Research paper

Associations between feelings/behaviors during COVID-19 pandemic lockdown and depression/anxiety after lockdown in a sample of Chinese children and adolescents

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ABSTRACT

Background: Children and adolescents may be more susceptible to mental disorders due to COVID-19 pandemic than adults. This study aimed to identify correlated factors for depression/anxiety among children and adolescents after COVID-19 pandemic lockdown.
Methods: An online survey by cluster sampling was conducted after lockdown in 5175 Chinese children and adolescents with informed consents from their parents. The 9-item Patient Health Questionnaire and the 7-item Generalized Anxiety Disorder scales with 10-point cutoff were used to measure depression and anxiety, separately. Stepwise logistic regression was conducted. Stata 15.1 Version was used.
Results: 12.33% and 6.26% of all participants reported depression and anxiety after lockdown, separately. Suicidal ideation, quarreling with parents, insomnia, difficulty in concentrating during online learning, and anxious and depressed mood during lockdown were positively associated with depression and anxiety after lockdown. Missing teachers was negatively associated with both depression and anxiety. Living in urban and not living with parents were positively associated with depression.
Limitations: The past history and familial history of mental disorders have not been collected. The recall biases for collecting self-reporting information might exist, and the causal inferences cannot be drawn.
Conclusions: The prevalence of depression and anxiety in children and adolescents might decline a bit after lockdown but is still at a high level after lockdown. Gatekeepers should pay more attention to modifiable factors of psychological well-being in children and adolescents, including family and school contexts and even feelings and behaviors during COVID-19 pandemic lockdown.

1. Introduction

Since the outbreak of the novel coronavirus pneumonia occurred in December 2019 (WHO, 2020) , the 2019 coronavirus disease (COVID-19) pandemic has been a global public health threat and emergency of international concern (Wang et al., 2020a; Zhu et al., 2020). Chinese government took swift responses to contain the spread of the disease with an imposed lockdown and strict travel restrictions

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(Wang et al., 2020b). Most of Chinese people kept staying at home and were socially isolated for preventing the quick spread of COVID-19, including 180 million children and adolescents after a nationwide school closure (Horton, 2020; Wang et al., 2020a; Xie et al., 2020).

As a natural disaster and traumatic event globally, COVID-19 pandemic forces people to face the fact of death and causes the feeling of insecurity, which have negative impacts on people's mental health. No definite answer about the end of the pandemic and no effective treatment further exacerbate the issue. To evaluate its effect on mental health and provide protective and intervention strategy, various studies have been conducted to investigate the psychological effects of COVID-19 during the pandemic focusing on depressed feeling, anxious feeling, family violence, stress, sleep problems, discomfort, etc. (Guessoum et al., 2020; Liu et al., 2020a; Torales et al., 2020). The studies have been performed in different populations, including general population, medical personnel, elderly people, college students, children and adolescents (Chen et al., 2020; Jiao et al., 2020; Liu et al., 2020b; Picaza Gorrochategi et al., 2020; Rajkumar, 2020; Spinelli et al., 2020; Urooj et al., 2020; Wang et al., 2020a; Wang and Zhao, 2020; Xie et al., 2020).

Compared with other populations, the strict lockdown, school closures, attending online curriculums, conducting daily activities indoors and decreased social relations have imposed greater challenges on children and adolescents in terms of psychological problems and psychiatric disorders (Green, 2020; Lee, 2020; Liu et al., 2020a). Children and adolescents would suffer from anxiety and depression more frequently while remaining at home as much as possible during COVID-19 pandemic lockdown (Chen et al., 2020; Lee, 2020; Torales et al., 2020). From a study of 8079 Chinese high school students, the prevalence of depression which was defined by Patient Health Questionnaire-9 (PHQ-9) with a cutoff point of 5 and anxiety which was defined by Generalized Anxiety Disorder (GAD-7) with a cutoff point of 5 was reported as 43.7% and 37.4%, respectively, during COVID-19 pandemic lockdown (Zhou et al., 2020). From a study of 2330 Chinese primary students in Hubei Province, the prevalence of depression (by the Children's Depression Inventory–Short Form) and anxiety (by the Screen for Child Anxiety Related Emotional Disorders) during COVID-19 pandemic lockdown was reported as 22.6% and 18.9%, respectively (Xie et al., 2020).

Most studies focused on mental health status during COVID-19 pandemic period (Chen et al., 2020; Jiao et al., 2020; Liu et al., 2020b; Spinelli et al., 2020; Xie et al., 2020), however, little is known about the prevalence of depression and anxiety in children and adolescents after lockdown, and the relationship with the experiences (feelings/behaviors) during the lockdown period. This study aimed to estimate the prevalence of depression and anxiety in children and adolescents after lockdown and to identify correlated factors during COVID-19 pandemic lockdown period.

2. Methods

2.1. Study setting and data collection procedure

A cross-sectional study was conducted in children and adolescents (9-18 years old) with the informed consent from their parents after the COVID-19 pandemic lockdown. It covered five cities and counties in Shandong Province, China. As the background policy information, children and adolescents in Shandong Province had been restricted at home for isolation or quarantine and attended online curriculums from February 10th to April 15th, 2020. This survey was conducted from June 9th to June 28th, 2020, when children and adolescents had been back to school for two months. An online questionnaire survey (www.wjx.cn, i. e., "The SurveyStar", Changsha Ranxing Information Science and Technology Co., Changsha, China) was used to collect individual's general information, feelings and behaviors during the COVID-19 pandemic lockdown period and current mental health status.

The inclusion criteria were children and adolescents who: (1) were

primary students (Grade 5 and Grade 6), middle school students (Grade 7, Grade 8 and Grade 9) and high school students (Grade 10 and Grade 11); (2) volunteer to participate in this survey and could finish the survey by themselves; (3) were living and studying in Shandong Province during the outbreak of COVID-19 and lockdown period; (4) could read and understand the whole questionnaire items; (5) were with parents' consent for attending this study; (6) were back to school after lockdown. The exclusion criteria were children and adolescents who: (1) refused to participant this survey; (2) could not finish the questionnaire by themselves; (3) were without parents' consent; (4) could not back to school after lockdown; (5) were primary students (Grade 1-4) and high school students (Grade 12).

On the premise that the students and head teachers had agreed to participate in the survey, informed consent information was sent to all participants' parents with a quick response code (QR code) or a website link by the head teacher of each selected class. After scanning the QR code or clicking the website link to read the informed consent information, parents would first decide whether their children would continue this survey. Only the parents who chose "Yes" would be taken to the questionnaire page. Then, children and adolescents would complete the questionnaire independently. The questionnaires were anonymous to ensure the confidentiality of participants and the reliability of results.

To control the research quality of the questionnaire and to avoid repeated answers, the physical address of the phone or computer could be accepted only once and it would be denied when participants answered the questionnaire and uploaded more than once. Logical jumps and checks were set in the survey system and questionnaires. Two independent researchers (JZ & ZFW) have checked the automatically saved dataset, separately.

2.2. Participants included in this study

The total number of primary school students, middle school students and high school students in Shandong Province was 7.386 million, 3.609 million and 1.672 million, respectively. The multi-stage cluster random sampling technique was used for sampling, i.e., we randomly selected two prefecture-level cities with the GDP accounting for the medium development level in Shandong Province which was the 6th and the 8th among 16 prefecture-level cities in 2019, and then randomly selected two primary schools, four middle schools and one high school in each prefecture-level city. When the school was selected, all qualified respondents would be included. If the selected school refuses to attend this study, another school would be selected with convenience sampling.

The qualified children and adolescents were about 2,500 in five primary schools, 4,000 in eight middle schools and 3,000 in two high schools and the total number was about 9500. Finally, 5331 students finished the online survey with the proportion of 56.12%. 5175 completed questionnaires were deemed to be qualified for the analysis with a qualified rate of 97.07%.

156 excluded participants consisted of 120 students who had reported the wrong birthday and 36 adults (with ages of 22 and over). The proportion of exclusion students was 2.27%.

2.3. Measurements

2.3.1. Depression

The Chinese version of PHQ-9 which was used to assess participants' depression had satisfied reliability in Chinese adolescents with the Cronbach's α coefficient of 0.869 (Leung and Mak, 2020). It is used to assess nine depressive symptoms in the past 2 weeks (Kocalevent et al., 2013; Kroenke et al., 2010). The response to each of the 9 symptom items has a 4-point Likert scale, i.e., (0) "Not at all", (1) "Several days", (2) "More than half of the days", (3) "Nearly every day". The total scores were from 0 to 27. The higher scores indicate greater severity of depression. The severity of depression is categorized as: 0-4 (no

depression), 5-9 (mild depression), 10-14 (moderate depression), 15-19 (severe depression), and 20 and over (extremely severe depression). In this study, 10-point was used as the cutoff to define depression (Liu and Wang, 2015).

2.3.2. Anxiety

The Cronbach α coefficient of Chinese version of GAD-7 was 0.917 (Leung and Mak, 2020). Each item rates on a 4-point Likert scale, i.e., (0) "Not at all", (1) "Several days", (2) "More than half of the days", (3) "Nearly every day". The total scores are from 0 to 21. The higher scores indicate the greater severity of anxiety. The severity of anxiety is categorized as: 0-4 (no anxiety), 5-9 (mild anxiety), 10-14 (moderate anxiety), and 15 and over (severe anxiety). In this study, 10-point was used as the cutoff to define anxiety (Spitzer et al., 2006).

2.3.3. General information and independent variables

Sociodemographic data were collected including age, gender, school level, only child, residential location and living status. Experiences (feelings/behaviors) including scare, unhappiness, pressure, depressed mood, anxious mood, suicidal thoughts, missing teachers and classmates, not eating on time, not getting up on time, insomnia, quarreling with parents, inattention during online learning, etc., during COVID-19 pandemic lockdown period were collected by self-reported questions. Most of the independent variables were bi-variate variables (Yes/No).

2.4. Statistical analysis

All analyses were conducted using STATA 15.1 (STATA, 2015). The frequency and distribution values of independent variables were calculated. Bi-variate analyses between selected variables and the occurrence of depression and anxiety in children and adolescents were conducted. The independent variables with a significance level of <0.05 were kept for multivariate logistic analysis. Due to the collinearity of independent variables, stepwise logistic regression including forward and backward steps was conducted to determine the final models.

3. Results

3.1. Characteristics of participants

The descriptive characteristics of participants were shown in Table 1. Among the 5175 participants, 1339 of them (25.87%) were from primary school, 3117 of them (60.23%) were from middle school and 719 of them (13.89%) were from high school. It indicates that 0.02% of all primary school students, 0.09% of all middle school students and 0.04% of all high school students in Shandong Province were covered in this study. The mean age was 13.37 years (SE=0.02). 2502 (48.35%) students were females. 1093 (21.12%) students were only child. 4082 (78.88%) students were from rural areas. 1333 (25.76%) students reported that they were living with single parent or without parent during COVID-19 lockdown period.

There were no differences in sex (χ^2=1.18, P=0.28), residence (χ^2=4.73, P=0.03) and family structure (only child) (χ^2=0.01, P=0.94) between 120 exclusion students and 5175 inclusion students at the significant level of 0.01.

3.2. Feelings/behaviors of participants during COVID-19 pandemic lockdown

The most predominating perceived feelings during COVID-19 pandemic lockdown period were psychological pressure (41.51%), scare (27.86%), depressed mood (26.01%), anxious mood (23.65%), unhappiness (20.19%), suicidal thoughts (3.00%), and disliking parents (2.96%). The most predominating behaviors included inattention during online learning (21.93%), not getting up on time (19.86%), not eating on time (8.33%), quarreling with parents (6.63%) and insomnia

Table 1
Characteristics of 5175 participants and frequencies of different levels of depression and anxiety based on different cutoff point criteria

Variables	Categories	n	Frequency (%)
Age	Mean±SE (years)	13.37±0.02	
Sex	Male	2673	51.65
	Female	2502	48.35
Only child	Yes	1093	21.12
	No	4082	78.88
Residence	Urban	1362	26.32
	Rural	3813	73.68
Living arrangement	With both parents	3842	74.24
	With single parent	1013	19.57
	Other*	320	6.18
School level	Primary school	1339	25.87
	Middle school	3117	60.23
	High school	719	13.89
Depression score**			
0-4	No	3517	67.96
5-9	Mild	1020	19.71
10-14	Moderate	352	6.80
15-19	Severe	163	3.13
20-27	Extremely severe	124	2.40
Total		5175	100.00
0-9	No	4537	87.67
10-27	Yes	638	12.33
Total		5175	100.00
Anxiety score***			
0-4	No	3846	74.32
5-9	Mild	1005	19.42
10-14	Moderate	179	3.46
15-21	Severe	145	2.80
Total		5175	100.00
0-9	No	4851	93.74
10-21	Yes	324	6.26
Total		5175	100.00

* Living without parents but with grandparents, relatives, friends, live-in nanny, etc.
** Screened by PHQ-9
*** Screened by GAD-7.

(6.24%). However, 49.97% participants reported that they missed their classmates very much, 47.09% reported that they wanted to go back to school and 40.12% reported that they missed their teachers very much.

3.3. Prevalence of depression and anxiety after lockdown

The prevalence of depression and anxiety of all participants was 12.33% and 6.26%, separately. 5.16% participants were suffering from both depression and anxiety (Table 1).

The prevalence of depression in female participants (16.35%) was higher than that in males (8.57%) (χ^2=72.37, P<0.001). The prevalence of anxiety in female participants (8.19%) was also higher than that in males (4.45%) (χ^2=30.83, P<0.001). The prevalence of depression in primary school students, middle school students and high school students was 8.22%, 13.41% and 15.30% (χ^2=30.21, P<0.001), respectively. However, there was no significant difference of the prevalence of anxiety among primary school students, middle school students and high school students with the proportions of 4.93%, 6.71% and 6.82%, respectively (χ^2=5.47, P=0.065).

3.4. Univariate logistic regression analysis results

The correlations between perceived feelings/behaviors during COVID-19 pandemic lockdown period and depression/anxiety after lockdown were analyzed by univariate logistic regression (Table 2). Females, participants from urban area, participants not living with parents or living with single parent and participants from high school were more likely to have depression. Female sex was a correlated factor for anxiety. Only child was not associated with depression and anxiety after lockdown. However, hoping back to school, missing teachers and

Table 2

The univariate logistic regression analysis results for depression and anxiety after lockdown in 5175 children and adolescents

Items	Factors	References	Depression				Anxiety			
			OR	95 % CI		*P* Value	OR	95 % CI		*P* Value
				Lower	Upper			Lower	Upper	
Demographic characteristics										
	Age	Continuous variable	1.16	1.10	1.22	<0.001	1.07	0.99	1.15	0.076
	Sex	Female/Male	2.09	1.76	2.48	<0.001	1.91	1.52	2.42	<0.001
	Only child	Yes/No	1.02	0.84	1.25	0.816	0.89	0.67	1.19	0.445
	Residence	Rural/Urban	0.72	0.61	0.87	0.001	0.81	0.64	1.04	0.098
	Living arrangement	Single parent/Both parents	1.26	1.03	1.54	0.026	1.29	0.98	1.68	0.067
		Other/Both parents	1.45	1.06	1.99	0.021	1.06	0.66	1.69	0.819
	School level	Middle school/ Primary school	1.73	1.39	2.16	<0.001	1.39	1.04	1.84	0.024
		High school/ Primary school	2.02	1.52	2.67	<0.001	1.41	0.96	2.06	0.077
Feelings during COVID-19 pandemic lockdown period										
	Scare	Yes/No	1.24	1.04	1.49	0.018	1.88	1.50	2.37	<0.001
	Psychological pressure	Yes/No	1.50	1.27	1.77	<0.001	1.65	1.31	2.06	<0.001
	Unhappiness	Yes/No	1.44	1.19	1.76	<0.001	1.90	1.49	2.43	<0.001
	Depressed mood	Yes/No	3.39	2.86	4.02	<0.001	4.47	3.55	5.63	<0.001
	Anxious mood	Yes/No	4.30	3.62	5.10	<0.001	5.61	4.45	7.09	<0.001
	Disliking parents	Yes/No	10.39	7.46	14.48	<0.001	11.63	8.22	16.46	<0.001
	Suicidal ideation	Yes/No	26.59	18.24	38.76	<0.001	22.86	16.25	32.15	<0.001
	Hoping back to school	Yes/No	0.69	0.58	0.82	<0.001	0.63	0.50	0.80	<0.001
	Missing teachers very much	Yes/No	0.52	0.59	0.82	<0.001	0.54	0.42	0.69	<0.001
	Missing classmates very much	Yes/No	0.69	0.58	0.82	<0.001	0.64	0.51	0.81	<0.001
	No special feelings	Yes/No	0.62	0.48	0.79	<0.001	0.47	0.32	0.68	<0.001
Behaviors during COVID-19 pandemic lockdown period										
	Not eating on time	Yes/No	5.20	4.19	6.47	<0.001	4.12	3.13	5.43	<0.001
	Not getting up on time	Yes/No	2.47	2.06	2.96	<0.001	1.92	1.50	2.45	<0.001
	Insomnia	Yes/No	7.20	5.66	9.14	<0.001	7.18	5.43	9.48	<0.001
	Quarreling with parents	Yes/No	9.42	7.47	11.88	<0.001	8.79	6.72	11.49	<0.001
	Inattention during online studying	Yes/No	3.58	3.01	4.26	<0.001	3.34	2.65	4.20	<0.001

students very much, and no special feelings during COVID-19 pandemic lockdown period were protective factors for depression and anxiety after lockdown (Table 2).

3.5. Stepwise logistic regression analysis results

The stepwise logistic regression results for depression and anxiety were shown in Table 3. Seven factors during the COVID-19 pandemic lockdown period were correlated factors for both depression and anxiety after lockdown in children and adolescents, i.e., suicidal ideation, quarreling with parents, females, anxious mood, insomnia, depressed mood and inattention during online learning. Furthermore, missing teachers very much was a protective factor for both depression and anxiety. Age, living in urban area, not living with parents and not eating on time were correlated factors for depression but not for anxiety. No special feelings and hoping back to school were protective factors for anxiety but not for depression.

4. Discussion

4.1. Main findings

We found that a number of demographic characteristics and experiences (feelings and behaviors) during COVID-19 pandemic lockdown period were associated with depression and anxiety after lockdown when children and adolescents went back to school. Suicidal ideation, quarreling with parents, insomnia, inattention during online learning, anxious and depressed mood were positively associated with depression and anxiety. Missing teachers was negatively associated with depression and anxiety. Females were more likely to have depression and anxiety.

The prevalence of depression (defined by PHQ-9 with a cutoff point of 10) was 13.76% in 3836 participants from middle schools and high schools after lockdown. Zhou et al. reported that the prevalence of depression during COVID-19 pandemic period was 17.35% in middle school and high school students (N=8079) with the same scale and cutoff point (Zhou et al., 2020). The difference between these two prevalence was statistically significant (χ^2=24.68, P<0.001). The

Table 3

The stepwise logistic regression results for depression and anxiety after lockdown in 5175 children and adolescents

Outcomes	Variables	OR	95% CI		*P* value
			Lower	Upper	
Depression					
SDS*	Female	2.05	1.69	2.49	<0.001
	Age	1.13	1.06	1.20	<0.001
	Rural students	0.70	0.57	0.86	0.001
Exposures during lockdown	Suicidal ideation	8.30	5.34	12.91	<0.001
	Quarreling with parents	3.14	2.35	4.19	<0.001
	Insomnia	2.02	1.47	2.79	<0.001
	Anxious mood	1.99	1.56	2.54	<0.001
	Inattention during online studying	1.64	1.32	2.03	<0.001
	Not living with parents	1.64	1.15	2.33	0.006
	Not eating on time	1.55	1.16	2.07	0.003
	Depressed mood	1.42	1.11	1.82	0.005
	Missing teachers very much	0.47	0.38	0.58	<0.001
Anxiety					
SDS*	Female	1.75	1.35	2.26	<0.001
Exposures during lockdown	Suicidal ideation	7.37	4.89	11.10	<0.001
	Quarreling with parents	2.54	1.81	3.56	<0.001
	Anxious mood	2.39	1.76	3.30	<0.001
	Insomnia	1.69	1.17	2.42	0.005
	Depressed mood	1.63	1.18	2.26	0.003
	Inattention during online studying	1.34	1.01	1.77	0.045
	No special feelings	0.64	0.41	0.98	0.042
	Missing teachers very much	0.62	0.45	0.84	0.002
	Hoping back to school	0.56	0.42	0.76	<0.001

* Socio-demographic status.

prevalence of anxiety (defined by GAD-7 with a cutoff point of 10) was 6.73% in participants from middle schools and high schools after lockdown. With the same scale and cutoff point, the prevalence of anxiety

was 10.35% during COVID-19 pandemic period in middle school and high school students (Zhou et al., 2020). The difference between these two prevalence was also statistically significant (χ^2=40.92, P<0.001). Although the prevalence of depression and anxiety might decline a bit in adolescents after the COVID-19 pandemic lockdown, they were still at a high level.

Female sex was positively associated with depression and anxiety in both children and adolescents, which was consistent with previous studies (Oosterhoff et al., 2020; Zhou et al., 2020). Age also played an important role in children and adolescents' depression but not in anxiety. It was reported that the higher grade of primary school students, the more vulnerable and prone for them to suffer from depression (Xie et al., 2020). The positive association between age and depression might be explained by the limited indoor activities and the reduction of social interactions during the pandemic lockdown as children and adolescents need more social activities and communications with the upgrading of grade (Xie et al., 2020). Consistently, most of the participants reported that they missed their teachers and classmates very much and were eager to back to school.

The lockdown measures had affected all aspects of daily lives. Moreover, adolescence was a time of difficult transition and maturation towards early adulthood (Guessoum et al., 2020). In the context of insufferable lockdown and school closures, vulnerable children and adolescents would be deprived of school, extra-family and intra-family supports. Family confinement might be a trigger for domestic violence during the COVID-19 pandemic lockdown period and even after lockdown (Guessoum et al., 2020). Children were at more risk of abuse and neglect when they lived at home for a long time and were at more risk of enduring domestic violence and pressure during this COVID-19 pandemic crisis (Liu et al., 2020b). Exposure to the family violence may significantly affect children and adolescents' mental health and potentially have negative long-term consequences (Hillis et al., 2017; Holt et al., 2008; MacMillan et al., 2013), such as depression, anxiety, suicidal ideation and even suicide attempt (McIntyre and Lee, 2020).

From a summarizing research of 10 years' follow-up studies on mental and psychological health of SARS, we know that the prevention and treatment of psychological diseases during pandemic were deeply urgent (Maunder, 2009; Mo et al., 2020). Furthermore, due to the high pathogenicity and mortality, the COVID-19 has caused global panic and anxiety (Mo et al., 2020). In the time of crisis, the psychological suffering may be more discreet in children and adolescents: anxiety, insomnia, problematic peer relationship, isolation, and depression (Guessoum et al., 2020). The comorbidity of depression and anxiety is common while children and adolescents undergo the period of uncertainty and insecurity. The associations between depressed mood/anxious mood during lockdown and depression/anxiety after lockdown suggested that some of the participants might have experienced an episode of depression/anxiety during lockdown, and the symptoms had a persistent impact on the participants' mental health even after the closure measures were removed.

Although worldwide educational institutions had been closed, school routines were still important coping mechanisms for children and adolescents with mental health issues (Lee, 2020). Compared with the traditional teaching methods on campus, the effects of long-distance online teaching on children and adolescents' mental health are not clear. For children and adolescents, periods without school were associated with decreased physical activity, more surfing time, irregular sleep and diets (Wang et al., 2020a). Although there were obvious advantages of remote learning, e.g., accessibility and comfort during online learning, limitations of inefficient learning and difficulty in keeping academic integrity should also be concerned (Mukhtar et al., 2020). It is difficult for children and adolescents to concentrate all the time during the online learning. It has to be noted that difficulty in concentrating is a symptom or a precursor of depression. Considering the various advantages and disadvantages of online learning, student-centered learning, and developing education plan with reduced cognitive loads and

increased interactivities between students and teachers were suggested during the COVID-19 lockdown period (Mukhtar et al., 2020).

A better understanding of how the COVID-19 pandemic lockdown affects children and adolescents' mental health could help guide better intervention targets and policy development. The correlated factors for depression and anxiety in children and adolescents are diverse and complex, covering individual psychology, family, school and social domains. Each factor contributes a small proportion of risk and risk profiles may vary greatly between different individuals (Hoare et al., 2020). The identification of available combined prevention targets is with great challenges, because not all factors correlated with mental disorders in observational studies may translate into robust intervention programs (Choi et al., 2020). The identification of modifiable factors for depression and anxiety is crucial in children and adolescent. Their mental health problems after school reopening should be a target for investigation and prevention. Gatekeepers, such as educators, parents and even policy-makers should pay more attention to modifiable factors of psychological well-being in children and adolescents, including family context, psychological traits and even feelings and behaviors during the COVID-19 pandemic lockdown period.

4.2. Limitations

There were several limitations in this study. First of all, the past histories of mental disorderswere not collected which would had impacted current mental health status of participants. The post-lockdown depression and anxiety might only be the persistence of depressive symptoms and anxiety symptoms before the COVID-19 pandemic due to the disease history. Secondly, the family history was not collected which could be explained by genetic effects of mental disorders. Thirdly, the recall bias might occur in this cross-sectional study if the participants could not accurately and completely recall past events and experiences. This kind of information bias might contribute to the overestimation or underestimation of the correlations between exposures and outcomes. Fourthly, the correlations could not be used for causal inferences due to the synchronicity of independent and dependent variable measurements. This was the biggest disadvantage of cross-sectional study. However, this study could still contribute to offering clues for future research. Last but not least, this study was conducted only in Shandong Province and the response rate was only 56%. The selection bias and non-response bias had impacted on the generalizability of the findings.

4.3. Implications for future researches

We should care about not only routine correlated factors for depression and anxiety in children and adolescents (such as age, gender, anxious and depressed mood, suicidal ideation, insomnia etc.), but also special factors during COVID-19 pandemic lockdown period (e.g., difficulty in concentrating during online studying, negative domestic parent-child relationships, etc.). With the growing understanding of the key correlated factors of depression and anxiety in children and adolescents, the pursuits of depression and anxiety prevention are worthy and yet challenging. According to the large gaps in the literature on the mental disorders for children and adolescents during and after the COVID-19 pandemic, more studies on this topic are needed. Actually, in this cross-sectional study, we could only describe the correlations between lockdown exposures and mental health outcomes in children and adolescents. We could not draw any causal conclusion now. However, based on the results of this cross-sectional study, new longitudinal studies are needed to verify the associations between lockdown exposures and mental health outcomes in children and adolescents after lockdown. Because here comes worsened epidemics of COVID-19, lockdown strategies were conducted again in London, Beijing, Shijiazhuang etc. Students are experiencing lockdown periods again. Due to stronger exposure-outcome correlations and much causal clues, the

panel or cohort study should be designed and conducted in future research for more rigorous causal conclusions. With a well-designed panel or cohort study, we may know the exact correlations between exposures before lockdown, during lockdown and after lockdown and the mental health status of children and adolescents.

Despite the school re-opening, significant proportions of children and adolescents have depression and anxiety which may be related to their experiences during the school closure. The results of this study may assist educators, parents, government agencies and healthcare professionals in safeguarding the psychological well-being of children and adolescents in the context of COVID-19.

Conflict of interest

None.

Author contributions

YL, JLW & YW contributed to the study design. JZ & ZFW did the online survey, data collection and logical check. SY& XRH analyzed the data. YL wrote this manuscript. YL, JLW & YW revised the manuscript. YL, SY& XRH contribute equally to this study. All authors reviewed and approved the manuscript.

Ethics statement

This study was approved by the Research Ethics Committee in Jining Medical University, Jining, China.

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