

RESEARCH

Open Access



# Effects of mindfulness, music therapy, and social support on adolescents test anxiety

Chenzi Xiang<sup>1\*</sup> and Xiuming Li<sup>1</sup>

## Abstract

**Background** Test anxiety is a common form of situational anxiety among adolescents, which can seriously affect their academic performance and mental health. Guided by Emotion Regulation Theory and Social Support Theory, this study explores the mechanism by which mindfulness influences adolescent test anxiety, introducing music therapy and social support as chained mediators.

**Method** A cross-sectional questionnaire survey was conducted among 372 adolescents from a secondary school in China. Measurement tools included the Mindfulness Scale, Music Therapy Perception Scale, Social Support Scale, and Test Anxiety Scale. Correlation analysis was performed using SPSS 26.0, and chained mediation analysis was conducted using the PROCESS macro (Model 6).

**Results** The results showed that mindfulness had a significant negative effect on adolescent test anxiety ( $\beta = -0.349$ ,  $p < 0.001$ ). Music therapy mediated the relationship between mindfulness and test anxiety, with an indirect effect of  $-0.074$  (95% CI  $[-0.109, -0.042]$ ), accounting for 12.1% of the total effect. Social support also served as an independent mediator ( $\beta = -0.161$ , 95% CI  $[-0.216, -0.112]$ ), explaining 26.2% of the total effect. In addition, music therapy and social support jointly played a chained mediating role ( $\beta = -0.029$ , 95% CI  $[-0.049, -0.014]$ ), accounting for 4.8% of the total effect.

**Conclusion** Mindfulness can alleviate adolescent test anxiety both directly and indirectly through music therapy and social support. This study reveals the potential mechanisms of mindfulness-based interventions and provides theoretical and practical implications for school-based mental health education. Especially in resource-limited settings, promoting mindfulness training and music therapy appears to be a feasible and valuable intervention strategy.

**Keywords** Adolescents, Mindfulness, Music therapy, Social support, Test anxiety, Chain mediation

\*Correspondence:

Chenzi Xiang  
xiangchenzi-413@163.com

<sup>1</sup>School of Music and Dance, XiHua University, Chengdu 611730, Sichuan, China



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

## Introduction

Test anxiety (TA) refers to a set of abnormal physiological and psychological reactions triggered by excessive exam-related stress, including pre-exam anxiety, anxiety during the exam, and post-exam tension [1, 2]. Anxiety is not limited to specific age groups or educational environments, but is a widespread phenomenon [3]. TA, as a form of situational trait anxiety, is marked by negative cognitive reactions and physiological symptoms in evaluative settings [4, 5]. During adolescence, especially in secondary school, academic pressure significantly increases, and expectations for academic success rise, making adolescents more sensitive to exam and evaluation situations [6–8]. Research by Putwain et al. [7] found that TA negatively impacts academic performance and overall well-being. Additionally, Yue et al. [8] pointed out that students with high levels of TA not only face the risk of declining academic performance but may also develop anxiety disorders and other mental health issues. Given these adverse consequences, identifying effective psychological and environmental protective factors is essential.

Existing research on adolescent TA typically focuses on several core domains. First, studies have explored the factors leading to TA, including academic pressure, family expectations, individual emotional regulation abilities, and self-efficacy [9–11]. Second, research has evaluated various interventions and strategies to reduce TA, including mindfulness (MF), music therapy (MT), and social support (SS) [8, 12, 13]. Yue et al. [8] emphasized the potential of MF as an emotion regulation strategy to alleviate adolescent TA. Hu et al. [13] found that MT effectively reduces adolescent TA by using music to induce relaxation and emotional regulation. Finally, studies have also explored the influence of environmental factors on adolescent TA, particularly the support from family and peers, which is considered crucial in alleviating TA [14]. MT and SS represent the internal and external regulatory mechanisms, respectively, through which MF may influence TA. According to Emotion Regulation Theory (ERT), individuals manage stress by actively adjusting their emotional responses [15]. MF helps reduce anxiety levels by enhancing emotional awareness and acceptance [16]. As a commonly used emotion regulation strategy, MT facilitates positive emotions and reduces physiological arousal through musical elements such as rhythm and melody, thereby serving as a mediator in the relationship between MF and TA [17]. Meanwhile, Social Support Theory (SST) posits that perceived social support provides individuals with emotional comfort and practical assistance during stressful situations, serving a buffering role [18]. MF may enhance individuals' sensitivity to interpersonal environments and satisfaction with relationships, indirectly increasing their perception of SS [19]. Further studies have shown that musical activities

promote interpersonal interaction and social bonding [20], suggesting that MT may also enhance adolescents' perceived SS by improving emotional states. This forms a potential chain mediation pathway: MF → MT → SS → TA. Such a pathway theoretically integrates internal emotional regulation and external social resources, revealing the multilayered mechanism by which MF operates. Therefore, drawing on both ERT and SST, this study proposes that MF reduces adolescent TA through the chained mediating effects of MT and SS. This model aims to clarify how MF facilitates both internal emotional adjustment and external resource mobilization, providing theoretical and practical implications for school-based mental health interventions targeting test anxiety in adolescents, particularly in filling the current structural gap in related research.

## MF and TA

MF refers to the conscious awareness of one's present experiences, maintained with an open, accepting, and non-judgmental attitude [21–23]. This practice enhances metacognitive awareness of thought processes and offers effective support for managing anxiety. Based on ERT, MF enhances individuals' emotional awareness and regulation abilities through strategies such as cognitive reappraisal and attentional deployment, thereby helping individuals cope with TA [15]. Sun et al. [21] found that MF practice helps increase individuals' awareness of their internal emotions, particularly in dealing with negative emotions and intrusive thoughts related to TA. Numerous studies recommend MF training as an effective approach for managing negative thought patterns and supporting adolescents' emotional stability under exam-related stress [24–26]. Zandi et al. [25] noted that MF training not only reduces emotion-driven and avoidant coping strategies but also enhances students' well-being and problem-solving abilities. This transition in coping style positively influences adolescents' mental health and improves their capacity to manage TA effectively. Dundas and Nygård [26] found that the application of MF skills is universally effective across different contexts, not only reducing TA but also enhancing adolescents' psychological flexibility in daily learning and life. In summary, based on ERT, enhancing MF in adolescents helps improve psychological stability and coping abilities, thereby alleviating TA.

## The mediating role of MT

MT is a structured intervention that employs musical activities to achieve specific therapeutic outcomes. It is widely applied in the field of mental health, showing significant effectiveness in alleviating anxiety, stress, and emotional regulation [27–30]. Based on ERT, MT can effectively regulate individuals' emotional responses

through variations in rhythm, melody, and harmony, helping to alleviate anxiety and stress, thereby playing a key role in psychotherapy [31]. Park et al. [29] explored the practical applications of MT, highlighting its effectiveness in reducing psychological stress. Additionally, MT facilitates emotional expression among early adolescents and individuals with mental health challenges [32].

As an emotional regulation strategy, MF enhances individuals' emotional awareness and self-regulation, thereby strengthening the effectiveness of MT [33–35]. The study by Chan et al. [35] indicated that MF improves emotional tolerance, enabling individuals to engage more deeply in MT and experience greater emotional relief and anxiety reduction. For example, MF can help individuals reduce emotional overreaction during MT, making it easier for them to derive emotional regulation benefits from the music [36]. Therefore, when combined with MF, MT serves as an effective tool for helping adolescents alleviate the stress and pressure associated with exams. Through MF practice, individuals are better equipped to cope with stress and anxiety, enhancing the effectiveness of MT and enabling it to play a more significant role in alleviating TA.

#### The mediating role of SS

SS refers to the respect, care, and assistance individuals receive from their important social networks, typically from parents, friends, peers, and close family groups [37, 38]. Based on SS theory (SST) [18], SS alleviates negative emotions when individuals cope with stressful situations through emotional support (such as comfort and understanding), instrumental support (such as practical help), and informational support (such as advice and guidance). Ren et al. [38] noted that by establishing a strong support system, adolescents can receive more emotional support and practical help when facing academic pressure and TA. SS enables individuals to reinterpret stressful situations, thereby reducing psychological burden and mitigating the adverse effects of stress [39–41]. Cortés-Denia et al. [40] found that SS not only promotes positive emotional states but also effectively reduces TA, enhancing adolescents' ability to manage academic pressure. Shabang et al. [42] pointed out that through such support, adolescents can reduce feelings of loneliness caused by a lack of belonging, and experience companionship and understanding during stressful events, effectively reducing anxiety tendencies. Thus, SS contributes to a stronger psychological foundation, allowing adolescents to cope with academic pressure more effectively and lowering the incidence of TA.

The enhancement of MF increases adolescents sensitivity to SS, further promoting their ability to receive more emotional support when facing TA [43–45]. Yan et al. [45] noted that MF improves adolescents' perception of

care and support from others, which in turn plays a critical role in reducing TA. Singh et al. [43] explored how MF not only teaches adolescents effective coping strategies but also creates a platform for SS, allowing them to receive understanding and encouragement from peers during the practice process, thereby reducing anxiety caused by academic pressure. By enhancing adolescents sensitivity to SS, MF can indirectly reduce their TA [46]. Therefore, MF enhances adolescents' sensitivity to SS, effectively alleviating TA through this support.

#### The chain-mediating role of MT and SS

Based on the above literature, most studies focus on the relationship between MF and mental health mediated by either MT or SS. At the same time, a substantial body of research indicates a significant positive correlation between MT and SS [47–49]. This may be attributed to the way in which passive listening, active participation, and music creation promote interpersonal connection, communication, and social understanding [50]. MT, by promoting emotional regulation and expression, enhances adolescents perception of SS, thereby helping to alleviate TA [27]. MT not only helps individuals regulate emotions but also enhances their adaptability and sense of belonging in social contexts, significantly reducing feelings of anxiety [51–53]. The study by Annesley et al. [52] highlighted that adolescents often feel encouragement and care from their parents during MT, reinforcing their SS networks. Lin et al. [53] further emphasized that participation in musical activities helps adolescents integrate socially, thereby enhancing their perceived SS and indirectly reducing TA. MT, by enhancing adolescents sense of connection to society, significantly boosts their SS, thereby mitigating the negative emotions caused by TA [54]. In conclusion, MT not only directly alleviates adolescents anxiety but also plays an indirect role in reducing TA by enhancing their sense of social integration and level of SS [55]. Therefore, beyond the individual mediating effects of MT and SS, their potential chain-mediating role should not be overlooked.

It is worth noting that although this study conceptualized MF as the antecedent variable and focused on its mechanisms in alleviating TA, previous research has suggested that anxiety itself may in turn influence individuals' emotional regulation capacity and access to psychological resources [56, 57]. For instance, persistent TA may reduce adolescents' receptivity to MF practices and decrease their motivation to engage, thereby weakening the effectiveness of MF-based interventions [57]. Furthermore, elevated levels of TA may compromise the efficacy of emotion regulation strategies [58], and even diminish individuals' sensitivity to and trust in SS [59]. These findings imply that the relationships among MF, MT, SS, and TA may not be strictly unidirectional, but

may involve reciprocal or interactive dynamics. Although this study employed a chained mediation model with MF as the independent variable, future research should consider possible reverse paths or bidirectional interactions among these variables to gain a more comprehensive understanding of how MF-based interventions function in the context of adolescent TA.

### The current study

This study is the first to explore the chain-mediating role of MT and SS in the relationship between MF and TA in adolescents. Based on ERT and SST, MF enhances emotional awareness and cognitive reappraisal abilities [15], while MT, as an emotional regulation tool, alleviates anxiety by reducing stress. Meanwhile, SST emphasizes that emotional support from family and peers can effectively reduce anxiety through a stress-buffering mechanism [18]. On the basis of these theories, we have constructed the theoretical model shown in Fig. 1 and proposed the following hypotheses:

H1: MF is negatively correlated with adolescent TA.

H2: MT mediates the relationship between MF and adolescent TA independently.

H3: SS mediates the relationship between MF and adolescent TA independently.

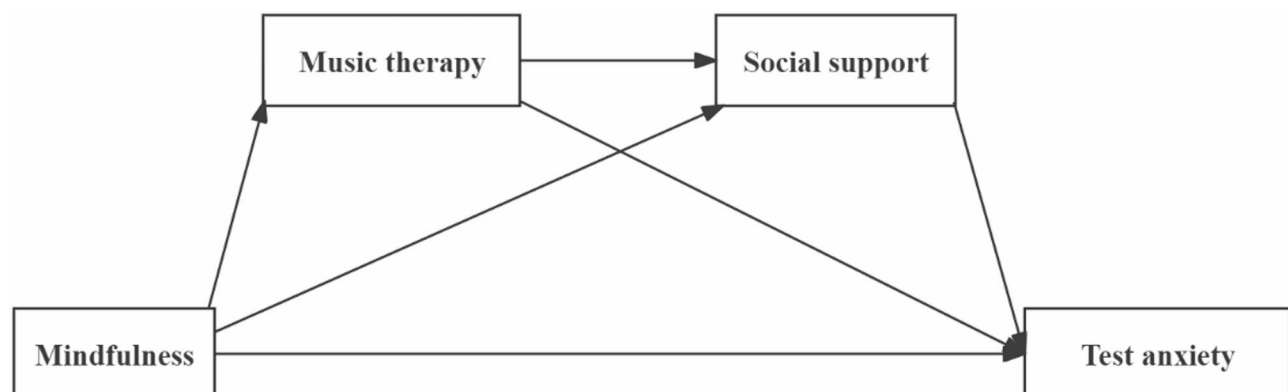
H4: MT and SS mediate the relationship between MF and adolescent TA in a chain-mediated manner.

## Method

### Data collection

This study employed a cross-sectional survey design, and data were collected through the online questionnaire platform Questionnaire Star ([www.sojump.com](http://www.sojump.com)) to test the proposed hypothetical model. The data collection took place between March and November 2024. The participants were students from Xihua University Affiliated Middle School. A stratified random sampling method was used to ensure representativeness across gender, grade level, and socioeconomic background. The study

procedures adhered to the ethical principles outlined in the Declaration of Helsinki [60], and ethical approval was obtained from the Biomedical Ethics Committee of Xihua University Affiliated Middle School (Approval No. 20240156). All participants and their legal guardians were fully informed about the purpose, procedures, and rights related to the study, including the voluntary nature of participation, the right to withdraw at any time without penalty, and the confidentiality and anonymity of their responses. Written informed consent was obtained from both the participants and their guardians. The inclusion criteria for this study were as follows: (1) students currently enrolled in middle or high school; (2) the ability to read and comprehend Chinese; and (3) provision of written informed consent by both the participant and their legal guardian. The exclusion criteria were: (1) incomplete questionnaires, such as missing responses or entire sections left unanswered; and (2) patterned or careless responding, including selecting the same response option throughout the questionnaire or exhibiting a uniform response pattern [61]. After screening out incomplete responses and careless answers, a total of 372 valid questionnaires were obtained [62]. In this study, the maximum number of arrows pointing to endogenous latent variables was three. According to Hair et al. [63], to achieve an  $R^2$  value of 0.10 in model explanation, the minimum required sample size at a 1% significance level is 191. The 372 samples used in this study clearly exceed this minimum requirement, ensuring the robustness and reliability of the results. Demographic information collected in this study included gender, grade level, place of residence, parental education level, and family economic status. A summary of participants' demographic characteristics is presented in Table 1. Among the 372 respondents, 212 were male (56.99%) and 160 were female (43.01%). A total of 163 participants (43.82%) were junior high school students, while 209 (56.18%) were senior high school students. In terms of place of residence,



**Fig. 1** Theoretical hypothesis model

**Table 1** Demographic information of the sample

Demographic Characteristics	Category	Quantity	Percentage (%)
Gender	Male	212	56.99
	Female	160	43.01
Grade	Junior high school	163	43.82
	Senior high school	209	56.18
Place of residence	Urban	154	41.40
	Suburban	129	34.68
	Rural	89	23.92
Parental education level	Primary school or below	28	7.53
	Junior high school	122	32.80
	Senior high school	131	35.22
	College or bachelor degree	77	20.70
	Graduate degree or above	14	3.76
Family economic status	Very difficult	5	1.34
	Quite difficult	44	11.83
	Average	141	37.90
	Fairly good	126	33.87
	Very good	56	15.05

41.40% lived in urban areas, 34.68% in suburban areas, and 23.92% in rural areas.

### Measurement tools

The survey consists of two parts: the first part collects demographic information about the participants, and the second part assesses the constructs related to this study. All constructs in this study are measured using established scales. In addition to demographic-related factors, each construct is measured using a Likert five-point scale, ranging from “Strongly Disagree”, “Disagree”, “Neutral”, “Agree”, to “Strongly Agree”.

### Demographic factors

Demographic factors include gender (male or female), grade level (junior high school or senior high school), place of residence (urban, suburban, or rural), parental education level (primary school or below, junior high school, senior high school, college or bachelor’s degree, graduate degree or above), and family economic status (very difficult, quite difficult, average, fairly good, or very good).

### MF scale

This study used a MF scale (MFs) to assess the impact of MF on adolescent TA. The scale was adapted from Sumell et al. [64] and includes 16 items across four dimensions: distraction, awareness level, frequency of mobile device use in the classroom, and frequency of anxiety experienced during exams. For example, “I am too focused on wanting to do well in the exam, neglecting the current learning process”. A 5-point Likert scale was used, with response options ranging from 1 (“strongly agree”) to 5 (“strongly disagree”). The total score ranged from 16 to

80, with higher scores indicating higher levels of MF. To maintain consistency with the original scale, no modifications were made to the item content in this study. The Cronbach’s alpha for this scale in the current study was 0.845, demonstrating good internal consistency.

### MT scale

The MT scale (MTs) was adapted from Liu [65] and includes 7 items to measure the impact of MT on adolescent TA. Examples of items include: “I believe that MT can improve emotional health” and “I know that MT can reduce the likelihood of mental breakdowns”. A 5-point Likert scale was used, with response options ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). The total score ranged from 7 to 35, with higher scores indicating greater perceived effectiveness of MT. To ensure consistency with the original scale, no modifications were made to the item content in this study. The internal consistency of this scale was good, with a Cronbach’s alpha of 0.892 in this study.

### SS scale

The SS scale (SSs) used in this study was adapted from Sun and Guo [66] and includes 12 key items across three dimensions: family, friends, and other sources of support. Examples of items include: “My family can provide me with practical help” and “I can rely on my friends when I face difficulties”. A 5-point Likert scale was used, with response options ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). The total score ranged from 12 to 60, with higher scores indicating greater levels of SS perceived by adolescents. To ensure consistency with the original scale, no modifications were made to the item content in this study. The Cronbach’s alpha for this scale



in this study was 0.950, demonstrating excellent internal consistency.

TA scale

The measurement of adolescent TA in this study primarily refers to Tan and Pang [67]. The scale consists of 23 items across three dimensions: social devaluation (worrying about being socially devalued or rejected by significant others after failing the exam), cognitive interference (difficulty concentrating, recalling information, and solving problems before or during the exam), and tension (physical and emotional discomfort). Examples of items include: “Even if I am well prepared, I still get nervous before the exam” and “During important exams, I feel my heart racing”. Five items require reverse scoring, such as “I feel no nervousness or anxiety when entering the exam room” and “I am confident that I will perform well in the exam”. A 5-point Likert scale was used, with response options ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). The total score ranged from 23 to 115, with higher scores indicating higher levels of test anxiety TA. To ensure consistency with the original scale, no modifications were made to the item content in this study. The Cronbach’s alpha for this scale in this study was 0.924, demonstrating good internal consistency.

Statistical analysis

All data analyses were conducted using SPSS 26.0 [68]. Prior to hypothesis testing, the assumptions for regression analysis—including normality, linearity, and multicollinearity—were examined to ensure the appropriateness of the model specification. Descriptive statistics were first calculated, including means and standard deviations for all variables. Pearson correlation analyses were then performed to assess the relationships among MF, MT, SS, and TA. Guided by ERT and SST, the study hypothesized that MF influences individuals’ emotional regulation via MT, which in turn enhances their perception of SS, ultimately reducing TA. To test this chained mediation model, PROCESS Macro Model 6 was employed. The Bootstrap method was used with 5,000 resamples to construct 95% bias-corrected confidence intervals. A mediation effect was considered significant if the confidence interval did not include zero. In addition, the analysis reported the coefficient of determination

(R<sup>2</sup>), F-statistics, Unstandardized coefficient, t-values, and 95% confidence intervals to clearly present the effects among variables and the explanatory power of the model, thereby ensuring the scientific rigor and interpretability of the findings. A significance threshold of  $p < 0.001$  was adopted for all statistical tests [69].

Result

To ensure that the data met the assumptions for multivariate analysis and to enhance the accuracy and validity of the results, this study verified normality by examining kurtosis and skewness. According to Kline [70], an absolute skewness value below 3 and an absolute kurtosis value under 10 are considered acceptable benchmarks. Thus, the primary variables in this research satisfy the requirements for normal distribution (see Table 2). In addition, to test the assumption of linearity, a scatterplot of standardized predicted values against standardized residuals was generated (see Fig. 2). The results showed that the data points were randomly distributed without any discernible curve or systematic pattern, indicating that the relationships among variables were essentially linear. This supports the appropriateness of conducting chained mediation analysis based on regression techniques.

Common method bias test

The Harman’s Single Factor Test was used to examine common method bias in the data. The results of the exploratory factor analysis revealed three factors with eigenvalues greater than 1. The first factor explained 39.04% of the variance, which is below the critical threshold of 40% [71]. This indicates that there is no significant common method bias in this study.

Collinearity diagnostics

To ensure the stability of the model and the validity of its interpretation, a detailed collinearity diagnosis was performed on the independent variables. As shown in Table 3, all tolerance values were above 0.1, and the variance inflation factor (VIF) values ranged from 1.407 to 1.703, which are well below the commonly accepted threshold of 3.3 [72]. These results indicate that multicollinearity was not a serious concern in this study.

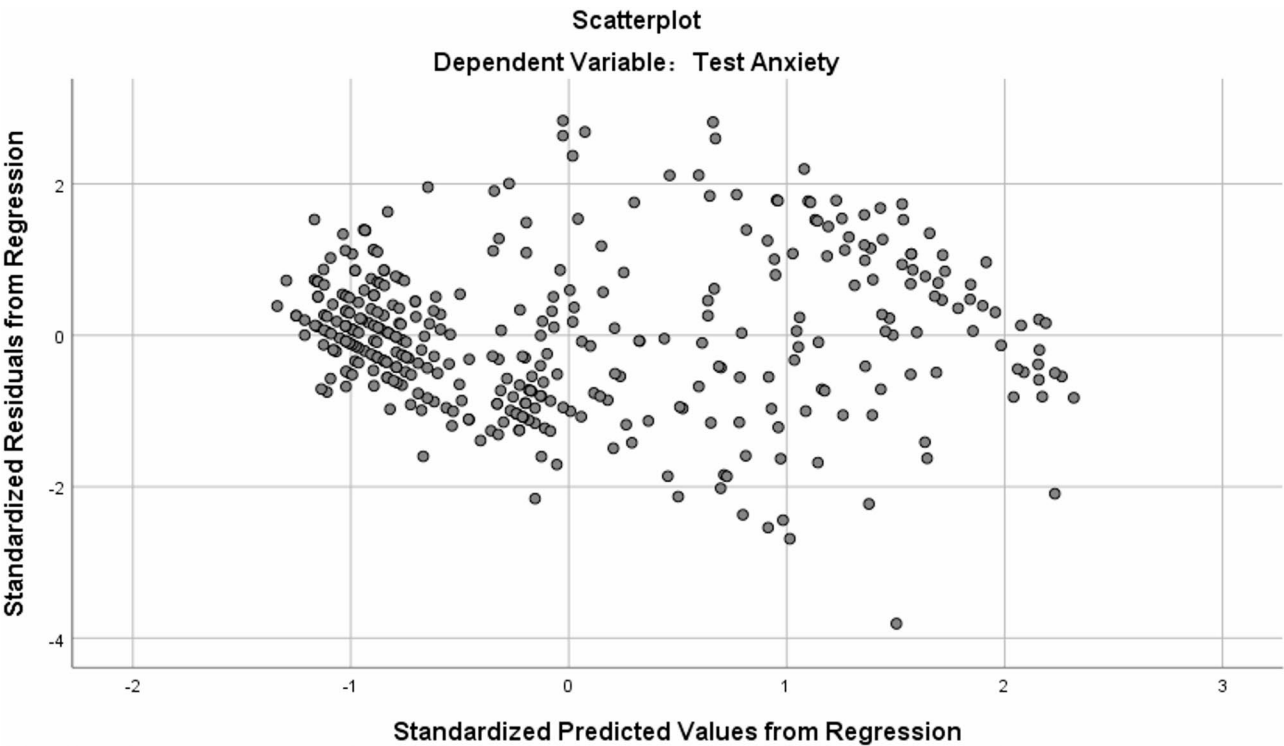
Descriptive statistics and correlation analysis

Descriptive statistics and correlation analysis were conducted on the data from 372 valid samples to explore the relationships between MF, MT, SS, and adolescent TA. As shown in Table 4, the means, standard deviations, and correlation coefficients of all variables were statistically significant ( $p < 0.001$ ,  $N = 372$ ). Pearson correlation analysis revealed a significant positive correlation between MF and MT ( $r = 0.503$ ,  $p < 0.001$ ). MF ( $r = 0.582$ ,  $p < 0.001$ ) and

Table 2 Descriptive statistics of variables

Variables	N	MIN	MAX	SK	Kur
MF	372	1.00	5.00	-0.349	-1.274
MT	372	1.00	5.00	-1.504	1.389
SS	372	1.00	5.00	-0.608	-1.433
TA	372	1.11	4.78	0.825	-0.727

Note: N=sample size; MIN=minimum value; MAX=maximum value; SK=skewness; Kur=kurtosis



**Fig. 2** Scatterplot of standardized predicted values and standardized residuals

**Table 3** Collinearity diagnostics of the structural model

	Tolerance	VIF
MF	0.587	1.703
MT	0.711	1.407
SS	0.629	1.589

**Table 4** Descriptive statistics and correlation analysis of variables (r)

Variable	M ± SD	MF	MT	SS	TA
MF	3.30 ± 1.12	1			
MT	3.86 ± 0.89	0.503***	1		
SS	3.41 ± 1.31	0.582***	0.447***	1	
TA	2.55 ± 0.99	-0.730***	-0.587***	-0.708***	1

Note: N = 372, \*\*\* $p < 0.001$ , M ± SD = Mean ± Standard Deviation

MT ( $r = 0.447$ ,  $p < 0.001$ ) were positively correlated with SS. Moreover, there were significant negative correlations between MF ( $r = -0.730$ ,  $p < 0.001$ ), MT ( $r = -0.587$ ,  $p < 0.001$ ), SS ( $r = -0.708$ ,  $p < 0.001$ ), and adolescent TA.

**Mediation effect analysis**

The results of the correlation analysis met the statistical requirements for further testing of the mediation effects of MT and SS. To account for the potential influence of demographic factors on the relationships among the primary variables, gender, grade level, place of residence, parental education level, and family economic status were included as covariates in the regression analyses. In this study, regression analysis and chain mediation effect

analysis were conducted using Model 6 of the PROCESS macro in SPSS 26.0 on 372 participants (Tables 5 and 6).

The mediation effects were tested using the PROCESS macro and bootstrap method in SPSS 26.0. According to the hypothesized model of this study, MF is directly or indirectly related to TA through four pathways. As shown in Table 6; Fig. 3, the total effect of MF on adolescent TA is -0.614, and the direct effect of MF on TA is -0.349. The effect of MF → MT → TA is -0.074 (95% CI: [-0.109, -0.042]), the effect of MF → SS → TA is -0.161 (95% CI: [-0.216, -0.112]), and the effect of MF → MT → SS → TA is -0.029 (95% CI: [-0.049, -0.014]). The 95% confidence intervals for these indirect effects do not include 0, and the overall indirect effect ratio is 43.1%. Therefore, the hypothesized model of this study is supported.

**Discussion**

In this study, based on ERT and SST, we used a chained mediation model to explain the mediating roles of MT and SS in the relationship between MF and adolescent TA. The results of this study suggest that MF not only directly reduces adolescent TA but also influences TA through a series of mediating effects involving MT and SS. The stronger the MF, the more effective the MT, and the higher the level of SS, which in turn reduces the risk of TA. This study offers new insights into preventing and managing adolescent TA, with potential implications for promoting their mental well-being.

**Table 5** Regression analysis of the relationships between variables in the chain mediation model

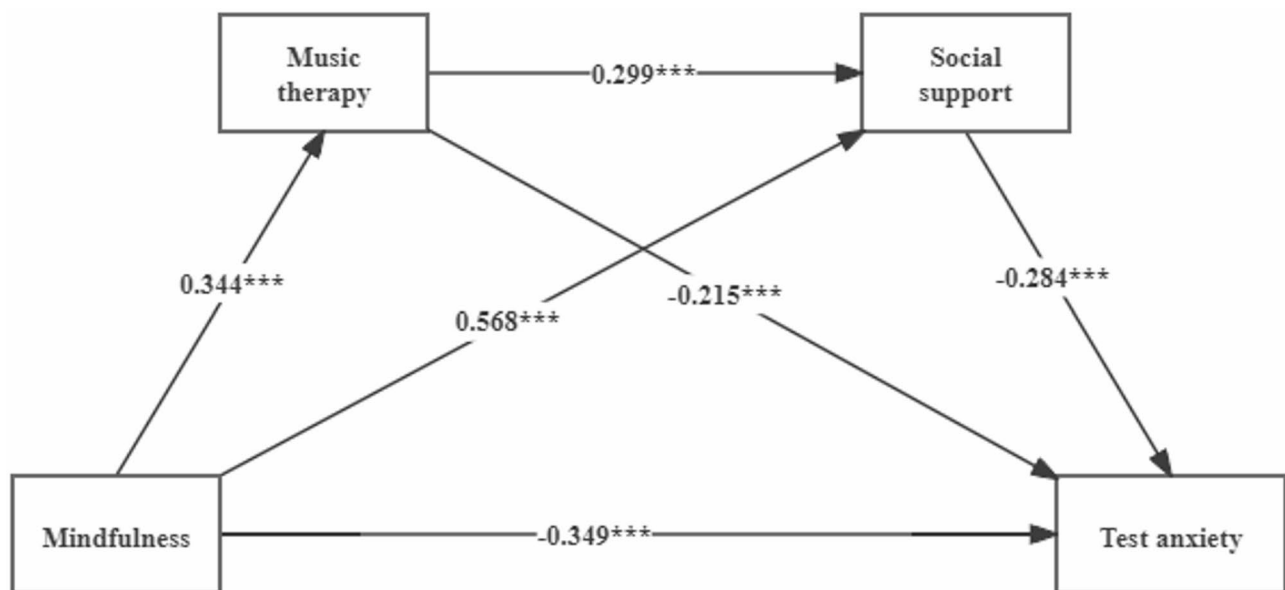
Outcome variable	Predictor variable	$\beta$	SE	T	CI (95%)		$R^2$	F
					LLCI	ULCI		
MT	MF	0.344***	0.036	9.435	0.272	0.416	0.313	27.721
SS	MF	0.568***	0.058	9.864	0.455	0.682	0.373	30.873
	MT	0.299***	0.074	4.034	0.153	0.445		
TA	MF	-0.349***	0.034	-10.231	-0.416	-0.282	0.697	104.333
	MT	-0.215***	0.040	-5.385	-0.293	-0.136		
	SS	-0.284***	0.028	-10.298	-0.338	-0.230		

Note: \*\*\* $p < 0.001$ ,  $\beta$  = Unstandardized Coefficients, SE = Standard Error, T = T-value, CI = Confidence Interval, LLCI = Lower Limit Confidence Interval, ULCI = Upper Limit Confidence Interval,  $R^2$  = Coefficient of Determination, F = F-value

**Table 6** Mediation effect analysis of MT and SS

Type	Effect value	Boot SE	Bootstrap 95% CI		Percentage
			Boot LLCI	Boot ULCI	
Total effect	-0.614	0.033	-0.678	-0.549	100%
Direct effect	-0.349	0.034	-0.416	-0.282	56.9%
MF $\rightarrow$ MT $\rightarrow$ TA	-0.074	0.017	-0.109	-0.042	12.1%
MF $\rightarrow$ SS $\rightarrow$ TA	-0.161	0.027	-0.216	-0.112	26.2%
MF $\rightarrow$ MT $\rightarrow$ SS $\rightarrow$ TA	-0.029	0.009	-0.049	-0.014	4.8%

Note: Boot SE = Bootstrap Standard Error, 95% CI = 95% Confidence Interval

**Fig. 3** Mediation model of MT on adolescent TA

#### The direct effect of MF on TA

MF significantly negatively affects adolescent TA, which is consistent with the findings of Sun et al. [21], supporting Hypothesis 1. A substantial body of research has shown that MF is closely related to TA [24–26]. MF practice helps adolescents disengage from exam-related worries and anchor their attention in the present, thereby alleviating TA more effectively [24]. This enhanced focus enables adolescents to approach exams with a calmer mindset, reducing the psychological burden associated with fear of failure. Moreover, long-term MF practice can enhance adolescents psychological stability, enabling

them to respond more flexibly to unexpected situations during exams, without being easily disturbed by external factors [26]. This study found that MF effectively reduces adolescent TA. The improvement in psychological stability not only helps them manage emotions better but also directly reduces the frequency and intensity of TA. Additionally, mindful awareness through intentional practice helps regulate individuals tension responses, alleviating the physiological symptoms triggered by exam stress, thereby helping adolescents focus more on the preparation process and improving learning [73].



### The mediating role of MT

MT plays a significant mediating role between MF and TA, indicating that MF indirectly influences TA through MT. This result is consistent with the findings of Chan et al. [35], supporting Hypothesis 2. Specifically, MF enhances individuals' engagement with and acceptance of MT, further improving its effectiveness in alleviating TA [33–35]. MF guides individuals to focus on the present moment, helping them fully experience the relaxation brought by the rhythm, melody, and harmony of MT, rather than being immersed in worry or anxiety about exam outcomes [34]. Moreover, MF can enhance the experience of MT, leading to deeper stress relief [27, 29]. Under the guidance of MF, individuals' attention to and depth of experience in MT significantly increase, enabling them to better utilize MT to cope with the pressure and anxiety caused by exams [29]. This study found that MF can effectively reduce adolescent TA by enhancing the effectiveness of MT. When individuals have a higher level of MF, they are more likely to engage deeply in the experience of MT, such as noticing subtle changes in the music, thereby receiving stronger psychological support and relaxation [31]. The positive effects triggered by MF enhance the effectiveness of MT and indirectly reduce the level of TA. This finding expands the theoretical perspective of ERT to some extent: MF not only functions as an effective emotion regulation strategy on its own, but may also enhance the efficacy of other regulation approaches, such as MT. However, the effectiveness of MT may be influenced by factors such as individual music preferences, cultural background, and sensitivity to musical stimuli—none of which were included in the present study. This limitation restricts the generalizability of the findings across diverse populations.

### The mediating role of SS

SS plays a significant mediating role between MF and TA, indicating that MF indirectly alleviates TA by enhancing individuals' sense of SS. This result is consistent with the findings of Shabahang et al. [42], supporting Hypothesis 3. Specifically, MF significantly increases individuals' sensitivity to SS, making adolescents more likely to perceive emotional support from peers, family, and teachers, thereby effectively reducing TA [43, 45, 46]. MF guides adolescents to focus more on current social interactions and approach others' support with an open and accepting attitude, further strengthening the role of SS in test pressure situations [45]. MF helps adolescents actively seek and accept emotional support from their surrounding environment [46]. This proactive social behavior helps them form stronger interpersonal connections and build a support network capable of providing emotional buffering and assistance [43]. This study found that MF enables individuals to more sensitively perceive and understand

others' supportive intentions, thereby maximizing the effectiveness of SS [44]. However, this pathway may be influenced by individual personality traits, past interpersonal experiences, and levels of interpersonal trust—variables that were not included in the present study. Moreover, SST primarily emphasizes the buffering effects of perceived support, without fully addressing how MF may influence the quality and depth of actually received support. Future research could incorporate theories of interpersonal relationships or attachment theory to explore, from a more complex interactional perspective, how MF may reshape individuals' SS systems.

### The chained mediating role of MT and SS in adolescent TA

MT and SS play a chained mediating role between MF and adolescent TA, with the effect sizes accounting for 4.8% of the total effect. This finding is consistent with the results of Lin et al. [53]. In other words, the higher the level of MF in adolescents, the better the effects of MT and the more SS they receive, which in turn further reduces the occurrence of TA symptoms. This finding further explains the mechanism through which MF influences adolescent TA. Moreover, MT has a significant positive impact on SS [47–49]. By providing emotional resonance and opportunities for positive interaction, MT enhances individuals' interpersonal connections and willingness to communicate, thus significantly increasing their perceived level of SS [47]. MF can indirectly alleviate adolescents' TA through MT and SS [51–53]. When adolescents engage in MT, they not only experience emotional relaxation but also receive encouragement and support from family and peers, which significantly reduces the occurrence of anxiety [52]. In this study, MT and SS not only directly affected adolescent TA but also mediated the influence of MF on TA. MT, through rich emotional expression and social interaction, facilitates emotional release and the establishment of social connections, thereby enhancing adolescents' sensitivity to external support and ultimately reducing TA [55].

Grounded in ERT and SST, this study constructed and validated a chained mediation model linking MF, MT, SS, and TA. It is the first to integrate internal emotional regulation mechanisms and external social resources within a unified theoretical framework, thereby expanding the multi-level theoretical understanding of how mindfulness influences mental health. Furthermore, the findings suggest that MF not only operates by regulating internal psychological states but may also enhance individuals' perception of and responsiveness to external interventions and support systems, offering new empirical support for the integration of ERT and SST. Although demographic variables such as gender, grade level, and place of residence were statistically controlled, the study did not thoroughly examine the influence of other

potential confounding variables. For example, participants' baseline mental health status, emotional regulation capacity, family academic expectations, and perceived academic pressure may moderate the effects of MF, MT, and SS. These factors were not systematically assessed, which may limit the interpretation of the findings. Future research is encouraged to incorporate a broader range of psychosocial variables and conduct subgroup analyses based on individual differences, thereby enhancing the precision and generalizability of the proposed model.

## Implications

### *Theoretical implications*

First, this study, based on ERT and SST, explored the impact of MF on adolescent TA in depth. The model revealed the interactions between MF, MT, SS, and TA, providing a more systematic theoretical framework for research on adolescent TA, addressing the limitation of previous studies that focused on single dimensions. Secondly, this study investigated the mediating roles of MT and SS in the relationship between MF and adolescent TA, particularly their chained mediating effect between MF and TA. By introducing the mediating effects of MT and SS, this study further enriches the understanding of the mechanisms behind adolescent TA, clarifying the indirect effects of MF on TA. This innovation not only broadens the perspective of TA research but also provides a theoretical foundation for future studies exploring mediating effects. Finally, the explanatory power of the model in this study demonstrating its significant predictive ability for TA, further validating the model's rationale and scientific rigor. It not only proves the effectiveness of a multidimensional model but also highlights the importance of integrating multiple factors into a single model. This model offers a new theoretical perspective for research on adolescent TA and contributes to further exploring the applicability of MT and SS in other areas of mental health, as well as the synergistic effects of multiple interventions.

### *Practical implications*

The findings of this study provide practical guidance for the intervention of adolescent TA. First, schools may consider incorporating MF training into regular mental health education. Specific strategies could include allocating the first five minutes of class for brief breathing awareness exercises or organizing low-cost mindfulness meditation sessions using audio recordings during home-room or physical education classes. Second, MT can be promoted by integrating it into daily teaching activities. Schools can play soothing background music during music classes or self-study periods to create a calm and relaxed learning atmosphere. Teachers may also guide students to create their own emotion-regulation playlists

and encourage their use during exam preparation as a means to reduce anxiety. In the absence of professional music therapists, basic interventions can be implemented by teachers or school counselors using simple MT tools or mobile applications. In addition, schools can strengthen students' SS networks by establishing peer support groups or "psychological help corners," fostering a campus environment that emphasizes inclusion and understanding. This can encourage students to actively seek help and express their emotions when under pressure. Lastly, schools could develop anxiety risk screening tools based on the psychological mechanisms proposed in this study. These tools could be administered at critical academic time points (e.g., midterms or final exams) to identify high-risk students and provide individualized psychological support, such as one-on-one counseling or coordinated family-based interventions, to help them manage emotional stress and enhance psychological resilience. These measures not only help alleviate adolescent TA symptoms but also provide long-term protection and support for their psychological health development.

### *Limitations and future research*

Although this study explored the impact of MF, MT, and SS on adolescent TA from both theoretical and practical perspectives, and validated the rationality of the chained mediation model, there are still some limitations. First, the study employed a cross-sectional design, which does not reveal the causal relationships or dynamic changes between the variables. Future research could further explore the long-term intervention effects of related variables through longitudinal studies. Second, this study relied primarily on self-report questionnaires for data collection, which may be subject to social desirability effects and response biases, potentially compromising the objectivity and validity of the measurements. Future research could incorporate multiple data sources, such as teacher evaluations, physiological indicators, or behavioral observations, to enhance the reliability and validity of the findings. Third, the sample was drawn from a single school. Although the sample size met the requirements for statistical analysis, the geographic limitation may restrict the generalizability of the results. Future studies should include more diverse samples from different regions and school types to improve the external validity of the findings. In addition, this study lacked experimental control and a comparison group, which limited the ability to isolate the independent effects of each intervention component. For instance, it remains unclear whether different forms or intensities of music therapy have differential effects on varying levels of test anxiety—an issue that warrants further investigation. Lastly, the study's intervention did not fully consider individual differences, such as participants' personality traits,

emotion regulation abilities, and other factors that may influence the intervention's effectiveness. Future research could adopt a more personalized approach in intervention design, exploring tailored strategies for different groups. These future directions will not only help refine the theoretical model but also provide scientific evidence for developing more targeted intervention programs.

## Conclusion

This study, based on ERT and SST, constructs a chained mediation model that includes MF, MT, SS, and TA, and explores in-depth the mechanisms through which psychological and SS factors influence adolescent TA. The results show that MF not only has a direct and significant alleviating effect on adolescent TA but also indirectly influences TA through the mediating pathways of MT and SS. This finding further deepens our understanding of the causes and intervention mechanisms of TA, particularly in terms of how psychological regulation and SS work in tandem. The results of this study provide educators and mental health professionals with new intervention strategies, namely, by cultivating adolescents MF skills, incorporating MT, and strengthening SS networks to help adolescents effectively cope with exam pressure and reduce anxiety levels. This, in turn, can enhance their academic performance and overall psychological well-being.

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s40359-025-02842-6>.

Supplementary Material 1

## Acknowledgements

We would like to thank the action teams, staff, and students involved in the university survey for their assistance in gathering information.

## Author contributions

Conceptualization: Chenzi Xiang; Methodology: Chenzi Xiang; Formal analysis and investigation: Chenzi Xiang; Writing - original draft preparation: Chenzi Xiang; Writing - review and editing: Chenzi Xiang; Supervision: Xiuming Li. All the authors have read and agreed to the published version of the manuscript.

## Funding

Not applicable.

## Data availability

The data that support the findings of this study are available on request from the corresponding author.

## Declarations

### Ethics approval and consent to participate

The researchers confirms that all research was performed in accordance with relevant guidelines/regulations applicable when human participants are involved (e.g., Declaration of Helsinki or similar). **This study was approved by the Ethics Committee of XiHua University (Approval No. 20240156).** The participants received oral and written information and provided written informed consent before participating in the study.

## Consent for publication

Not applicable.

## Competing interests

The authors declare no competing interests.

Received: 17 December 2024 / Accepted: 6 May 2025

Published online: 14 May 2025

## References

- O'Driscoll D, McAleese M. The protective role of self-compassion on test anxiety among adolescents. *Pastoral Care Educ.* 2023;41(2):211–24. <https://doi.org/10.1080/02643944.2022.2054021>.
- Liu Y, Pan H, Yang R, Wang X, Rao J, Zhang X, Pan C. The relationship between test anxiety and emotion regulation: the mediating effect of psychological resilience. *Ann Gen Psychiatry.* 2021;20(1):40. <https://doi.org/10.1186/s12991-021-00360-4>.
- Wang K, Qian J. The mediating and moderating role of Social-Emotional skills in the relationship between sports participation and test anxiety. *Behav Sci.* 2024;14(6):512. <https://doi.org/10.3390/bs14060512>.
- Wadi M, Yusoff MSB, Abdul Rahim AF, Lah NAZN. Factors affecting test anxiety: a qualitative analysis of medical students' views. *BMC Psychol.* 2022;10(1):8. <https://doi.org/10.1186/s40359-021-00715-2>.
- Rose SE, Lomas MHR, Mind. *Brain Educ.* 2020;14(4):335–40. <https://doi.org/10.1111/mbe.12255>.
- Jerrim J. Test anxiety: is it associated with performance in high-stakes examinations? *Oxf Rev Educ.* 2023;49(3):321–41. <https://doi.org/10.1080/03054985.2022.2079616>.
- Putwain DW, Gallard D, Beaumont J, Loderer K, von der Embse NP. *Cogn Therapy Res.* 2021;45(6):1150–62. <https://doi.org/10.1007/s10608-021-10211-x>. Does Test Anxiety Predispose Poor School-Related Wellbeing and Enhanced Risk of Emotional Disorders?
- Yue N, Li C, Si S, Xu S, Zhang Q, Cui L. Brief Meditation on Test Anxiety of Eighth Grade Chinese Students. Chain-Mediating roles of mindfulness and Self-Efficacy. *School Mental Health.* 2024;16(2):483–99. <https://doi.org/10.1007/s12310-024-09652-y>.
- Suhas DT, Sathiyaseelan A, Suhas DT. Role of parents education and occupation in parental pressure and adolescents test anxiety. *Bioscience Biotechnol Res Commun.* 2020;13(1):288–95. <https://doi.org/10.21786/bbrc/13.1/47>.
- Lee MY, Cho S, Huy VN, Lee SM. A multilevel analysis of change in emotional exhaustion during high school: focusing on the individual and contextual factors. *Curr Psychol.* 2021;40(11):5648–57. <https://doi.org/10.1007/s12144-020-00869-z>.
- Rodrigo C, Welgama S, Gurusinghe J, Wijeratne T, Jayananda G, Rajapakse S. Symptoms of anxiety and depression in adolescent students; a perspective from Sri Lanka. *Child Adolesc Psychiatry Mental Health.* 2010;4(1):10. <https://doi.org/10.1186/1753-2000-4-10>.
- Putwain P DW, Jansen in de Wal J, van Alphen T. Academic buoyancy: overcoming test anxiety and setbacks. *J Intell.* 2023;11(3):42. <https://doi.org/10.3390/jintelligence11030042>.
- Hu Z, Chen G, Liu Y, Ma X, Guan N, Wang X. Make a song curative: A spatio-temporal therapeutic music transfer model for anxiety reduction. *Expert Syst Appl.* 2024;240:122161. <https://doi.org/10.1016/j.eswa.2023.122161>.
- Feige P, Watermann R, Perceived Peer Integration P, Control, Support A. Differential effects on test anxiety during the transition to secondary school for girls and boys. *J Youth Adolesc.* 2024;53(11):2610–22. <https://doi.org/10.1007/s10964-024-02053-z>.
- Gross JJ. The emerging field of emotion regulation: an integrative review. *Rev Gen Psychol.* 1998;2(3):271–99. <https://doi.org/10.1037/1089-2680.2.3.271>.
- Shen Y. Mitigating students' anxiety: the role of resilience and mindfulness among Chinese EFL learners. *Front Psychol.* 2022;13. <https://doi.org/10.3389/fpsyg.2022.940443>.
- Ho C-H, Zhang H-q, Li J, Liu, Aa. Mindfulness's moderating role applied on online SEL education. *Front Psychol.* 2024;15. <https://doi.org/10.3389/fpsyg.2024.1499357>.
- Cohen S, Wills T, Stress. Social support, and the buffering hypothesis. *Psychol Bull.* 1985;98. <https://doi.org/10.1037/0033-2909.98.2.310>. 310–57.
- Liang J, Zhang X, Wang Y. The relationship between mindfulness and suboptimal health status: a chain/serial mediation model. *Front Psychol.* 2024;15. <https://doi.org/10.3389/fpsyg.2024.1354975>.

20. Yang H, Wang S, Chen X, Zhang H, Wong CUI. Does participation in group music activities and Pro-Social behavior among college students have an association?? A study of the interlocking mediating effects of positive social connections and peer support. *Behav Sci*. 2025;15(1):64. <https://doi.org/10.3390/bs15010064>.
21. Sun J, Dehghan M, Soltanmoradi Y, Altwalbeh D, Ghaedi-Heidari F, Saurombe MD, Hermis AH, Kahnouji M, Farahmandnia H, Pourmasumi S, Zakeri MA. Quality of life, anxiety and mindfulness during the prevalence of COVID-19: a comparison between medical and non-medical students. *BMC Public Health*. 2024;24(1):2976. <https://doi.org/10.1186/s12889-024-20477-x>.
22. Eshet Y, Grinautsky K, Steinberger P. To behave or not (un)ethically? The meditative effect of mindfulness on statistics anxiety and academic dishonesty moderated by risk aversion. *Int J Educational Integr*. 2024;20(1):6. <https://doi.org/10.1007/s40979-024-00151-w>.
23. Yin Y, Li B, Hu X, Guo X, Yang C, Luo L. The relationship between dispositional mindfulness and relative accuracy of judgments of learning: the moderating role of test anxiety. *J Intell*. 2023;11(7):132. <https://doi.org/10.3390/jintelligenc11070132>.
24. Klug K, Tolgout T, Schilbach M, Rohrmann S. Intrusions in test anxiety. *Curr Psychol*. 2021;40(5):2290–300. <https://doi.org/10.1007/s12144-019-0167-x>.
25. Zandi H, Amirinejad A, Azizfar A, Aibod S, Veisani Y, Mohamadian F. The effectiveness of mindfulness training on coping with stress, exam anxiety, and happiness to promote health. *J Educ Health Promotion*. 2021;10(1):177. [https://doi.org/10.4103/jehp.jehp\\_616\\_20](https://doi.org/10.4103/jehp.jehp_616_20).
26. Dundas I, Nygård I. Mindfulness for test anxiety and negative self-evaluation in high school. *Curr Psychol*. 2024;43(38):30027–37. <https://doi.org/10.1007/s12144-024-06557-6>.
27. Tang Q, Huang Z, Zhou H, Ye P. Effects of music therapy on depression: A meta-analysis of randomized controlled trials. *PLoS ONE*. 2020;15(11):e0240862. <https://doi.org/10.1371/journal.pone.0240862>.
28. Matokhniuk L, Avramenko N, Koval T, Matokhniuk L, Avramenko N, Kushnir Y, Shportun O, Shevchuk V, Shorobura I, Kaplinsky V, Overchuk V, Koval T. Psychocorrection of adolescents' anxiety by music therapy. *BRAIN BROAD Res Artif Intell Neurosci*. 2021;12(1):51–66. <https://doi.org/10.18662/brain/12.1/170>.
29. Park J-H, Lee I-H, Lee S-J, Kwon R-W, Choo E-A, Nam H-W, Lee J-B. Effects of music therapy as an alternative treatment on depression in children and adolescents with ADHD by activating serotonin and improving stress coping ability. *BMC Complement Med Ther*. 2023;23(1):73. <https://doi.org/10.1186/s12906-022-03832-6>.
30. O'Donoghue J, Egan G, Moss H, Clements-Cortes A. Participation in group music therapy: A preliminary study of the experiences and perceptions of adolescents who stammer. *Arts Psychother*. 2021;75:101809. <https://doi.org/10.1016/j.aip.2021.101809>.
31. Kakar E, Ottens T, Stads S, Wesselius S, Gommers DAMPJ, Jeekel J, van der Jagt M. Effect of a music intervention on anxiety in adult critically ill patients: a multicenter randomized clinical trial. *J Intensive Care*. 2023;11(1):36. <https://doi.org/10.1186/s40560-023-00684-1>.
32. Salokivi M, Salantera S, Saarikallio S, Ala-Ruona E. Promoting emotional skills in early adolescents with mental health conditions in music therapy—a content analysis of focus group interviews. *Nordic J Music Therapy*. 2023;32(5):423–44. <https://doi.org/10.1080/08098131.2023.2169336>.
33. Czajkowski A-ML, Greasley AE, Allis M. Mindfulness for musicians: A mixed methods study investigating the effects of 8-week mindfulness courses on music students at a leading Conservatoire. *Musicae Sci*. 2020;26(2):259–79. <https://doi.org/10.1177/1029864920941570>.
34. Liu X, Liu Y, Shi H, Zheng M. Effects of mindfulness meditation on musical aesthetic emotion processing. *Front Psychol*. 2021;12. <https://doi.org/10.3389/fpsyg.2021.648062>.
35. Chan SHW, Cheung MYC, Chiu ATS, Leung MHT, Kuo MCC, Yip DYC, Hui CCY, Kam SWI, Yeung K, Mui DSP, Wang S-M, Yip CCK. Clinical effectiveness of mindfulness-based music therapy on improving emotional regulation in blind older women: A randomized controlled trial. *Integr Med Res*. 2023;12(4):100993. <https://doi.org/10.1016/j.imr.2023.100993>.
36. Axelsen JL, Meline JSJ, Staiano V, Kirk U. Mindfulness and music interventions in the workplace: assessment of sustained attention and working memory using a crowdsourcing approach. *BMC Psychol*. 2022;10(1):108. <https://doi.org/10.1186/s40359-022-00810-y>.
37. Hoferichter F, Lohilahti J, Hufenbach M, Grabe HJ, Hageman G, Raufelder D. Support from parents, teachers, and peers and the moderation of subjective and objective stress of secondary school student. *Sci Rep*. 2024;14(1):1161. <https://doi.org/10.1038/s41598-024-51802-4>.
38. Ren Z, Hu L, Yu JJ, Yu Q, Chen S, Ma Y, Lin J, Yang L, Li X, Zou L. The influence of social support on physical activity in Chinese adolescents: the mediating role of exercise Self-Efficacy. *Children*. 2020;7(3):23. <https://doi.org/10.3390/children7030023>.
39. Tang Y, Ma Y, Zhang J, Wang H. The relationship between negative life events and quality of life in adolescents: mediated by resilience and social support. *Front Public Health*. 2022;10. <https://doi.org/10.3389/fpubh.2022.980104>.
40. Cortés-Denia D, El Ghoudani K, Pulido-Martos M, Alaoui S, Luque-Reca O, Ramos-Álvarez MM, Augusto-Landa JM, Zarhouch B, Lopez-Zafra E. Socioemotional resources account for academic adjustment in Moroccan adolescents. *Front Psychol*. 2020;11. <https://doi.org/10.3389/fpsyg.2020.01609>.
41. Liu Y, Yang M, Zhao Y, Wang Z, He J, Wang Y, Anne T. Social support mediates social frailty with anxiety and depression. *BMC Pulm Med*. 2024;24(1):390. <https://doi.org/10.1186/s12890-024-03202-7>.
42. Shabahang R, Shim H, Aruguete MS, Zsila A. Adolescent sadfishing on social media: anxiety, depression, attention seeking, and lack of perceived social support as potential contributors. *BMC Psychol*. 2023;11(1):378. <https://doi.org/10.1186/s40359-023-01420-y>.
43. Singh R, Singh B, Mahato S, Hambour VK. Social support, emotion regulation and mindfulness: A linkage towards social anxiety among adolescents attending secondary schools in Birgunj. *Nepal PLOS ONE*. 2020;15(4):e0230991. <https://doi.org/10.1371/journal.pone.0230991>.
44. Lothes IJE, Matney S, Naseer Z, Pfyffer R, Sitting Meditation and Mindfulness Effects on Overall Anxiety and Test Anxiety Among College Students, *Mind. Brain Educ*. 2023;17(1):61–9. <https://doi.org/10.1111/mbe.12344>.
45. Yan X, Jia X, Feng L, Ge W, Kong B, Xia M, Yan X. Enhancing nursing competence in China: the interplay of resilience, mindfulness and social support. *Nurse Educ Pract*. 2024;79:p104087. <https://doi.org/10.1016/j.nepr.2024.104087>.
46. Yüksel Doğan R, Metin EN. Exploring the relationship between mindfulness and life satisfaction in adolescents: the role of social competence and Self-Esteem. *Child Indic Res*. 2023;16(4):1453–73. <https://doi.org/10.1007/s12187-023-10028-y>.
47. Jaschke AC, Howlin C, Pool J, Greenberg YD, Atkinson R, Kovalova A, Merriam E, Pallás-Ferrer I, Williams S, Moore C, Hayden K, Allison C, Odell-Miller H, Baron-Cohen S. Study protocol of a randomized control trial on the effectiveness of improvisational music therapy for autistic children. *BMC Psychiatry*. 2024;24(1):637. <https://doi.org/10.1186/s12888-024-06086-3>.
48. Reschke-Hernández AE, Gfeller K, Oleson J, Tranel D. Music therapy increases social and emotional Well-Being in persons with dementia: A randomized clinical crossover trial comparing singing to verbal discussion. *J Music Ther*. 2023;60(3):314–42. <https://doi.org/10.1093/jmt/thad015>.
49. van Rooyen A, dos Santos A. Exploring the lived experiences of teenagers in a children's home participating in a choir: A community music therapy perspective. *Int J Community Music*. 2020;13(1):81–101. [https://doi.org/10.1386/jjcm\\_00011\\_1](https://doi.org/10.1386/jjcm_00011_1).
50. Savage PE, Loui P, Tarr B, Schachner A, Glowacki L, Mithen S, Fitch WT. Music as a coevolved system for social bonding. *Behav Brain Sci*. 2020;44:e59. <https://doi.org/10.1017/s0140525x20000333>.
51. Chen X, Li H, Zheng X, Huang J. Effects of music therapy on COVID-19 patients' anxiety, depression, and life quality: A protocol for systematic review and meta-analysis. *Med (Baltim)*. 2021;100(26):e26419. <https://doi.org/10.1097/md.00000000000026419>.
52. Annesley L, McKeown E, Curtis-Tyler K. Parents' perspectives on their children's music therapy: A synthesis of qualitative literature. *Br J Music Therapy*. 2020;34(1):39–52. <https://doi.org/10.1177/1359457520907636>.
53. Lin Y, Jia G, Zhao Z, Li M, Cao G. The association between family adaptability and adolescent depression: the chain mediating role of social support and self-efficacy. *Front Psychol*. 2024;15. <https://doi.org/10.3389/fpsyg.2024.1308804>.
54. Taipale M, Emily C, Saarikallio S. The role of music listening in the music therapy process for people with anxiety disorders: the therapist's perspective. *Nordic J Music Therapy*. 2025;34(2):86–104. <https://doi.org/10.1080/08098131.2024.2377974>.
55. Jacobsen SL, Gattino G, Holck U, Bøtker JØ. Music, families and interaction (MUFASA): a protocol Article for an RCT study. *BMC Psychol*. 2022;10(1):252. <https://doi.org/10.1186/s40359-022-00957-8>.
56. Liu X, Xu Y, Xu H, Jiang L, Wang T, Chen C, Lee A, Zhu P. Anxiety and sleep quality among front-line nurses treating first wave COVID-19 in China: the mediating role of mindfulness. *Arch Psychiatr Nurs*. 2022;41:341–7. <https://doi.org/10.1016/j.apnu.2022.09.007>.

57. Lamarre C, Marcotte D. Anxiety and dimensions of perfectionism in first year college students: the mediating role of mindfulness. *Eur Rev Appl Psychol*. 2021;71(6):100633. <https://doi.org/10.1016/j.erap.2021.100633>.
58. Carl JR, Fairholme CP, Gallagher MW, Thompson-Hollands J, Barlow DH. The effects of anxiety and depressive symptoms on daily positive emotion regulation. *J Psychopathol Behav Assess*. 2014;36(2):224–36. <https://doi.org/10.1007/s10862-013-9387-9>.
59. Sahraç Ü, Çelik E, Turan ME. Mediating and moderating effects of social support in the relationship between social anxiety and hope levels in children. *J Happiness Stud*. 2018;19(4):1003–19. <https://doi.org/10.1007/s10902-017-9855-0>.
60. Association WM, World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. *JAMA*. 2013;310(20):2191–4. <https://doi.org/10.1001/jama.2013.281053>.
61. Meade A, Craig B. Identifying careless responses in survey data. *Psychol Methods*. 2012;17:437–55. <https://doi.org/10.1037/a0028085>.
62. Xiang C. Raw data \_ factors influencing test anxiety in adolescents. *Zenodo*. 2025. <https://doi.org/10.5281/zenodo.15172677>.
63. Hair J, Sarstedt M, Hopkins L, Kuppelwieser V, Partial Least Squares Structural Equation Modeling (PLS-SEM). An emerging tool for business research. *Eur Bus Rev*. 2014;26:106–21. <https://doi.org/10.1108/EBR-10-2013-0128>.
64. Sumell AJ, Chiang EP, Koch S, Mangelaja E, Sun J, Péduessel Wu J. A cultural comparison of mindfulness and student performance: evidence from university students in five countries. *Int Rev Econ Educ*. 2021;37:100213. <https://doi.org/10.1016/j.iiree.2021.100213>.
65. Liu Y. Psychological wellbeing with music therapy: the moderating role of health awareness, and strategic health management in post Covid-19 era. *BMC Psychol*. 2024;12(1):355. <https://doi.org/10.1186/s40359-024-01845-z>.
66. Sun X, Guo C. Evaluating the multidimensional scale of perceived social support (MSPSS) in children aged between 8–14 years. *J Child Fam Stud*. 2024;33(4):1297–308. <https://doi.org/10.1007/s10826-024-02794-2>.
67. Tan SH, Pang JS. Test anxiety: an integration of the test anxiety and achievement motivation research traditions. *Educational Psychol Rev*. 2023;35(1):13. <https://doi.org/10.1007/s10648-023-09737-1>.
68. Hayes AF. *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. 2013, New York, NY, US: Guilford Press. xvii, 507–xvii, 507.
69. Field A. *Discovering statistics using IBM SPSS statistics*. Sage Publications Ltd; 2013.
70. Kline R. *Principles and practice of structural equation Modeling[M]*. New York: Guilford; 2005.
71. Podsakoff PM, Organ DW, SELF-REPORTS IN, ORGANIZATIONAL RESEARCH - PROBLEMS AND PROSPECTS. *JOURNAL OF MANAGEMENT.*, 1986. 12(4): pp. 531–44. <https://doi.org/10.1177/014920638601200408>.
72. Hair JF, Sarstedt M, Ringle CM. Rethinking some of the rethinking of partial least squares. *Eur J Mark*. 2019;53(4):566–84. <https://doi.org/10.1108/ejm-10-2018-0665>.
73. Pires CP, Putwain D, Salvador MC, Of TE, Compassion A. Acceptance and Mindfulness-based pilot intervention for adolescents' test anxiety: A case study using the academic program. *J Evidence-Based Psychotherapies*. 2023;22:37–66. <https://doi.org/10.24193/jebp.2023.1.3>.

## Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.