Trajectories of Depression and Anxiety among Adolescents in the Late Pandemic and Their Potential Causality: A Longitudinal Study

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Abstract

In the early stages of the COVID-19 pandemic, depression and anxiety among adolescents deteriorated sharply, while the developmental status of adolescent depression and anxiety in the later stages of the pandemic remains unclear. In light of the pandemic development trends in China, this study utilized the Center for Epidemiological Studies Depression Scale, Self-Rating Anxiety Scale, Resilience Scale, and Prosocial Tendencies Measure to collect three waves of data from 1,170 Chinese middle school students in the later stages of the pandemic (T1 = May 2021; T2 = November 2021; T3 = May 2022), and employed latent growth curve modeling to examine the trajectories of change, gender differences, and potential causal relationships of adolescent depression and anxiety in the later pandemic period. The results indicated that depression and anxiety levels among adolescents gradually declined in the later stages of the pandemic, with no significant differences in change trajectories between males and females; psychological resilience significantly predicted both the initial levels and change trajectories of depression and anxiety, such that higher resilience levels at T1 were associated with lower depression and anxiety levels at T1 and faster subsequent rates of decline in depression and anxiety. Additionally, both the initial level and change trend of adolescent depression negatively predicted prosocial tendencies at T3, meaning that higher depression levels at T1 were associated with lower prosocial tendencies at T3, while faster rates of decline in depression were associated with higher prosocial tendencies at T3. In summary, mental health changes among Chinese adolescents showed a positive trend in the later stages of the pandemic, and these findings can provide empirical evidence for adolescent mental health service systems.

Full Text

Preamble

A Longitudinal Study on Depression and Anxiety Among Chinese Adolescents in the Late Phase of the COVID-19 Pandemic: The Trajectories, Antecedents, and Outcomes

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Abstract

During the COVID-19 pandemic, all age groups' mental health has substantially declined. Compared to other age groups, the impact of the COVID-19 pandemic on adolescent mental health problems was more salient, particularly on depression and anxiety. Previous studies, which were primarily conducted during the phase of COVID-19 pandemic, have mainly covered the first and second phases of COVID-19-related prevention and containment in China, without adequate attention being paid to the third and fourth phases of COVID-19-related prevention and containment in China. Currently, there are three competing hypotheses for the longitudinal trajectories of depression and anxiety among Chinese adolescents in the post-COVID era, making the construction of the mental health monitoring system and the mental health service system for adolescents in China "blind spots." Based on developmental contextualism and three-dimensional theoretical framework of mental health change, the present study thus investigated the developmental trajectories of depression and anxiety among adolescents, as well as the potential antecedent (psychological resilience) and outcome (prosocial tendency) of such trajectories in the late phase of the COVID-19 pandemic in China.

In this study, 1170 adolescents in Shandong province were assessed at three time points with a six-month interval (Time 1=May 2021; Time 2=November 2021; Time 3=May 2022) from the normalization period of the pandemic through self-report questionnaires. The adolescents completed Center for Epidemiologic Studies Depression Scale and Self-Rating Anxiety Scale during the three measurements. Furthermore, all adolescents completed the Connor-Davidson Resilience Scale at Time 1 and Prosocial Tendencies Measure at Time 3. Attrition analyses, common method bias analyses, and descriptive statistics were analyzed by SPSS software. The trajectories of depression and anxiety, as well as their associated antecedent (i.e., psychological resilience) and outcome (i.e., prosocial tendency) were further analyzed via latent growth curve models using Mplus software.

According to the results of the latent growth curve models, adolescents' depres-

sion and anxiety levels tended to decline. The higher the level of depression and anxiety at Time 1, the slower the decline over time. Furthermore, psychological resilience at Time 1 negatively predicted initial levels of depression and anxiety but positively predicted the decreasing speed of depression and anxiety trajectories. Concerning the outcomes, we found that the initial level and speed of depression trajectories significantly and negatively predicted the levels of prosocial tendency at Time 3. Regarding the anxiety trajectory, its intercept factor negatively predicted prosocial tendency at Time 3, but its slope factor's predictive effect was non-significant. Finally, multi-group analyses revealed that both boys and girls showed declining trends in depression and anxiety over time, while girls scored significantly higher on depression and anxiety initially than boys.

In conclusion, this research found that the changes in mental health (particularly depression and anxiety problems) among Chinese adolescents in the late phase of the COVID-19 pandemic were developing well, which provides empirical evidence for better construction of adolescent mental health service systems in China.

Keywords: adolescents, depression, anxiety, psychological resilience, prosocial tendency

1.1 Trajectories of Adolescent Depression and Anxiety in the Late Phase of the COVID-19 Pandemic

Regarding the developmental trajectories of depression and anxiety among Chinese adolescents in the late phase of the COVID-19 pandemic, three competing hypotheses currently exist. First, numerous studies have found that the COVID-19 pandemic was indeed associated with increased depression and anxiety problems among adolescents. For example, compared with the pre-pandemic period, adolescents' emotional problems, peer relationship problems, and behavioral problems further deteriorated during the early stage of the pandemic (Stevens et al., 2023). In the late phase of the pandemic, the "aftershocks" of COVID-19 still persisted (Su et al., 2023; Xie et al., 2022; Yang & Xin, 2020). Therefore, depression and anxiety problems among Chinese adolescents may continue to worsen in the short term due to these pandemic aftershocks during the late phase.

Second, during the pandemic, China issued multiple policies to protect adolescent mental health, aiming to alleviate depression and anxiety caused by COVID-19 at the family and societal system levels. Such multi-level social support may "offset" the impact of external risk factors (Wu et al., 2016), slowing down the deterioration of adolescent depression and anxiety problems. In other words, the levels of depression and anxiety among Chinese adolescents in the late phase of the pandemic may show non-significant changes over time.

However, developmental contextualism (Lerner, 2002; Lerner et al., 2005) also emphasizes human plasticity, meaning that individual developmental changes

can achieve positive growth through education or intervention activities. Research has shown that after coping with stressful events, individuals with good and effective social support networks and timely psychological intervention can, to some extent, activate positive qualities (such as optimism and hope), leading to positive psychological growth (Tu & Guo, 2008; Zhang et al., 2022). In the late phase of the pandemic, mental health education courses and psychological counseling services for adolescents have become widespread in China (Fu et al., 2023), which helps adolescents obtain higher levels of potential for post-traumatic self-recovery and development, resulting in positive changes in their depression and anxiety problems (Tu & Guo, 2010). In fact, relevant research has also indicated that the prevalence rates of depression and anxiety among adolescents have significantly decreased compared with the early stage of the pandemic (Li et al., 2021). We therefore have reason to speculate that there may be a third scenario for the trajectory of depression and anxiety levels among Chinese adolescents in the late phase of the pandemic, namely, a significant declining trend. Based on this, the present study will use a three-wave longitudinal design to explore the changing characteristics of adolescent depression and anxiety.

1.2 The Predictive Role of Psychological Resilience on Adolescent Depression and Anxiety Trajectories

Psychological resilience generally refers to an individual's "bounce-back ability" or "resilience" when facing life stress and setbacks (Yu & Zhang, 2005; Connor & Davidson, 2003). The systemic mechanism model of psychological resilience (Davydov et al., 2010) suggests that psychological resilience has three mechanisms of action on individual mental health: protective mechanism (psychological resilience can buffer the harm of environmental threat factors to one's mental health), harm-reduction mechanism (also known as recovery mechanism, psychological resilience can help individuals traumatized return to pre-trauma mental health levels), and promotion mechanism (psychological resilience can help individuals achieve post-traumatic growth and gain more positive experiences). Previous researchers have examined the protective mechanism of psychological resilience from a static perspective by exploring its mediating or moderating role in the mechanism influencing adolescent mental health (Gao et al., 2019). The harm-reduction and promotion mechanisms of psychological resilience need to be explored dynamically from a developmental perspective. However, current relevant research has mainly focused on "acute" stressful events with high crisis and challenge, such as earthquakes (Tu & Guo, 2010; Wu et al., 2016), while lacking research foundation on the harm-reduction and promotion mechanisms of psychological resilience under long-term and large-scale "chronic" stressful events. COVID-19 has long-term and potential impacts on individuals (Su et al., 2023), providing an environmental background for exploring the long-term effects of psychological resilience on adolescent depression and anxiety development under "chronic" stressful events. However, currently only a few longitudinal studies have shown that psychological resilience can "buffer" the deterioration of indi-

vidual mental health problems of depression and anxiety in the early stage of COVID-19 (Hezel et al., 2022). For example, a study conducted in the early stage of the COVID-19 outbreak in the United States found that psychological resilience could "buffer" the deterioration of mental health problems in individuals with depression during the early stage of the pandemic (Hezel et al., 2022). However, this study had a small sample size, mostly consisting of patients with obsessive-compulsive disorder, and the survey time was in the early stage of the pandemic in the United States, which does not match the characteristics of Chinese adolescent groups and the features of the late pandemic phase. Therefore, in the late phase of the pandemic in China, will the trajectories of adolescent depression and anxiety, as consequences of social changes in the late pandemic phase, be influenced by psychological resilience as a positive psychological quality? To answer this question, this study will use a longitudinal research design to explore the predictive effect of psychological resilience on the trajectories of adolescent depression and anxiety in the late phase of the pandemic, that is, the harm-reduction or promotion mechanism of psychological resilience.

1.3 The Predictive Effect of Adolescent Depression and Anxiety Trajectories on Prosocial Tendency

Changes in adolescent depression and anxiety emotions also correspond to changes in social mentality (Yang, 2006). From a social development perspective, prosocial tendency is an important reflection of social well-being (Moldes & Ku, 2020). By exploring the impact of adolescent anxiety and depression trajectories on prosocial tendency, we can reveal how changes in social mentality such as emotional well-being affect social well-being, which indirectly proves that mental health construction has significant socio-economic importance. From an individual development perspective, prosocial tendency is also a core indicator of individual social development, and improving individual or group prosocial tendency is an important task in building a social psychological service system (Xin, 2018). However, current research has mainly focused on the impact of prosocial tendency on internalizing problems (such as depression and anxiety) (Duan et al., 2022), with only a few studies finding that individuals with depressive and anxiety symptoms are more likely to disconnect from society and have difficulty noticing others' needs (Li, 2000; Li et al., 2019). However, there is no clear answer yet as to whether individuals with good mental health are more concerned about the connection between self and society and have higher prosocial motivation. The empathy-altruism hypothesis (Batson, 1987) suggests that when individuals connect emotionally with others' experiences, they generate feelings of sympathy and warmth, which spontaneously activate individuals' prosocial motivation. Both depression and anxiety are related to individuals' emotional experiences (Li, 2000; Li et al., 2019), so the changing trends of depression and anxiety may both affect their prosocial tendency. However, a meta-analysis found that depression was significantly negatively correlated with prosocial tendency, while anxiety was not significantly correlated with prosocial tendency (Memmott-Elison et al.,

2020). Another longitudinal study found that adolescents' depression levels negatively predicted family-related prosocial tendency, meaning that individuals with higher depression levels were less willing to contact others and thus had difficulty perceiving others' needs; but the study found that individuals who experienced anxiety were more likely to show prosocial tendency toward peers but less prosocial tendency toward parents (Padilla-Walker et al., 2015). Based on this, we hypothesize that depression and anxiety have different effects on individuals' prosocial tendency.

1.4 Gender Differences in the Changing Trends of Adolescent Depression and Anxiety in the Late Phase of the Pandemic

Nolen-Hoeksema and Girgus (1994) found that adolescence is a turning point for gender differences in mental health problems. Specifically, there were no significant gender differences in depression and peer problems in primary school, but adolescent girls had significantly more depression and peer problems than boys. Therefore, exploring gender differences in adolescent depression and anxiety and providing targeted intervention suggestions will help adolescents better navigate this transition period. Current research generally believes that girls are more sensitive than boys, meaning that the negative effects of social environmental changes have a greater impact on girls, so girls' depression and anxiety levels are significantly higher than boys' (Ma et al., 2021). However, some researchers have recently challenged this view. A meta-analysis of the detection rates of depression and anxiety among junior high school students in mainland China from 2010 to 2020 showed no significant gender differences in the detection rates of depression and anxiety among junior high school students (Zhang et al., 2022). However, other studies have found inconsistent trajectories of depression and anxiety among adolescents of different genders. Cross-temporal historical research has shown that before the pandemic, the deterioration rate of depression and anxiety among girls was significantly higher than that among boys (Wang & Yu, 2017; Yu et al., 2016), and in the early stage of the pandemic, girls' depression and anxiety and their deterioration rates were also significantly higher than boys' (Hafstad et al., 2022). Since gender differences in adolescent depression and anxiety in the late phase of the pandemic are not yet clear, this study will use multi-group latent growth curve models to explore the above issues, hoping to compare with previous research and obtain essential basic information for constructing an adolescent mental health service system.

In summary, this study aims to explore the following questions: First, the trajectories of adolescent depression and anxiety in the late phase of the pandemic; second, the predictive effect of psychological resilience on adolescent depression and anxiety trajectories; third, whether adolescent depression and anxiety development affects their prosocial tendency; and fourth, whether there are gender differences in adolescent depression and anxiety trajectories. Based on developmental contextualism (Lerner, 2002; Lerner et al., 2005) and the three-

dimensional theoretical framework of mental health change (Peng et al., 2023; Xin et al., 2021), we will use a three-wave longitudinal design and latent growth curve models (LGCM; Duncan et al., 1999) to depict the changing trends of adolescent depression and anxiety in the late phase of the pandemic and their antecedents and outcomes, thereby providing empirical evidence for adolescent mental health construction.

2.1.1 Survey Background

The National Health Commission of China has pointed out that China's COVID-19 pandemic process has been divided into four stages (Ma, 2022): The first stage is the emergency containment phase of the sudden outbreak (from the beginning of the COVID-19 outbreak in 2020 to May 2020), which successfully curbed the rapid spread of the virus; the second stage is the exploration phase of normalized prevention and control (from May 2020 to August 2021), which used nucleic acid testing as the center to promote prevention and controlled the epidemic within 2 to 3 incubation periods (General Office of the State Council of the People's Republic of China, 2020); the third stage is the whole-chain precise prevention and control and dynamic zero-COVID phase (from August 2021 to March 2022) (China Central Television, 2021); after that, China News Service Website (2022) reported that since March 2022, China has gradually entered the fourth stage of comprehensive prevention and control with "scientific precision and dynamic zero-COVID." This study collected national daily existing confirmed COVID-19 cases from the official website of the National Health Commission from January 20, 2020, to June 30, 2022, and plotted the trajectory of national existing confirmed COVID-19 cases (as shown in Figure 1 [Figure 1: see original paper]). We also found that Shandong's daily existing confirmed COVID-19 cases were significantly positively correlated with national daily existing confirmed COVID-19 cases [$r(N=893)=0.63$, $p<0.001$], indicating similarity between Shandong's and the nation's COVID-19 background. Therefore, to more comprehensively and finely depict the changing trends of adolescent mental health in the late phase of the pandemic, this study conducted three-wave questionnaire surveys among adolescents from 5 middle schools in Shandong based on the three stages after the normalization of COVID-19 prevention and control.

2.1.2 Participants

Using convenience sampling, offline surveys were conducted in 5 middle schools in Shandong Province. The interval between the three surveys was 6 months, with the entire survey lasting 12 months. As shown in Figure 1, the first survey (T1) was conducted in May 2021, when China was in the second stage of pandemic prevention and control; T1 recruited 2,342 middle school students, with girls accounting for 51.3%, and the average age of participants was 13.7 years, ranging from 11 to 17 years old. The second survey (T2) was conducted in November 2021, during the third stage of pandemic prevention and control, with 1,587 middle school students participating. The third survey (T3) was con-

ducted in May 2022, during the fourth stage of pandemic prevention and control, with 1,291 students participating. Ultimately, 1,170 students completed all three surveys (boys accounted for 47.7%, with an average age of 13.32 years at T1, ranging from 11 to 17 years old; other demographic information is shown in Table 1), and their data were used for subsequent analyses.

2.2.1 Procedure

This study was approved by the Ethics Review Committee of Ludong University and obtained permission from the principals of the surveyed schools and the guardians of the adolescents. All three surveys were administered in groups, with participants completing the questionnaires in quiet classrooms. Each survey took approximately 25 minutes. During the questionnaire completion process, one research assistant was present in each classroom to maintain order, answer questions, collect questionnaires, and distribute gifts at the end of the survey.

2.2.2 Measures

The main measurement tools used in this study are as follows. Variables measured at all three time points included depression and anxiety; variables measured only at T1 included psychological resilience and demographic variables; and the variable measured only at T3 was prosocial tendency.

(1) Depression
Depression was measured using the Chinese revised version of the Center for Epidemiologic Studies Depression Scale (CES-D) originally developed by Radloff (1977) (Chen et al., 2009). This scale primarily measures depressive mood and experiences, requiring participants to rate the frequency of depressive feelings in the past week. The scale includes 20 items using a 4-point scale (1=Rarely or none of the time, 2=Some or a little of the time, 3=Occasionally or a moderate amount of time, 4=Most or all of the time). A sample item is "I thought my life had been a failure." After reverse-scoring 4 items, the mean score was calculated to represent individual depression levels, with higher scores indicating higher depression. In this study, the scale showed good internal consistency reliability (T1/T2/T3: α=0.91/0.92/0.92).

(2) Anxiety
Anxiety was measured using the Chinese revised version of the Self-Rating Anxiety Scale (SAS) developed by Zung (1971) (Liu et al., 1997), which requires participants to rate their anxiety level in the past week. The scale consists of 20 items using a 4-point scoring method (1=None or a little of the time, 2=Some of the time, 3=Good part of the time, 4=Most or all of the time). A sample item is "I feel more nervous and anxious than usual." The mean score of the scale represents individual anxiety levels. This study found good internal consistency reliability for the scale (T1/T2/T3: α=0.86/0.86/0.84).

(3) Psychological Resilience
Adolescents' psychological resilience was measured at T1 using the Chinese version of the Connor-Davidson Resilience Scale (Connor & Davidson, 2003), translated and revised by Yu and Zhang (2007). This questionnaire contains 25 items, such as "I can adapt to change," using a 5-point rating scale (1=Not true at all, 5=True nearly all the time). Higher mean scores represent stronger psychological resilience (α=0.90).

(4) Prosocial Tendency
Prosocial tendency was measured at T3 using the Prosocial Tendencies Measure revised by Kou et al. (2007) (Carlo & Randall, 2002). This scale consists of 9 items including two dimensions: public prosocial tendency (4 items, e.g., "In many public places, I am more willing to help classmates") and anonymous prosocial tendency (5 items, e.g., "I am more willing to donate money anonymously"). The mean score of the scale represents prosocial tendency (α=0.89).

2.3 Data Analysis Strategy

First, common method bias analysis and descriptive statistics were conducted. Second, as shown in Figure 2 [Figure 2: see original paper], a series of latent growth curve models (LGCM; Duncan et al., 1999) were constructed to depict the trajectories of adolescent depression and anxiety. Without controlling for covariates, unconditional linear LGCM was used to explore the shape of depression and anxiety trajectories. In LGCM, the intercept factor represents the initial value of the outcome variable at three time points, i.e., the baseline level of depression or anxiety (intercept mean), while the slope factor represents the average rate of change over time (slope mean). A positive correlation between intercept and slope factors means that individuals with higher initial depression (or anxiety) show faster changes in depression (or anxiety); conversely, a negative correlation indicates that individuals with higher initial levels show slower changes. To handle missing data, Mplus's full information maximum likelihood estimation was used for data imputation (Enders & Bandalos, 2001). CFI, TLI, RMSEA, and SRMR indices were used to evaluate LGCM fit. When CFI and TLI are greater than 0.90, and RMSEA and SRMR are less than 0.08, the model fit is considered good (Hu & Bentler, 1999). Third, multi-group LGCM was constructed to explore whether the intercepts (initial values) and slopes (growth rates) of adolescent depression and anxiety trajectories differed by gender. To test for significant gender differences, a constrained model and an unconstrained model were set up, and then compared to see if there were significant differences between the two models. ΔCFI and ΔRMSEA were used to compare the change in fit between the constrained model and the unconstrained model (Chen, 2007): if ΔCFI>-0.01 and ΔRMSEA<0.015, the two models are not significantly different; otherwise, the unconstrained model is significantly better, indicating gender differences in anxiety or depression trajectories. Fourth, LGCM with predictor variables was constructed to examine the predictive effect of psychological resilience at T1 on depression and anxiety trajectories, with control variables being

gender, age, grade, residence type, parental education, and family monthly income. Finally, LGCM with outcome variables was constructed to examine the predictive effect of depression and anxiety trajectories on prosocial tendency at T3, controlling for a series of demographic variables.

3.1 Common Method Bias Test and Descriptive Statistics

Harman's single-factor method was used to test for common method bias in the three-wave measurement data. The results showed that at T1, 12 factors with eigenvalues greater than 1 were extracted, with the maximum factor variance explanation rate being 25.2%; at T2, 6 factors with eigenvalues greater than 1 were extracted, with the maximum factor variance explanation rate being 34.3%; at T3, 8 factors with eigenvalues greater than 1 were extracted, with the maximum factor variance explanation rate being 26.8%. In summary, the maximum factor variance explanation rates for the three-wave measurement data were all less than 40% (Zhou & Long, 2004). Therefore, there was no significant common method bias in this study. Table 2 presents the means, standard deviations, and correlation coefficients of depression and anxiety (T1/T2/T3), psychological resilience (T1), and prosocial tendency (T3).

3.2 Trajectories of Depression and Anxiety

Regarding the trajectories of depression and anxiety, the linear LGCM showed good fit (depression: $^{2}(1)=0.14$, p=0.711, CFI=1.000, TLI=1.000, RMSEA<0.001, SRMR=0.002; anxiety: $^{2}(1)=0.01$, p=0.941, CFI=1.000, TLI=1.000, RMSEA<0.001, SRMR<0.001). Therefore, the linear LGCM was selected as the final model. As shown in Table 3 , the intercept of the depression trajectory model was positive (b=1.86, p<0.001), and the mean slope was significantly negative (b=-0.10, p<0.001), indicating that depression significantly decreased over time (estimated means at each time point: MT1=1.86; MT2=1.76; MT3=1.66). The intercept and slope were negatively correlated (r=-0.34, p<0.001), meaning that higher depression at T1 was associated with slower decline in depression over time. Similarly, the intercept of the anxiety model was significantly positive (b=1.84, p<0.001), and the mean slope was significantly negative (b=-0.09, p<0.001), indicating that anxiety significantly decreased over time (estimated means at each time point: MT1=1.84; MT2=1.75; MT3=1.66). The intercept and slope were significantly negatively correlated (r=-0.37, p<0.001), meaning that higher anxiety at T1 was associated with slower decline in anxiety over time.

3.3 Gender Differences in Depression and Anxiety Trajectories

Next, multi-group LGCM analysis was conducted to explore whether the intercepts and slopes of depression and anxiety trajectories differed between genders. Regarding gender differences in depression trajectories, comparing the

constrained model with the unconstrained model revealed that the constrained model was significantly worse than the unconstrained model (ΔCFI=-0.017, ΔRMSEA=0.025), indicating possible gender differences in the intercept or slope of depression. Therefore, the unconstrained model (^{2}(2)=11.78, p=0.003, CFI=0.992, TLI=0.977, RMSEA=0.091, SRMR=0.020) was used to examine gender differences in depression trajectories. As shown in Table 3 and Figure 3 [Figure 3: see original paper]A, the intercept mean of boys' depression trajectory (b=1.80, p=0.001) was significantly lower than that of girls (b=1.91, p<0.001), diff=-0.11, 95% CI [-0.17, -0.05], p=0.001, indicating that boys' depression at T1 was significantly lower than girls'; however, the slope mean of boys' depression trajectory (b=-0.12, p<0.001) did not significantly differ from that of girls (b=-0.09, p<0.001), diff=-0.03, 95% CI [-0.06, 0.01], p=0.115, indicating no significant gender difference in the rate of depression change among adolescents.

Regarding gender differences in anxiety trajectories, the constrained model was significantly worse than the unconstrained model (ΔCFI=-0.021, ΔRMSEA=0.067), indicating gender differences in the intercept or slope of anxiety trajectories. Therefore, the unconstrained model (^{2}(2)=3.97, p=0.137, CFI=0.998, TLI=0.995, RMSEA=0.041, SRMR=0.012) was used to examine gender differences in anxiety trajectories. As shown in Table 3 and Figure 3B, the intercept mean of boys' anxiety trajectory (b=1.79, p<0.001) was significantly lower than that of girls (b=1.89, p<0.001), diff=-0.10, 95% CI [-0.15, -0.04], p<0.001, indicating that boys' anxiety at T1 was significantly lower than girls'; but the slope mean of boys' anxiety trajectory (b=-0.10, p<0.001) did not significantly differ from that of girls (b=-0.08, p<0.001), diff=-0.02, 95% CI [-0.04, 0.01], p=0.187, indicating no significant gender difference in the rate of anxiety decline.

3.4 The Predictive Effect of Psychological Resilience on Depression and Anxiety Trajectories

First, multi-group LGCM analysis was conducted to explore the effect of psychological resilience on depression and anxiety across genders. The results showed no significant difference between the constrained model and the unconstrained model (depression: ΔCFI=0, ΔRMSEA=-0.004; anxiety: ΔCFI=-0.001, ΔRMSEA=-0.001). Therefore, multi-group analysis was not conducted further. Instead, psychological resilience was used as the independent variable, with the intercept and slope of depression (or anxiety) trajectories as dependent variables, and demographic characteristics including gender as control variables.

The results showed good model fit (depression: ^{2}(9)=49.44, p<0.001, CFI=0.974, TLI=0.922, RMSEA=0.065, SRMR=0.029; anxiety: ^{2}(9)=25.14, p=0.003, CFI=0.988, TLI=0.964, RMSEA=0.041, SRMR=0.017). Psychological resilience at T1 significantly negatively predicted depression at T1 (b=-0.43, 95%CI [-0.48, -0.39], p<0.001) and positively predicted the declining speed of depression (b=0.09, 95%CI [0.07, 0.12], p<0.001). Similarly, psychological

resilience at T1 significantly negatively predicted anxiety at T1 (b=-0.28, 95%CI [-0.33, -0.24], p<0.001) and positively predicted the declining speed of anxiety (b=0.08, 95%CI [0.05, 0.10], p<0.001). These results indicate that the higher the adolescents' psychological resilience, the lower their depression and anxiety at T1, and the faster their depression and anxiety declined over time.

3.5 The Predictive Effect of Depression and Anxiety Trajectories on Prosocial Tendency

First, multi-group LGCM analysis was conducted to explore the effect of depression or anxiety trajectories on prosocial tendency across genders. No significant difference was found between the constrained model and the unconstrained model (depression: ΔCFI=-0.002, ΔRMSEA=-0.007; anxiety: ΔCFI=-0.003, ΔRMSEA=0.003). Therefore, multi-group analysis was not conducted further. Instead, the intercept and slope of depression (or anxiety) trajectories were used as independent variables, prosocial tendency as the dependent variable, and demographic characteristics as control variables. The results showed good model fit (depression: $^{2}(23)=85.80$, p<0.001, CFI=0.955, TLI=0.933, RMSEA=0.049, SRMR=0.053; anxiety: $^{2}(23)=86.05$, p<0.001, CFI=0.951, TLI=0.927, RMSEA=0.049, SRMR=0.051). The intercept of depression trajectory significantly negatively predicted prosocial tendency at T3 (b=-0.40, 95%CI [-0.50, -0.30], p<0.001), and the slope of depression trajectory significantly negatively predicted prosocial tendency (b=-0.49, 95%CI [-0.72, -0.26], p<0.001), indicating that lower initial depression levels were associated with higher prosocial tendency at T3, and faster depression decline was associated with higher prosocial tendency at T3. Additionally, the intercept of anxiety trajectory significantly negatively predicted prosocial tendency at T3 (b=-0.45, 95%CI [-0.58, -0.32], p<0.001), but the slope of anxiety trajectory did not significantly predict prosocial tendency (b=-0.34, 95%CI [-0.70, 0.02], p=0.061). This indicates that lower initial anxiety levels were associated with higher prosocial tendency at T3.

4 Discussion

Previous studies on COVID-19 and adolescent depression and anxiety have mainly focused on the first phase (emergency containment of the sudden outbreak) and second phase (exploration of normalized prevention and control) of pandemic prevention and control in China, with few studies involving the third phase (whole-chain precise prevention and control, dynamic zero-COVID) and fourth phase (comprehensive prevention and control with "scientific precision, dynamic zero-COVID"). Based on this, this study selected 1,170 middle school students from 5 middle schools in Shandong based on the three stages after the normalization of prevention and control, collected three waves of data, and used latent growth curve models to depict the changing trends of adolescent depression and anxiety in the late phase of the pandemic. Since Shandong's pandemic situation was significantly positively correlated with the national pan-

demic situation, the results to some extent reflect the changing trajectories and "antecedents and outcomes" of adolescent depression and anxiety in China in the late phase of the pandemic. First, this study systematically depicted the changing characteristics of adolescent depression and anxiety from three aspects: initial levels, changing trends, and their relationship. The results showed that the development of depression and anxiety among Chinese adolescents in the late phase of the pandemic did not deteriorate but instead showed a positive trend. This result affirms China's efforts to improve adolescent mental health, but we still need to correctly understand this positive change. Second, with the help of the three-dimensional theoretical framework of mental health change (Peng et al., 2023; Xin et al., 2021), the decline in depression and anxiety levels is not only due to distal and proximal environmental factors but also involves the key role of individual-group factors. Through the discussion of this study, we attempt to explain the changing characteristics of depression and anxiety, explore the mechanism of psychological resilience in the development of depression and anxiety, and the impact of this development trend on prosocial tendency, thereby providing systematic intervention ideas for adolescent mental health construction.

4.1 Trajectories of Adolescent Depression and Anxiety in the Late Phase of the Pandemic

This study found that adolescent depression and anxiety showed a declining trend in the late phase of the pandemic. This result is contrary to previous cross-temporal historical studies that found an upward trend in depression and anxiety among Chinese adolescents (Wang et al., 2022; Xin & Chi, 2020; Xin et al., 2020). The reason for this divergence may be that previous cross-temporal historical studies did not include data from the pandemic period, i.e., data from 2020 and beyond. After the pandemic outbreak, China's intervention and prevention of adolescent mental health developed unprecedentedly. After the pandemic outbreak, China first opened online psychological assistance hotlines for students and continuously established and improved psychological assistance systems for adolescents (Fu et al., 2023; Xu et al., 2022). The improvement of the social support system in the distal environment may have reduced the threat of pandemic-related social environmental factors to adolescent mental health, gradually reducing their fear of future uncertainty and enabling them to make adaptive responses to environmental changes in the late pandemic phase (Lin et al., 2022), thereby reducing adolescent depression and anxiety levels from the distal perspective. In addition, the "Report on National Mental Health Development in China (2021~2022)" released by the Institute of Psychology, Chinese Academy of Sciences in 2023 showed that compared with 2020~2021, the incidence of depression and anxiety among adolescents decreased in 2021~2022 (Fu et al., 2023), which can corroborate the findings of this study. Compared with the "landslide" of adolescent mental health in the early stage of the pandemic (Wang et al., 2023), adolescents in the late phase of the pandemic showed more positive adaptation. Another reason may be that due to the high infectivity

of the novel coronavirus, China had to issue relevant control measures (such as city lockdowns, home isolation, etc.) at the beginning of the pandemic. Since adolescents are in a critical period of social development and have a greater need for social connection and support (Yu, 2022), home quarantine and online learning temporarily interrupted adolescents' social connections, creating greater temporary stress and resulting in higher levels of depression and anxiety among adolescents in the early stage of the pandemic (Ma et al., 2021). Under normalized control measures, social connections in proximal environments such as school management and family systems gradually recovered (Wu & Liu, 2023), and adolescents' interpersonal networks returned to normal operation, which may have enabled them to better recover from depression and anxiety difficulties. Overall, the social support system in the distal environment and the interpersonal network in the proximal environment may be the reasons for the improvement in adolescent depression and anxiety. However, it is worth noting that we also found a significant negative correlation between the intercept and slope of adolescents' depression and anxiety levels, meaning that the higher the initial level of depression and anxiety, the slower the decline. Therefore, personalized intervention programs need to be developed for adolescents with high depression or anxiety to improve their conditions.

4.2 The Interaction Between Psychological Resilience and Social Change—Promoting Positive Changes in Adolescent Depression and Anxiety

Although this study found that adolescent depression and anxiety gradually improved, depression and anxiety problems remain major threats to adolescent mental health (Fu et al., 2023), which has attracted widespread social attention. However, the increase in problems and the increase in attention put us more in a passive state. The main model of mental health services is a "problem-centered" approach of "solving problems when they appear" or "preventing problems when they appear," which puts our mental health service work in a mode of following behind problems. The COVID-19 pandemic has given us new insights: in the stage of rapid social development, mental health problems have typical characteristics of unpredictability and rapid frequent occurrence. At this time, researchers and practitioners need to pay more attention to adolescents' agency, scientifically and effectively explore the mechanism of interaction between adolescents and society, and change the "passive coping" model to an "active response" approach. According to the three-dimensional theoretical framework of mental health change (Peng et al., 2023; Xin et al., 2021), adolescent mental health change is influenced by the interaction between proximal and distal environmental factors and social change, as well as by the interaction between individual-group factors and social change. As a concept integrating many protective factors (Ma et al., 2008), psychological resilience is closely related to individual cognition, psychological development, and social adaptation, and is an important internal potential of individuals (Zhang et al.,

2022). Therefore, the mechanism of psychological resilience can serve as an important entry point for stimulating adolescents' subjective agency.

The results of this study showed that the initial level of psychological resilience measured at the first time point could significantly negatively predict adolescents' depression and anxiety levels, with higher individual psychological resilience associated with lower depression and anxiety levels, which verifies the protective mechanism of psychological resilience. Based on the compensatory model of psychological resilience (Garmezy, 1984), individuals' psychological resilience interacts with threat factors by mobilizing their own protective factors to reduce the probability of psychological imbalance. Although the social environment in the late phase of the pandemic gradually recovered from a tense state, adolescents still faced many environmental threats (such as locally outbreaks of the pandemic), which might trigger the interaction between individuals' protective factors and dangerous factors such as anxiety they experienced. Individuals with higher psychological resilience can mobilize more protective factors, making it easier to interact with the threat factors they experience, preventing the pandemic from disrupting their mental health balance, thereby reducing depression and anxiety levels.

In addition, psychological resilience is a complex concept with multiple levels, and its mechanism of action involves multiple modes (Ma et al., 2008; Davydov et al., 2010). This study found that the initial level of psychological resilience measured at the first time point could significantly positively predict the declining speed of adolescent depression and anxiety, with higher individual psychological resilience associated with faster decline in depression and anxiety. This finding demonstrates to some extent that psychological resilience can not only protect individuals from harm by stressful events in "adversity" (Gao et al., 2019) but also continuously promote the improvement of adolescent depression and anxiety under chronic stressful events, playing a promotion mechanism of psychological resilience and thereby achieving individual post-traumatic growth. The psychological resilience framework proposed based on ecological systems theory (Kumpfer, 1999; Zhang et al., 2022) can further explain this process. This model points out that the process of psychological resilience involves three aspects: the external environment, individual internal factors, and the interaction between the two. In this process, individuals may intentionally or unintentionally change their environment or selectively perceive the environment. In China's social environment in the late phase of the pandemic, there are both threat factors (negative information in the late pandemic phase) and protective factors (such as social support systems). Adolescents with higher psychological resilience may timely seek protective factors in the environment and use their own coping strategies to reasonably regulate negative emotions, thereby stimulating the long-term mechanism of their internal potential with the help of appropriate external resources, and achieving post-traumatic growth. In summary, the results of this study not only demonstrate the dynamic process of individual psychological resilience under social change but also align with the systematic thinking proposed by the three-dimensional theoretical framework

of mental health change (Peng et al., 2023; Xin et al., 2021). The two major mental health threats of adolescent depression and anxiety require not only improvement in proximal and distal environments but also full play of adolescents' agency, especially the cultivation of their psychological resilience, to promote positive changes in their mental health.

4.3 The Social Outcome of Adolescent Depression and Anxiety Development—Prosocial Tendency

Furthermore, this study also explored the potential impact of adolescent depression and anxiety development on their prosocial tendency. The study found that after the positive impact of social change in the late pandemic phase on adolescent mental health change, it also increased their positive social feedback. Specifically, the study found that both the initial level and declining speed of depression could predict prosocial tendency, but the declining trajectory of anxiety could not predict prosocial tendency. We believe that the reason for the differential impact of depression and anxiety trajectories on adolescent prosocial tendency may be related to the different mechanisms by which different types of emotional problems affect individual prosocial tendency. First, the empathy-altruism hypothesis (Batson, 1987) emphasizes that empathizing with others' predicaments is a prerequisite for generating prosocial tendency. Individuals who have experienced depression often have higher empathy abilities (Yan & Li, 2021). The declining trend of adolescent depression levels indicates to some extent that the adolescent group is gradually recovering from depressive difficulties. Adolescents recovering from depression may be more likely to empathize with others' pain and thus generate prosocial motivation to help others, while individuals with high depression have difficulty jumping out of their own negative cognition, which may leave them lacking sufficient cognitive resources to perceive others' needs. Compared with depression, anxiety is an immediate emotion generated by individuals when facing learning and life events, and is a "distress signal" sent by individuals to the outside world (Van Kleef & Lelieveld, 2022). Therefore, adolescents in an anxious state are more inclined to seek help from others (such as peers), so the changing trend of adolescent anxiety may increase peers' prosocial tendency but cannot predict their own prosocial tendency (Padilla-Walker et al., 2015). However, currently only a few studies have explored the relationship between adolescent depression, anxiety, and prosocial tendency, and it is still not possible to precisely elaborate the mechanism between the changing trends of depression and anxiety and prosocial tendency. Future research could conduct longitudinal experimental designs on this basis to further explore the relationship between depression, anxiety, and different types of prosocial tendency.

4.4 Changing Trends and Gender Differences in Adolescent Depression and Anxiety in the Late Phase of the Pandemic

This study used multi-group latent growth curve models to analyze the changing trends of depression and anxiety among adolescents of different genders. The results found that at all three time points, girls' depression and anxiety levels were significantly higher than boys'. This result is consistent with previous research (Wang & Yu, 2017; Yu et al., 2016). Under the interaction of physiological and cognitive factors, girls are more likely to generate negative emotions when facing stress during adolescence and are more susceptible to negative emotional distress (Hafstad et al., 2022). Moreover, during the pandemic, the negative effects of the pandemic had a greater impact on girls' mental health status (Ma et al., 2021). Overall, girls' higher sensitivity during adolescence is the main reason for their poorer depression and anxiety conditions (Yu et al., 2016). However, this study also found no significant gender differences in the changing trends of adolescent depression and anxiety in the late phase of the pandemic. This result provides some evidence for the gender similarities hypothesis. The gender similarities hypothesis suggests that boys and girls are similar on most psychological variables (Hyde, 2014). Especially since the mental health changes of Chinese adolescents are closely related to social environmental changes, many studies also believe that the impact of physiological gender differences on individual mental health has weakened (Hyde, 2014), while the impact of social background on mental health is greater (Yu & Wang, 2020). Therefore, as China's pandemic-related environment has generally stabilized, both boys and girls have shown similar rates of decline in anxiety and depression levels. This also tells us that although there are some differences in depression and anxiety between boys and girls, these differences should not be viewed as deficits. Teachers and parents need to be cautious about these differences in adolescent education and should think more about how to better leverage the advantages of the interaction between current adolescent gender and social environment to better help adolescents cope with mental health problems such as depression and anxiety.

4.5 Research Significance, Limitations, and Future Directions

In summary, exploring the changing trajectories of adolescent depression and anxiety levels in the late phase of the pandemic has unique value for mental health research. First, the results of this study show that adolescent depression and anxiety levels show a declining trend, which gives us a deeper understanding of the changing trends of adolescent mental health in the context of major public health emergencies. Second, psychological resilience plays a promoting role in the declining trend of adolescent depression and anxiety. This not only expands the explanatory scope of the systemic mechanism model of psychological resilience (Davydov et al., 2010) but also demonstrates the important value of psychological resilience in the recovery process of adolescent depression and anx-

iety. For example, under long-term and large-scale "chronic" stressful events, psychological resilience can play its promotion mechanism to boost the improvement of mental health problems. Third, the changing trajectories of adolescent depression and anxiety also affect their prosocial tendency. By using prosocial tendency as an "outcome variable" in the changing trends of individual depression and anxiety, this study reveals the development of China's social mentality from the psychological relationship of mutual construction between individual and society, which to some extent proves that adolescent mental health construction has important value for improving social well-being. Fourth, gender differences in adolescent depression and anxiety only exist at the three survey time points, but there are no significant gender differences in the changing trends of depression and anxiety, which also provides new thinking for the controversial issue of gender differences in mental health.

Although the levels of depression and anxiety among Chinese adolescents have decreased, their incidence rates remain high (Yu, 2022). To prevent the deterioration of depression and anxiety, we provide the following intervention ideas for adolescent mental health construction based on the research results: First, education departments need to closely monitor the dynamic changes in various indicators of adolescent mental health. To this end, regular follow-up surveys can be conducted to identify adolescents' mental health problems such as depression and anxiety and provide timely intervention. Second, how to shorten the recovery time of adolescents from negative cognition or negative emotions is a key link in adolescent mental health construction. Currently, psychological resilience intervention is the most widely used and effective application in adolescent education practice (Yu & Zhang, 2005; Zhang et al., 2022). This study also found that psychological resilience acts as a promoting factor in the improvement of adolescent mental health (for example, higher initial levels of psychological resilience are associated with faster decline in depression and anxiety). Therefore, teachers can design a series of courses to enhance adolescent psychological resilience, thereby strengthening their resistance to stressful events. Third, attention should also be paid to adolescent prosocial tendency. Schools can use adolescent prosocial tendency as a subsequent impact indicator of adolescent depression and anxiety changes to comprehensively examine adolescent mental health status. Fourth, girls' depression and anxiety levels remain higher than boys', which is a long-standing problem. Therefore, educators should consider changing previous intervention models and more precisely improve mental health problems such as depression and anxiety among different gender groups.

Admittedly, the current research also has certain limitations. First, this study used three-wave survey data over a 12-month period and used latent growth curve models to depict the changing trajectories of adolescent depression and anxiety. Future research could collect data from multiple time points to further examine whether there are non-linear change patterns in adolescent depression and anxiety. Second, considering that non-social changes such as high school entrance examinations and college entrance examinations might affect the mea-

surement of adolescent depression and anxiety in the late phase of the pandemic, we did not collect data from third-year junior high school and third-year senior high school students. Future researchers could consider including these two special adolescent groups to further explore the changing trajectories of adolescent depression and anxiety and more precisely construct mental health monitoring systems and mental health service systems. Third, since this study only collected Chinese samples, future research could conduct cross-cultural studies to verify the universality of the changing trends of adolescent depression and anxiety. Despite these limitations, this study provides basic information for describing the long-term impact of COVID-19 on adolescent mental health.

5 Conclusion

This study draws the following conclusions:

(1) In the late phase of the COVID-19 pandemic, the depression and anxiety levels of Chinese adolescents showed a declining trend, but the higher the initial levels of depression and anxiety, the slower the decline.

(2) After controlling for relevant demographic variables, psychological resilience significantly negatively predicted the initial levels of adolescent depression and anxiety and significantly positively predicted the declining speed of depression and anxiety, meaning that higher initial levels of psychological resilience were associated with lower initial levels of depression and anxiety and faster decline in depression and anxiety.

(3) After controlling for relevant demographic variables, the initial levels of adolescent depression and anxiety both significantly negatively predicted their prosocial tendency, but only the positive development of adolescent depression could affect their prosocial tendency.

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Note: Figure translations are in progress. See original paper for figures.