.39	(-0.44, -0.34)	<0.001	0.277
18	Item 6	Friend: call for help	1.32 (1.38)	1.63 (1.38)	-0.31	(-0.36, -0.26)	<0.001	0.224
19				11.3				
20	Total score		9.65 (6.31)	(5.92)	-1.73	(-1.96, -1.51)	<0.001	0.283
21				8				
22								
23		LSNS-6	Married	Not married		Difference (95%CI)	p	Cohen's d
24								
25	Item 1	Relatives: size	2.33 (1.22)	1.69 (1.30)	-0.64	(-0.69, -0.59)	<0.001	0.508
26	Item 2	Relatives: discuss private matters	2.19 (1.19)	1.57 (1.26)	-0.62	(-0.66, -0.57)	<0.001	0.503
27	Item 3	Relatives: call for help	2.25 (1.20)	1.69 (1.28)	-0.57	(-0.61, -0.52)	<0.001	0.457
28	Item 4	Friend: size	1.36 (1.45)	1.31 (1.43)	-0.06	(-0.11, -0.01)	0.032	0.042
29	Item 5	Friend: discuss private matters	1.70 (1.39)	1.58 (1.43)	-0.12	(-0.18, -0.07)	<0.001	0.088
30	Item 6	Friend: call for help	1.52 (1.37)	1.41 (1.41)	-0.12	(-0.17, -0.06)	<0.001	0.084
31								
32	Total score		11.3	9.24	-2.12	(-2.36, -1.89)	<0.001	0.347
33			(5.96)	(6.27)				
34			6					
35								
36		LSNS-6	With child	Without child		Difference (95%CI)	p	Cohen's d
37								
38	Item 1	Relatives: size	2.45 (1.20)	1.67 (1.26)	-0.78	(-0.82, -0.73)	<0.001	0.632
39	Item 2	Relatives: discuss private matters	2.24 (1.19)	1.63 (1.24)	-0.61	(-0.65, -0.56)	<0.001	0.499
40	Item 3	Relatives: call for help	2.28 (1.20)	1.76 (1.26)	-0.53	(-0.57, -0.48)	<0.001	0.427
41	Item 4	Friend: size	1.42 (1.46)	1.26 (1.42)	-0.16	(-0.22, -0.11)	<0.001	0.113
42	Item 5	Friend: discuss private matters	1.71 (1.39)	1.59 (1.43)	-0.12	(-0.18, -0.07)	<0.001	0.088
43	Item 6	Friend: call for help	1.52 (1.37)	1.44 (1.41)	-0.08	(-0.13, -0.03)	0.002	0.057
44								
45	Total score		11.6	9.34	-2.28	(-2.50, -2.05)	<0.001	0.375
46			(5.93)	(6.22)				
47			2					
48								
49								
50								
51								
52	4	Cohen's d:	0.200~ small; 0.500~ medium; 0.800~ large					
53	5	LSNS-6:	the abbreviated Lubben Social Network Scale					
54								
55								
56								
57								
58								
59								
60								

Table 5 Comparisons of each item of the LSNS-6 by age group, occupational status, and annual household income

LSNS-6		Mean (SD)						Group difference						
		18-39		40-64		≥65		<i>F</i>	<i>p</i>	η^2				
<i>Item 1</i>	<i>Relative: size</i>	2.15	(1.28)	2.03	(1.29)	2.19	(1.30)	16.53	<0.001	0.003				
<i>Item 2</i>	<i>Relative: discuss private matters</i>	2.02	(1.24)	1.86	(1.25)	2.17	(1.26)	44.32	<0.001	0.008				
<i>Item 3</i>	<i>Relative: call for help</i>	2.16	(1.25)	1.91	(1.25)	2.21	(1.25)	63.07	<0.001	0.011				
<i>Item 4</i>	<i>Friend: size</i>	1.43	(1.46)	1.22	(1.39)	1.64	(1.54)	57.49	<0.001	0.011				
<i>Item 5</i>	<i>Friend: discuss private matters</i>	1.88	(1.43)	1.50	(1.38)	1.70	(1.40)	90.76	<0.001	0.016				
<i>Item 6</i>	<i>Friend: call for help</i>	1.73	(1.44)	1.32	(1.33)	1.48	(1.39)	90.39	<0.001	0.018				
<i>Total score</i>		2.15	(1.28)	2.03	(1.29)	2.19	(1.30)	16.53	<0.001	0.003				
LSNS-6		Employed		Home maker		Student		Unemployed		Other		<i>F</i>	<i>p</i>	η^2
<i>Item 1</i>	<i>Relative: size</i>	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
<i>Item 2</i>	<i>Relative: discuss private matters</i>	1.89	(1.25)	2.36	(1.15)	2.10	(1.21)	1.75	(1.30)	1.77	(1.30)	70.39	<0.001	0.022
<i>Item 3</i>	<i>Relative: call for help</i>	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
<i>Item 4</i>	<i>Friend: size</i>	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
<i>Item 5</i>	<i>Friend: discuss private matters</i>	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
<i>Item 6</i>	<i>Friend: call for help</i>	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
<i>Total score</i>		10.40	(6.16)	11.77	(5.82)	13.19	(5.90)	8.99	(6.23)	9.53	(6.13)	58.08	<0.001	0.020
LSNS-6		< 2.0 million		2.0-3.9 million		4.0-5.9 million		6.0-7.9 million		≥ 8.0 million		<i>F</i>	<i>p</i>	η^2
<i>Item 1</i>	<i>Relative: size</i>	1.41	(1.32)	1.82	(1.32)	2.08	(1.27)	2.23	(1.24)	2.33	(1.22)	92.18	<0.001	0.043
<i>Item 2</i>	<i>Relative: discuss private matters</i>	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
<i>Item 3</i>	<i>Relative: call for help</i>	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
<i>Item 4</i>	<i>Friend: size</i>	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

Item 5	Friend: 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
Item 6	Friend: 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)	11.80	(6.20)	74.70	<0.001	0.036

η^2 : 0.010~ small; 0.060 medium; 0.140~ large
LSNS-6: the abbreviated Lubben Social Network Scale

Table 6 Comparison of items specific to mild lockdown by the presence of social isolation

	Mean (SD)		Group difference		
	LSNS-6 < 12	LSNS-6 ≥ 12	Difference (95% CI)	<i>p</i>	Cohen's <i>d</i>
UCLA-LS3	25.86 (5.15)	20.42 (4.85)	5.44 (5.26, 5.63)	<0.001	1.088
Lifestyle and coping behavior during mild lockdown					
<i>Exercise</i>	3.83 (1.84)	4.60 (1.68)	-0.77 (-0.83, -0.70)	<0.001	0.435
<i>Healthy eating habits</i>	4.03 (1.59)	4.72 (1.42)	-0.69 (-0.74, -0.63)	<0.001	0.457
<i>Healthy sleep habits</i>	4.40 (1.83)	4.91 (1.70)	-0.51 (-0.58, -0.44)	<0.001	0.289
<i>Activity</i>	3.73 (1.70)	4.39 (1.57)	-0.66 (-0.72, -0.60)	<0.001	0.405
<i>Offline interaction with familiar people</i>	3.17 (1.81)	3.98 (1.86)	-0.81 (-0.88, -0.74)	<0.001	0.440
<i>Online interaction with familiar people</i>	2.74 (1.82)	3.94 (2.02)	-1.20 (-1.28, -1.13)	<0.001	0.626
<i>Preventive behaviors of COVID-19</i>	5.31 (1.81)	5.92 (1.39)	-0.61 (-0.67, -0.55)	<0.001	0.379
<i>Optimism</i>	3.65 (1.57)	4.57 (1.42)	-0.92 (-0.97, -0.86)	<0.001	0.614
Stressors related to mild lockdown					
<i>Deterioration of household economy</i>	3.85 (1.82)	3.73 (1.84)	0.12 (0.05, 0.19)	<0.001	0.065
<i>Deterioration of relationship with familiar people</i>	2.55 (1.58)	2.16 (1.47)	0.39 (0.33, 0.45)	<0.001	0.255
<i>Frustration</i>	3.41 (1.77)	3.18 (1.73)	0.23 (0.16, 0.29)	<0.001	0.131
<i>COVID-19-related anxiety</i>	4.00 (1.72)	4.09 (1.67)	-0.10 (-0.16, -0.03)	0.003	0.057
<i>COVID-19-related sleeplessness</i>	2.49 (1.54)	2.38 (1.53)	0.11 (0.06, 0.17)	<0.001	0.075
<i>Difficulties owing to the lack of daily necessities</i>	3.66 (1.86)	3.59 (1.84)	0.06 (-0.01, 0.13)	0.085	0.033
<i>Difficulties in work or schoolwork</i>	3.73 (2.03)	3.93 (2.07)	-0.20 (-0.27, -0.12)	<0.001	0.097

Cohen’s *d*: 0.200~ small; 0.500~ medium; 0.800~ large
LSNS-6: the abbreviated Lubben Social Network Scale

For peer review only

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	7
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	6
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	7
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-8
		(b) Report category boundaries when continuous variables were categorized	7-8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.