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The negative impact of loneliness and perceived stress on mental health during two-month lockdown in Shanghai

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ABSTRACT

Background: Shanghai undergone COVID-19 lockdown for 2 months in 2022, affecting >25 million population. We aim to find changes in mental health during Shanghai lockdown and if mental health was associated with Shanghai lockdown, loneliness, and perceived stress.

Methods: We conducted two cross-sectional online surveys in China, which were before and at the end of Shanghai lockdown (survey 1 in January 2022, N = 1123; survey 2 in June 2022, N = 2139). Participants reported mental health, loneliness, and perceived stress through the 12-item General Health Questionnaire (GHQ-12), the short-form UCLA Loneliness Scale (ULS-8), and the 10-item Perceived Stress Scale (PSS-10). We compared data between survey 1 and 2. We ran a multiple linear regression model to investigate the impact of Shanghai lockdown, loneliness and perceived stress on mental health.

Results: There's an increase in the proportion of lonely people during Shanghai lockdown (49.77 % to 65.26 %). During Shanghai lockdown, the proportion of lonely people (68.97 % VS. 61.35 %, $p < 0.001$) and risk for mental health conditions (50.50 % VS. 43.27 %, $p < 0.001$) were higher among residents in Shanghai than outside Shanghai. Shanghai lockdown ($b = 0.556$, $p = 0.02$), higher ULS-8 (b = 0.284, $p < 0.001$) and higher PSS-10 (b = 0.365, $p < 0.001$) were associated with higher GHQ-12.

Limitations: Participants reported their mental health status during Shanghai lockdown retrospectively.

Conclusion: Shanghai lockdown had psychological impacts not only on residents in Shanghai but also outside Shanghai. Addressing loneliness and perceived stress accommodated to the lockdown situation should be considered.

1. Introduction

It has been the third year for us living with coronavirus disease since 2019. The variants of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) kept evolving and COVID-19 waves continued to emerge (Hirabara et al., 2021; Moghnieh et al., 2022). Since the identification of a novel severe acute respiratory SARS-CoV-2 variant of concern in November 2021, Omicron variant has expanded globally (Tian et al., 2022). With the dynamic zero-COVID policy to address COVID-19, China also met enormous challenges of Omicron variant epidemic (Yuan et al., 2022). Shanghai began to find cases of Omicron variant from March 2022. At the end of March, Shanghai Government decided to impose a lockdown for 9 days in two phases for screening and managing COVID-19 (CGTN, 2022) However, with rapid increases of the cases, a city-wide lockdown commenced on 1 April 2022 and persisted for 2 months. With the efforts of all walks of life, Shanghai triumphed over Omicron variant and the city re-opened on 1 June 2022 (Global Times, 2022) Such a long period of lockdown in Shanghai can be compared with the lockdown time in Wuhan, which was 76 days in total (Zhou et al., 2020).

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Wuhan saw the world's first COVID-19 lockdown. Suicides in Wuhan were 79 % higher under lockdown policy than in the same period a year earlier (The Economist, 2022). Lockdown has also been imposed by a variety of countries to contain the spread of COVID-19. The lives of general population were impacted deeply by lockdown from multiple aspects and the concerns on mental health ranked very high (Gloster et al., 2020; The Lancet, 2021). It was indicated that mental health problems increased among general population from pre-pandemic assessments during lockdown (Richter et al., 2021). An international study showed that about 10 % of the respondents on average were languishing from low levels of mental health at the time of a population-wide lockdown (Gloster et al., 2020). A study of non-coercive lockdown and psychological distress in Japan showed that the proportion of participants with psychological distress was significantly higher than the proportion of national surveys before COVID-19, which revealed that even non-coercive lockdown could have a negative influence on mental health (Yamamoto et al., 2020). There is a lack of studies on mental health during a strict two-month citywide lockdown in Shanghai in 2022. Located on the coast of the East China Sea, Shanghai is the largest city in China and an important center of trade and finance (Statista, 2022). A study reported a dramatic increase in telephone hotlines for psychological crisis intervention services provided by the Shanghai Mental Health Hotline (Su et al., 2022).

Moreover, the lifestyle of people in Shanghai has been changed due to the outbreak of COVID-19 in 2022. People were confined to home. And their work, study, and social communications mainly relied on internet and digital devices. Daily concerns or worries appeared such as food shortages and difficulties in getting medical service. These changes may bring feelings of loneliness and stress to people. Many previous studies showed that the prevalence of loneliness increased during COVID-19 (Bu et al., 2020b; Killgore et al., 2020; Liu et al., 2021a; Liu et al., 2021b; Liu et al., 2021c; van Tilburg et al., 2021). Before COVID-19, A study showed that loneliness was significantly associated with mental distress (Beutel et al., 2017). During the era of COVID-19, loneliness was regarded as one of a major public health concerns (Bu et al., 2020a; Bu et al., 2020b; Liu et al., 2021b). Perceived stress was also a focus of investigation during COVID-19 because it may have negative effects on our behaviors and wellbeing (Achterberg et al., 2021; Badura-Brzoza et al., 2022; Keller et al., 2012). Studies from different countries found that 11 %–36 % of the population reported a high level of perceived stress (Gloster et al., 2020; Kyprianidou et al., 2021; J. Xu et al., 2021).

Although mental health, loneliness, perceived stress as well as their relationships were largely studied over the COVID-19 pandemic, there was scarce reports on how a strict and long city-wide lockdown in Shanghai took a huge mental health toll. According to a cross-sectional study among participants who experienced lockdown in Shanghai, the prevalence of depression, anxiety and suicidal ideation was 26.1 %, 20.1 %, and 3.8 % (Hall et al., 2023). Before this harsh lockdown, only 'sporadic' cases were detected in Shanghai and COVID-19 infections remained stable. Besides, in response to Omicron variant epidemic in Shanghai, regions outside Shanghai also adopted a series of strategies such as lockdown and nucleic acid screening. The severe situation of Omicron variant epidemic in Shanghai may also have an influence on the population outside Shanghai. In this study, we performed two cross-sectional online surveys among general population in China before and during Shanghai lockdown. We aim to investigate changes in population mental health during Shanghai lockdown and if such changes are associated with Shanghai lockdown, loneliness and perceived stress. We hypothesize that participants would have higher levels of mental health problems, loneliness and perceived stress during Shanghai lockdown compared to before Shanghai lockdown. In particular, we would find a stronger effect among participants living in Shanghai than those living outside Shanghai. Shanghai lockdown, loneliness, and perceived stress would have a negative impact on mental health.

2. Methods

2.1. Study design

We conducted two cross-sectional online anonymous surveys among general population in China before and during Shanghai lockdown. The survey 1 was performed in February 2022 as the baseline. The survey 2 was conducted at the end of Shanghai lockdown in June 2022. Precisely, Shanghai lockdown were implemented from 1 April to 31 May 2022. Participants got access to the survey on the Wenjuanxing platform (https://www.wjx.cn/) through hyperlinks or quick response codes. The study was conducted in accordance with the Helsinki Declaration and was approved by the Ethics Committee of Shanghai Mental Health Center (2021ky-15).

2.2. Participants

The inclusion criteria for the online survey included that participants were at least 18 years old and gave informed consent. We recruited participants mainly through social media in both surveys. Wenjuanxing platform allowed each participant can only fill in the survey once. In survey 1, participants were from all over China without special ratios in different provinces. In survey 2, participants living in Shanghai and outside Shanghai during Shanghai lockdown were recruited with a ratio of 1:1. We have set a question for attention test in order to control the quality of the surveys. Participants did not receive incentives in survey 1. Each participant received 5 Chinese Yuan (CNY) once they completed the survey and got through the attention test in survey 2. Finally, we recruited 1123 participants before Shanghai lockdown in survey 1, and 2139 participants in survey 2 with 1099 participants from Shanghai and 1040 from outside Shanghai during Shanghai lockdown.

2.3. Measurement

In both surveys, we collected the socio-demographic status of participants including age (continuous variable), sex (binary variable, i.e., male and female), education years (continuous variable), and marital status (binary variable, i.e., married and unmarried). In survey 2, we also asked participants to report whether they lived in Shanghai or not during Shanghai lockdown to control the Shanghai residence ratio of 1:1.

We used the 12-item General Health Questionnaire (GHQ-12) to assess the overall mental health of participants (Anjara et al., 2020). Each item of GHQ-12 had 4 choices adapted with a Likert scoring method of 0-1-2-3 (Lundin et al., 2016). A higher score indicated worse mental health and a cut-off score was set at $\geq$12 indicating a high risk of mental disorders (Feng et al., 2021). We assessed loneliness through the short-form UCLA Loneliness Scale (ULS-8) ranging from 8 to 32. A higher score reflected a higher level of loneliness (Hays and DiMatteo, 1987; Xu et al., 2018). We divided participants into loners and non-loners with a cut-off score of 16, which indicated mild loneliness (Haucke et al., 2022b; Haucke et al., 2022a). We assessed perceived stress by using the 10-item Perceived Stress Scale (PSS-10), which had a total score of 0–40 with an increased score reflecting increased perceived stress (Cohen et al., 1983; Wang et al., 2013). We defined high perceived stress as PSS-10 scores $\geq$27 (Pieh et al., 2021). In survey 1, we asked participants to report their recent mental health status, loneliness, and perceived stress. In survey 2, we asked participants to recall their mental status, loneliness, and perceived stress during Shanghai lockdown period.

2.4. Data analysis

We performed statistical analysis through R Statistical Software (version 4.1.0; R Foundation for Statistical Computing, Vienna, Austria, www.r-project.org). Firstly, we described characteristics of participants

before and during Shanghai lockdown using mean ± standard deviation (SD) or frequency and percentage. For participants taking part in the survey during Shanghai lockdown period, we described characteristics of them in Shanghai and outside Shanghai. Secondly, we compared the characteristics of participants between different groups, i.e., before lockdown vs. during lockdown, in Shanghai vs. outside Shanghai, by *t*-test and chi-square test. Thirdly, we used multiple linear regression model to show the impact of lockdown (before and during), city (Shanghai and outside Shanghai), loneliness (the total score of ULS-8) and perceived stress (the total score of PSS-10) on mental health (the total score of GHQ-12) by adjusting age, gender, education years, and marital status. The variance inflation factor (VIF) of the independent variables was calculated for multicollinearity. For there were more than two variables in the model, we applied 3D scatter plots for data visualization by using "plot3D" package in R software (Soetaert, 2021). In this study, statistical significance was defined as $p < 0.05$, and hypothesis tests were 2-sided.

3. Results

3.1. Group description

In survey 1 (before lockdown), there were 1123 participants with a mean age of 28.80 ± 11.54 years, 37.67 % male participants, a mean education year of 15.84 ± 3.03 years, and 29.83 % married participants. There were 2139 participants taking part in survey 2 in June 2022 with a mean age of 26.12 ± 6.37 years and male participants accounting for 65.83 %. The education years were 12.57 ± 5.35 years and 35.58 % participants were married. Table 1 showed the sociodemographic characteristics of participants before Shanghai lockdown and during Shanghai lockdown, in Shanghai and outside Shanghai.

3.2. Characteristics of mental health, loneliness, and perceived stress

The characteristics of mental health, loneliness, and perceived stress were presented in Table 1. There was a similar percentage of participants at high risk for mental health conditions (GHQ-12 ≥ 12) before (N = 503, 44.79 %) and during (N = 1005, 46.98 %) Shanghai lockdown ($\chi^2 = 1.338$, $p = 0.25$). The percentage of participants with high perceived stress (PSS-10 ≥ 27) was also noted as similar before (N = 70, 6.23 %) and during (N = 116, 5.42 %) Shanghai lockdown ($\chi^2 = 0.755$, $p = 0.39$). However, we found a 15.49 % increase in prevalence of loneliness (ULS-8 ≥ 16) during (N = 1396, 65.26 %) compared to before (N = 559, 49.77 %) Shanghai lockdown ($\chi^2 = 72.905$, $p < 0.001$). In comparison with participants living outside Shanghai, a 7.23 % increase in those living in Shanghai were at high risk for mental health conditions during Shanghai lockdown period (50.5 % in Shanghai vs. 43.27 % outside Shanghai, $\chi^2 = 10.929$, $p < 0.001$). There was also a higher proportion of loneliness among participants in Shanghai than those outside Shanghai (68.97 % in Shanghai vs. 61.35 % outside Shanghai, $\chi^2 = 13.372$, $p < 0.001$). However, we did not find significant difference in percentages of participants with high perceived stress between these two groups (5.73 % in Shanghai vs. 5.10 % outside Shanghai, $\chi^2 = 0.307$, $p = 0.58$).

3.3. The impact of Shanghai lockdown, loneliness, and perceived stress on mental health

In multiple linear regression model (Table 2), VIF values of all variables were below 2, which means there was no multicollinearity between variables. As shown in multiple linear regression model ($F = 169.4$, $p < 0.001$, adjusted R squared = 0.292), Shanghai lockdown ($b = 0.556$, $p = 0.02$), higher scores of ULS-8 ($b = 0.284$, $p < 0.001$) and PSS-10 ($b = 0.365$, $p < 0.001$) were associated with higher GHQ-12 scores by adjusting sociodemographic variables (i.e., age, sex, education years and marital status) and the factor "city" had no significant influence on GHQ-12 score ($b = 0.372$, $p = 0.08$). The results revealed that Shanghai lockdown, loneliness, and high perceived stress had negative impacts on mental health (Fig. 1). Besides, we also found that females ($b = 0.838$, $p < 0.001$) were more likely to report a higher GHQ-12 score compared to males. More education years ($b = 0.108$, $p < 0.001$) were associated with a higher GHQ-12 score.

Table 1
Characteristics of participants before versus during Shanghai lockdown, in Shanghai versus outside Shanghai.

	Before lockdown N = 1123	Lockdown N = 2139			Lockdown N = 2139			
			Before lockdown vs. Lockdown		In Shanghai N = 1099	Outside Shanghai N = 1040	In Shanghai vs. outside Shanghai	
			z/χ^2	p			z/χ^2	p
Age in years, mean (SD)	28.80 (11.54)	26.12 (6.37)	7.077	<0.001*	26.42 (5.54)	25.80 (7.14)	−2.261	0.02*
Sex, n (%)			235.97	<0.001*			2.152	0.14
Male	423 (37.67)	1408 (65.83)			740 (67.33)	668 (64.23)		
Female	700 (62.33)	731 (34.17)			359 (32.67)	372 (35.77)		
Education years, mean (SD)	15.84 (3.03)	12.57 (5.35)	22.274	<0.001*	12.70 (5.51)	12.43 (5.17)	−1.163	0.25
Marital status, n (%)			10.644	0.001*			1.718	0.19
Married	335 (29.83)	761 (35.58)			406 (36.94)	355 (34.13)		
Unmarried	788 (70.17)	1378 (64.47)			693 (63.06)	685 (65.87)		
GHQ-12 score, mean (SD)	11.25 (4.81)	11.60 (6.83)	−1.683	0.09	11.88 (6.99)	11.31 (6.66)	−1.948	0.05
Mental health conditions, n (%)			1.338	0.25			10.929	<0.001*
Low risk (GHQ-12 < 12)	620 (55.21)	1134 (53.02)			544 (49.50)	590 (56.73)		
High risk (GHQ-12 ≥ 12)	503 (44.79)	1005 (46.98)			555 (50.50)	450 (43.27)		
ULS-8 score, mean (SD)	15.75 (4.25)	17.45 (5.23)	−10.011	<0.001*	17.75 (5.08)	17.14 (5.37)	−2.716	0.007*
Loneliness, n (%)			72.905	<0.001*			13.372	<0.001*
Non loner (ULS-8 < 16)	564 (50.22)	743 (34.74)			341 (31.02)	402 (38.65)		
Loner (ULS-8 ≥ 16)	559 (49.77)	1396 (65.26)			758 (68.97)	638 (61.35)		
PSS-10 score, mean (SD)	19.23 (5.36)	18.67 (6.84)	2.553	0.01*	18.90 (6.89)	18.43 (6.78)	−1.612	0.11
High perceived stress, n (%)			0.755	0.39			0.307	0.58
Low (PSS-10 < 27)	1053 (93.77)	2023 (94.58)			1036 (94.27)	987 (94.90)		
High (PSS-10 ≥ 27)	70 (6.23)	116 (5.42)			63 (5.73)	53 (5.10)		

SD: standard deviation.
GHQ-12: The 12-item Goldberg General Health Questionnaire.
PSS-10: The 10-item Perceived stress scale.
ULS-8: The short form UCLA Loneliness Scale.
* $p < 0.05$.

Table 2
Multiple linear regression model.

Variables	b	p
Intercept	−3.187	
Age	0.023	0.09
Sex		
Male	Ref	
Female	0.838	<0.001*
Education years	0.108	<0.001*
Marital status		
Married	Ref	
Non-married	0.073	0.76
Shanghai lockdown		
Before lockdown	Ref	
Lockdown	0.556	0.02*
City		
Outside Shanghai	Ref	
Shanghai	0.373	0.08
ULS-8 score	0.284	<0.001*
PSS-score	0.365	<0.001*

SD: standard deviation.
GHQ-12: The 12-item Goldberg General Health Questionnaire.
PSS-10: The 10-item Perceived stress scale.
ULS-8: The short form UCLA Loneliness Scale.
* $p < 0.05$.

4. Discussion

We carried out a study consisting of two cross-sectional online surveys on mental health and its related risk factors (i.e., loneliness and perceived stress) among general population before and during Shanghai. We also compared participants living in Shanghai and outside Shanghai during Shanghai lockdown. We found that mental health of participants living in Shanghai was worse than those outside Shanghai. A higher proportion of loneliness was observed during Shanghai lockdown compared to the period before Shanghai lockdown, especially among those who lived in Shanghai. Lastly, we found that high loneliness, high perceived stress, Shanghai lockdown, female and more education years were associated with poorer mental health.

Our study found around 47 % of participants were at high risk for mental health conditions across China during Shanghai lockdown period while the proportion was around 50 % of participants living in Shanghai and around 40 % outside Shanghai. This reflected that there is an extremely negative impact of Shanghai lockdown on mental health among people living Shanghai. Consistent with previous studies, the epicenter of the epidemic was more influenced than outside regions (Liang et al., 2020; Shi et al., 2020). In the initial wave of COVID-19 in Wuhan City in Hubei province in 2020, residents in Hubei had increased psychological symptoms than other districts (Liang et al., 2020; Shi et al., 2020). The Shanghai lockdown had psychological impacts on people even from a nation-wide perspective. Our study found that the prevalence of loneliness across China was higher during lockdown than before. For participants living in Shanghai, they were affected by the lockdown directly due to social isolation and loneliness (Hwang et al., 2020). For participants outside Shanghai, they may be affected by this serious COVID-19 situation indirectly. On the one hand, loneliness was of complexity and many risk factors including socio-environment factors may contribute to it (Lim et al., 2020). On the other hand, the social culture of China is collectivistic (Oyserman et al., 2002). People from collectivistic cultures prefer to be integrated into tightly-knit social networks, so it is expected loneliness is more likely to increase in collectivistic cultures than in individual cultures (Beller and Wagner, 2020; Dahlberg, 2021).

In addition to loneliness, we found that percentages of participants with high perceived stress were quite stable before and during Shanghai lockdown and the mean score of PSS-10 during lockdown was even lower than before lockdown. There may be several reasons why the results are inconsistent with our hypothesis. Previous studies showed associations between stress and fear of COVID-19, and fear of the unknown was at the forefront of the mental challenges (Cabarkapa et al., 2020; Morales-Rodríguez, 2021). During Shanghai lockdown in 2022, people across China have gained some understanding of Omicron variants including milder symptoms than previous variants (Tian et al., 2022), which may alleviate the perceived stress of Omicron. In response

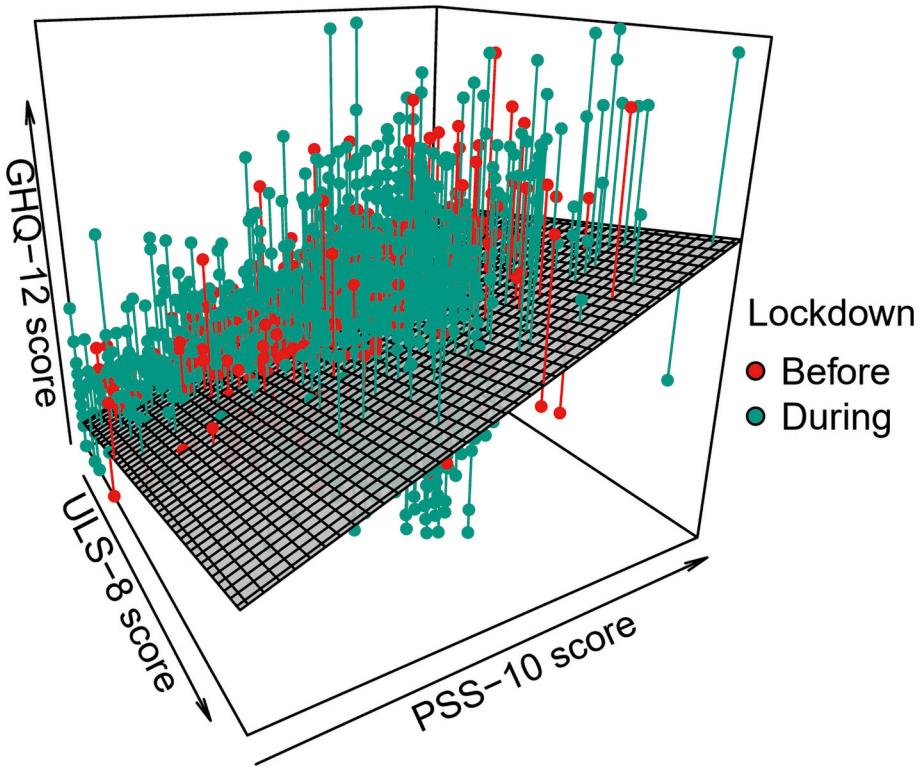

Fig. 1. 3D plots showed the relationship between Shanghai lockdown (Before and During), loneliness (ULS-8) and perceived stress (PSS-10) and mental health (GHQ-12).
GHQ-12: The 12-item Goldberg General Health Questionnaire
PSS-10: The 10-item Perceived stress scale
ULS-8: The short form UCLA Loneliness Scale.

to Omicron, the entire city of Shanghai was under lockdown, people may feel that everyone was under the same situation, thus perceived stress was buffered by emotional similarity (Townsend et al., 2014). Moreover, time with family members, leisure time, or sleep time may be more sufficient during lockdown than before, all these factors were beneficial to reduce perceived stress (Kim et al., 2019; Pieh et al., 2021).

Our multiple linear regression model revealed that Shanghai lockdown, loneliness and high perceived stress were risk factors of poor mental health. Besides, our study also indicated that one needs to draw attention to mental health of females and people with more education years. A previous study in seven middle-income countries in Asia also showed that females and high education background individuals were associated with adverse mental health (Wang et al., 2021). As an important economic hub in China, the national influence of Shanghai lockdown may partly be attributed to the radiation effect of economy of Shanghai on the whole country (Reuters, 2022). Loneliness and perceived stress have been regarded as emerging public health problems before COVID-19 which had great influence on mental health (Beutel et al., 2017; Cacioppo and Cacioppo, 2018; Cristóbal-Narváez et al., 2020; S. Wang et al., 2019). Now the problems are more prominent. As lockdown is an important measure to control infection during this COVID-19 era in China, interventions on loneliness and stress reduction accommodated to the new normal situation should be considered. For example, digital technology could play a role in tackling loneliness by social connection and networking online (Shah et al., 2020). Such management should be provided properly to the vulnerable people, such as older adults and individuals with a history of mental illness, and ensures the access to the digital technology (Berg-Weger and Morley, 2020; Shah et al., 2020; Varga et al., 2021). Social workers could also help people reduce their loneliness by assessing loneliness and developing and adapting evidence-based interventions (Berg-Weger and Morley, 2020). For perceived stress, a telephone hotline may be useful to address stress issues in the initial stage of lockdown (Su et al., 2022). Online psychosocial interventions and online multimedia psychoeducational interventions were well studied and suggested to mitigate stress and promote mental health (Shaygan et al., 2021; Wang and Mei, 2022; Ye et al., 2022).

The findings of this study are limited by several aspects. First of all, our study combined two cross-sectional studies, in which the population included before and during lockdown were two different samples. And we asked participants to report their status during Shanghai lockdown retrospectively, which may bring recall bias. Secondly, some confounding variables were lacking, such as global health, needs for health care, history of psychiatric disorders, adverse life events, employment, distance between Shanghai and area of residence and so on. Thirdly, online surveys are based on voluntary participation, so, they are limited by selection biases, and they do not reflect prevalence. Another limitation was that respondents in Shanghai and outside Shanghai from the nationwide data before Shanghai lockdown weren't at a 1:1 ratio, which we could not compare the data of Shanghai residents before and during lockdown period. Although with these limitations, our study provided the information of mental health status during Shanghai lockdown from both in Shanghai and outside Shanghai. One can see the epicenter psychological impacts of Shanghai lockdown and the effects spread at a national scale. Strategies aimed at reducing loneliness and perceived stress accommodated to the lockdown situation should be implemented, thus to promote the mental health both in the lockdown city and the whole country.

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Ethical standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 200.

Data sharing

Data can be requested by contacting the corresponding authors.

CRediT authorship contribution statement

Conceptualization, R.L., S.L.; Methodology, R.L., S.L.; Formal analysis, R.L.; Investigation, R.L., C.H., B.G., S.L.; Data curation, R.L., C.H.; Writing—original draft preparation, R.L.; Writing—review and editing, C.H., B.G., J.D., M.Z., S.L.; Supervision, J.D., M.Z., S.L.; Project administration, J.D., M.Z., S.L.; Funding acquisition, M.Z. All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

The authors declare no conflict of interest.

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