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Research paper

Social Isolation and Anxiety Disorder During the COVID-19 Pandemic and Lockdown in China

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ABSTRACT

The COVID-19 pandemic and lockdown measures have had a profound impact on the emotions, anxiety, and mental health of affected communities. Despite this, there is a lack of knowledge about the possible generational and geographical differences in the effects on the mental health of individuals. This study examines the impact of COVID-19 related quarantine on symptoms of generalized anxiety disorders (GAD) among parents and children ($N = 4503$). It also compares the outcomes of residents from the initial COVID-19 epicenter of Wuhan to those in surrounding areas. Subgroup analyses were conducted by child and parent samples, and by Wuhan city and other cities in the Hubei province. Propensity score radius matching and ordinary least squares regressions were used to examine the relationship between quarantine and GAD symptoms. Results showed that quarantine had more psychological impact on parents than children, regardless of geographic location. Parents that experienced quarantine in Wuhan city, reported a significantly higher level of symptoms of GAD than those that did not. Parents from other cities showed no such difference. For both children and parents, interpersonal communication about COVID-19 and social media exposure to pandemic-related information were linked to GAD symptoms. Targeted policies and interventions are needed to address the psychological impacts of COVID-19 lockdown.

1. Introduction

The novel coronavirus disease 2019 (COVID-19) was first reported in China and rapidly spread to 220 countries, areas, and territories through human-to-human transmission (World Health Organization [WHO], 2021a; WHO, 2021b). As of June 18, 2021, the emerging pandemic has claimed over 3.8 million lives, with more than 177 million confirmed cases worldwide (WHO, 2021a). Wuhan, a city in Hubei Province, became the first epicenter of the pandemic and reported the highest number of COVID-19 cases among all cities in Mainland China. Wuhan accounted for 54.6% of total cases (92,121) and 95.0% of reported deaths (4748, 5.2% mortality) in the country (Chinese Center for Disease Control and Prevention, 2020).

In an effort to control the pandemic and halt COVID-19 transmission, Wuhan imposed an unprecedented total lockdown to quarantine its 11 million residents for 77 days. The Hubei province, along with multiple other provinces in China, declared a first-level emergency response (Chinazzi et al., 2020; N. Liu et al., 2020). Following strict travel restrictions implemented overnight, children were out of school, adolescents were allowed to attend only online classes and working parents struggled to keep their jobs while providing childcare at home (S. Liu et al., 2020; Tian et al., 2020; Zhang et al., 2020). As a stressful event, the pandemic itself has brought mass panic, grief, financial losses, and an economic downturn across continents. These factors can cause serious psychological distress and increased diagnoses of psychiatric disorders among the general public (Dubey et al., 2020; N. Liu et al., 2020; Zhu et al., 2020). Children and adolescents are especially susceptible to mental health disorders during a public health crisis, and are at high risk for posttraumatic stress and somatic symptom disorders (Guessoum et al., 2020; Li et al., 2020; N. Liu et al., 2020).

The experience of a quarantine and living in extended home confinement makes families live in close quarters and follow strict social distancing rules outside the home. This threatens the physical health and psychological well-being of community members across the most affected areas in China and around the world (Abrams and Szefler, 2020; Luo et al., 2020; Qiu et al., 2020; Smith et al., 2020). The negative effects of prolonged psychosocial stressors (e.g. financial burden and problematic labor market) include stressful living circumstances, and a lack

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of social support and coping strategies that exacerbate loneliness and anxiety (Brooks et al., 2020; Smith et al., 2020; Tull et al., 2020). Since social connection has been recognized as a crucial factor for human development, and length and quality of life (Holt-Lunstad et al., 2017), both parents and children can struggle with anxiety disorders in isolation when there is no access to social supports and quality close relationships outside their homes.

Certain demographic and attitudinal characteristics appear to predict symptoms of generalized anxiety disorders (GAD), post-traumatic stress symptoms (PTSS) and depression. Key variables include, age, gender, education, marital status, time spent thinking about the pandemic, low socioeconomic status, and working in agriculture or healthcare (Huang and Zhao, 2020; N. Liu et al., 2020; Luo et al., 2020; Tian et al., 2020; Zhu et al., 2020). Previous studies have also shown that there is an association between anxiety and depression symptoms and COVID-related quarantine. A meta-analysis of 62 studies ($N = 162, 639$) across 17 countries identified social isolation as a common risk factor for negative mental health outcomes (Luo et al., 2020). In a cross-sectional study Smith et al. (2020) confirmed that self-isolation and social distancing measures in the UK are correlated with high levels of anxiety and depression in community members experiencing perceived isolation, lack of social connections, and heightened tensions among people who share confined physical spaces. A study done in the United States using a community-based adult sample showed findings consistent with other studies about increased anxiety and loneliness associated with stay-at-home orders, but generated contrary results in regards to the relationship between loneliness and the impact of COVID on daily life (Tull et al., 2020).

Although previous studies have captured the overall impact of quarantine on mental health outcomes, few have compared the effects among different age groups. Yeasmin et al. (2020) found that a high percent of children under the age 15 suffer from mental health issues in Bangladesh. These children also reported mental health issues if their parents had higher education levels, needed to physically attend the workplace, or displayed abnormal behaviors. Among adolescents, mental health status during the COVID-19 lockdown is associated with both protective factors related to coping abilities, and to risk factors at the individual, familial, and community levels as intrafamilial violence increased (Guessoum et al., 2020). For adults, mental health conditions and distress during lockdown are associated with their work status, existing medical conditions, exercise levels, and the severity of COVID-19 in their hometown (Zhang et al., 2020).

There is also relatively little research on the generational and geographical differences on mental health status. This study aims to fill these gaps by examining the differential impact of COVID-related quarantine on anxiety between parents and children, and by comparing the outcomes of people living in Wuhan and those in other parts of the Hubei province. As mentioned above, different household members might be exposed to and cope with the stressor in various degrees, although everyone is more likely to suffer from anxiety disorders and depression when in isolation. In addition, since Wuhan was the first epicenter of the pandemic, it implemented much stricter lockdown rules and longer quarantine than the rest of the province or any other areas in China. This study tests two hypotheses: 1) residents in Wuhan showed different levels of anxiety than those in other parts of Hubei province, and 2) COVID-related quarantine has different effects on anxiety levels between parents and children.

2. Methods

2.1. Data collection and ethical statement

This study uses data from the Social Cognition and Behavior Investigation of COVID-19 (Hubei) survey, which was conducted from January 31 to February 8, 2020, in Hubei Province, China (Li et al., 2020). This survey aimed to understand how children and their parents in Wuhan and other cities in Hubei responded to COVID-19 and lockdown. Children and their parents were recruited by convenience sampling through social media, a common method used in public health emergency studies (e.g., Elrggal et al., 2018). On the premise of obtaining the school's informed consent, 11 schools in Hubei Province were randomly selected for investigation. For recruitment, an advertisement, information sheet, and consent form detailing the project were forwarded to school officials to post on the school websites. In addition, via teachers, a uniform resource locator link of the survey questionnaire was sent to social media groups that aimed to keep the parents in contact with school. The school number, class number, and phone number filled in by the participants were used to match the children with their parents, one-to-one. Confidentiality was maintained by password protecting survey documents. Data collection began once the informed consent of each participant was obtained by clicking the "AGREE" button. The Human Subjects Ethics Subcommittee of pertinent University gave approval for the survey.

2.2. Sample

In total, 7058 participants voluntarily participated in the survey. Four criteria were adopted to identify qualified participants for the current study: a) native speakers of Chinese, b) currently residing in Hubei province, c) matched sample of children aged between 8 and 18 years while parents aged older than 30 years, and d) identified COVID-19 as a major stressful event experienced in the past two weeks. As a result, 2110 children (1203 girls and 907 boys; mean age = 13.37, SD = 1.21) and 2393 parents (1843 females and 550 males; mean age = 39.12, $SD = 1.49$) were involved in the study (total $n = 4503$).

2.3. Measures

Dependent Variable. Generalized anxiety disorder (GAD) symptoms were measured by the Generalized Anxiety Disorder Screener-2 item (GAD-2) scale (Kroenke et al., 2007). It is the shorter version of GAD-7, which was developed to conduct a quick and brief initial screening for GAD symptoms, and has acceptable validity and reliability (Plummer et al., 2016; Kehoe, 2017; Li et al., 2020). Respondents were asked to answer how often have they been bothered by the following problems due to COVID-19 over the last two weeks: a) Feeling nervous, anxious or on edge and b) Not being able to stop or control worrying (0= Not at all; 1= Several days; 2= More than half the days; 3 = Nearly every day; Cronbach's alpha = 0.77). Responses for these two items were summed, with higher scores indicating greater severity of GAD symptoms.

Independent variable. The key independent variable is whether the respondent was ever isolated or quarantined during the pandemic (1 = yes; 0 = no). Overall, about 9% ($n = 191$) of children and 9% ($n = 207$) of the parent sample reported that they had been isolated during the COVID-19 pandemic.

Covariates. To explore the relationship between social isolation and GAD symptoms during the pandemic, this study controlled for the following covariates: gender (1=male; 0 = female), age, and self-perceived socioeconomic status relative to other people (1= lowest, 10= highest). We also controlled for the respondents' frequency of interpersonal (e.g., with family members, friends, or colleagues) communication/discussion about COVID-19 (recoded as two binary variables: *Low* [reference group]; *Medium*; and *High*), and the total hours of average daily social media exposure on COVID-19 information after lockdown in Wuhan. In addition, for the child sample, we controlled for their grade, and for the parent sample, we controlled for parental education levels (recoded as three binary variables: *primary school or less* [reference group], *middle school, high school*, and *some college or above*). See Table 1 for detailed measures for child and parent samples.

Table 1
Sample descriptions.

Variables	Children									Parents								
	Total Children (n = 2110)				Isolated (n = 191)		Not Isolated (n = 1919)			Total Parents (n = 2393)				Isolated (n = 207)		Not Isolated (n = 2186)		
	Mean	SD	Min	Max	Mean	SD	Mean	SD	p	Mean	SD	Min	Max	Mean	SD	Mean	SD	p
Dependent Variable Anxiety Total Scores	4.18	1.76	2	8	4.09	1.83	4.19	1.76		4.88	1.83	2	8	5.14	1.83	4.86	1.83	
Independent Variable Isolation	0.09	0.29	0	1	1	0	0	0		0.09	0.28	0	1	1	0	0	0	
Covariates																		
Male	0.43	0.50	0	1	0.46	0.50	0.43	0.50		0.23	0.42	0	1	0.24	0.43	0.23	0.42	
Age	13.37	1.21	12	18	13.51	1.13	13.36	1.21		39.12	4.88	30	63	39.79	4.61	39.06	4.90	
Grade	7.59	1.81	1	12	7.65	1.97	7.58	1.79		–	–	–	–	–	–	–	–	
Parental education level																		
Primary or less	–	–	–	–	–	–	–	–		0.07	0.25	0	1	0.03	0.18	0.07	0.26	**
Middle school	–	–	–	–	–	–	–	–		0.31	0.46	0	1	0.17	0.38	0.33	0.47	*
High School	–	–	–	–	–	–	–	–		0.35	0.48	0	1	0.30	0.46	0.35	0.48	
Some college or above	–	–	–	–	–	–	–	–		0.27	0.44	0	1	0.50	0.50	0.25	0.43	***
Social class levels	4.95	1.85	1	10	5.21	1.73	4.92	1.86	**	4.97	1.85	1	10	5.22	1.87	4.95	1.85	**
Interpersonal communication on COVID-19																		
Low	0.05	0.22	0	1	0.03	0.16	0.05	0.22	*	0.05	0.21	0	1	0.03	0.17	0.05	0.21	*
Medium	0.25	0.43	0	1	0.21	0.41	0.25	0.43	**	0.32	0.46	0	1	0.21	0.41	0.33	0.47	**
High	0.70	0.46	0	1	0.76	0.43	0.70	0.46	***	0.64	0.48	0	1	0.76	0.43	0.63	0.48	***
Total hours of average daily social media exposure on COVID-19 information after Lockdown Wuhan	5.18	3.21	1	13	5.32	3.30	5.16	3.21	*	5.90	3.23	1	13	6.45	3.34	5.85	3.21	*

Notes. p value indicates the significant level of differences of the covariates between isolated and not isolated groups; *** $p < .001$, ** $p < .01$, * $p < .05$.

2.4. Analyses strategies

First, descriptive statistics were conducted by child and parent samples separately. For each sample, we reported the sample characteristics by total, isolated, and not isolated samples. Secondly, to reduce the sample selection bias from the nonprobability sample of cross-sectional survey between the isolated and not isolated groups, propensity score radius matching approach was used to balance the significant differences of all covariates between the two groups (Guo and Fraser, 2015). As shown in Table 1, before matching, the isolated and not isolated groups significantly differed in more than half of the covariates. The balance check results after matching showed that none of the covariates significantly differed between the two groups. Then, based on the balanced data, a series of ordinary least squares (OLS) regressions were conducted to examine the relationship between isolation and GAD symptoms. We conducted subgroup analyses on child and parent sample separately, to assess whether the COVID-related quarantine has different effects on GAD symptoms between parents and children, and between the residents from Wuhan and those in other cities of Hubei province.

3. Results

3.1. Descriptive statistics

As shown in Table 1, for child respondents (n = 2110), about 43% were boys, and the average age of these children was about 13 years old (range from 12 to 18). The average child grade was the 8th. The average child self-perceived social class level was middle class (about 5 out of 10). 70% of the participants reported a high level of interpersonal communication frequency on COVID-19 with their family members or friends, 25% reported medium level, and only 5% reported a low level of interpersonal communication frequency. The average total hours of daily exposure to social media on COVID-19′s information after lockdown in Wuhan for the child sub-sample was about five hours. We also found a significant difference in social class between the isolated child group and non-isolated group (p = .03).

For parent respondents (n = 2393), about 23% were males, and the average age was about 39 years old (range from 30 to 63). The majority of the parents had a middle school or higher degree (i.e., 35% had high school, 31% had middle school, and 27% had some college or higher degree), whereas only 7% had a primary degree or less. The average parents' self-perceived social class level was similar to the one reported by their children, middle class (about 5 out of 10). Approximately two-thirds of the participants reported a high level of interpersonal communication frequency on COVID-19 with their family members, friends, or colleagues, 32% reported medium level, and only 5% reported a low level. The average total hours of daily social media exposure on COVID-19 information after lockdown in Wuhan for the adult sub-sample was about six hours.

3.2. Relationship between social isolation and GAD symptoms

OLS regressions based on the matched sample were used to test the two research hypotheses. To examine the first research hypothesis, we split the whole sample into two subsamples: residents from Wuhan (in short "Wuhan" sample) and those in other cities of Hubei province (in short "other cities" sample). To examine the second research hypothesis, the child and parent sub-samples were further split into two subsamples of child sample and parent sample.

Table 2 shows the regression coefficients of the social isolation on GAD symptoms based on the six models (Column 1- 6), controlling for demographic characteristics and other covariates. The results indicate that individuals that experienced social isolation had significantly different levels of GAD symptoms, but only for the parent sample not the child sample. Specifically, as shown in Table 2 column 4, parents that experienced social isolation had significantly higher GAD symptoms by 0.309 ($p < .05$; Table 2 Column 4). Based on Table 2 column 1, however, children who experienced social isolation showed no statistically significant differences on GAD symptoms from their non-isolated counterparts.

Regarding geographic differences, our results show that parents from Wuhan city that experienced social isolation had significantly higher levels of GAD symptoms than their non-isolated counterparts from

Table 2
OLS regression results based on the matched samples.

	Child			Parent		
Variables	(1) Total	(2) Wuhan	(3) Hubei Others	(4) Total	(5) Wuhan	(6) Hubei Others
Isolation (1=Yes)	−0.112	−0.144	0.076	0.309*	0.407*	0.160
	[−0.375 - 0.150]	[−0.525 - 0.237]	[−0.281 - 0.432]	[0.050 - 0.569]	[0.008 - 0.805]	[−0.173 - 0.493]
Gender (1= Male)	−0.304*	−0.483*	−0.247	−0.393**	−0.883***	−0.080
	[−0.572 - −0.036]	[−0.925 - −0.040]	[−0.559 - 0.066]	[−0.687 - −0.098]	[−1.278 - −0.488]	[−0.463 - 0.303]
Age	0.022	0.265*	−0.092	0.003	0.002	−0.000
	[−0.117 - 0.162]	[0.022 - 0.507]	[−0.293 - 0.108]	[−0.029 - 0.035]	[−0.053 - 0.057]	[−0.036 - 0.035]
Parental education level						
(Ref.=Primary or less) Middle school	–	–	–	−0.825	−1.816***	−0.649
	–	–	–	[−2.016 - 0.367]	[−2.764 - −0.869]	[−1.919 - 0.621]
High School	–	–	–	−0.915	−2.000***	−0.766
	–	–	–	[−2.104 - 0.273]	[−2.812 - −1.188]	[−2.042 - 0.510]
Some college or above	–	–	–	−1.216*	−2.044***	−1.189
	–	–	–	[−2.400 - −0.031]	[−2.810 - −1.277]	[−2.459 - 0.082]
Social class levels	−0.121***	−0.083	−0.116**	−0.029	−0.127	0.035
	[−0.192 - −0.049]	[−0.196 - 0.030]	[−0.203 - −0.028]	[−0.107 - 0.050]	[−0.265 - 0.010]	[−0.053 - 0.122]
Interpersonal communication on COVID-19						
(Ref.= Low) Medium	−0.048	0.145	0.135	0.286	0.841*	−0.440
	[−0.707 - 0.611]	[−0.656 - 0.946]	[−0.740 - 1.010]	[−0.235 - 0.808]	[0.091 - 1.591]	[−1.146 - 0.266]
High	0.583	0.654	0.732	0.834***	1.273***	0.234
	[−0.036 - 1.203]	[−0.057 - 1.366]	[−0.092 - 1.555]	[0.356 - 1.312]	[0.603 - 1.942]	[−0.438 - 0.905]
Total time of social media exposure on COVID-19 information after Lockdown Wuhan	0.068**	0.006	0.108***	0.045*	0.007	0.067**
	[0.023 - 0.113]	[−0.060 - 0.072]	[0.056 - 0.159]	[0.005 - 0.085]	[−0.067 - 0.081]	[0.020 - 0.114]
Child's grade	−0.039	−0.109	−0.037	–	–	–
	[−0.143 - 0.064]	[−0.227 - 0.009]	[−0.241 - 0.167]	–	–	–
Constant	4.169***	1.212	5.440***	4.990***	6.515***	5.030***
	[2.502 - 5.836]	[−1.889 - 4.312]	[3.480 - 7.399]	[3.175 - 6.804]	[3.767 - 9.263]	[2.960 - 7.100]
Observations	2038	626	1412	2057	673	1384
R-squared	0.064	0.077	0.084	0.067	0.112	0.079

Notes. 95% confident interval in brackets; *** $p< .001$, ** $p< .01$, * $p< .05$.

Wuhan City by 0.407 ($p < .05$; Table 2 Column 5). None of the child subgroups of Wuhan or other cities samples showed significant differences. In addition, parents from other cities that experienced social isolation had no significantly different levels of GAD symptoms than their non-isolated counterparts.

Table 2 also demonstrates that several covariates were associated with significantly lower level of GAD symptoms. For the total parent sample (Column 4), compared to those who had a low frequency of interpersonal communication on COVID-19, parents who had high frequency reported a significantly higher level of GAD symptoms by 0.834 ($p < .001$). However, this significant relationship was found only for the Wuhan parent subsample ($b = 1.273$, $p < .001$), not the other cities' parent subsample. In addition, for the total child sample (Column 1), every hour increase in average daily social media exposure on COVID-19 information after lockdown of Wuhan increased the level of GAD symptoms of the total child sample by 0.068 ($p < .01$). However, this significant relationship was shown only for other cities' child subsample ($b = 0.108$, $p < .001$) not the Wuhan child subsample. Similarly, for the total parent sample, every hour increase of average daily social media exposure on Covid-19 information after lockdown of Wuhan increases the level of GAD symptoms of total parents by 0.045 ($p < .05$). However, such significance relationship was shown only for other cities parent subsample ($b = 0.067$, $p < .01$), not the Wuhan parent subsample.

Compared to male parents, female parents had a significantly lower level of GAD symptoms by 0.393 ($p < .05$; Column 4). However, such significant relationship was presented only for the Wuhan parent subsample ($b = -0.883$, $p < .001$), not the other cities parent subsample. Results showed similar gender differences on GAD symptoms for the child sub-samples. Boys had a significantly lower level of GAD symptoms than girls by 0.304 ($p < .05$; Column 1). However, such significant relationship was presented only for the Wuhan child subsample ($b = -0.483$, $p < .05$), not the other cities child subsample. In addition, for every one level increase in social class for the child sample, the level of GAD total symptoms for children decreased by 0.121 ($p < .001$). However, such significant relationship only applied to the other cities' child sub-sample ($b = -0.116$, $p < .05$), not the Wuhan child subsample. There were no significant differences on the GAD symptoms for either parent subsample.

We also conducted the same OLS regression analyses based on the raw date (without matching) to test the robustness of the main analytic results based on matched samples. Overall, as shown in Table 3, the relationships between social isolation and GAD symptoms were consistent between the raw and matched data.

4. Discussion

Using data from Hubei province of China, this study examined the differential influence of COVID-related quarantine on GAD symptoms

Table 3
OLS regression results with raw data.

VARIABLES	Child			Parent		
	(1) Total	(2) Wuhan	(3) Hubei Others	(4) Total	(5) Wuhan	(6) Hubei Others
Isolation (1=Yes)	−0.113	−0.179	0.104	0.308*	0.401*	0.175
	[−0.372 - 0.145]	[−0.542 - 0.184]	[−0.258 - 0.465]	[0.050 - 0.566]	[0.007 - 0.795]	[−0.169 - 0.519]
Gender (1=Male)	−0.185*	−0.186	−0.197*	−0.424***	−0.866***	−0.248*
	[−0.336 - −0.034]	[−0.444 - 0.072]	[−0.382 - −0.013]	[−0.598 - −0.250]	[−1.197 - −0.535]	[−0.453 - −0.043]
Age	−0.005	0.090	−0.054	−0.014	0.009	−0.022*
	[−0.078 - 0.068]	[−0.047 - 0.227]	[−0.160 - 0.053]	[−0.029 - 0.002]	[−0.018 - 0.037]	[−0.040 - −0.004]
Parental education level						
(Ref.=Primary or less) Middle school	–	–	–	0.162	0.417	0.083
	–	–	–	[−0.145 - 0.469]	[−0.393 - 1.227]	[−0.252 - 0.418]
High School	–	–	–	−0.055	0.128	−0.116
	–	–	–	[−0.362 - 0.252]	[−0.677 - 0.933]	[−0.455 - 0.222]
Some college or above	–	–	–	−0.316	0.057	−0.464**
	–	–	–	[−0.633 - 0.002]	[−0.765 - 0.880]	[−0.815 - −0.112]
Social class levels	−0.080***	−0.095**	−0.068**	−0.065**	−0.108**	−0.045
	[−0.121 - −0.039]	[−0.164 - −0.026]	[−0.118 - −0.018]	[−0.106 - −0.023]	[−0.181 - −0.034]	[−0.095 - 0.005]
Interpersonal communication on COVID-19						
(Ref.= Low) Medium	0.130	0.428	0.048	0.389*	0.616*	0.237
	[−0.238 - 0.498]	[−0.207 - 1.064]	[−0.400 - 0.495]	[0.033 - 0.746]	[0.039 - 1.192]	[−0.218 - 0.692]
High	0.515**	0.872**	0.391	0.832***	1.102***	0.688**
	[0.166 - 0.864]	[0.271 - 1.473]	[−0.033 - 0.815]	[0.487 - 1.178]	[0.537 - 1.667]	[0.248 - 1.127]
Total time of social media exposure on COVID-19 information after Lockdown Wuhan	0.061***	0.033	0.074***	0.058***	0.052**	0.060***
	[0.038 - 0.085]	[−0.005 - 0.070]	[0.045 - 0.104]	[0.035 - 0.081]	[0.013 - 0.092]	[0.032 - 0.088]
Child's grade	0.009	−0.050	0.022	–	–	–
	[−0.039 - 0.058]	[−0.106 - 0.006]	[−0.077 - 0.122]	–	–	–
Constant	3.950***	2.716**	4.606***	4.860***	3.918***	5.229***
	[3.019 - 4.880]	[0.816 - 4.615]	[3.501 - 5.712]	[4.076 - 5.644]	[2.436 - 5.400]	[4.274 - 6.185]
Observations	2110	647	1463	2393	765	1628
R-squared	0.036	0.050	0.036	0.060	0.091	0.055

Notes. Robust 95% confident interval in brackets, *** $p< .001$, ** $p< .01$, * $p< .05$.

among parents and children, then compared the outcomes of people living in Wuhan with those in other parts of Hubei province. Our findings partially support the first hypothesis that only parents who experienced social isolation had significantly higher levels of GAD symptoms. The results showed no such differences among the sample of children, regardless of geographic location. Our results also partially support the second hypothesis, that individuals who experienced social isolation had significantly different levels of GAD symptoms compared to those who did not. However, only participants from Wuhan city showed a significant relationship between social isolation and GAD symptoms. Quarantine appears to have more psychological impact on parents than children in this study. This supports the findings of the only other study about parental mental health during the pandemic to date that identified protective factors, such as good marital relationship, family harmony and social support, as well as risk factors including having school-age children, stress, and history of mental illness (Wu et al., 2020).

One unique contribution is the analysis of geographical differences among individuals in the hardest hit city, Wuhan, and the surrounding areas in the same province with less strict quarantine rules. This type of regional comparison is rare in the literature (Fu et al., 2020; N. Liu et al., 2020). Our findings demonstrate that those living in other cities in the Hubei province that had more social media exposure during the COVID-19 pandemic reported significantly higher level of GAD symptoms. This is not the case for those in Wuhan. Recent studies have consistently found that negative health outcomes and risk behaviors are strongly associated with social media usage, especially exposure to misinformation and conspiracy theories during the outbreak (Allington et al., 2020; Gao et al., 2020). It is reasonable to believe that residents in Wuhan had more first-hand information about the pandemic. Whereas those in other regions might have relied more on social media to access information and had a higher chance of being exposed to misinformation and anxiety-driving messages.

Considering that COVID-19 is still spreading throughout the world and many regions are currently experiencing the second wave of cases, important prevention measures, such as regional shutdown and quarantine, may still take place in the near future. Therefore, it is important to understand the mental health consequences and develop appropriate intervention methods for hardest-hit areas, like Wuhan.

Our results are consistent with the findings of several previous studies about children's psychological and behavioral health outcomes in COVID-19 (Dubey et al., 2020; N. Liu et al., 2020; Yeasmin et al., 2020). For younger children, like the sample of children in this study with an average age of 13, their main concerns about the COVID-19 pandemic could be directly related to life and death. On the other hand, the burden of getting everyday necessities and prevention efforts often falls on the shoulders of their parents, whose support and behaviors impact the stress levels of their young children (N. Liu et al., 2020). Yeasmin et al. (2020) found some mental health disturbances in Bangladeshi children, they also recognized parents' role modeling as an

essential source of resilience among their children. Dubey et al. (2020) also emphasized the crucial role that parents play in supporting children's online learning. This eases children's anxiety related to potential loss of education, and in maintaining regular sleep and physical exercise routines of children. These factors were linked to reducing boredom and developmental issues, and in teaching proper hygiene practices which effectively ease the fear of infection among their children (Dubey et al., 2020). Thus, this literature supports our interpretation of the reasons why the young children in our study showed no difference in GAD symptoms.

In term of the relationship between demographics and anxiety level during quarantine, this study found that male parents are significantly more likely to experience GAD than female parents. This finding contradicts previous studies showing either no significant gender differences (Tian et al., 2020; Tull et al., 2020; Wu et al., 2020) or more psychological stress symptoms among women than men (N. Liu et al., 2020; Smith et al., 2020). These mixed findings were not well explained in the literature. Poorer mental health outcomes have consistently been documented among women prior to the pandemic, which reveals pre-existing gender differences in mental health status before quarantine experiences (Brooks et al., 2020; Smith et al., 2020; Stickley and Koyanagi, 2018). The reversed gender difference in our findings could be biased by the relatively small proportion of male participants in our study or perhaps male parents may be more exposed to risk due to their work. While there are no significant gender differences among children, our findings show that children from family with higher socioeconomic status had lower level of GAD symptoms, which aligns with previous studies in identifying family economic condition as an important determinant of mental health (Abrams and Szefler, 2020; Sareen et al., 2011). Based on these findings, we suggest that low household income is associated with increased risk for multiple lifetime mental disorders. This relationship has been established prior to the pandemic (Golberstein, 2015; Sareen et al., 2011), and can often exacerbate during crises, like the COVID-19 pandemic, for vulnerable children and families (Kämpfen et al., 2020). This can be explained by the conservation of resources theory as lack of resources leading to higher level of family stress (Hobfoll, 2011), In addition, lower income households might face additional structural barriers, such as frontline work or small dwellings, that prevent measures against both COVID-19 and mental health problems.

Several limitations of the study need to be acknowledged. First, we adopted an online survey approach to collect data due to the pandemic and all the information was based on self-report measures. This is likely to yield biased information due to the social desirability response bias in online surveys (Brajša-Žganec et al., 2011). Second, we should be cautious not to generalize the findings to the entire population due to the convenience sampling. Third, the survey only included those who identified COVID-19 as a major stressful event in the past two weeks, and may have potential bias towards anxiety. Last, this study collected only one wave of data from an early stage of the pandemic. Individuals' mental health status might change overtime. Therefore, collecting more waves of data within a longitudinal design is recommended for future studies.

Despite these limitations, this study has several strengths. First, using a propensity score matching approach can reduce the sample selection bias. This method also allows equivalent comparisons between those that experienced social isolation during the pandemic and those that did not. Second, this study used subgroup analyses to explore the geographic differentiations between Wuhan city and other cities in Hubei Province. Third, this study also helps to better understand the relationships between social isolation and anxiety levels, especially for defining the differences between the child sample and the parent sample. Thus, the subgroup analyses based on geographic locations and by child and parent's samples can help to develop tailored policies and intervention programs, and to provide better supports and services for targeted populations. The social media and other means of communication can influence the perception of the pandemic and related prevention measures, which in turn can support community members' psychosocial wellbeing.

5. Conclusion

This study found that social isolation did not significantly affect GAD symptoms among children in Wuhan and other cities of Hubei province. However, our findings showed significantly higher GAD symptoms among parents from Wuhan city that experienced social isolation than their Wuhan counterparts that did not. Yet parents from other cities who experienced social isolation showed no such difference in their GAD symptoms. This study highlights the need to develop targeted psychological interventions to mitigate negative mental health outcomes related to COVID-19 pandemic. The findings also have significant implications for not only policy makers but also practitioners providing services to address the adverse impacts of COVID-19. It is necessary to consider geographic differences, and to tailor programs and interventions to the needs of parents and children.

Author statement contributors

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The funders had no role in the study.

Declaration of Competing Interest

Author declares that we have no conflict of interest.

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