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

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ABSTRACT

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

Design A cross-sectional study.

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

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

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

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

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

INTRODUCTION

COVID-19 has rapidly spread worldwide since its outbreak in December 2019. To deter the spread of COVID-19, many countries have imposed a lockdown with restrictions on outings, service closure, etc. The lockdown in most countries is mandatory, with penalties for violations. The lockdown can be expected to deter the spread of the infection, which if

Strengths and limitations of this study

► The survey was conducted in real-time to minimise 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 are 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.

not stopped can cause economic damage and psychological distress.[1–3]

Lockdowns and 'stay-at-home' orders for COVID-19 announced internationally have led to physical and social distancing, with reports of many individuals experiencing social isolation and loneliness.[1 4] Social isolation and loneliness are conceptually distinct, with social isolation generally defined in terms of objective availability of social contacts and frequency of contact with social network members, whereas loneliness referring to the perception that intimate and social needs are not being met.[5 6] Social isolation has been reported to be inter-related with loneliness and is often a risk factor for loneliness.[7] Sociodemographic characteristics that increase the likelihood of being socially isolated or lonely include being very old, single or widowed, living alone, having no education, low income or having financial burdens.[8–10] Social isolation and loneliness have been reported to affect health and mortality risk,[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 the UK conducted before and during the COVID-19 pandemic[1] reported that loneliness levels were higher during the pandemic than before the pandemic, and being a student emerged as a higher risk factor for loneliness during lockdown than usual. Young adults, people living alone, people with lower education or income, the economically inactive women, ethnic minority groups and urban residents also had a higher risk of being lonely both before and during the pandemic. During stay-at-home orders in the USA, elevated loneliness was strongly associated with greater depression and suicidal ideation.[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 lockdown[19] reported that the proportion of individuals with psychological distress was significantly higher when compared with the previous national survey data from 2010, 2013, 2016 and 2019. The degree of psychological distress was influenced by a specific interaction structure of risk factors such as high loneliness and COVID-19-induced negative influence, deterioration in interpersonal relationships, insomnia, anxiety, deterioration in family finances and work and academic difficulties. Thus, these voluntary restrictions on behaviour under mild lockdown during pandemics may lead to serious problems of social isolation among the Japanese.

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

METHODS

Participants and data collection

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

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

The data for this study were partly extracted from a database that contained data used in our published papers.[19 20] The extracted data were secondarily reanalysed with different dependent and independent variables compared with those in the above-mentioned papers.

Patient and public involvement

No patient involved.

Measurements

Sociodemographic data

Participants' sociodemographic information including age, sex, employment status (employed, homemaker, student, unemployed or other), marital status and annual household income (<2.0 million, 2.0–3.9 million, 4.0–5.9 million, 6.0–7.9 million, ≥8.0 million or unknown) was collected. The details of the survey items are available on the open data platform (the Open Science Framework).[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 Scale[27] 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 6-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 V.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 behaviour 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 behaviour 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 V.25.0 (IBM, New York, 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 ≥12). We used the t-test and one-way analysis of variance (ANOVA) to compare each item of LSNS-6 between sociodemographic characteristics, and the post hoc t-test with Bonferroni correction was employed to test the difference between groups for the one-way ANOVA. The t-test was applied to compare lifestyle, coping behaviour and stressors related to COVID-19 by the presence of social isolation. The power analysis was performed using G*power V.3.1.9.4 (https://www.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 1161 participants (10.2%) answered that they did not know their annual household income and 1707 participants (15.1%) did not provide an answer to the item about annual household income, there were no missing data for the other variables. The mean scores of the LSNS and UCLA were 10.56±6.17 and 23.46±5.70, respectively.

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

The average statistical powers of the 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 6337 participants (55.9%).

Table 1 Characteristics of participants

	N (%)					
	Total		**Male**		**Female**	
Overall	11 333	(100)	5391	(100)	5942	(100)
Age (years)						
18–39	3888	(34.3)	1077	(20.0)	2811	(47.3)
40–64	6024	(53.2)	3295	(61.1)	2729	(45.9)
≥65	1421	(12.5)	1019	(18.9)	402	(6.8)
Occupation						
Employed	7685	(67.8)	4235	(78.6)	3450	(58.1)
Homemaker	1806	(15.9)	25	(0.5)	1781	(30.0)
Student	407	(3.6)	122	(2.3)	285	(4.8)
Unemployed	1068	(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	1990	(17.6)	947	(17.6)	1043	(17.6)
4.0–5.9 million	2214	(19.5)	1150	(21.3)	1064	(17.9)
6.0–7.9 million	1495	(13.2)	818	(15.2)	677	(11.4)
≥8.0 million	2130	(18.8)	1247	(23.1)	883	(14.9)
Unknown	2871	(25.3)	921	(17.1)	1950	(32.8)
Marital status (married)	7043	(62.1)	3492	(64.8)	3551	(59.8)
The presence of child (yes)	6072	(53.6)	3091	(57.3)	2981	(50.2)

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' (ie, Cohen's d >0.200), male participants showed lower scores for items 2, 3, 5 and 6, and unmarried participants and participants without children had higher scores for items 1, 2 and 3.

Regarding the results of the ANOVA that exceeded the lower limit of 'small effect size' (ie, 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 years group and the over 65-year group. The score for item 4 in the 18–39 years group was significantly lower than that in patients aged >65 years. The score for item 5 in the over 65-year group was significantly lower than that in the 18–39 year group.

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

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	P value	Cramer's *V* or φ
Overall	6337	(55.9)	4996	(44.1)			
Sex					147.47	<0.001	0.114
Male	3335	(61.9)	2056	(38.1)			
Female	3002	(50.5)	2940	(49.5)			
Age (years)					118.12	<0.001	0.102
18–39	1950	(50.2)	1938	(49.8)		*	
40–64	3654	(60.7)	2370	(39.3)		*	
≥65	733	(51.6)	688	(48.4)		*	
Occupation					161.82	<0.001	0.119
Employed	4369	(56.9)	3316	(43.1)		*	
Homemaker	866	(48.0)	940	(52.0)		*	
Student	155	(38.1)	252	(61.9)		*	
Unemployed	713	(66.8)	355	(33.2)		*	
Other	234	(63.8)	133	(36.2)		*	
Marital status					167.91	<0.001	0.122
Married	3606	(51.2)	3437	(48.8)			
Unmarried	2731	(63.7)	1559	(36.3)			
The presence of child					219.18	<0.001	0.139
Yes	3005	(49.5)	3067	(50.5)			
No	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
Yes	294	(61.0)	188	(39.0)			
No	6043	(55.7)	4808	(44.3)			
Treatment of severe previous physical diseases					1.35	0.246	0.011
Yes	492	(57.8)	359	(42.2)			
No	5845	(55.8)	4637	(44.2)			
Treatment of current psychological problems					53.83	<0.001	0.069
Yes	448	(69.8)	194	(30.2)			
No	5889	(55.1)	4802	(44.9)			
Treatment of previous psychological problems					62.63	<0.001	0.074
Yes	900	(65.9)	466	(34.1)			
No	5437	(54.6)	4530	(45.4)			

Cramer's V (or φ): 0.100~small; 0.300~medium; 0.600~large.
*Significant group difference found by residual analysis (absolute value of adjusted residual ≥1.96).
LSNS-6, Lubben Social Network Scale.

3, except that there was no significant difference between the employed and homemaker groups.

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

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

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

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

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 behaviour 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 behaviour during mild lockdown, the LSNS-6 <12 group showed significantly lower scores than the LSNS-6 ≥12 group for all items. The effect sizes in 'online interaction with familiar people' and 'optimism' were medium, and those in other items were small. Regarding items about stressors related to mild

lockdown, although there were significant differences between groups in all items except 'difficulties owing to the lack of daily necessities', the effect sizes in these items except 'deterioration of relationship with familiar people' exceeded the lower limit of 'small effect size' (Cohen's d >0.200).

DISCUSSION

As in other previous surveys during the period of the COVID-19 pandemic,[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] Compared to the previous studies before COVID-19 pandemic, our participants had a lower mean LSNS-6 score and a higher mean UCLA-LS3 score,[26 29] suggesting an elevated severity of isolation during the COVID-19 mild lockdown.

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

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

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

Sociodemographic data that predicted social isolation were being male, middle-aged (40–64 years) and lower income. Regarding occupation status, being a student was found to be a protective factor for social isolation. While the association between lower income and social isolation in the present study is consistent with previous results during the COVID-19 pandemic,[1] a previous study reported an association between female sex and younger age with loneliness.[34] Given the severe loneliness among people with social isolation found in the present study, the previous results of loneliness in women and younger age groups did not support our results. However, previous studies prior to the COVID-19 pandemic have shown inconsistent results regarding sex differences, and several studies prior to the COVID-19 pandemic have shown that men are more likely to be socially isolated and lonely than women.[35 36] Other studies have reported that women are more likely to be lonely than men, although this effect tends to disappear when other factors are controlled for in the analysis.[8 9] Results regarding sex differences may be influenced by region and culture, and may be similar during the COVID-19 pandemic.

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

Table 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	F	P value	η^2
Item 1 relative: size	2.15 (1.28)	2.03 (1.29)	2.19 (1.30)	16.53	<0.001	0.003
Item 2 relative: discuss private matters	2.02 (1.24)	1.86 (1.25)	2.17 (1.26)	44.32	<0.001	0.008
Item 3 relative: call for help	2.16 (1.25)	1.91 (1.25)	2.21 (1.25)	63.07	<0.001	0.011
Item 4 friend: size	1.43 (1.46)	1.22 (1.39)	1.64 (1.54)	57.49	<0.001	0.011
Item 5 friend: discuss private matters	1.88 (1.43)	1.50 (1.38)	1.70 (1.40)	90.76	<0.001	0.016
Item 6 friend: call for help	1.73 (1.44)	1.32 (1.33)	1.48 (1.39)	90.39	<0.001	0.018
Total score	11.37 (6.36)	9.84 (5.82)	11.39 (5.90)	16.53	<0.001	0.003

LSNS-6	Mean (SD)					Group difference		
	Employed	Homemaker	Student	Unemployed	Other	F	P value	η^2
Item 1 relative: size	2.05 (1.29)	2.36 (1.24)	2.37 (1.24)	1.87 (1.32)	1.90 (1.28)	35.90	<0.001	0.013
Item 2 relative: discuss private matters	1.89 (1.25)	2.36 (1.15)	2.10 (1.21)	1.75 (1.30)	1.75 (1.30)	70.39	<0.001	0.022
Item 3 relative: call for help	1.98 (1.26)	2.41 (1.15)	2.21 (1.26)	1.83 (1.29)	1.86 (1.30)	60.72	<0.001	0.019
Item 4 friend: size	1.34 (1.44)	1.33 (1.41)	1.99 (1.56)	1.16 (1.44)	1.29 (1.43)	24.99	<0.001	0.009
Item 5 friend: discuss private matters	1.65 (1.41)	1.77 (1.36)	2.33 (1.44)	1.29 (1.36)	1.44 (1.38)	46.57	<0.001	0.016
Item 6 friend: call for help	1.49 (1.39)	1.54 (1.34)	2.20 (1.50)	1.08 (1.27)	1.31 (1.38)	52.90	<0.001	0.019
Total score	10.40 (6.16)	11.77 (6.02)	13.19 (5.90)	8.99 (6.23)	9.55 (6.13)	58.08	<0.001	0.020

LSNS-6	Mean (SD)					Group difference		
	<2.0 million	2.0–3.9 million	4.0–5.9 million	6.0–7.9 million	≥8.0 million	F	P value	η^2
Item 1 relative: size	1.41 (1.32)	1.82 (1.32)	2.08 (1.27)	2.23 (1.24)	2.35 (1.22)	92.18	<0.001	0.043
Item 2 relative: discuss private matters	1.39 (1.33)	1.79 (1.24)	1.95 (1.24)	2.06 (1.22)	2.14 (1.22)	52.56	<0.001	0.026
Item 3 relative: call for help	1.42 (1.32)	1.90 (1.26)	2.03 (1.23)	2.16 (1.23)	2.19 (1.22)	52.45	<0.001	0.026
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, 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)	P value	Cohen's d
UCLA-LS3	25.86	(5.15)	20.42	(4.85)	5.44 (5.26 to 5.63)	<0.001	1.088
Lifestyle and coping behaviour during mild lockdown							
Exercise	3.83	(1.84)	4.60	(1.68)	−0.77 (−0.83 to −0.70)	<0.001	0.435
Healthy eating habits	4.03	(1.59)	4.72	(1.42)	−0.69 (−0.74 to −0.63)	<0.001	0.457
Healthy sleep habits	4.40	(1.83)	4.91	(1.70)	−0.51 (−0.58 to −0.44)	<0.001	0.289
Activity	3.73	(1.70)	4.39	(1.57)	−0.66 (−0.72 to −0.60)	<0.001	0.405
Offline interaction with familiar people	3.17	(1.81)	3.98	(1.86)	−0.81 (−0.88 to −0.74)	<0.001	0.440
Online interaction with familiar people	2.74	(1.82)	3.94	(2.02)	−1.20 (−1.28 to −1.13)	<0.001	0.626
Preventive behaviours of COVID-19	5.31	(1.81)	5.92	(1.39)	−0.61 (−0.67 to −0.55)	<0.001	0.379
Optimism	3.65	(1.57)	4.57	(1.42)	−0.92 (−0.97 to −0.86)	<0.001	0.614
Stressors related to mild lockdown							
Deterioration of household economy	3.85	(1.82)	3.73	(1.84)	0.12 (0.05 to 0.19)	<0.001	0.065
Deterioration of relationship with familiar people	2.55	(1.58)	2.16	(1.47)	0.39 (0.33 to 0.45)	<0.001	0.255
Frustration	3.41	(1.77)	3.18	(1.73)	0.23 (0.16 to 0.29)	<0.001	0.131
COVID-19-related anxiety	4.00	(1.72)	4.09	(1.67)	−0.10 (−0.16 to −0.03)	0.003	0.057
COVID-19-related sleeplessness	2.49	(1.54)	2.38	(1.53)	0.11 (0.06 to 0.17)	<0.001	0.075
Difficulties owing to the lack of daily necessities	3.66	(1.86)	3.59	(1.84)	0.06 (−0.01 to 0.13)	0.085	0.033
Difficulties in work or schoolwork	3.73	(2.03)	3.93	(2.07)	−0.20 (−0.27 to −0.12)	<0.001	0.097

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

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

income (many unemployed people in the low-income group) are related to social isolation.

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

In terms of gender differences in social isolation, men were more likely to have fewer people to talk to about their personal problems and seek help, rather than just the number of relatives and friends they met and talked to. Those who were unmarried and without children scored lower on the three items related to 'relatives' in the LSNS-6 than those who were married and/or had children. However, there was no significant difference in the social network related to 'friends'. It is not surprising that there are differences in items affected by the number of people in the household between those who are married/with children versus those who are single/without children, and it is difficult to say that this finding is the result of the mild lockdown. However, as noted above, this feature in these groups may have been more severe under mild lockdown because the number of people who

actually met the criteria for social isolation in the LSNS-6 was significantly higher than in previous studies. In the present study, the middle-aged group (40–64 years) had a lower social network of friendships. One possible reason for this result is that the middle-aged group includes a large number of people who work in offices, and it is possible that working remotely has reduced their interaction with their colleagues. Regarding occupational status, except for the number of friends that they could meet and talk to, the social network of the students was enhanced. Younger people are more likely to interact online[42] and are able to maintain communication with many people to some extent even when they cannot meet in person. In terms of annual household income, the lower the income, the lower the social network was for all LSNS-6 items, so the characteristics of each LSNS-6 item were not clear.

Regarding items specific to mild lockdown, the LSNS-6 <12 group showed decreased 'online interaction with familiar people' and 'optimism'. These results are consistent with previous results indicating the association between loneliness and lower contact with relatives or lower positive emotions by Losada-Baltar et al.[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.[43] Additionally, the association between social isolation and being able to think positively about the future even under mild lockdown is consistent with the results of previous studies (eg, Garner et al[44]) 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, being a parent and living with a child could affect social isolation and loneliness. Third, we did not assess the quality of relationships with relatives and friends. Even if the network size is small, mental health may be good if the quality of the relationships is sufficient. Fourth, we did not exclude people who did not stay in mild lockdown for any reason (eg, work) and people who were affected by COVID-19, and we could not adjust for their effect on the results of the present study. In the future, it would be useful to investigate whether the participants were in an environment affected by mild lockdown or COVID-19. Fifth, we collected the data for this study through an online survey and were not able to conduct random sampling, so we cannot guarantee the representativeness of the sample;

the sample we collected could not be matched to the proportions of each age group and gender group in each region.

CONCLUSION

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

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