Changes of psychotic-like experiences and their association with anxiety/depression among young adolescents before COVID-19 and after the lockdown in China

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ABSTRACT

Objective: Lockdown policies during COVID-19 pandemic have potential adverse psychological impacts on youth. However, little is known about their influence on the changes of psychotic-like experiences (PLEs) among adolescents, nor about the possible association between changes in PLEs and changes in anxiety/depression symptoms. We investigated these two questions through a longitudinal comparative study.
Methods: In total, 1825 adolescents were surveyed before COVID-19 and after the lockdown in China (T0, October 20th, 2019 and T1, May 18th, 2020). PLEs, anxiety, and depression were measured with paranoia, anxiety and depression subscales of the Mental Health Inventory of Middle school students (MMHI-60). Within-subjects Wilcoxon test, Spearman correlation test, and Kruskal-Wallis test were adopted.
Results: Significant increase in adolescent PLEs scores was observed after the lockdown (Wilcoxon's w = 9.302, p < 0.001). We also found positive correlation between changes of PLEs and changes of anxiety/depression (Spearman's rho = 0.59/0.53, both p < 0.001). Furthermore, four PLEs trajectories were identified based on the report of PLEs at two timepoints: 60.4% with no PLEs, 9.3% remitted PLEs, 16.7% new PLEs, and 13.6% persistent PLEs. Significant difference was found in changes of anxiety/depression among four groups (p < 0.001); notably, the group with new-onset PLEs had the greatest exacerbation in anxiety/depression symptoms (both p Bonferroni <0.001).
Conclusions: This work is the first to identify increases in adolescent PLEs across the COVID-19 pandemic and suggested a close longitudinal association between PLEs and anxiety/depression. Our findings have implications for adolescent mental health crisis interventions during the pandemic.

1. Introduction

The coronavirus disease 2019 (COVID-19) outbreak was first announced in China in December 2019, which soon turned into an epidemic, and ultimately, a pandemic. Public health strategies, including quarantine and social distancing, have been put into urgent practice in many countries to contain the spread of the virus (WHO, 2020). As a consequence, schools in China were closed from January to April of 2020 and home-based distance-learning models were enforced during that period (National Health Center of China, 2020).

Minors are still under development both mentally and physically. Moreover, schools offer a major source of mental health care for most circumstances; thus, online-based home schooling could render this group more vulnerable to a mental health crisis during the pandemic (Golberstein et al., 2020). In line with this hypothesis, burgeoning evidence has shown that these public health measures have adverse psychological impacts on children and adolescents, including stress, fear, anxiety and depression (Brooks et al., 2020; Chen et al., 2020; Guessoum

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et al., 2020; Xie et al., 2020). Consequently, experts called for mental health care towards minors during the strict domestic quarantine (Liu et al., 2020). However, children and adolescents are not a homogeneous population. It was found that children and teenagers were disproportionally impacted by confinement due to COVID-19, with children showing more rebellious behavior and teenagers presenting with more affective symptoms (Pizarro-Ruiz and Ordóñez-Camblor, 2021). Zhou et al. suggested that adolescents in higher grades exhibited more severe anxiety and depression symptoms (Zhou et al., 2020). Further, academic pressure might confound the study of the interaction between multiple mental health symptoms in minors (Högberg, 2021). Thus, studies targeting a specific subgroup in adolescence is warranted to reach a more precise understanding of youth mental health in the context of COVID-19 pandemic and to better serve policy making.

Psychotic-like experiences (PLEs) usually refers to subclinical delusions or hallucinations, which is a spectrum of subclinical symptoms that are common among the general population and are being reported by an even larger group of young adolescents (prevalence from 4.7% to 35.5%) (Kelleher et al., 2012). It was reported that adolescents reporting PLEs were more likely to be diagnosed with psychotic disorders in adulthood and a dose-response effect was found (Poulton et al., 2000), suggesting that PLEs could be part of extended psychosis phenotype. In addition, more recent studies observed the frequent co-occurrence of psychotic phenomena with depression and anxiety, thus it was postulated that PLEs may be more likely to serve as a marker of common mental distress than a single risk state for psychotic illness such as schizophrenia (Stochl et al., 2015). This notion was replicated in a 2-year longitudinal study concluding that the presence of PLEs was associated with poorer mental health condition during follow-up (Chan et al., 2020). Accordingly, psychotic phenomena should be regarded as one crucial part of assessment in psychiatric epidemiology. However, in contrast to a growing body of studies mostly covering emotional distress during COVID-19, such as anxiety and depression (Bignardi et al., 2021; Guessoum et al., 2020; Hafstad et al., 2021; Pierce et al., 2020; Singh et al., 2020), the condition of PLEs is less studied despite the latest evidence regarding it as a unitary indicator of common mental distress. To our knowledge, current published studies longitudinally investigating PLEs during COVID-19 were conducted only in college students, with one finding no significant change in prevalence of PLEs after COVID-19 among Slovak college students (Hajduk et al., 2020) and another observing a downward trend in PLEs prevalence among Chinese college students (Sun et al., 2021). Considering the modest sample size (the Slovak study consisted of only 235 participants in final analysis) and relatively large population heterogeneity (the Chinese study's participants' age ranging from 14 to 25 years), further studies on the impact of COVID-19 on PLEs are still needed. Moreover, targeted investigations towards the possible impact of the pandemic on changes of adolescent PLEs are still lacking.

Considering the majority of COVID-related studies on youth mental health focused on affective symptoms including anxiety/depression, another critical question to be explored is whether the changes in PLEs would be associated with the changes of affective symptoms across the lockdown. Addressing this question could help us bridge the gap between the lack of studies on adolescent psychotic phenomena and the abundance of studies on affective symptoms during the pandemic. In cross-sectional settings, PLEs have been positively associated with the severity of various affective symptoms, especially anxiety and depression in healthy individuals (Stochl et al., 2015; Unterrassner et al., 2017). Studies on adolescents have also identified that PLEs, especially persecutory ideas and bizarre experiences, are strongly associated with stress, depression, and poor functioning (Armando et al., 2010). These associations were extended to longitudinal designs. De Loore et al. found that adolescents with persistent PLEs showed increased depressive mood after a 2-year follow-up (De Loore et al., 2011). Another study conducted on Japanese adolescents found that participants with newly emergent PLEs had significantly worse depression and anxiety after 1-

year follow-up, but those with remitted PLEs showed no significant improvement in anxiety and depression (Yamasaki et al., 2018). Together, these previous studies spurred us to further examine the longitudinal association between PLEs and anxiety/depression during the pandemic, considering the unprecedented impact COVID-19 has had on adolescents.

In this study, we investigated the aforementioned questions through a longitudinal comparative study surveying 1825 young adolescents (we selected seventh-graders) before the onset of COVID-19 and after the lockdown in China. This work tackled two hypotheses. First, in accordance with a well-acknowledged deterioration of adolescent mental health due to the pandemic, we expected to observe an exacerbation of PLEs among these young adolescents. Second, considering the possible role of PLEs as an indicator of common mental distress just like anxiety and depression (Chan et al., 2020; Stochl et al., 2015), we hypothesized a longitudinal association between PLEs and anxiety/depression. Specifically, we expected to see changes of PLEs correlate with changes of anxiety/depression. A subgroup analysis was also conducted to further verify this association. We identified four distinct trajectories of PLEs (no PLEs, remitted PLEs, new PLEs, and persistent PLEs) based on the report of PLEs at two timepoints (Downs et al., 2013). Then, we compared subgroup difference in changes of anxiety/depression and further performed pairwise comparison. We expected to see participants with new-onset PLEs suffer greatest deterioration in anxiety and depression.

2. Methods

2.1. Participants

In total, 1825 seventh-grade students were enrolled in the first round of this study on October 20th, 2019 (T0), and 1709 from the same group participated in the second round after the lockdown of COVID-19 on May 18th, 2020 (T1). The follow-up rate is 84.5%. Specifically, we adopted single-stage cluster sampling (Levy et al., 1988) in our study: (i) we first defined our target population as seventh-graders in Changsha city of Hunan province, (ii) seventh-graders in every school within the city are regarded as a cluster, we located 341 clusters with 417,674 students in total, (iii) we randomly selected two clusters and expected to get data from around 1800 students, which we considered to be qualified based on previous studies (Kadam and Bhalerao, 2010; Pourhoseingholi et al., 2013). Finally, we contacted the administrations of two schools and recruited our participants using the following criteria.

Inclusion criteria of the study included: (i) seventh-grade students, (ii) speak Mandarin Chinese, (iii) those who consented to participate in this study. Exclusion criteria included: (i) personal history of psychiatric diagnosis or history of psychoactive substance use in the previous 6 months, (ii) those who were unable to fill in the questionnaires by hand, (iii) those with more than 25% missing data on any specific assessments (Sun et al., 2015).

All participants and their supervisors gave written informed consent to this longitudinal study starting from October 2019, in which researchers would assess the mental health status of these participants every year in the following 3 years since they were admitted to the school. On average, it took 9 mins for the participants to finish the survey in classrooms. The study was approved by the Ethics Committees of the Second Xiangya Hospital of Central South University.

2.2. Assessments

2.2.1. Psychotic-like experiences

PLEs were measured with the paranoia subscale from Mental Health Inventory of Middle school students (MMHI-60), a tool designed by Professor Jisheng Wang from the Institute of Psychology of the Chinese Academy of Science (Wang, 1997). This scale is adapted from the Symptom Checklist-90 (SCL-90) (Bonicatto et al., 1997) and consists of

60 items covering 10 distinct dimensions, each containing 6 items. It has been widely used in China to measure the mental health of middle school students. The six items used to measure PLEs focus on subclinical delusions (poor social adaptivity, ideas of reference, ideas of persecution, ideas of grandiosity) and the detailed questions are as follows:

- Your thoughts are always contradictory to others'
- You think others are trying to take advantage of you
- You think someone is talking about you without your presence
- You think most people around you are untrustworthy
- You think you are more important than others think
- You think others are against you

Similar items were used to measure PLEs in previous studies and proved to be valid (McGrath et al., 2015; Schreier et al., 2009; Sun et al., 2017). Possible answers to these questions include: never, rarely, sometimes, often, and always, scoring from 1 to 5. We defined participants who answered 'often' or 'always' to any of these 6 questions as those with PLEs, in accordance with our previous studies (Sun et al., 2017; Yamasaki et al., 2018). Based on the report at two timepoints, we determined four PLEs trajectories using the method employed in a previous study (Downs et al., 2013): (i) no PLEs (adolescents reporting no PLEs at two timepoints), (ii) remitted PLEs (adolescents reporting at T0 but remitting at T1), (iii) new PLEs (adolescents reporting no PLEs at T0 but reporting PLEs at T1), (iv) persistent PLEs (adolescents reporting PLEs at two timepoints). Meanwhile, we calculated the mean paranoia scores (referred to as 'PLEs score' in the following section) at the two timepoints for further analysis. Cronbach's alpha for paranoia subscale in our sample was 0.79 at baseline and 0.83 during follow-up.

2.2.2. Anxiety and depression symptoms

Anxiety and depression subscales of MMHI-60 were used. Both subscales contain 6 items to measure relevant symptoms. Specifically, the anxiety subscale includes the following items:

- You feel nervous easily
- You feel restless and uneasy
- You feel scared suddenly for no apparent reason
- You feel agitated
- You feel insecure
- You always worry about something

And, depression subscale includes following items:

- You feel miserable
- You cry easily
- You feel hopeless for the future
- You often blame yourself
- You often feel listless
- You often have suicidal thoughts

There are also 5 answers to these questions: never, rarely, sometimes, often, and always, carrying a score from 1 to 5. We calculated the mean scores for each subscale at two time points for further analysis (referred to as 'anxiety score' and 'depression score' in the following section, respectively). Cronbach's alpha for the anxiety subscale in our sample was 0.87 at baseline and 0.89 during follow-up, and that was 0.82 and 0.86 for the depression subscale.

2.2.3. Demographic information, previous psychiatric diagnosis and substance use

We obtained the following demographic information: age, gender, and personal history of psychiatric illness. We screened participants' personal history of psychiatric diagnoses with questions: 'Have you ever been diagnosed with any mental disorder?'. Substance use was measured with 'Have you been using any psychoactive substance in the past six months? For example, marijuana.'

2.3. Data analysis

Before statistical analysis, we excluded participants with any previous psychiatric diagnosis or substance use to focus on subclinical symptoms and exclude the confounding effect of substance use. We eliminated subjects with more than 25% missing values on any questionnaires (Sun et al., 2015). Our analysis consists of three major steps. First, we used descriptive analysis to present the characteristics of our sample and identified four subgroups based on their report of PLEs at two timepoints: no PLEs, remitted PLEs, new PLEs, and persistent PLEs (Downs et al., 2013). We detected the normality and skewness of these variables using the Shapiro–Wilk test. Since these data didn't meet the assumption of normality ($p < 0.05$), we adopted non-parametric methods below. Second, on the global level, we compared the prevalence of PLEs and mean scores of PLEs as well as anxiety/depression at two timepoints using within-subjects analysis (McNemar's test and Wilcoxon test) (Pembury Smith and Ruxton, 2020). Then, we calculated the changes in scores of PLEs and anxiety/depression for each participant and performed Spearman correlation analysis between changes in PLEs scores and changes in anxiety/depression scores. Finally, we conducted subgroup analysis. Specifically, at the within-group level, we examined the significance of changes in anxiety/depression among four PLEs groups using within-subjects analysis. At the between-group level, we compared the changes in anxiety/depression scores among the four PLEs groups using the Kruskal-Wallis test. Pairwise comparison was used to determine which group showed the worst anxiety/depression deterioration after the lockdown. IBM SPSS 24.0 for Windows (IBM, Released 2016) was used for statistical analyses.

3. Results

3.1. Sample characteristics

Thirty participants were excluded for previous diagnosis of any mental disorders or recent substance use. In the initial phase, there were 10 participants (2 males and 8 females, mean age: 12.2 years) with more than 25% missing values on any assessment, and incomplete data was 17 (14 males and 3 females, mean age: 12.7 years) in the second phase. After eliminating all flawed samples, 1627 subjects (869 males and 758 females, mean age: 12.7 years) with valid data at two timepoints were entered into our statistical analysis.

In total, 158 subjects with qualified data at baseline didn't finish the second phase of assessment. Among those finishing the two assessments, the mean age was 12.7 years and 46.6% were females. At the population level, there were 417,674 middle school students registered in 2020, and females account for 49.4% according to the municipal governmental report (Statistics of Changsha, 2021). Details of sample characteristics are shown in Table 1.

3.2. Within-subjects analysis and Spearman's correlation

The prevalence of PLEs was 22.9% before the onset of COVID-19 and then increased to 30.2% after the lockdown (McNemar's test, $\chi2 = 32.917$, $p < 0.001$). Mean PLEs score of participants at T0 was 10.3 and increased to 11.3 during follow-up (Wilcoxon test, $w = 9.302$, $p < 0.001$). Mean anxiety score of participants at T0 was 11.6 and increased to 13.0 during the follow-up (Wilcoxon test, $w = 10.496$, $p < 0.001$). Similarly, mean depression score at T0 was 10.5 and was 12.1 at T1 (Wilcoxon test, $w = 12.972$, $p < 0.001$).

Spearman's correlation test showed that changes in PLEs scores were correlated with changes in anxiety (Spearman's rho = 0.59, $p < 0.001$) and depression (Spearman's rho = 0.53, $p < 0.001$), as shown in Fig. 1.

Table 1

Sample characteristics.

N = 1627	
Females, n (%)	758 (46.6)
Age, years, mean (S.D.)	12.7 (0.6)
PLEs prevalence at T0, n (%)	373 (22.9)
PLEs prevalence at T1, n (%)	492 (30.2)
PLEs trajectory, n (%)	
No PLEs	983 (60.4)
Remitted PLEs	152 (9.3)
New PLEs	271 (16.7)
Persistent PLEs	221 (13.6)
PLEs score at T0, mean (S.D.)	10.3 (4.0)
PLEs score at T1, mean (S.D.)	11.3 (4.7)
PLEs score changes, mean (S.D.)	1.0 (4.2)
Anxiety score at T0, mean (S.D.)	11.6 (5.2)
Anxiety score at T1, mean (S.D.)	13.0 (6.2)
Anxiety score changes, mean (S.D.)	1.5 (5.2)
Depression score at T0, mean (S.D.)	10.5 (4.3)
Depression score at T1, mean (S.D.)	12.1 (5.5)
Depression score changes, mean (S.D.)	1.6 (4.7)

3.3. Subgroup analysis

Four distinct PLEs trajectories were identified: 60.4% with no PLEs, 9.3% remitted PLEs, 16.7% new PLEs, and 13.6% persistent PLEs (Table 1.). Except the fact that the group with remitted PLEs showed alleviated anxiety/depression symptoms, the other three groups showed an exacerbation in affective symptoms during the pandemic. Details were shown in Table 2.

Significant differences in changes of anxiety symptoms across the pandemic was observed in four PLEs subgroups (Kruskal-Wallis h = 211, p < 0.001), along with significant differences in changes of depression symptoms (Kruskal-Wallis h = 167, p < 0.001). The trajectories of PLEs and anxiety/depression symptoms among four groups were depicted in Fig. 2.

Pairwise comparison found that significant difference in changes of anxiety symptoms existed between the following pairs of groups: 'No PLEs' and 'Remitted PLEs'; 'No PLEs' and 'New PLEs'; 'Remitted PLEs'

and 'New PLEs', 'Remitted PLEs' and 'Persistent PLEs'; 'New PLEs' and 'Persistent PLEs' (all p < 0.001 with Bonferroni correction). Similar results were found in changes of depression symptoms, as seen in Table 3.

4. Discussion

Our work investigated the possible impacts of the COVID-19 pandemic on PLEs among young adolescents and had two major findings. First, we found a significant deterioration in our participants' PLEs symptoms after the lockdown of COVID-19. Second, our results suggested a close association between changes of PLEs and changes in anxiety/depression across the pandemic. Those young adolescents with new-onset PLEs had more severe exacerbation in anxiety/depression symptoms.

We first identified an increase in PLEs among young adolescents, both at the prevalence level and score level. Our findings didn't replicate the findings of two previous studies investigating PLEs during the pandemic, which found no significant change and even a trend of decrease in PLEs after the onset of COVID-19 among their participants (Hajduk et al., 2020; Sun et al., 2021). For the first study, the results

Table 2

Within-subjects analysis of changes in anxiety/depression among four groups.

|	Mean		SD		Statistics[a]	P value
	T0	T1	T0	T1		
Anxiety						
No PLEs	9.82	10.72	3.61	4.55	6.39	<0.001
Remitted PLEs	14.75	12.61	5.62	5.34	4.64	<0.001
New PLEs	11.13	16.52	4.06	6.06	11.53	<0.001
Persistent PLEs	17.88	19.37	6.44	6.68	3.32	0.001
Depression						
No PLEs	9.06	10.06	3.04	3.96	8.22	<0.001
Remitted PLEs	12.69	11.74	4.20	4.87	2.29	0.022
New PLEs	10.35	15.20	3.41	5.75	11.81	<0.001
Persistent PLEs	15.32	17.25	5.85	6.43	4.41	<0.001

[a] Wilcoxon w.
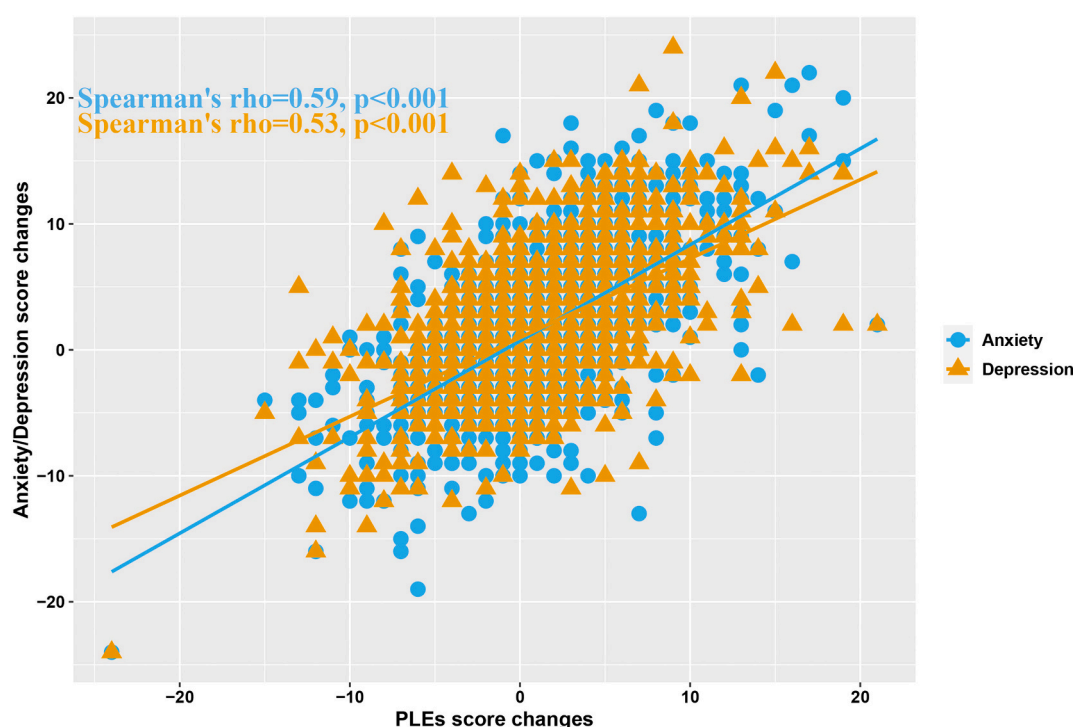
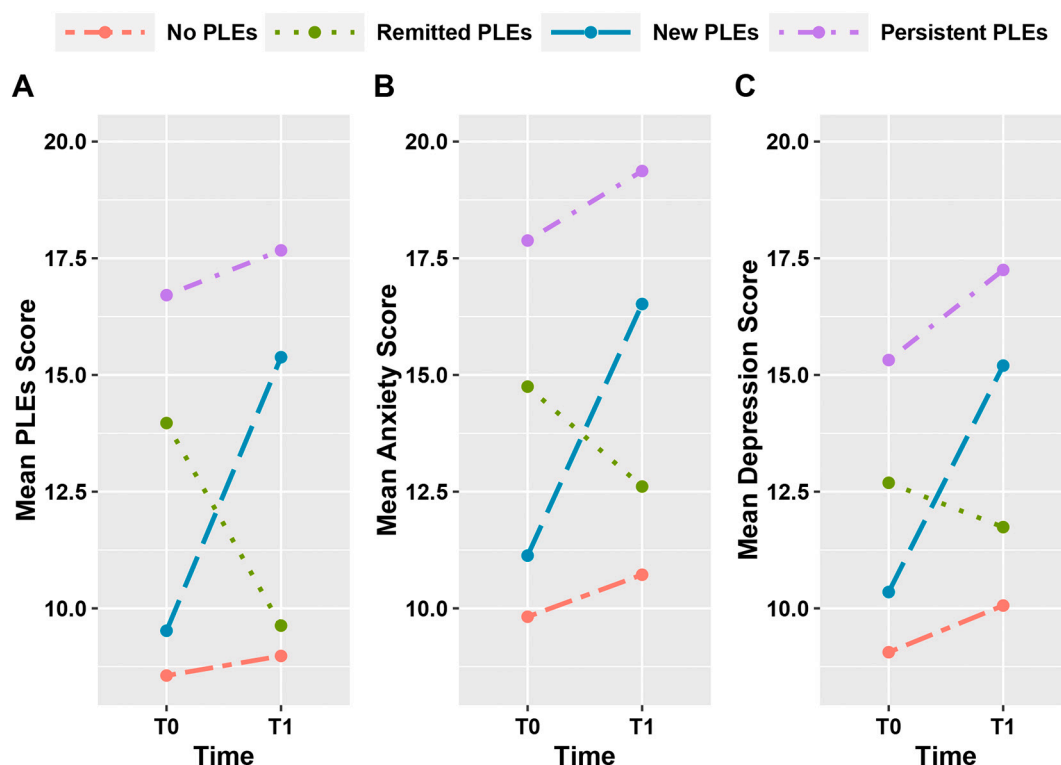**Fig. 1.** Correlation between changes of PLEs and changes of anxiety/depression scores.

Fig. 2. Trajectories of PLEs, anxiety and depression in four groups across the pandemic.

Table 3
Group difference in changes of anxiety and depression across the pandemic.

	Mean changes	SD	Statistics[a]	P value	Pairwise comparison[b]
Anxiety					
No PLEs	0.93	4.00	211	<0.001	New PLEs >
Remitted PLEs	−1.80	4.96			Persistent PLEs/ No PLEs >
New PLEs	5.45	5.85			Remitted PLEs
Persistent PLEs	1.32	5.71			
Depression					
No PLEs	1.02	3.51	167	<0.001	New PLEs >
Remitted PLEs	−0.80	4.70			Persistent PLEs/ No PLEs >
New PLEs	4.93	5.40			Remitted PLEs
Persistent PLEs	1.80	5.95			

[a] Kruskal-Wallis h.
[b] All P value <0.001 with Bonferroni correction.

could be explained by the fact that the second timepoint to screen for PLEs was at the beginning of COVID-19 in their country (the first week of April), which could be too early to detect the impact of the pandemic on PLEs (Hajduk et al., 2020). Moreover, their baseline data was collected in October 2018, PLEs were known to be more common at a younger age (Kelleher et al., 2012), so a downward trend in PLEs scoring in their studies is reasonable. Further, considering the age heterogeneity in participants of the above two studies (one recruited undergraduate and graduate students, the other recruited students aging from 14 to 25), finding no increase in PLEs across the pandemic is possible because aging would alleviate PLEs. Instead, our work utilized a shorter longitudinal design (around 7 months) and investigated a targeted population of young adolescents, providing robust evidence of an increase in their PLEs after the lockdown. However, our results also revealed that not all individuals showed the same trend in changes of PLEs. Although at the

global level the PLEs symptoms exacerbated, some people may have no significant changes, or even experienced varying degrees of alleviation. Further studies are warranted to explore the possible risk and protective factors for adolescent PLEs during this special time.

It should be noted that the anxiety and depression symptoms were also exacerbated among young adolescents across this pandemic, this finding is in line with a growing body of literature that argues that the COVID-19 pandemic generally had adverse effects on youth mental health (Meherali et al., 2021; Pizarro-Ruiz and Ordóñez-Camblor, 2021; Ran et al., 2020; Singh et al., 2020). Although the majority of epidemiological studies during the pandemic adopted a cross-sectional design, a few longitudinal studies emerged and provided support to our findings. A nationwide longitudinal investigation of the UK population identified a general deterioration in mental distress, and youngsters were one of the most vulnerable groups in this mental health decline (Pierce et al., 2020). Other studies specifically suggested increases in anxiety and depression symptoms among minors during the lockdown (Bignardi et al., 2021; Hafstad et al., 2021).

Moreover, changes of PLEs in young adolescents was significantly associated with the changes of anxiety/depression symptoms. This finding bridged the gap of current COVID-related literature focusing more on anxiety/depression while less on assessing psychotic phenomena, which might be regarded as a unitary indicator of common mental distress (Stochl et al., 2015). In addition, we identified the proportion of young adolescents with new-onset PLEs and we further proved that this minority indeed suffered the greatest mental health decline during the pandemic. Although no studies to date covered PLEs and anxiety/ depression simultaneously when investigating adolescent mental health during this pandemic, previous findings resonated with our major findings. Cross-sectionally, it is well-established that PLEs correlate with anxiety/depression symptoms across populations (Stochl et al., 2015; Unterrassner et al., 2017; Varghese et al., 2011). This notion was further extended to longitudinal settings. Mackie et al. first identified different trajectories of PLEs and suggested that adolescents with persistent PLEs reported elevated scores in anxiety/depression (Mackie et al., 2011).

Downs et al. concluded that persistent PLEs from mid-childhood are associated with later internalizing and externalizing psychopathology in the general population. Yamasaki et al. found that anxiety/depression worsen significantly in adolescents with new-onset PLEs after a year (Yamasaki et al., 2018). Using a similar design, our work adopted the largest sample size and was conducted under the context of COVID-19 pandemic. Taken together, we call for more attention to be paid to adolescents with new-onset PLEs as well as those with persistent PLEs, as they are more susceptible to the long-term adverse effects on mental health posed by the pandemic.

Our findings may have implications for clinical practice, considering the potential longitudinal interaction between PLEs and anxiety/depression symptoms. A randomized control trial studying the intervention of PLEs found that using psychological interventions, such as cognitive behavioral therapy, can alleviate associated anxiety and depression among participants (Addington et al., 2011). Similar results were seen in other studies (Bechdolf et al., 2005; Ising et al., 2016), which further consolidates a close longitudinal association between PLEs and anxiety/depression. Thus, we recommend targeted interventions for subclinical psychotic symptoms towards mentally distressed young adolescents during the pandemic.

However, the exact mechanism of the worsening of mental health among young adolescents during this pandemic remains to be studied. Excessive psychological stress from the spread of virus or from family conflicts, social isolation, changes in exercises or schoolwork could be related to an increase in PLEs, considering the effect of perceived stress on PLEs among adolescents (Turley et al., 2019). Sun et al. concluded that students living in a single-parent family, having more childhood trauma and having a higher family income were more likely to have new-onset PLEs; while better resilience was a protective factor (Sun et al., 2021). Ran et al. suggested that being a female, having more than 6 family numbers and doing frequent outdoor activities are risk factors for anxiety symptoms, while living in a place where there were higher general health problems could render people more susceptible to depression symptoms (Ran et al., 2020). Since our follow-up was conducted after the lockdown in China, other factors not directly associated with COVID-19, such as those related to schooling, may contribute to worsening of adolescent mental health. In total, we acknowledge the notion that the pandemic has placed an inevitable long-term impact on youth mental health from the perspective of biological, environmental, and social factors (de Figueiredo et al., 2021). Further follow-up studies, especially those targeting the clinical visits or help-seeking behaviors of these young adolescents, are warranted.

Finally, limitations should also be considered. First, our study is based on self-reported data, which could lead to over- or under-reporting of mental health problems at the individual level compared to interview-based methods. Second, the scale we used to measure PLEs only covered participants' delusional experiences while it did not include perceptual abnormality, such as hallucinational experiences, which is a major limitation. For example, transient auditory hallucination could predict affective symptoms (Chan et al., 2020). Further studies involving assessment of perceptual abnormality is strongly needed. Third, our study reported a relatively high prevalence and persistence of PLEs symptoms among young adolescents after the lockdown, this could be due to the direct or indirect impact from the pandemic, or it can also be related to other factors, such as that the variation in assessment tools of PLEs can contribute to the discrepancies in numerous studies (Lee et al., 2016). Fourth, our participants were recruited solely from the capital city of Hunan province. Further replication of our results in more representative population, such as in a nationwide or global youth population, is still warranted.

To conclude, our work is the first study to report an increase in PLEs symptoms among young adolescents during the pandemic and further verify a longitudinal association between changes in PLEs and anxiety/depression symptoms. Of note, our results have implications for targeted interventions towards young adolescents with new-onset PLEs due to their greatest mental health decline after the lockdown.

CRediT authorship contribution statement

Zhening Liu, Haojuan Tao, Yicheng Long, Zhipeng Wu, Mengran Zhu helped design the study; Feiwen Wang, Zhuling Zou collected the data and double-checked the data input. Zhipeng Wu finished the statistical analysis and drafted the manuscript. Zhening Liu, Yicheng Long, and Brendan Ross revised the manuscript. All authors agreed on the final version of the paper.

Declaration of competing interest

None.

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