Mindfulness training on the resilience of adolescents under the COVID-19 epidemic: A latent growth curve analysis

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ABSTRACT

As a preventive measure during the COVID-19 epidemic, we have had to stay at home for a long time. The lifestyle of adolescents has undergone severe changes. Almost every school started online education for the first time. Some adolescents have shown low resilience when faced with these changes. Most previous research has focused on mindfulness training and resilience by using cross-sectional or two-point tracking designs. However, little is known about the developmental trajectories of the impact of mindfulness training on resilience, particularly during this epidemic. Therefore, this study aims to explore how the developmental trajectories of resilience are impacted by mindfulness training. After administering the CD-RISC, we recruited 90 students with low levels of resilience in intervention group. Finally, 84 adolescents provided data at each assessment. At the same time, we selected 90 students in the control group. Paired sample *t*-test was used to compare every factor defined above by time. The result showed that mindfulness training increased students' resilience and emotional intelligence in experiment group. Then in the experiment group, latent growth modeling was used to (1) examine initial levels and changes in resilience over time and (2) predict initial levels and growth in resilience based on emotional intelligence. The findings of this study are as follows: during a mindfulness training intervention, (1) individual resilience tends to increase, and rate of increase grows gradually; there are also significant individual differences in the initial level and development speed; (2) individual emotional intelligence can promote the growth of resilience. With the worldwide outbreak of COVID-19, more and more attention is paid to the mental health of students. The research in this article shows that mindfulness training program should be given increasing consideration in the future.

1. Introduction

In January 2020, a novel coronavirus (COVID-19) began to spread in China. COVID-19 is contagious and highly pathogenic. The main route of transmission is respiratory transmission. As a preventive measure, we have had to stay at home for a long time. Thus, lifestyles have undergone severe changes, and the range of activities has been significantly restricted, resulting in biological rhythm disorders and impacts on sleep rhythms and sleep quality. We were feeling worried and anxious about the epidemic, life, work, and even experienced stress reactions such as excessive fear and nervousness. Therefore, a Chinese mental health expert team formulated the "Novel Coronavirus Pneumonia National Mental Health Case Manual", which introduces various methods of psychological interventions. One such intervention was mindfulness meditation training, as it is one of the current emerging psychotherapy methods. The main aims of mindfulness are to maintain current

awareness; to accept reality with an open, tolerant, and nonevaluative attitude; to reduce experiential avoidance behavior; to relieve anxiety and fear; and to promote psychological and physical health. This study aims to explore the influence of a mindfulness training intervention on the resilience and emotional intelligence of ordinary adolescents during the COVID-19 epidemic.

1.1. Resilience

Resilience can be defined as the ability to positively adapt to stress, crisis, and adversity while remaining healthy (Seery et al., 2010). Resilience plays a protective role in moderating the passive consequences of internalizing and externalizing difficulties (Luthar et al., 2000). Resilience can also prevent further emotional and behavioral problems in the face of serious stress and adversity (Bahmani et al., 2016; Bethell et al., 2016). For instance, researchers have observed that

when different individuals face the same adversity, some people can overcome life stress and stay healthy due to having higher levels of resilience, while those with lower levels of resilience will develop mental distress (Elisei et al., 2013). Meanwhile, Peng et al. (2012) illustrated that subjects who have higher levels of resilience are inclined to engage in more positive adaptive behaviors than those who have low levels of resilience in the face of negative life events. The literature has proven that resilience is a crucial factor that mediates the impact of psychological maltreatment and emotional and behavioral troubles (Arslan, 2016; Bethell et al., 2014; Bethell et al., 2016) and protects against the development of psychiatric disorders (Bethell et al., 2014; Skrove et al., 2013).

In psychological research, resilience is typically evaluated through a variety of self-report instruments, and higher levels of psychological resilience are related to better mental health (Hu et al., 2015). Through a literature review, we can see that resilience is a skill that can be gained though training and enhanced through practice (Grabbe et al., 2012; Joyce et al., 2018). There is growing evidence that resilience is not a stable characteristic but instead a malleable characteristic that can be learned and bolstered (Joyce et al., 2018). Resilience training programs in the workplace have been found to benefit mental health, well-being, and psychosocial functioning (Robertson et al., 2015), particularly when they include mindfulness-based and cognitive-behavioral techniques (Joyce et al., 2018).

1.2. Mindfulness training and resilience

Mindfulness training (MT) mainly involves accepting the present moment with intentional attention and nonjudgmental awareness (Germer, 2005). When subjects use a nonjudgmental attitude to focus on the present reality, they can reduce internalizing and externalizing behaviors in the face of adversity and stress (Thompson et al., 2011). Ultimately, MT cultivates the comprehensive upgrowth and enhancement of individuals' resilience (Schonert-Reichl & Lawlor, 2010). In addition, the most crucial factor in experiencing trauma and adversity is holding an accepting, positive attitude toward life events (Grabbe et al., 2012). Additionally, MT helps individuals accept their present moment in a nonjudgmental approach, thus avoiding negative attitudes. Accepting the present moment with a peaceful and nonjudgmental attitude is one of the most important components of nurturing resilience (Jha et al., 2019). Hence, mindfulness and resilience have a strong mechanical connection to one another conceptually.

The fact that resilience can be increased by mindfulness training has been studied both conceptually (Grabbe et al., 2012; Jha et al., 2019) and empirically (Pidgeon & Keye, 2014). A number of studies have elucidated the mechanism of the effects of MT on resilience, i.e., reducing emotional and behavioral problems (Bluth & Eisenlohr-Moul, 2017; Esmaeilinasab et al., 2011). Some researchers have suggested that MT interventions have a positive effect on resilience among children and adolescents by decreasing internalizing and externalizing stress and adversity (Durlak et al., 2011; Mak et al., 2018). For example, researchers demonstrated that adolescents' attention and self-control were enhanced after 8 weeks of MT (Bogels et al., 2008). In addition, a latent growth curve analysis indicated that after a 5-week MT, low income and ethnic minority elementary school students' behavior was improved for up to 7 weeks (Black & Fernando, 2014). In China, a study of migrant children showed that a 4-week school-based MT intervention could significantly reduce internalizing and externalizing difficulties, especially for students with lower baseline mindfulness scores (Lu et al., 2017). In a study conducted in the southeast United States, researchers selected 47 adolescents to participate in an 8-week MT program. After the program, resilience, curiosity and gratitude improved among all participants (Bluth & Eisenlohr-Moul, 2017). Moreover, many empirical studies have shown similar results in young people from different backgrounds (Bogels et al., 2008; Brown & Ryan, 2003; Keng et al., 2011; Mak et al., 2018; Napoli et al., 2005).

1.3. Mindfulness training for adolescents

The definition of adolescence is usually 10–19 years. At that age, individuals experience significant physical, social and psychological changes that provide a bridge between child and adult health concerns (Population Reference, 2014). Additionally, their patterns of emotions, attitudes, behavior, and cognition are still developing (Kar et al., 2015). Some studies have found that MT is a useful approach for simultaneously decreasing internalizing and externalizing adversity and increasing resilience among both young kids and adolescents (Bluth & Eisenlohr-Moul, 2017; Bogels et al., 2008; Lu et al., 2018). In addition, researchers discovered that great trait mindfulness is beneficial (Broderick & Metz, 2009; Schonert-Reichl & Lawlor, 2010) for navigating hard issues (Biegel et al., 2009), such as how individuals experience and cope with their negative emotions (e.g., anxiety, stress), enhance resilience (Bluth & Blanton, 2014; Tan, 2016) and improve mental well-being (Huppert & Johnson, 2010). These initial studies indicate that it is useful to advocate a mindfulness training approach.

During the critical period of epidemic prevention, students had to stay at home every day, and middle schools started using online education, which caused every adolescent's lifestyle to change drastically. They were feeling worried and anxious about the epidemic, life, and work, and they even experienced stress reactions such as excessive fear and nervousness. Additionally, adolescents easily feel lonely when they are disconnected from peers (Jacobs et al., 2002). During the COVID-19 epidemic, it is essential to facilitate resilience among adolescents to help them adapt negative life experiences. Mindfulness practice is an important method for regulating and enacting positive affect (Rogers, 2013). Therefore, we hypothesize that MT will be useful for adolescents by increasing their resilience to adapt to their experiences during this special period.

1.4. Resilience and emotional intelligence

Salovey and Mayer (1990) originally proposed the concept of emotional intelligence (EI), which describes the capability to be conscious of emotion, conform emotion and cognition, understand causes and consequences of emotion, and manage one's own emotions and others' emotions, and utilize EI to guide thinking and actions to produce beneficial outcomes (Zeidner et al., 2004; Mayer, Roberts, & Barsade, 2008). Adolescents with higher EI scores have a better ability to regulate their emotions (Mayer et al., 2004; Mayer, Salovey, & Caruso, 2008), report a lower rate of depressive experiences (Kat et al., 2019; Mavroveli et al., 2007), and obtain higher grades on their exams (Downey et al., 2008; Pekrun et al., 2009).

Individuals with high levels of EI have the ability to deal with their own emotions and impulses, which is also known as a personality trait of resilience. Resilience refers to one's ability to overcome suffering, to use one's experiences to become a stronger person, and to exploit one's abilities even when experiencing high levels of mental pressure (León García-Inquierdo et al., 2009). A number of compelling studies indicate that there is a strong association between EI and resilience (Armstrong et al., 2011). For instance, a study indicated that those who are vulnerable and have lower EI scores usually have a low level of resilience, while nonvulnerable individuals have higher resilience and EI scores (Armstrong et al., 2011). Moreover, New et al. (2009) revealed that the main factor of EI is the ability to manage emotions effectively, which has been found to be a useful way to improve one's resilience. Therefore, EI is not only directly connected to resilience (Armstrong et al., 2011) but also is an antecedent of resilience (Kat et al., 2019).

All in all, these literature review appear to indicate that MT is beneficial for improving resilience and emotional intelligence of adolescents. Most previous research has focused on mindfulness training and resilience by using cross-sectional or two-point tracking designs. However, little is known about the developmental trajectories of the impact of mindfulness training on resilience, particularly during this

epidemic. Thus, in this research, we hypothesis that MT increased students' resilience and emotional intelligence in experiment group. When undergoing an intervention of MT, individual resilience tends to increase, and the speed of this development gradually increases.

2. Method

2.1. Participants

This study started in February during the COVID-19 epidemic in China. At the time, a new semester should have been starting for most middle schools. In this research, data were collected from a middle school in areas that were not seriously influenced by delays in school or by starting online education at home for the first time.

The researcher administered the Connor–Davidson Resilience Scale (CD-RISC) to all students (N = 1558) via the internet. Then, 90 students with low levels of resilience were recruited to participate in the experiment of MT group. All 90 participants provided informed consent and agreed to participate in this training to complete the Emotional Intelligence Scale (EIS) on February 2020 (T1). The other 3 assessments took place in April 2020 (T2), June 2020 (T3), and August 2020 (T4); 89, 86, and 84 students provided data at each assessment, respectively. In total, 84 subjects (male = 41; female = 43) provided data across all 4 assessments, and their data were analyzed in the current study. In the MT group, the participants' ages ranged from 12 to 14 years old, and the average age was 13.25 years old (SD = 0.78).

Meanwhile, 90 (male = 45; female = 45; age: M = 13.50 ; SD = 0.75) students were selected in control group randomly. All participants in control group took CD-RISC and EIS on February 2020 (T1) and August 2020 (T4), as can be seen in Fig. 1.

2.2. Measures

2.2.1. The Connor–Davidson Resilience Scale (CD-RISC)

In this study, we used Connor and Davidson's (2003) Resilience Scale (Chinese version). The Chinese version of the CD-RISC was translated by Yu and Zhang (2007) and adapted to the Chinese population. In the current study, the Chinese version of the CD-RISC consists of 25 items across 5 dimensions: strength, optimism, control, tenacity and spirituality. Responses to each item were provided on a 5-point Likert scale from 0 to 4. The resilience score is obtained by averaging the scores of all 25 items. Higher scores indicate higher levels of resilience. The reliability coefficients of the CD-RISC in MT group at T1, T2, T3, and T4 were 0.88, 0.86, 0.87, and 0.89, respectively (see Table 1). Confirmatory factor analysis supported a single-factor structure for the CD-RISC (χ^2(df) = 13.81(5), CFI = 0.92, RMSEA = 0.19, and SRMR = 0.05).

2.2.2. Emotional Intelligence Scale (EIS)

The Emotional Intelligence Scale was established by Schutte et al. (1998, 2001) and translated by Wang (2002). Responses to the 33-item scale were measured on a 5-point Likert scale ranging from 1 (completely inconsistent) to 5 (complete consistent). The EIS consists of 4 dimensions: managing one's own emotions, perceiving emotions, using emotions, and managing others' own emotions. Higher scores indicate higher levels of emotional intelligence. In the current sample, the Cronbach's α values of the EIS at T1, T2, T3, and T4 were 0.87, 0.90, 0.87, and 0.91, respectively (see Table 2). The results of a confirmatory factor analysis supported a single-factor structure for the EIS in the current study ($\chi2$(df) = 18.03(13), p < 0.001, CFI = 0.71, RMSEA = 0.20, and SRMR = 0.11).

2.3. Procedure

In the MT group, this 6-month study consisted of the four assessments: T1 (pretraining), T2 (2-month training), T3 (4-month training), and T4 (6-month training). All of the participants were instructed to
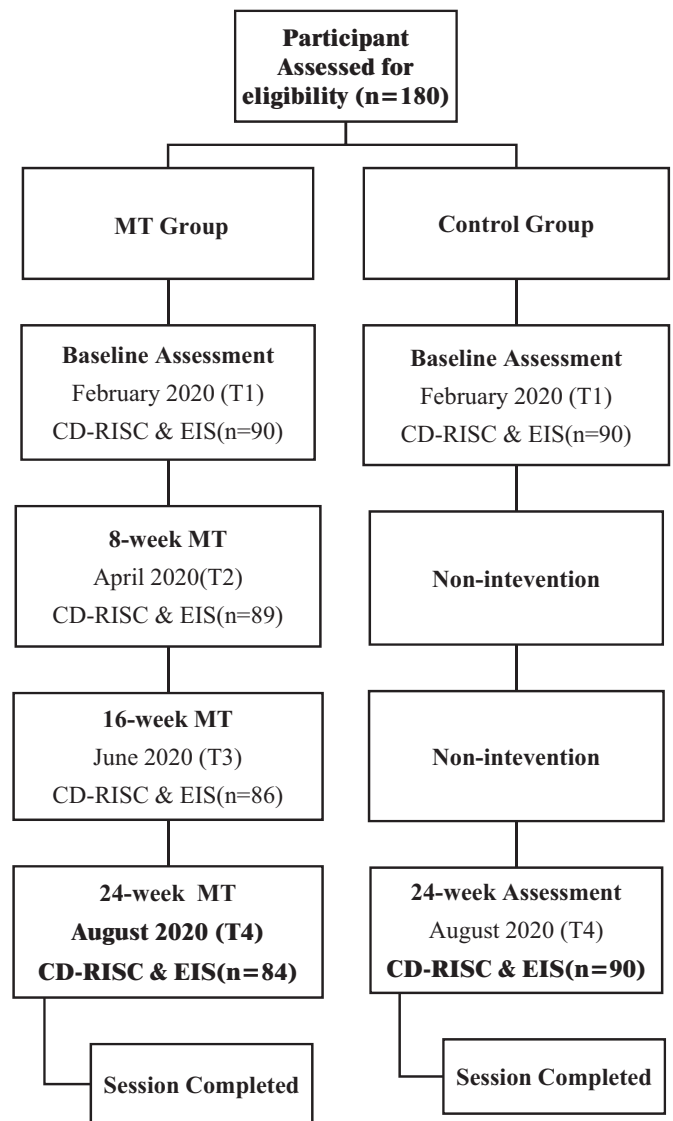

Fig. 1. Flow diagram of controlled trial.

listen to approximately 15 min of a mindfulness training recording every day for 6 months. Each training task was sent to students by the teacher through Dingding homework software to supervise the students' daily training. The teacher set up a learning group for these 90 students and sent mindfulness training recordings every night. All subjects were required to check in to complete the homework every night. Subjects were excluded if they missed at least one training task per week for two consecutive weeks. Additionally, to supervise each subject's participation, a certain amount of credit was deducted as punishment for students who failed to complete. Meanwhile, subjects who adhered to mindfulness training at least six times per week received small prizes to promote subject retention. There's no intervention in the control group, more details showed in the Fig. 1.

2.4. Data analysis strategy

First, SPSS 26.0 was used for data management, descriptive analysis, paired-sample *t*-test, repeated ANOVA and analyzing the relationship between resilience and emotional intelligence. Then, Mplus Version 8.3 (Muthén & Muthén, 1998–2019) was used for latent growth modeling (LGM).

In this study, we first use pair sample t-test and repeated ANOVA to

Table 1

Paired-samples test result of CD-RISC and EIS by group and time.

Scale		MT						Control
	Time	T2 − T1	T3 − T1	T4 − T1	T3 − T2	T4 − T2	T4 − T3	T4 − T1
CD-RISC	Mean	0.64	0.92	1.55	0.26	0.89	0.62	−0.04
	SD	0.25	0.24	0.19	0.03	0.11	0.1	−0.53
	t	24.72***	35.16***	77.03***	88.89***	75.63***	60.51***	0.78*,***
EIS	Mean	0.36	0.37	0.55	0.03	0.18	0.18	0.02
	SD	0.18	0.18	0.2	0.04	0.02	0.02	0.11
	t	18.99***	18.85***	24.88***	6.84***	69.67***	70.04***	1.69

Note: T1 (pre-training), T2 (2-month training), T3 (4-month training), T4 (6-month training).

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

Table 2

Descriptive and correlation matrix data of CD-RISC and EIS score on T1, T2, T3, T4.

Variance	Max	Min	M	SD	Skew	Kurt	Cronbach α	1	2	3	4	5	6	7	8
T1:CD-RISC	1.64	3.32	2.92	0.33	−1.13	1.43	0.88	1.00							
T1:EIS	2.44	3.58	3.56	0.09	−1.11	0.35	0.87	0.973**	1.00						
T2:CD-RISC	3.33	3.65	3.82	0.09	−0.27	−1.20	0.86	0.952**	0.952**	1.00					
T2:EIS	3.58	3.82	4.44	0.18	0.50	−0.31	0.90	0.896**	0.887**	0.955**	1.00				
T3:CD-RISC	3.66	3.96	3.35	0.23	−1.06	0.63	0.87	0.948**	0.954**	0.860**	0.794**	1.00			
T3:EIS	3.58	3.81	3.71	0.06	−0.33	−0.94	0.87	0.960**	0.963**	0.993**	0.955**	0.883**	1.00		
T4:CD-RISC	4.16	4.92	3.71	0.06	−0.33	−0.92	0.89	0.961**	0.962**	0.993**	0.958**	0.885**	0.998**	1.00	
T4:EIS	3.82	3.97	3.88	0.05	0.47	−0.94	0.91	0.886**	0.862**	0.958**	0.988**	0.760**	0.948**	0.949**	1.00

Note: T1 (pre-training), T2 (2-month training), T3 (4-month training), T4 (6-month training). *p<0.05;**p<0.01;***p<0.001

compare every factor defined above by time and group. Then, in MT group, we first built an unconditional LGM to examine the trajectory of changes in resilience and to determine whether there were significant individual differences in the initial levels of resilience or in the speed of resilience development. Finally, the time variation factor of emotional intelligence was added to the model to investigate whether the trajectory of resilience is affected by emotional intelligence.

3. Results

3.1. Comparison of experimental group and control group

To compare every factor defined above by time, pair sample t-test was performed in this study (Table 2). The result showed that resilience was significant different in MT group over time at 0.001 levels. It indicated that mindfulness training can improve resilience from T2 to T1 (t = 24.72, p < 0.001, mean: 0.64, SD: 0.25), from T3 to T2 (t = 88.89, p < 0.001, mean: 0.26, SD: 0.03), and from T4 to T3 (t = 60.51, p < 0.001, mean: 0.62, SD: 0.10). However, there's no difference in control group,
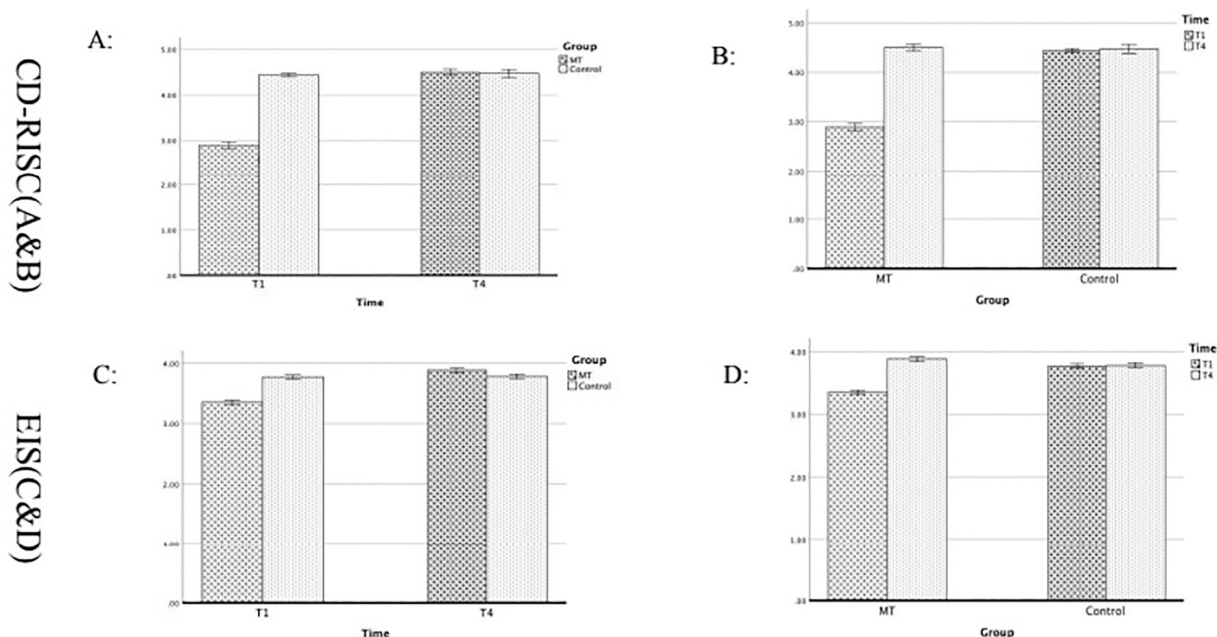

Fig. 2. Mean differences for CD-RISC (A & B) and EIS (C & D) in different groups. The error bars represent the standard deviation.

implying that the score of CD-RISC will not increase over time. Details of descriptive statistics for CD-RISC of participants in different groups at T1, T2, T3 and T4 have been depicted in Table 2 respectively. Besides, the result of EIS showed that emotional intelligence was significant different in MT group over time at 0.001 levels. It also indicated that mindfulness training can increase emotional intelligence from T2 to T1 (t = 18.99, p < 0.001, mean: 0.36, SD: 0.18), from T3 to T2 (t = 6.84, p < 0.001, mean: 0.03, SD: 0.04), and from T4 to T3 (t = 70.04, p < 0.001, mean: 0.18, SD: 0.02). However, there's no difference in control group, implying that emotional intelligence won't increase over time. Details of descriptive statistics for EIS of participants in different groups at T1, T2, T3 and T4 have been depicted in Table 1 respectively.

This study performed 2 (group: MT, control) × 2 (time: T1 at baseline, T4 at 24-week) analyses. To compare every factor defined above by group, repeated measure ANOVA was performed in this study (Table 2). The result showed that CD-RISC of Time (F = 395.35, p < 0.001) and Group (F = 734.34, p < 0.001) was significantly difference in different groups at 0.001 level. Fig. 2(A) is the comparison of the CD-RISC values of each group before and after the intervention. It can be seen that at T1, the CD-RISC score of the control group is significantly higher than that of the experimental group, but after 24 weeks of MT intervention, there's no significant difference between two group. Fig. 2(B) is the comparison of the CD-RISC score of the experimental group and the control group at different time points. It can be seen that the CD-RISC score of the control group have no significant differences at different time points, however the score of MT group has been increased significantly after 24 weeks MT intervention. It can be seen that in this experiment, MT intervention contributes to the improvement of CD-RISC.

The result of repeated ANOVA showed that EIS of Time (F = 126.68, p < 0.001) and Group (F = 396.78, p < 0.001) was significantly difference in different groups at 0.001 level. Fig. 2(C) is the comparison of the EIS values of each group before and after the intervention. It can be seen that at T1, the EIS score of the control group is significantly higher than that of the experimental group, but after 24 weeks of MT intervention, there's no significant difference between two group. Fig. 2(D) is the comparison of the EIS score of the experimental group and the control group at different time points. It can be seen that the EIS score of the control group have no significant differences at different time points, however the score of MT group has been increased significantly after 24 weeks MT intervention. It can be seen that in this experiment, MT intervention contributes to the improvement of EIS.

3.2. Descriptive statistics of experimental group

Table 2 shows the mean value (M), standard deviation (SD), skewness, kurtosis, Cronbach's α and correlation coefficient matrix of resilience and emotional intelligence at various assessments. From pretraining to 6 months after training, resilience showed an upward trend; resilience and emotional intelligence were significantly positively

correlated at different test times; additionally, resilience and emotional intelligence were stable. The skewness and kurtosis of the CD-RISC and EIS were 1.5 across all assessments, and the departure of data from normality was acceptable. All variables satisfy the assumption of normal distribution, and the maximum likelihood (ML) method was applied to estimate the parameters of the model (Curran et al., 1996) while performing the LGM.

3.3. Trajectory of resilience

To explore whether the trajectory of resilience is linear or quadratic, we conducted unconditional linear LGM (Fig. 3) and unconditional quadratic LGM (Fig. 4).

Unconditional linear LGM only needs to estimate the intercept (α) and the slope (β). The intercept represents the initial level of the resilience trajectory, and all factor loadings are fixed at 1.0. The slope represents the change in the increase of the trajectory of resilience. The factor loads are set to 1.0, 2.0, 3.0 and 4.0, corresponding to the time point of the assessments. The equation of the first-level horizontal model is CD-RISC$it = \alpha i + \beta i \lambda t + \xi it$. CD-RISC$it$ is the resilience score of participant i at time t; αi is the intercept of participant i, which is the level of resilience at T1. βi is the slope of participant i, which is the average rate of change in resilience for participant i. λt represents the code of time, ξit represents the residuals of participant i at time t. The equation of the second level horizontal model is $\alpha i = \mu \alpha + \xi \alpha i$; $\beta i = \mu \beta + \xi \beta i$. $\mu \alpha$ and $\mu \beta$ are the means of the intercept and slope, respectively, and $\xi \alpha i$ and $\xi \beta i$ are the intercept and slope residuals of *participant i*, respectively.

The unconditional Quadratic LGM adds a quadratic term to the linear unconditional LGM, and the equation at the first level becomes CD-RISC$it = \alpha i + \beta 1 i \lambda t + \beta 2 i \lambda t^2 + \xi it$. $\lambda t2$ is the square of the time code, $\beta 1i$ is the slope code, and $\beta 2i$ is the linear slope code. The equations at the second level are $\alpha i = \mu \alpha + \xi \alpha i$, $\beta 1i = \mu \beta 1 + \xi \beta 1i$, and $\beta 2i = \mu \beta 2 + \xi \beta 2i$.

First, the unconditional LGM has a good fit. The mean of the slope and the variance of the slope are 0.65 and 0.25, respectively, and both are significant at the 0.001 level. This finding indicates that there are significant differences in the initial level and growth rate between individuals. The correlation coefficient between the slope and intercept is 0.036 (p < 0.001), suggesting that there is a significant positive relationship between the growth rate and the initial level of an individual's resilience; that is, individuals with high initial levels show a faster increase. Moreover, it can be seen from the fitting indicators in Table 2 that the unconditional quadratic LGM fits the data better than the unconditional LGM, indicating that the development of adolescents' resilience shows a curved trend. Resilience showed an increasing trend during the four tests (Slope = 0.56, p < 0.001), and the rate of increase increased month by month (Linear Slope = 0.28, p < 0.01). In addition, the variation in slope (σ^2 = 0.22, p < 0.001) and the variation in linear slope (σ^2 = 0.02, p < 0.05) indicate that the initial level of resilience in
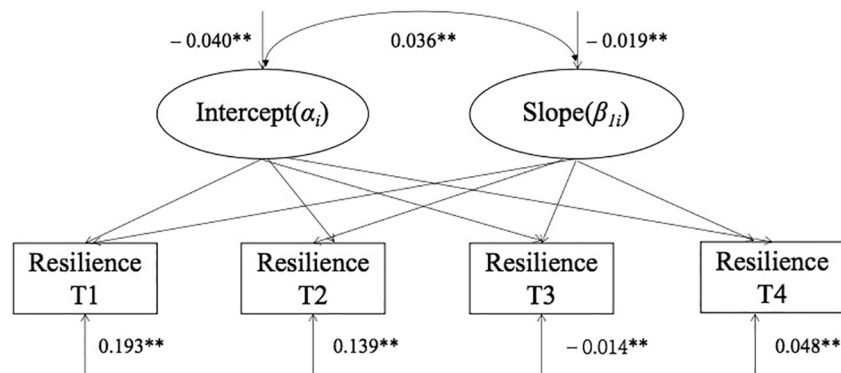

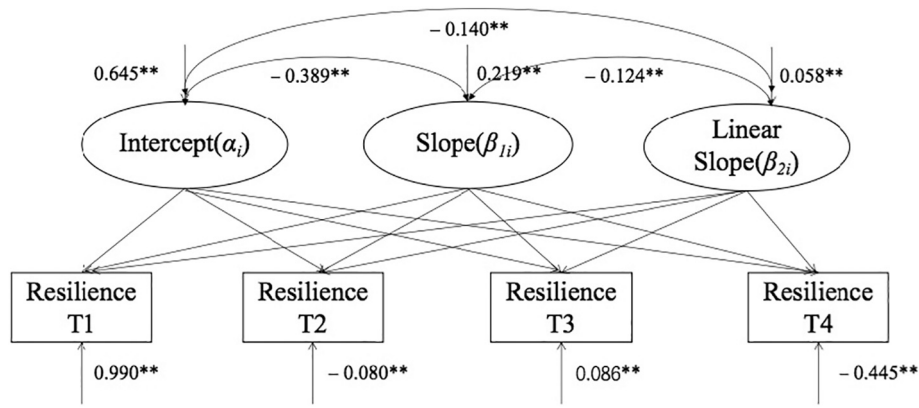**Fig. 3.** Unconditional LGCM of resilience.

Fig. 4. Unconditional quadratic LGCM of resilience.

adolescents and the subsequent change speed show obvious interindividual differences. Finally, the correlation coefficients between the intercept and slope (r = −0.389, p < 0.01), the intercept and linear slope (r = −0.140, p < 0.01), and the slope and linear slope (r = −0.124, p < 0.01) were significantly different, indicating that there are significant correlations among the speed, acceleration and the initial level of resilience changes.

3.4. Trajectory of resilience: the influence of emotional intelligence

To investigate the influence of emotional intelligence on the trajectory of resilience, emotional intelligence is used as a time varying covariate to build a condition model (Fig. 5). In this model, the equation of the first level model is CD-RISC$it = \alpha i + \beta i\lambda t + \gamma t\omega it + \xi it$. ωit is the emotional intelligence score of participant i at time t, and γt 为 is the partial regression coefficient of emotional intelligence to resilience at time t. The equation of the second level model is $\alpha i = \mu\alpha + \gamma\alpha xi + \xi\alpha i$; $\beta 1i = \mu\beta 1 + \gamma\beta 1xi + \xi\beta 1i$; $\beta 2i = \mu\beta 2 + \gamma\beta 2xi + \xi\beta 2i$.

The results show that LGM fit the data well, $\chi^2(17) = 21.48$, p < 0.01, CFI = 0.90, RMSEA = 0.06, SRMR = 0.06. The variances of the intercept and slope are −0.003 and −0.001, respectively, and both are significant at the level of 0.001. This finding indicates that there are significant individual differences in the initial level and growth rate of individuals. The correlation coefficient of slope and intercept is 0.002 (p < 0.001), which indicates that there is a positive relationship between the rate of individual growth and the initial state. That is, individuals with high initial levels of resilience show faster growth. In addition, the variance of intercept is ($\sigma^2 = -0.001$, p < 0.001), and the variance of slope is ($\sigma^2 = -0.003$, p < 0.001).

4. Discussion

4.1. Mindfulness training induced change on resilience

In this research, we performed an experiment MT group and a control group to check whether MT can improve students' resilience and emotional intelligence. The result showed that both resilience and emotional intelligence were significant different in MT group over time. Then in MT group, we constructed a linear growth model and a nonlinear growth model of resilience development. The results of the models show that the slopes of the parameters of both models were significantly positive, indicating that during the test period, the resilience levels of the subjects increased. The slope of the curve was significantly positive, which indicates that the psychological elasticity level of the subjects increased. Therefore, some aspects of this phenomenon can be explained.

First, we believe that mindfulness and resilience have a strong mechanical connection with each other. The most crucial factor in experiencing trauma and adversity is maintaining an accepting positive attitude toward life events (Grabbe et al., 2012). Mindfulness training helps individuals accept their present moment in a nonjudgmental manner, thus avoiding negative emotions. Accepting the present moment with a peaceful and nonjudgmental attitude is one of the most important components of resilience (Jha et al., 2019). In this program, subjects were trained to use a nonjudgmental attitude to focus on the present reality, which was an effective way to reduce their internalizing and externalizing behaviors in response to pressure and adversity (Durlak et al., 2011; Mak et al., 2018). Thus, the MT intervention led to increased resilience.
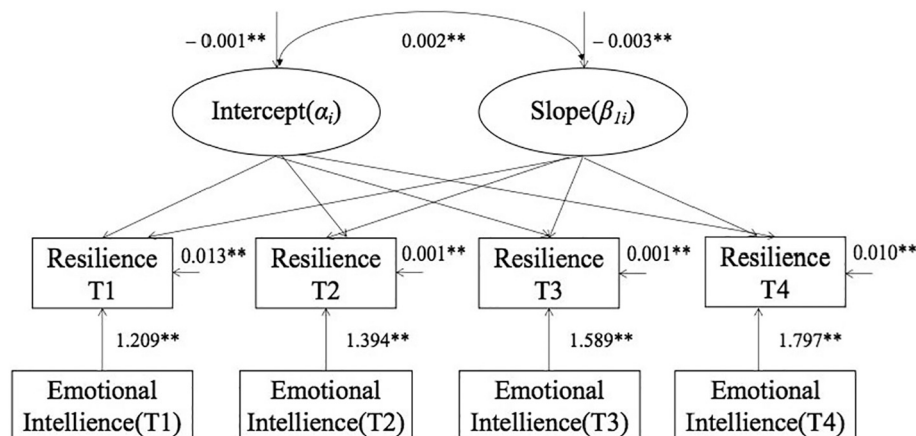

Fig. 5. The influence of emotional intelligence on the track of resilience.

The second aspect addresses the improvements in coping with negative emotions by MT, which is beneficial for enhancing resilience. Mindfulness training can shift attention to breathing and distract individuals from negative emotions such as anxiety, depression, and fear that are caused by the epidemic. Additionally, holding a mindfulness acceptance and non-evaluation attitude toward the epidemic can also help prevent the generation of negative emotions. Experiments have confirmed that the brainwave θ wave activity of long-term mindfulness training is significantly increased, indicating that the brain's alertness is increased, and the level of attention and cognition is improved, thereby improving the individual's emotional regulation ability (Cahn & Polich, 2006). Mindfulness training can change brain activity related to emotions to a certain extent, enhance the individual's positive emotions, and improve the development of mental health (Levin et al., 2015). Thus, through this training program, subjects ultimately obtain the overall improvement of resilience.

In addition, this research conclusion confirms previous studies that resilience can be trained and improved (Bluth & Eisenlohr-Moul, 2017; Bogels et al., 2008; Brown & Ryan, 2003; Esmaeilinasab et al., 2011; Keng et al., 2011; Mak et al., 2018; Napoli et al., 2005). Resilience is not a stable trait (Joyce et al., 2018) but rather a malleable characteristic that can be trained and bolstered. Additionally, using mindfulness-based and cognitive-behavioral techniques to improve resilience is beneficial for mental health (Joyce et al., 2018; Robertson et al., 2015). This has been shown in previous studies. Black and Fernando (2014) used a latent growth curve analysis and found that children's resilience improved after a 5-week mindfulness training, and this change was maintained for up to 7 weeks. Lu et al. (2017) reported a study of migrant children and showed that a 4-week school-based MT intervention significantly reduced internalizing and externalizing behaviors, especially for those with lower baseline mindfulness scores. In a study conducted in the southeast United States, researchers selected 47 adolescents to participate in an 8-week MT program. After the program, resilience, curiosity and gratitude improved among all participants (Bluth & Eisenlohr-Moul, 2017).

Apart from the intervention of mindfulness training, the improvement of the subjects' resilience may be due to the better control of the epidemic situation in the area. In mid-March, all the areas where the subjects are located gradually resumed work and production, and the living conditions of the residents in the participants' community changed from mandatory home isolation to being able to go out. Starting in late March, schools officially resumed classes. The students returned to the campus again and were able to receive in-person education as usual. Additionally, all subjects were able to communicate and play with students of the same generation, and the relative improvement of the epidemic situation may have also affected the improvement in the subjects' mental flexibility.

4.2. The influence of mindfulness training on emotional intelligence

In this study, we used MT as the intervention method, and we believe that EI may have an important impact on resilience. Existing studies have mostly used cross-sectional research designs to examine the correlation between emotional intelligence and resilience or the mediating role of EI, resilience, and other factors. This study uses a latent growth curve model to examine the variance in EI over time and to investigate its role in the development of resilience. Existing research shows that there is a strong association between EI and resilience (Armstrong et al., 2011). EI not only plays a crucial predictive role in resilience, but also antecedent to resilience (Armstrong et al., 2011; Kat et al., 2019). EI is the ability to manage emotions effectively, which has been found to be a useful way to improve one's resilience (New et al., 2009). The results show that the level of EI can affect resilience, and a higher level of EI can accelerate the rise of resilience to a certain extent.

According to the results of this study, after the MT intervention, EI showed an upward trend. EI is the ability to be conscious of emotion, conform emotions with cognition, understand the causes and consequences of emotion, manage one's own emotions and others' emotions, and utilize this skill to guide thinking and actions to produce beneficial outcomes (Zeidner et al., 2004; Mayer, Roberts, & Barsade, 2008). MT cause the brain regions change that regulate emotion process. During mindfulness training, Sperduti et al. (2012) use meta-analysis provided insight into the brain areas active. Sperduti et al. (2012) found that the basal ganglia (caudate), the entorhinal cortex (parahippocampal region), and the medial prefrontal cortex are the important regions of brain subserve the meditative state through activation likelihood estimation (ALE). Those three regions are crucial for cognitive and emotional processes that relevant for the mindfulness training. Sperduti et al. (2012) believes when individuals are in the state of MT, the basal ganglia can help inhibit irrelevant thoughts, the entorhinal cortex help the control of the mental state, and the mPFC contributes to the enhanced sense of emotional self-awareness. Therefore, MT is a useful way to enhance emotional awareness, which is beneficial for increasing EI.

Besides, in this study, the level of EI improved with training. This may be because in the continuous practice of mindfulness training, the participants are more sensitive to emotion recognition. In addition, the level of emotional intelligence increased with training. This may be caused by the fact that the subjects' ability to recognize emotions is more acute in the continuous practice of mindfulness training. Additionally, mindfulness training requires subjects to accept the present moment with nonjudgmental awareness of emotion, which may be beneficial for individuals to perceive, understand the cause and consequence of emotions. This is a core aspect of EI.

4.3. Contributions

Through 4 follow-up tests over 6 months, this study systematically investigated the impact of mindfulness training on the resilience of adolescents in the context of the COVID-19 epidemic. To a certain extent, it proved that mindfulness training leads to a significant improvement in resilience. Regarding research on mindfulness training and resilience, most studies have used cross-sectional or two-point tracking designs. Although these designs can help us understand the impact of mindfulness training on resilience, they do not essentially explain the true trajectory of resilience development. This research not only examines the development trend of resilience under the training of mindfulness training but also explores the influence of mindfulness training on the development speed of resilience and examines individual differences in the speed of the development. The results obtained provide a certain empirical basis for the perfection of the resilience development theory model. Second, this study also systematically investigated the impact of gender and emotional intelligence on resilience among individuals undergoing mindfulness training. Few studies have used longitudinal research to explore the relationship between these two factors. The results of this study have certain theoretical significance for understanding and improving the development of resilience. Finally, the world is currently trying to control the COVID-19 pandemic. In this context, many middle school students will also face the same psychological problems. In the context of this epidemic, to a certain extent, improving the reveal of the development trend of resilience will help us better understand how to help young people spend this special stage reasonably.

4.4. Limitations and future research

There are a few limitations in this research. First, all subjects in this research have undergone other positive incidents, such as transitioning from being quarantined to being free and transitioning from taking classes online to being able to go to school. These incidents might have also been beneficial for improving the resilience of adolescents. Nevertheless, given the design of the research, other positive incidents were

not evaluated, which stopped us from taking into consideration their role in the connection between changes in mindfulness training and resilience over time. In addition, research on resilience is not meticulous enough. The Connor–Davidson Resilience Scale used in this study consists of 5 dimensions (Connor & Davidson's, 2003; Yu & Zhang, 2007). However, this study was focused on overall resilience. More meticulous research on the subtypes of resilience should be conducted in future studies. Third, further research can also extend the tracking time and comprehensively consider life changes, personality characteristics and other factors. Additionally, there was no control group.

5. Conclusion

The findings of this study are as follows:

(1) Mindfulness training increased students' resilience and emotional intelligence in experiment group.
(2) When undergoing a mindfulness training intervention, individual resilience tends to increase, and the speed of this development gradually increases. There are significant individual differences in the initial level and development speed.
(3) When undergoing a mindfulness training intervention, individual emotional intelligence can promote the growth of resilience.

CRediT authorship contribution statement

Yue Yuan: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization.

References

Armstrong, A. R., Galligan, R. F., & Critchley, C. R. (2011). Emotional intelligence and psychological resilience to negative life events. *Personality and Individual Differences, 51*, 331–336.

Arslan, G. (2016). Psychological maltreatment, emotional and behavioral problems in adolescents: The mediating role of resilience and self-esteem. *Child Abuse & Neglect, 52*, 200–209.

Bahmani, D. S., Hatzinger, M., Gerber, M., Lemola, S., Clough, P. J., Perren, S., … Brand, S. (2016). Origins of mental toughness. *Frontiers in Psychology, 7*. https://doi. org/10.3389/fpsyg.2016.01221.

Bethell, C., Gombojav, N., Solloway, M., & Wissow, L. (2016). Adverse childhood experiences, resilience and mindfulness-based approaches: Common denominator issues for children with emotional, mental, or behavioral problems. *Child and Adolescent Psychiatric Clinics of North America, 25*(2), 139–156.

Bethell, C. D., Newacheck, P., Hawes, E., & Halfon, N. (2014). Adverse childhood experiences: Assessing the impact on health and school engagement and the mitigating role of resilience. *Health Affairs, 33*(12), 2106–2115.

Biegel, G., Brown, K., Shapiro, S., & Schubert, C. (2009). Mindfulness-based stress reduction for the treatment of adolescent psychiatric outpatients: A randomized clinical trial. *Journal of Clinical and Consulting Psychology, 77*(5), 855–866. https:// doi.org/10.1037/a0016241.

Black, D. S., & Fernando, R. (2014). Mindfulness training and classroom behavior among lower-income and ethnic minority elementary school children. *Journal of Child and Family Studies, 23*, 1242–1246.

Bluth, K., & Blanton, P. W. (2014). Mindfulness and self-compassion: Exploring pathways to adolescent emotional well-being. *Journal of Child and Family Studies, 23*(7), 1298–1309. https://doi.org/10.1007/s10826-013-9830-2.

Bluth, K., & Eisenlohr-Moul, T. A. (2017). Response to a mindful self-compassion intervention in teens: A within-person association of mindfulness, self-compassion, and emotional well-being outcomes. *Journal of Adolescence, 57*, 108–118.

Bogels, S., Lieke van Dun, B. H., de Schutter, S., & Restifo, K. (2008). Mindfulness training for adolescents with externalizing disorders and their parents. *Behavioural and Cognitive Pscyhotherapy, 36*, 193–209.

Broderick, P., & Metz, S. (2009). Learning to breathe: A pilot trial of a mindfulness curriculum for adolescents. *Advances in School Mental Health Promotion, 2*(1), 35–46. https://doi.org/10.1080/1754730X.2009.9715696.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84*(4), 822–848.

Cahn, B., & Polich, J. (2006). Meditation states and traits: EEG, ERP, and neuro imaging studies. *Psychological Bulletin, 132*(2), 180–211.

Connor, K. M., & Davidson, J. R. (2003). Development of a new resilience scale: The Connor-Davidson resilience scale (CD-RISC). *Depression and Anxiety, 18*(2), 76–82.

Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to non-normality and specification error in confirmatory factor analysis. *Psychological Methods, 1*(1), 16.

Downey, L., Mountstephen, J., Lloyd, J., Hansen, K., & Stough, C. (2008). Emotional intelligence and scholastic achievement in Australian adolescents. *Australian Journal of Psychology, 60*(1), 10–17.

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development, 82*(1), 405–432.

Elisei, S., Sciarma, T., Verdolini, N., & Anastasi, S. (2013). *Resilience and depressive disorders. Paper presented at the Psychiatria Danubina*. Croatia: Zagreb.

Esmaeilinasab, M., Malek Mohamadi, D., Ghiasvand, Z., & Bahrami, S. (2011). Effectiveness of life skills training on increasing self-esteem of high school students. *Procedia Social and Behavioral Sciences, 30*, 1043–1047.

Germer, G. (2005). What is mindfulness. In G. Germer, R. Siegel, & P. Fulton (Eds.), *Mindfulness and psychotherapy* (pp. 1–27). New York: Guilford.

Grabbe, L., Nguy, S. T., & Higgins, M. K. (2012). Spirituality development for homeless youth: A mindfulness meditation feasibility pilot. *Journal of Child and Family Studies, 21*(6), 925–937.

Hu, T., Zhang, D., & Wang, J. (2015). A meta-analysis of the trait resilience and mental health. *Personality & Individual Differences, 76*, 18–27.

Huppert, F., & Johnson, D. (2010). A controlled trial of mindfulness training in schools: The importance of practice for an impact of well-being. *The Journal of Positive Psychology, 5*(4), 264–274. https://doi.org/10.1080/17439761003794148.

Jacobs, J. E., Lanza, S., Osgood, D., Ecles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*(2), 509–527. https://doi.org/10.1111/1467-8624.00421.

Jha, A. P., Denkova, E., Zanesco, A. P., Witkin, J. E., Rooks, J., & Rogers, S. L. (2019). Does mindfulness training help working memory "work" better? *Current Opinion in Psychology, 28*, 273–278. https://doi.org/10.1016/j.copsyc.2019.02.012.

Joyce, S., Shand, F., Tighe, J., Laurent, S. J., Bryant, R. A., & Harvey, S. B. (2018). Road to resilience: A systematic review and meta-analysis of resilience training programes and interventions. *BMJ Open, 8*(6), Article e017858. https://doi.org/10.1136/bmjopen- 2017-017858.

Kar, S. K., Choudhury, A., & Singh, A. P. (2015). Understanding normal development of adolescent sexuality: A bumpy ride. *Journal of Human Reproductive Sciences, 8*, 70–74.

Kat, D., Luke, D., Justine, L., Emily, R. B., Nathan, S., Andrew, W., … Con, S. (2019). Differentiating the contributions of emotional intelligence and resilience on adolescent male scholastic performance. *Personality and Individual Differences, 145*, 75–81.

Keng, S. L., Smoski, M. J., & Robins, C. J. (2011). Efffects of mindfulness on psychological health: A review of empirical studies. *Clinical Psychology Review, 31*, 1041–1056.

León García-Inquierdo, A., Ramos-Villagrasa, P. J., & García-Izquierdo, M. (2009). Big five factors and resiliency moderator effect on emotional exhaustion. *Revista de Psicología del Trabajoy de las Organizacones, 25*(2), 135–147.

Levin, M., Luoma, J., & Haeger, J. (2015). Decoupling as a mechanism of change in mindfulness and acceptance: A literature review. *Behavior Modification, 39*(6), 142.

Lu, S., Huang, C.-C., & Rios, J. (2017). Mindfulness and academic performance: An example of migrant children in China. *Children and Youth Services Review, 82*(1), 53–59. https://doi.org/10.1016/j.childyouth.2017.09.008.

Lu, S., Rios, J., & Huang, C.-C. (2018). Mindfulness, emotion, and behavior: An intervention study with chinese migrant children. *Children & Society, 32*(4), 290–300.

Luthar, S. S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development, 71*(3), 543–562.

Mak, C., Whittingham, K., Cunnington, R., & Boyd, R. N. (2018). Efficacy of mindfulnessbased interventions for attention and executive function in children and adolescentsa systematic review. *Mindfulness, 9*, 59–78.

Mavroveli, S., Petrides, K. V., Rieffffe, C., & Bakker, F. (2007). Trait emotional intelligence, psychological well-being and peer-rated social competence in adolescence. *British Journal of Developmental Psychology, 25*(2), 263–275.

Mayer, J. D., Roberts, R. D., & Barsade, S. G. (2008). Human abilities: Emotional intelligence. *Annual Review of Psychology, 59*, 507.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2004). Emotional intelligence: Theory, findings, and implications. *Psychological Inquiry, 15*(3), 197–215.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2008). Emotional intelligence: New ability or eclectic traits? *The American Psychologist, 63*, 503.

Muthén, B., & Muthén, L. K. (1998–2019). *Mplus*. Muthén & Muthén: Los Angeles (Version 8.3).

Napoli, M., Krech, P. R., & Holley, L. C. (2005). Mindfulness training for elementary school students. *Journal of Applied School Psychology, 21*(1), 99–125.

New, A. S., Fan, J., Murrough, J. W., Liu, X., Liebman, R. E., Guise, K. G., et al. (2009). A functional magnetic resonance imaging study of deliberate emotion regulation in resilience and posttraumatic stress disorder. *Biological Psychiatry, 6*, 656–664.

Pekrun, R., Elliot, A. J., & Maier, M. A. (2009). Achievement goals and achievement emotions: Testing a model of their joint relations with academic performance. *Journal of Educational Psychology, 101*(1), 115–135.

Peng, L., Zhang, J., Li, M., Li, P., Zhang, Y., Zuo, X., & Xu, Y. (2012). Negative life events and mental health of Chinese medical students: The effffect of resilience, personality and social support. *Psychiatry Research, 196*(1), 138–141. https://doi.org/10.1016/j. psychres.2011.12.006.

Pidgeon, M. A., & Keye, M. (2014). Relationship between resilience, mindfulness and psychological well-being in university students. *International Journal of Liberal Arts and Social Science, 2*(5), 27–32.

Population Reference Bureau. (2014). Adolescence: A foundation for future health. Retrieved January 14, 2019, from https://stage.prb.org/wp-content/uploads/2014/07/lancet-youth-factsheet-1.pdf.

Robertson, I. T., Cooper, C. L., Sarkar, M., & Curran, T. (2015). Resilience training in the workplace from 2003 to 2014: A systematic review. *Journal of Occupational and Organizational Psychology, 88*(3), 533–562. https://doi.org/10.1111/joop.12120.

Rogers, H. B. (2013). Mindfulness meditation for increasing resilience in college students. *Psychiatric Annals, 43*(12), 545–548.

Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition and Personality, 9*, 185–211.

Schonert-Reichl, K. A., & Lawlor, M. S. (2010). The effects of a mindfulness-based education program on pre- and early adolescents' well-being and social and emotional competence. *Mindfulness, 1*(3), 137–151. https://doi.org/10.1007/s12671-010-0011-8.

Schutte, N. S., Malouff, J., Bobik, C., Coston, T., Greeson, C., Jedlicka, C., & Wendorf, G. (2001). Emotional intelligence and interpersonal relations. *Journal of Social Psychology, 141*, 523–536.

Schutte, N. S., Malouff, J. M., Hall, L. E., Haggerty, D. J., Cooper, J. T., Golden, C. J., & Dornheim, L. (1998). Development and validation of a measure of emotional intelligence. *Personality and Individual Differences, 25*, 167–177.

Seery, M. D., Holman, E. A., & Silver, R. C. (2010). Whatever does not kill us: Cumulative lifetime adversity, vulnerability, and resilience. *Journal of Personality and Social Psychology, 99*(6), 1025–1041.

Skrove, M., Romundstad, P., & Indredavik, M. S. (2013). Resilience, lifestyle and symptoms of anxiety and depression in adolescence: The Young-HUNT study. *Social Psychiatry and Psychiatric Epidemiology, 48*(3), 407–416. https://doi.org/10.1007/s00127-012-0561-2.

Sperduti, M., Martinelli, P., & Piolino, P. (2012). A neurocognitive model of meditation based on activation likelihood estimation (ALE) meta-analysis, Conscious. *Cogn., 21*(1), 269–276.

Tan, L. B. (2016). A critical review of adolescent mindfulness-based programs. *Clinical Child Psychology and Psychiatry, 21*(2), 193–207. https://doi.org/10.1177/1359104515577486.

Thompson, R. W., Arnkoff, D. B., & Glass, C. R. (2011). Conceptualizing mindfulness and acceptance as components of psychological resilience to trauma. *Trauma, Violence, and Abuse, 12*(4), 220–235. https://doi.org/10.1177/1524838011416375.

Wang, C. K. (2002). Emotional intelligence, general self-efficacy and coping style of delinquent teenagers. *Chinese Mental Health Journal, 16*(8), 565–567.

Yu, X., & Zhang, J. (2007). Factor analysis and psychometric evaluation of the Connor Davidson Resilience Scale (CD-RISC) with Chinese people. *Social Behavior and Personality, 35*(1), 19–30.

Zeidner, M., Roberts, R. D., & Matthews, G. (2004). The emotional intelligence bandwagon: Too fast to live, too young to die? *Psychological Inquiry, 15*, 239–248.