




The Impact of School Education on Depressive Symptoms in Chinese Adolescents: a Prospective Longitudinal Study

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Abstract

There is a growing but limited literature on psychological distress among Chinese students, especially the impact of the COVID-19 pandemic, using a longitudinal comparison between in school and at home. This study aimed to assess the psychological status of adolescents in school and related risk and protective factors. We surveyed 13,637 adolescents before the COVID-19 outbreak (T1) and 10,216 after two months of home confinement (T2). The 9-item Patient Health Questionnaire (PHQ-9) was used to assess depressive symptoms or the severity of depression among the adolescents. In addition, the Childhood Trauma Questionnaire and the Connor-Davidson Resilience Scales were also used to screen for experiences of abuse and neglect and to measure resilience in adolescents. At baseline, 22.34% reported depressive symptoms. At T2, this rate decreased to 14.86%. When adolescents were in school, age ($P < .0001$), gender ($P < .0001$), and experience of abuse ($P < .0001$) were risk factors, while parent–child relationship ($P < .0001$), and resilience ($P < .0001$) were protective factors for depressive symptoms. After leaving school, age and physical abuse were no longer risk factors for depression. The negative impact of school education on the mental health of adolescents in China exceeds even the impact of the pandemic and home isolation. The focus should be on those adolescents with abuse experience and poor parent–child relationships to prevent the onset of psychological and psychiatric disorders.

Keywords Adolescents · Chinese school education · Mental health · Depression

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Chinese school education, as an exam-centered pedagogy (Schmitz, 2011), has been reported to be a major stressor and cause of anxiety, depression, suicide attempts, and undeveloped psychological development among Chinese adolescents (Kirkpatrick & Zang, 2011; Guo et al., 2019; Tang et al., 2020; Zhao et al., 2015). In China, school education stress has become a serious social problem, and Chinese adolescents are under tremendous academic pressure (Chen et al., 2014). However, most previously published articles are descriptive reports or cross-sectional studies, and it is difficult to determine whether the poor psychological status of Chinese adolescents is caused by school education or by physical and psychological changes during adolescence (Paus et al., 2008). Notably, a recent study by Qin et al. used longitudinal data to examine the mental health status of Chinese adolescents aged 13–16 years, and the study recruited 254 adolescents in only one Chinese province (Qin et al., 2021). Therefore, high-quality evidence supporting a causal relationship between schooling and adolescent mental health remains lacking. The reason for this lack is that due to the national policy of free and compulsory education for adolescents in China, we were unable to find a group of adolescents who did not receive school education as a reference under normal circumstances.

On the other hand, poor parent–child relationships and abuse have been shown to directly increase the incidence of depression in adolescents (Harkness & Monroe, 2002; Stein et al., 1996). Meanwhile, psychological resilience to cope with difficulties can alleviate depression caused by adverse circumstances (Ding et al., 2017). These important factors should be considered when studying the psychological state of Chinese adolescents under school education. Therefore, longitudinal or controlled studies are necessary to explore the psychological impact of school education on adolescents in China, taking into account the effects of parent–child relationships, abuse, and resilience. In 2020, the 2019 novel coronavirus disease (COVID-19) epidemic paralyzed the entire world, causing countless victims. From February 2020 to April 2020, all Chinese adolescents were dropping out of school and taking online classes at home due to the high contagiousness of COVID-19 and its consequent widespread and rapid spread. Due to the low prevalence of COVID-19 in China during this period, 0.6 per 100,000 population (China, 2020), most adolescents were unaffected by the epidemic. The only change in their lives was that they were confined to their homes and attended classes online, instead of in school. Therefore, if we had baseline psychological data of adolescents while they were still in school, and compared it to data after taking online classes at home, this provided a great opportunity to investigate the psychological impact of school education.

We had these two components of data because we conducted the Nationwide Investigation on Psychological Health in Early Adolescents of China (NIPHEAC) and completed the first round (T1) of the survey in secondary schools in five cities in January 2020. After two months of home study, in March 2020, we conducted the second round of the survey (T2) to participants of the T1 survey. The T2 survey was conducted after COVID-19 infection had spread to a minimal extent in these five cities.

Our purpose in writing this article was to assess the psychological status of these adolescents while they were still in school and compare it to their psychological state when they were studying online at home, ultimately exploring the psychological impact of school education on Chinese adolescents, revealing the confounding effects of other psychological factors. We expected to gain a better understanding of the psychological impact of school education on adolescents' depressive symptoms and to provide more evidence for better educational policies in the future.

Methods

Study Setting and Participants

NIPHEAC is a two-round school-based survey on depression, childhood abuse, and related factors among middle school students (grades 7, 8, and 9). The study began in November 2019 and was designed with two rounds of surveys. The first round was initially scheduled in the middle of the semester and the second round was initially scheduled during winter break, 3 months apart. The first round was designed as a pen-and-paper survey, while the second round was designed as an online survey because the adolescents were not in school. In this study, the first round of surveys was administered as planned prior to the COVID-19 pandemic. However, as COVID-19 spread in China, the Chinese government tried to stop the spread of the virus in the population, so everyone was asked to be confined to their homes for 2 months. In fact, the interval between the two rounds of surveys was 4 months.

At baseline, five representative middle schools in northern China were selected by cluster sampling. These five schools were located in the five cities including Qingdao, Zaozhuang, Gongyi, Shenmu, and Donggang in Shandong, Henan, Shanxi, and Liaoning provinces. We used an overall sampling method and conducted two rounds of surveys with students from these five schools according to the protocol.

The data collection protocol followed the American Association for Public Opinion Research (AAPOR) reporting guidelines and was approved by the Ethics in Human Research Committee of the Third Affiliated Hospital of Beijing University of Chinese Medicine (No. BZYSY-2019KYKTPJ-21). Informed consent was obtained from guardians before participants were enrolled in the study. The survey was anonymous, and participant information was kept confidential.

Procedures of survey

First round of Survey

In the first round of the survey, conducted between November 22, 2019, and January 4, 2020, we designed a self-report questionnaire to collect data on background factors, depressive symptoms, resilience, and childhood abuse. A pen-and-paper survey was conducted with all students in 5 secondary schools. The survey of students was administered on a class-by-class basis. Our research team consisted of eight experienced staff members who distributed uniformly printed questionnaires to each class, read the instructions aloud in Mandarin, answered students' questions, and observed the survey process. After confirming that all respondents had completed the survey, the questionnaires were collected on the spot.

The criteria for invalid questionnaires were set as follows: (1) the completion rate of the paper questionnaire was less than 90%; (2) unreasonable or illogical data were found; (3) important data such as gender and age were not filled in; and (4) the researcher confirmed that the student did not fill out the questionnaire seriously. Questionnaires on anyone of the above criteria were considered invalid.

Second Round of Survey

For the second round of the survey conducted from March 21, 2020, to March 31, 2020, to ensure validity and consistency between the first and second rounds, we used the exact same questions as in the first round and converted them into an online digital questionnaire through the professional version of Wenjuanxing. Wenjuanxing(www.wjx.cn) is an online crowdsourcing platform in mainland China, that provides the functionality as Amazon Machinery Turkey (Wu et al., 2018).

We had an online meeting before the survey, and all the head teachers participated. First, the purpose of the online meeting was to find out if any adolescents in the class were infected or exposed to COVID-19 and to assess the possible impact on the survey. However, as the spread of COVID-19 in these five cities was low during the second survey period (China, 2020), no infected students or close contacts were reported. Second, to ensure the validity and consistency of the first and second rounds of surveys, these head teachers received training on the survey process through online meetings. According to our protocol, all teachers posted a link to the questionnaire to their students after the online study and monitor the completion and submission of the questionnaire to minimize differences in subjects' attitudes toward participation. If the student's response rate was lower than 80% of the total number of students in the school, the head teacher inquired and tailed the list of students who did not participate in the online survey, and 5% of those students were randomly selected and contacted by the head teachers to ensure that they completed the online survey. Data from students who did not submit the questionnaire would be analyzed for the survey and adjusted for non-response bias.

In addition, we set the process and criteria for judging invalid data. (1) We added two questions to test the validity of the answers, namely "I answered all questions honestly." "All my answers are based on my real experiences and thoughts." We provided "yes" and "no" options and arranged them in a different order in these two questions. If the answer to either of these two questions was "no," then the questionnaire was considered invalid. (2) After repeated testing of 20 adolescents, it was found that the minimum time to answer the questionnaire seriously was 3 min. If participants took less than 3 min to complete the survey, then the questionnaire was also considered invalid. (3) We checked the IP addresses of the participants, and if different data were submitted repeatedly from the same IP address, all data were considered invalid. (4) If data on weight, height, or age were found to be unreasonable and illogical, the questionnaire was considered invalid.

Main Outcome Measures

The main outcome we focused on was depressive symptoms, while resilience and abuse were also outcomes that needed to be investigated. A Chinese version of a validated measurement instrument was applied in our survey, and all interpretations of scores and cutoffs were based on previous studies (Bernstein et al., 2003; KM & JR, 2003; Xingfu et al., 2005; Yu et al., 2011; Wang et al., 2014; Tiirikainen et al., 2019; Leung et al., 2020).

The depressive symptoms were measured by the 9-item Patient Health Questionnaire (PHQ-9; range 0–27). The total score was interpreted as follows: PHQ-9, normal (0–4), mild (5–9), moderate (10–14), and severe (15–27) depression (Lai et al., 2020; Xing-chen et al., 2014). The cutoff value for having depression was set at 10 (Lai et al., 2020; Leung

et al., 2020; Zhang et al., 2013). Students scoring below the cutoff point were considered asymptomatic.

Childhood abuse was assessed by the short form of the Childhood Trauma Questionnaire (CTQ-SF; range 25–125) (Bernstein et al., 2003; Ding et al., 2017), CTQ-SF is a retrospective self-report quantitative measurement consisting of 28 items, including 5 subscales. The 5 subscales are named and have the following cutoffs: emotional abuse (≥ 13), physical abuse (≥ 10), sex abuse (≥ 8), emotional neglect (≥ 15) and physical neglect (≥ 10) (Guo et al., 2018; Tietjen et al., 2010). In this study, the Cronbach alpha in this study was 0.851 for the first round of the survey and 0.773 for the second round of the survey.

Resilience was measured using the Connor-Davidson Resilience Scale (CD-RISC; range 0–100) (KM & JR, 2003; Yu et al., 2011; Ding et al., 2017). The CD-RISC consists of 25 items that assess stress-coping abilities. The higher the score, the greater the resilience. A high internal consistency (Cronbach alpha = 0.927 for the first round, and 0.918 for the second round) was shown in these study samples.

The background factors and demographic data were gender, age, siblings, parental marital status, baseline disease, and parent–child relationship. All data were self-reported by participants through questionnaires. Regarding the question “How to evaluate the parent–child relationship in your family?”, we provided three options, namely, “poor,” “moderate,” and “good.”

Statistical Analysis

We used the Shapiro–Wilk test, Q-Q plots, and p-p plots to confirm the normality of continuous variables. Age and psychological resilience scores were reported as mean \pm standard deviation (SD), and non-normally distributed continuous variables, such as depression and abuse scores, were described using median and interquartile ranges (IQRs). We used Student’s *t* or non-parametric Wilcoxon tests to assess any statistically significant differences. To assess how large the differences between groups, the effect size of Cohen’s *d* was calculated for the comparisons (Lenhard & Lenhard, 2016). We presented gender, sibling status, parental marital status, parent–child relationship, depression, and childhood abuse as numbers and percentages, and used χ^2 tests. We adjusted for the effect of nonresponse using the ratio and regression estimation (Okafor & Lee, 2000).

To better elucidate the impact of correlates (gender, sibling status, parental marital status, parent–child relationship, and childhood abuse) on depressive symptoms, we performed univariate and multivariate logistic regression to assess odds ratios (ORs) and 95% CIs between outcomes and correlates. A Breslow-Day test was performed to assess the homogeneity of odds ratios between the two rounds. We performed all statistical analyses using SAS (version 9.2; SAS Institute Inc., Cary, North Carolina, USA) software with statistical significance set at $P=0.05$ (two-sided).

Results

Survey Quality and Demographic Characteristics

The first (T1) and second (T2) surveys collected 14,241 and 10,768 questionnaires, respectively. After excluding invalid questionnaires, 13,637 and 10,216 valid questionnaires

were finally obtained respectively. The rates of valid questionnaires were 95.76% (13,637/14,241) and 94.87% (10,216/10,768). The valid follow-up rate was 74.91% (10,216/13,637) and varied by region ($P < 0.001$).

Adolescents were older in T2 than in T1 (14.33 vs 13.77, $P < 0.001$). There were no statistical differences between T1 and T2 data in terms of gender, sibling, parental marital status, and parent–child relationship (Table 1).

Psychological Outcomes of Adolescents in Schooling and Home Settings

Adolescents in T1 (studying in a school setting) had higher depression scores (median [IQR] PHQ-9 score: 5[2,9] vs 3[0,7]; $P < 0.001$) and lower resilience scores (2.27 vs 3.43, $P < 0.001$) than those in T2 (studying at home). Compared to adolescents in T2, adolescents in T1 reported higher rates of depressive symptoms (3046 [22.34%] vs 1518 [14.86%]; $P < 0.001$). After adjusting for the effect of nonresponse using ratio and regression estimation, the rate of depressive symptoms in T2 was 14.26%.

Rates of emotional abuse were the same for T1 and T2 (1111 [8.15%] vs 845 [8.36%]; $P = 0.5548$), although the median (IQR) score for emotional abuse was higher in T2 than in T1 (7 [5.9] vs 6 [5.9]; $P < 0.001$). Rates of other abuse subtypes decreased in T2, compared

Table 1 Demographic and depressive symptoms of first- and second-round responders

	In school ($N = 13,637$)	At home ($N = 10,216$)	p value	ES d_{Cohen}
Demographic characteristics				
Age, mean \pm SD	13.77 \pm 1.02	14.33 \pm 1.12	< .0001	
Sex, boys/girls (no.)	6993/5221	5221/4995	0.7908	
Only child, categories no. (yes/no)	3291/10294	2532/7684	0.3205	
Marital status of parents, M/D/R/S	12,323/631/394/234	9291/461/262/202	0.1945	
Parent–child relationship, P/M/G	345/3145/10074	266/2485/7465	0.1105	
Live with parents, no/yes	675/12932	411/9805	0.0006	
Depression symptoms				
PHQ-9 score, median (IQR)	5 (2.9)	3 (0.7)	< .0001	0.30
No symptom/with symptoms	10,591/3046	8698/1518	< .0001	
Resilience score, mean \pm SD	2.27 \pm 0.73	3.43 \pm 0.74	< .0001	1.58
Emotional abuse score, median (IQR)	6 (5.9)	7 (5.9)	< .0001	0.12
No experience/with experience	12,526/1111	9362/854	0.5548	
Physical abuse score, median (IQR)	5 (5.6)	5 (5.5)	< .0001	0.15
No experience/with experience	12,852/785	9803/413	< .0001	
Sex abuse score, median (IQR)	5 (5.5)	5 (5.5)	< .0001	0.11
No experience/with experience	13,209/428	10,008/208	< .0001	
Emotional neglect score, median (IQR)	10 (7,14)	9 (6.13)	< .0001	0.12
No experience/with experience	10,613/3024	8356/1860	< .0001	
Physical neglect score, median (IQR)	8 (6.10)	6 (5.9)	< .0001	0.29
No experience/with experience	9899/3738	8236/1980	< .0001	

M/D/R/S, married, divorced, remarried, single; P/M/G, poor, moderate, good; PHQ-9, 9-item Patient Health Questionnaire; ES, effect size

to those in T1 (Physical abuse: 413 [4.04%] vs 785 [5.76%]; $P < 0.001$; Sex abuse: 208 [2.04%] vs 428 [3.14%], $P < 0.001$; Emotional neglect: 1860 [18.21%] vs 3024 [22.17%], $P < 0.001$; Physical neglect: 1980 [19.38%] vs 3738 [27.41%], $P < 0.001$). Also they scored lower in T2 than in T1 (median [IQR] Physical abuse score: 5 [5.5] vs 5 [5.6]; $P < 0.001$; Sex abuse score: 5 [5.5] vs 5 [5.5], $P < 0.001$; Emotional neglect score: 9 [6.13] vs 10 [7.14], $P < 0.001$; Physical neglect score: 6 [5.9] vs 8 [6,10], $P < 0.001$). With the exception of the resilience score (1.58 [1.55, 1.61]), Cohen's d showed a small effect of the abuse score (0.12–0.30) (Table 1).

We randomly selected 202 non-responders in the second round and ensured they completed the questionnaire online. These data were compared with participants who initially responded in the second round, and no significant non-responder bias was found.

Factors Associated with Psychological Outcomes in Adolescents in School and Home Settings

Univariate logistic regression was used as the primary model to identify potential factors for depressive symptoms in adolescents in school and family settings. Spearman's correlation analysis was conducted to calculate correlation coefficients between continuous variables, and the parameter $\rho < 0.5$ was set to ensure the representativeness and independence of the selected main variables. The heatmap of correlations between continuous variables is shown in Fig. 1.

Multivariate stepwise forward logistic regression analysis showed that, for school-aged adolescents, resilience score was a protective factor for the development of depressive symptoms (OR, 0.433; 95%CI, 0.402–0.466; $P < 0.0001$). Adolescents who experienced emotional abuse, physical abuse, sex abuse, and physical neglect were more likely to develop depressive symptoms (all $P < 0.0001$). Older adolescents were more likely to develop depressive symptoms (OR, 1.157; 95%CI, 1.104–1.212; $P < 0.0001$). Girls tended to be more sensitive to depressive symptoms than boys (OR, 1.633; 95%CI, 1.484–1.798; $P < 0.0001$). Compared with poor parent–child relationship, good parent–child relationship prevented adolescents from developing depressive symptoms (OR, 0.218; 95%CI, 0.163–0.291; $P < 0.0001$) (Table 2).

For adolescents at home, the resilience score was also a protective factor for the development of depressive symptoms (OR, 0.451; 95%CI, 0.41–0.497; $P < 0.0001$). Adolescents with experiences of emotional abuse, physical abuse, and physical neglect were more likely to develop depressive symptoms (all $P < 0.05$). Girls tended to be more sensitive to depressive symptoms than boys (OR, 1.053; 95%CI, 1.43–1.853; $P < 0.0001$). Compared with poor parent–child relationship, good parent–child relationship prevented depressive symptoms in adolescents (OR, 0.183; 95%CI, 0.133–0.251; $P < 0.0001$). However, the experience of physical abuse was no longer a risk factor for depressive symptoms (OR, 1.258; 95%CI, 0.962–1.644; $P = 0.0937$). Age was also not a risk factor for depressive symptoms (OR, 1.053; 95%CI, 0.994–1.116; $P = 0.078$) (Table 2).

Discussion

Our study had three main findings: (1) Adolescents' depressive symptoms decreased significantly after leaving the school environment and taking online lessons at home. (2) When adolescents were in school, age, gender, and experiences of abuse were risk factors,

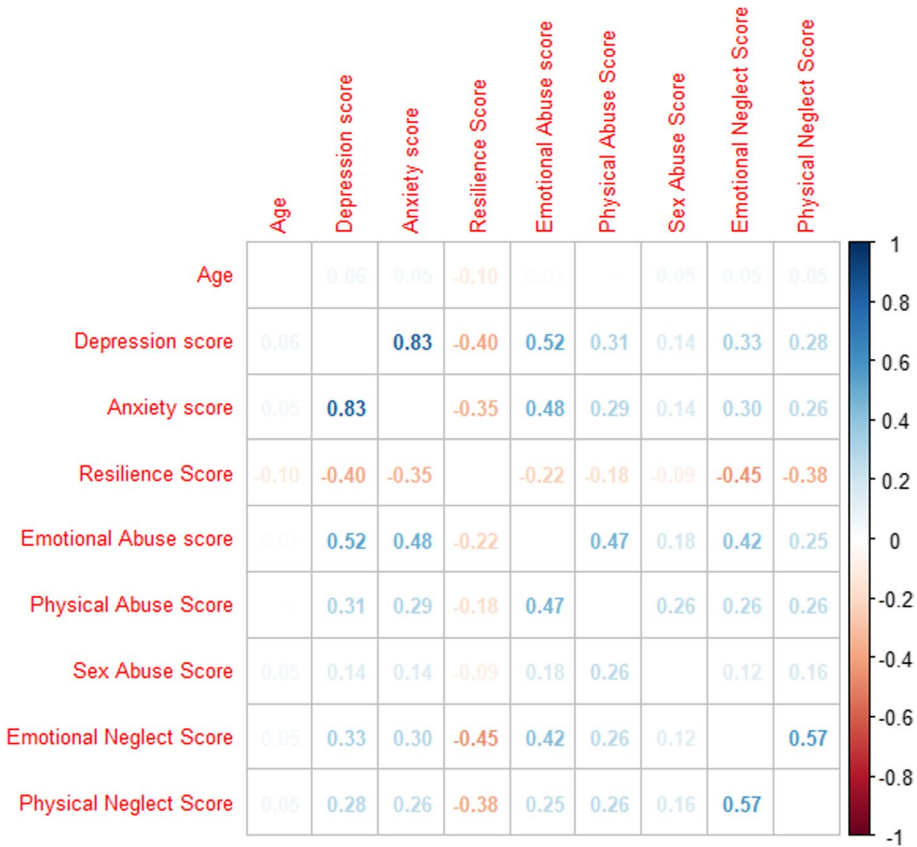


Fig.1 Spearman’s correlation analysis of continuous variables

whereas parent–child relationships, and resilience were protective factors for depressive symptoms. (3) After leaving the school setting, age and physical abuse were no longer risk factors for depression. The results suggest that Chinese school education may directly and indirectly affect the adolescents’ mental health.

The Psychological Impact of School Education on Adolescents

After 2 months of studying online at home, adolescents had significantly fewer depressive symptoms compared to their psychological state at school (depression 22.34% vs 14.59% $P < 0.001$). Our findings suggest that these Chinese adolescents may have experienced significant psychological stress while studying in the school environment, and recovered after leaving school.

It is well known that the main purpose of Chinese school education is to obtain higher scores in the National College Entrance Examination through repeated practice and examinations (Schmitz, 2011). In China, school education stress has become a serious social problem, and Chinese adolescents are under tremendous academic pressure (Chen et al., 2014). In Chinese schools, there are numerous tests and exams, as well as strict rules and regulations, which can be stressors for depression (Wuthrich et al., 2020; Xiao, 2013; Zhao

Table 2 Multivariate analysis of depressive symptoms among adolescents in school and at home

	Depression symptoms	
	In school	At home
	OR, <i>p</i> value	OR, <i>p</i> value
Demographic characteristics		
Age	1.157(1.104–1.212), < .0001	1.053(0.994–1.116), 0.078
Gender		
Boys	1 [Reference], NA	1 [Reference], NA
Girls	1.633(1.484–1.798), < .0001	1.628(1.43–1.853), < .0001
Marital status of parents		
Married	1 [Reference], NA	1 [Reference], NA
Divorced	1.156(0.939–1.423), 0.1705	0.861(0.643–1.152), 0.3136
Remarried	1.219(0.939–1.584), 0.1372	1.018(0.715–1.449), 0.9217
Single	1.279(0.919–1.78), 0.1439	1.317(0.874–1.986), 0.1884
Parent–child relationship		
Poor	1 [Reference], NA	1 [Reference], NA
Moderate	0.471(0.353–0.629), < .0001	0.5(0.367–0.683), < .0001
Good	0.218(0.163–0.291), < .0001	0.183(0.133–0.251), < .0001
Live with parents		
No	1 [Reference], NA	1 [Reference], NA
Yes	0.889(0.726–1.09), 0.2594	0.958(0.712–1.289), 0.7752
Psychological characteristics		
Resilience Score	0.433(0.402–0.466), < .0001	0.451(0.41–0.497), < .0001
Emotional abuse experience		
No	1 [Reference], NA	1 [Reference], NA
Yes	4.79(4.061–5.65), < .0001	5.692(4.75–6.822), < .0001
Physical abuse experience		
No	1 [Reference], NA	1 [Reference], NA
Yes	1.856(1.525–2.259), < .0001	1.258(0.962–1.644), 0.0937
Sex abuse experience		
No	1 [Reference], NA	1 [Reference], NA
Yes	2.474(1.936–3.163), < .0001	1.761(1.225–2.533), 0.0023
Emotional neglect experience		
No	1 [Reference], NA	1 [Reference], NA
Yes	1.085(0.96–1.225), 0.1915	1.125(0.954–1.328), 0.1623
Physical neglect experience		
No	1 [Reference], NA	1 [Reference], NA
Yes	1.28(1.146–1.43), < .0001	1.243(1.059–1.458), 0.0076

et al., 2015). Furthermore, the stress of these exams has been found to be a risk factor for impulsive suicidal behavior in adolescents (Guo et al., 2019). On the other hand, a survey in Shanghai revealed that up to 63.9% of Chinese adolescents attended extracurricular study classes to improve their scores in school exams (Chen et al., 2014). Extracurricular learning sacrifices sleep time of adolescents, with 51.0% of adolescents not getting the optimal amount of sleep (8.0 h per day) during weekdays (Chen et al., 2014). Sleep deprivation

among these adolescents may also contribute to the high prevalence of depression (Cheung & Wong, 2011; Roberts & Duong, 2014; Short & Louca, 2015).

In addition to the damaging effects of academic stress on adolescents' personal mental health, the damaging effects of academic stress on peer relationships have also been reported. Feelings of jealousy, mistrust, and hostility are common in peer relationships due to the intense academic competition in Chinese schools. Even close friends may be perceived as rivals or enemies in academic competition (Zhao et al., 2015). Therefore, academic pressure leads to interpersonal stress and poor peer relationships, which have been shown to be major risk factors for depression in adolescents (Hamilton et al., 2016; Shao et al., 2020).

Some previous studies have insisted on Confucian culture and high levels of parental involvement to explain the high prevalence of depression among Chinese adolescents (Sun et al., 2013; Tang et al., 2020; Xiao, 2013). However, in our study, adolescents who left school and continued to attend classes online at home with their parents had improved mental health even after leaving school. Because culture and parental status could not change significantly within 2 months, our results suggest that Chinese school education may play a more important role in the significant increase of depressive symptoms in adolescents, relative to culture and parental involvement. Therefore, our findings suggest that these Chinese adolescents may experience significant psychological stress while learning in a school setting and recover after leaving school. After 2 months of classes and online learning without the stress of schooling, they showed a much healthier psychological state than when they were in school.

The Impact of Home Confinement on Adolescents' Mental Health

At the same time, all these adolescents had to study online and were separated from classmates and friends due to home confinement, which may negatively affect adolescents' mental health (Brooks et al., 2020; Wang et al., 2020). In addition to social isolation, studying online at home inevitably increased adolescents' screen time, and one longitudinal study showed that increased screen time was significantly associated with higher levels of depression in adolescents (Boers et al., 2019).

Several previous studies have reported relatively high levels of depressive symptoms among Chinese adolescents in home confinement during the COVID-19 outbreaks (Chen et al., 2020; Duan et al., 2020; Qi et al., 2020; Zhou et al., 2020). The results of these studies are consistent with our second round (T2) survey of adolescents who left school and attended classes online at home. For example, Chen et al. reported that 13.35% of adolescents had depressive symptoms during the pandemic (Chen et al., 2020), compared to 14.59% in the second round (T2) of our study. Therefore, our T2 survey results are also a credible reflection of the psychological status of adolescents in home confinement. However, the prevalence of depressive symptoms was much lower in T2 than when adolescents were in school at T1.

In summary, home confinement may increase the risk of depression in adolescents. Both previous studies and our current findings provide evidence for a relatively high prevalence of depression among adolescents during home confinement. However, compared to the first round of data (when these adolescents were in school), our findings suggest that the effects of school stress on adolescents' mental health may be more negative and damaging than the effects of pandemics and home confinement.

Factors Associated with Adolescents' Mental Health in Schools and at Home

After adjusting for age, gender, parental marital status, and parent–child relationship, we found that risk factors for depressive symptoms in all 13,637 school-aged adolescents were emotional abuse, physical abuse, physical neglect, sexual abuse, age, and gender, whereas protective factors were resilience and good parent–child relationship.

Emotional abuse was defined as verbal insults, physical abuse was defined as physical assault, and sexual abuse was defined as sexual contact experienced by participants from adults or older adults. Physical neglect was defined as the failure of caretakers to provide basic physical needs (Bernstein et al., 1997). A study investigating Chinese adolescents showed that emotional, physical and sexual abuse, as well as physical neglect significantly increased the risk of suicide, with each 1-point increase in emotional abuse, physical abuse, sexual abuse or physical neglect scores, increasing the risk of multiple suicidal attempt by 12%, 17%, 22%, and 23%, respectively (Guo et al., 2018). Among the five subtypes, emotional abuse was considered the main factor negatively impacting mental health (Infurna et al., 2016), with a strong correlation between childhood emotional abuse and the diagnosis of major depression (Gibb et al., 2007; Infurna et al., 2016; McCabe et al., 2003). For physical abuse, a meta-analysis also reported a strong correlation with depression (Lindert et al., 2014). Neglect and sexual abuse, on the other hand, although meaningful, were less strongly associated with depression (Gibb et al., 2007; Infurna et al., 2016). These results from previous studies are consistent with results of our study.

In our study, girls had higher rates of depressive symptoms than boys, which is in line with previous studies, showing that girls were more vulnerable to educational stress than boys (Sun et al., 2013; Xiao, 2013). In our study, age was also a risk factor for the development of depressive symptoms in adolescents in school, with a 16% and 12% increase in the risk of depression, respectively, with increasing age by 1 year. This is consistent with the previous studies, where the greater the age and grade level, the more academic and test stress adolescents experience (Wuthrich et al., 2020; Xiao, 2013).

Meantime, resilience has been shown to moderate and mediate the negative psychological effects of adverse environments (Schulz et al., 2014) and childhood abuse among adolescents in China (Ding et al., 2017) and Turkey (Arslan, 2016). Resilience is viewed as the ability of individuals to demonstrate active defense (Davydov et al., 2010) and effective adaption (Luthar & Cicchetti, 2000) in the face of adversity. According to Nuttman-Shwartz, adolescents can often turn their adversity and negative experiences into positive factors, to take more responsibility and pro-social behaviors (Nuttman-Shwartz, 2019). Therefore, it is of great significance to cultivate and improve adolescents' mental resilience to prevent depressive symptoms.

In terms of family supports, good parent–child relationship is regarded as the primary preventive measure for children's psychological disorders (EC et al., 2016). A large body of evidence shows that learning effective parenting skills, improving family relationships, and encouraging positive interactions can reduce childhood abuse and behavioral problems, and promote adolescent mental health (Leslie et al., 2016). Conversely, poor family relationships, critical comments, low parental warmth, and harsh parenting skills have been shown to increase the incidence of depressive symptoms and behavioral problems in children (A et al., 2008; Davis et al., 2020; Sweeney & MacBeth, 2016). Our study revealed that in school, resilience (coping strategies) and good parent–child relationships were protective factors, while age, gender, emotional

abuse, physical abuse, sexual abuse, and physical neglect were risk factors for depression. However, after leaving school, age and physical abuse were no longer risk factors for depression. In addition, compared with the data from adolescents at school, the resilience scores increased significantly after leaving school and studying at home for 2 months (2.27 ± 0.73 vs 3.43 ± 0.74), whereas the gender, parent–child relationship and emotional abuse rate did not change significantly (Table 1), which may partially explain the decline in the incidence of depression after leaving school. These results suggest that Chinese school education may directly and indirectly affect adolescents' mental health.

Limitations and Strengths

Our study has both limitations and strengths. We have three main limitations. First, in the T1 survey, baseline data was collected using a pen-and-pencil questionnaire, whereas we administered it online in the T2 survey, which may have led to instrument bias. Differences in these two responses may have led to changes in subjects' attitudes toward participation, therefore, the reliability of comparing these two methods cannot be guaranteed. Because pen-and-pencil surveys were not feasible for adolescents who have left school, two rounds of online surveys may be conducted in the future to address consistency issues. Second, a quarter of the participants in the T1 survey did not respond to the T2 survey. Although no significant non-response bias was found based on the analysis of 202 no-responders in T2, we used ratio and regression estimation (Okafor & Lee, 2000) to adjust for non-responder effects. Third, all our data were self-reported by adolescents. These self-reports from adolescents may have limited the accuracy of their own parent–child relationship assessments. Fourth, at the beginning of the design, we used a convenience sampling method to select schools, which resulted in the findings of this study may not be nationally representative. However, we also have several strengths. First, we obtained baseline psychological data from a relatively large sample of adolescents to investigate their changes after home confinement. Second, we collected factors associated with depression, such as abuse, psychological resilience, and parent–child relationships.

In conclusion, our findings suggest that the negative impact of school education on the mental health of adolescents in China exceeds even the impact of the COVID-19 pandemic and home confinement. We should pay more attention to adolescents who have had experiences of abuse and poor parent–child relationships. In addition, parents need to communicate deeply with their adolescents to improve parent–child relationships and resilience. Although in recent years, the Ministry of Education has issued many official documents calling for quality education and in an effort to reduce the burden on students (Sun et al., 2013). The situation remains bleak, based on our current study. Further policy development and intervention programs are still urgently warranted. Furthermore, it will be interesting to assess factors such as long-term home confinement, risk of COVID-19 exposure, cruel grief, intra-family violence, excessive Internet and social media use in future studies (Guessoum et al., 2020). In addition, the assessment of addictive behaviors may also be relevant in future studies (Mallet et al., 2020).

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Data Availability Due to confidentiality, we are not able to share the data. Access to the data must be obtained through a formal application from the corresponding author.

Declarations

Conflict of Interest The authors declare no competing interests.

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