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**Test anxiety and emotion regulation among undergraduate medical students in
China: the mediating role of psychological resilience**

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Abstract

Background: Medical students experience a considerable amount of anxiety due to exams. Emotion regulation and psychological resilience are established protective factors of individual mental health, however, the investigations for the effects of anxiety were limited. The goal of the present study was to examine the relationship of psychological resilience and emotion regulation with test anxiety and the associated factors of them among medical students.

Methods: In this cross-sectional survey, a simple random sampling methods was used to select the participants. Information from a sample of 1266 medical students was collected by self-reporting questionnaires. Logistic regression was applied to test the associations between test anxiety and emotion regulation, resilience. Bootstrap were conducted to explore the mediating role of resilience.

Results: Our important results were that the prevalence of problematic test anxiety among medical students to be 71.4%, 33.7% was high test anxiety. Gender and academic performance correlated significantly with test anxiety, emotion regulation, and psychological resilience. There were correlations between test anxiety and various dimensions of emotion regulation and psychological resilience ($P<0.01$). Emotion regulation and psychological resilience predicted emerging test anxiety. The mediating role of psychological resilience was identified for the effects of emotion regulation on test anxiety.

Conclusions: Findings suggest that emotion regulation affected test anxiety through psychological resilience, which may provide insights for clinical psychologists, raise their awareness of the importance of cultivating and improving medical students' psychological resilience, and prompt them to offer psychological support to students with test anxiety as early as possible. The

combination of curing and self-healing can solve the root cause of the problem and truly apply psychological research to improving the mental health of the general public.

Keywords: Psychological resilience, Test anxiety, Emotion regulation, Medical student

Background

Test anxiety is considered as a set of psychological responses (such as worry, stress, emotionality) that individual experience negative consequences or failure of an exam or similar evaluation situation [1]. It can occur at any phase of exam. According to educational psychologists and experts in education, an average level of anxiety is useful as an effective motivational factor can enhance one's performance for more effort [2]. While for some, taking high-stakes exams has a significant influence on the emotional and physiological well-being of exam-takers, it may arouse feelings of fear, incompetence or even anger in others [3-4]. From 2001 to 2011, the proportion of students with test anxiety in China increased from 21.8% to 27.52%. Interestingly, students majoring in medicine generally have higher level of test anxiety than students of other majors. This is mainly attributed to the fact that medical students are demanding to master a large amount of knowledge, clinical practice skill and professional quality tests. Therefore, it is practical significance to study the prevalence of test anxiety in medical students.

Emotion regulation is defined as “the process by which we influence which emotions we have, when we have them, and how we experience and express them” [8]. Among the emotion regulation strategies researched in the field, cognitive reappraisal and expressive suppression emerged as two widely-investigated strategies associated with physical health, mental health, and social well-being [9-11]. Cognitive reappraisal refers to the process involving a reinterpretation of the meaning of an emotional stimulus and subsequently, leading to a change of the initial

trajectory of an emotional response [8]. In contrast, expressive suppression is a response- focused emotion regulation strategy whereby people adjust their emotional experience by suppressing the expression of that emotional state [10]. Previous studies suggested that cognitive reappraisal was view as an adaptive emotion regulation strategy [10,12-13]. For example, cognitive reappraisal was found to reduce negative emotions and heighten positive ones, thereby enhancing mental health and interpersonal functioning. Compared to cognitive reappraisal, expressive suppression potentially prevents the suppressors from experiencing positive emotions, increases experiences of negative emotions, and creates a sense of inauthenticity, which are detrimental to mental and physical health [14-15].

Studies have shown that cognitive reappraisal and expressive suppression are closely associated with anxiety. Cognitive reappraisal can regulate individual anxiety to promote his/her mental flexibility and emotional well-being [16], while negative emotion regulation is closely associated with individual negative emotions, especially anxiety. The anxiety level of adolescents depends on the use of cognitive reappraisal strategy, with less use of cognitive reappraisal associated with higher anxiety level [17]. Therefore, cognitive reappraisal is an important but difficult strategy for anxious individuals.

Psychological resilience refers to the ability of an individual to effectively adapt to and cope with frustrations, difficulties, or adversities, and maintain mental health [18]. Studies have found that psychological resilience can alleviate the impact of stress on anxiety [19], and individuals with high psychological resilience have faster cardiovascular recovery from negative emotional arousal and higher levels of positive emotions [20]. A large number of longitudinal studies have shown a significant correlation between positive emotions and psychological resilience [21-23].

Meanwhile, psychological resilience, as a positive psychological quality, may be an important regulating variable in the face of stress. Studies have shown that psychological resilience can be used to predict anxiety [24].

Studies have found that cognitive reappraisal strategy is associated with high anxiety level while expressive suppression strategy is associated with low anxiety level [25-26]. However, most of these studies did not involve other variables, making it impossible to determine whether the above relationship between emotion regulation strategies and anxiety would change with the addition of other variables. Emotion regulation and psychological resilience are protective factors of individual mental health; they are closely related [21-23] and may have a joint effect on anxiety. Based on literature analysis and current research gaps, we aimed to analyze the relationship of psychological resilience and emotion regulation with test anxiety among a large sample of medical students in China, and hypothesized as follows: psychological resilience and emotion regulation are associated with test anxiety and accurately predict it, and psychological resilience may play a mediating role in the effect of emotion regulation on test anxiety.

Methods

Study population and procedure

Totally 1300 undergraduate students at a Chinese medical university in Guangdong were selected with simple random sampling methods. Of these students were eligible to participate and written consent was obtained before the study began. This was an cross-sectional survey performed from June to December, 2019. The study was approved by the Ethics Committee of the Guangdong Medical University (ref. YJYS2019027). Face-to-face interview was applied to inform notes then participants completed surveys online for scales. On average participants took 15-20 min to

provide responses on the questionnaires. Concerning acute anxiety evoked during period of stress was shown to be worse than usual, we decided on the exam period at the end of the first and second semesters during this year for the present study [27].

Measures

Test anxiety

For measuring the students' test anxiety, the Chinese adaptation of Sarason's Test Anxiety Scale (TAS) was used [1, 28]. TAS consists of 37 items to which respondents are asked to report how often they experience anxiety symptoms before, during, and after taking tests. The responses are included "Yes" and "No". The "yes" responses are added one point up and "no" 0 point, except six items are reversed (e.g., the 3rd, 15th, 26th, 27th, 29th, 33th). Respondents were classified as three different levels of test anxiety according to TAS score. Scores falling at or below 12 were indicative of low-test anxiety, scores falling above 12 and below 20 were indicative of a normal level of anxiety, score falling at or above 20 were indicative of high level of test anxiety. The Cronbach's alpha was alpha of .77, split-half reliability of .60 in a Chinese sample [28]. The Cronbach's α of TAS in this sample was 0.884, indicates an acceptable level of internal consistency.

Emotion Regulation

Cognitive reappraisal and expressive suppression frequency during a student's daily life was measured by Emotion Regulation Questionnaire (ERQ), which developed by Gross and John [29]. It includes 14 items that describe five universal emotions (including disgust, anger, sadness, fear and joy) that involve regulating expression, and it can be divided into 2 dimensions: cognitive reappraisal scale includes 6 items, and the expressive suppression scale includes 4 items. Items are assessed on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The

total score range from 14 to 98; with higher scores indicate a higher frequency in using a particular emotion regulation strategy. Previous studies demonstrated ERQ as a reliable tool with Cronbach's alpha coefficient of .83 for cognitive reappraisal, and 0.77 for expressive suppression. Current research yielded that the Chinese version of this scale has adequate reliability and validity [30]. The Cronbach's α of ERQ in our study was 0.903.

Resilience

For the assessment of students' psychological resilience, the Chinese adaptation of Connor-Davidson Resilience Scale (CDRS) was used [31, 32]. The CDRS, developed by Connor and Davidson [33], measures the capability to deal with adversity and stress. Based on exploratory factor analysis of the designer, the 25 items of CDRS can be grouped into 3 dimensions: strength, optimism, resilience. The respondents were expected to answer items based on their own situation. Each statement is rated on a 5-point scale ranging from 0 (not true at all) to 4 (true nearly all the time). The combined score of CDRS ranges from 0 to 100, with a higher sum indicates a greater resilience. The scale was found to be internally consistent and reliable as indicated by the alpha coefficient value 0.89 [34]. Evidence suggests that the CDRS is a very reliable scale which was used by researchers to find out level of psychological resilience among Chinese college students [31-32]. In our sample, the internal consistency of CDRS was very high (Cronbach's alpha = 0.955).

Statistical analysis

All statistical data were imported to SPSS version 21.0 (SPSS Inc., USA) for analysis. The categorical variables were presented with frequencies and proportions while the continuous variables were described by means and standard deviations (SDs). Associated factors of test anxiety, resilience and emotion regulation were examined by using *t*-tests and ANOVA,

respectively. Comparisons the correlation between emotion regulation, resilience and test anxiety were performed via correlation analyses and the predictor of test anxiety were analyzed by regression analyses. Bootstrapping was conducted in testing mediation effects. A p -value was less than 0.05 was considered statistically significant.

Results

General characteristics of participants

The final sample consisted of 1266 participants for further analysis, because of missing information in critical items. The valid response rate was 96.6%. Major characteristics of study subjects were listed in Table 1. Of these participants, females hold the predominant majority ($N=820$, 64.8%). There were 991 participants (78.3%) that took 5 to 7 exams, as the predominant majority. Students reported engaged in part-time jobs or member account for 26.5%, 83.9%, respectively. More than half of the participants 781 (61.7%) came from town and most of the respondents were not single-child family 971(76.7%) and regarding education level of the respondent's majority of the participant were 1rd year 605(47.8%) followed by 3nd year 312(24.6%).

Table 1 Socio demographic characteristics of medical students

Variable	Category	Frequency	Percentage
Gender	Male	446	35.2
	Female	820	64.8
Grade	First year	605	47.8
	Second year	264	20.9
	Third year	312	24.6
	Fourth year	64	5.1
	Fifth year	21	1.7
Colleague	Public health	280	22.1
	Humanities and management	14	1.1
	Clinical medicine	100	7.9
	Medical technology	234	18.5
Part-time jobs	Pharmacy	638	50.4
	Yes	335	26.5
	No	931	73.5
Members of the club	Yes	1062	83.9
	No	204	16.1
Academic evaluation	Excellent	351	27.7
	Moderate	490	38.7
	Lower-moderate	241	19.0
	Poor	184	14.5
Examination number	Below 5	82	6.5
	5 to 7	991	78.3
	8 to 9	144	11.4
	Above 9	49	3.9
Birthplace	City	485	38.3
	Country	781	61.7
Single-child family	Yes	295	23.3
	No	971	76.7

Levels and associated factors of test anxiety, resilience and emotion regulation

As seen in Table 2, more than half (71.4%) of medical students had problematic test anxiety, 33.7% was high test anxiety. The average scores of the three specific dimensions of psychological resilience varied, ranging from 9.07 ± 2.70 (optimism) to 29.68 ± 8.557 (resilience). Regarding emotion regulation, cognitive reappraisal (34.30 ± 6.824) adopted by students was higher than expressive suppression (30.26 ± 7.046).

Moreover, we found gender and academic performance were significantly associated with among test anxiety, psychological resilience and emotion regulation. In other words, the odds of having positive test anxiety, psychological resilience and emotion regulation for those who have

222 excellent academic evaluation is higher than those who have poor academic evaluation.

223 Additionally, female reported more difficulties in above-mentioned three aspects compared to

224 male.

225 **Table 2** Means, standard deviations, and correlations

Variable		Psychological resilience	Resilience	Strength	Optimism	Emotion regulation	Cognitive reappraisal	Expressive suppression	Test anxiety
Total		58.89±15.28	29.68±8.56	20.14±5.01	9.07±2.70	64.56±11.92	34.30±6.82	30.26±6.82	16.75±7.62
Gender	Male	60.96±17.58	30.99±9.85	20.64±5.71	9.33±2.97	65.52±13.93	33.97±7.72	31.55±7.63	15.77±7.74
	Female	57.77±13.76	28.97±7.68	19.86±4.56	8.93±2.53	64.03±10.63	33.48±6.28	29.55±7.61	17.27±7.51
	<i>T</i>	3.33**	3.75***	2.49*	2.39*	1.97*	-1.184	4.66***	-3.36**
Grade	First year	59.87±15.31	30.19±8.61	20.45±4.97	9.22±2.69	64.42±11.99	34.22±6.88	30.20±7.25	16.61±7.61
	Second- year	59.59±16.70	30.36±9.09	20.10±5.47	9.13±2.92	64.91±12.54	34.26±6.88	30.65±7.17	16.74±7.74
	Third year	56.26±13.83	28.10±7.83	19.43±4.69	8.73±2.52	64.54±11.45	34.35±6.69	30.19±6.61	17.02±7.74
	<i>F</i>	3.17*	3.80**	2.38*	1.18	0.26	0.14	0.81	0.17
Academic evaluation	Excellent	61.89±13.41	31.22±7.59	21.26±4.48	9.40±2.46	65.89±11.08	35.28±6.21	30.61±6.81	15.49±6.67
	Moderate	60.22±14.41	30.37±8.14	20.56±4.61	9.29±2.67	64.76±11.46	34.55±6.57	30.21±7.00	16.51±7.61
	Lower-moderate	56.40±14.73	28.37±8.23	19.27±4.90	8.77±2.58	63.46±11.67	33.55±6.96	29.91±6.61	16.85±7.94
	Poor	52.92±19.11	26.64±10.62	18.00±6.17	8.28±3.15	62.92±14.47	32.75±8.01	30.17±8.12	19.64±8.22
	<i>F</i>	17.93***	15.01***	21.73***	9.22***	3.37*	6.86***	0.51	12.48***
Single-child family	Yes	59.37±16.45	29.94±9.14	20.19±5.35	9.24±2.85	64.01±12.75	33.49±7.16	30.52±7.41	17.12±7.88
	No	58.75±14.92	29.61±8.37	20.12±4.90	9.02±2.65	64.73±11.65	34.54±6.70	30.18±6.93	16.63±7.54
	<i>T</i>	0.58	0.58	0.21	1.21	-0.90	-2.32*	0.72	0.95
Part-time jobs	Yes	60.71±15.44	30.84±8.72	20.52±5.02	9.35±2.75	66.00±12.75	34.90±6.97	31.10±7.30	16.37±7.97
	No	58.24±15.18	29.26±8.46	20.00±5.00	8.98±2.68	64.04±11.56	34.08±6.76	29.95±6.93	16.88±7.49
	<i>T</i>	2.54*	2.91**	1.62	2.18*	2.59*	1.88	2.56*	-1.05
Members of the club	Yes	59.26±14.79	29.86±8.26	20.27±4.88	9.12±2.65	64.68±11.59	34.46±6.67	30.22±6.94	16.86±7.55
	No	57.00±17.53	28.74±9.91	19.42±5.60	8.84±2.93	63.92±13.49	33.47±7.53	30.45±7.59	16.17±7.97
	<i>T</i>	1.73	1.53	2.03*	1.34	0.83	1.90	-0.43	1.18
Birthplace	City	59.32±15.94	29.86±8.84	20.17±5.23	9.29±2.82	64.74±12.27	34.09±6.78	30.66±7.34	17.41±7.87
	Country	58.63±14.87	29.57±8.38	20.12±4.87	8.94±2.62	64.44±11.70	34.43±6.85	30.01±6.85	16.33±7.44
	<i>T</i>	0.78	0.57	0.18	2.23*	0.44	-0.87	1.58	2.46*

226

227 Correlation between study variables

228 To that extent we performed spearman rank correlation analyses between test anxiety, resilience

and emotion regulation. This correlation was shown in Table 3. As expected, test anxiety has a significant negative correlation with resilience ($r = -0.382, p < 0.01$) and emotion regulation ($r = -0.158, p < 0.01$). A low level of test anxiety is linked with a high degree of resilience as well as emotion regulation in medical students. Interesting, more than emotion regulation and resilience, all the dimensions of that were significantly negative correlations with test anxiety respectively.

Table 3 The correlation coefficients for the test anxiety, emotion regulation and resilience (N = 231)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)Test anxiety	-							
(2)Emotion regulation	-0.158**	-						
(3)Cognitive reappraisal	-0.191**	0.854**	-					
(4)Expressive suppression	-0.082**	0.864**	0.476**	-				
(5)Resilience	-0.382**	0.507**	0.559**	0.316**	-			
(6)Resilience	-0.374**	0.500**	0.537**	0.326**	0.972**	-		
(7)Strength	-0.364**	0.492**	0.562**	0.288**	0.946**	0.867**	-	
(8)Optimism	-0.304**	0.371**	0.420**	0.221**	0.827**	0.723**	0.723**	-

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Testing the mediating role of resilience

We finally set out to investigate whether resilience was a mediator. Multiple regression analysis showed that cognitive reappraisal negatively predicted test anxiety ($\beta = -0.191, p < 0.01$). Similarly, resilience and strength negatively predicted test anxiety ($\beta = -0.235, p < 0.01$; $\beta = -0.160, p < 0.01$, respectively). Table 4 indicates the unstandardized parameter estimates and standard errors in the model. It can be assumed that practical work aimed at developing the cognitive reappraisal and resilience could effectively ensure less test anxiety.

Furthermore, regression analyses found that dimensions of resilience possible be taken as mediating role. Total effects model was conducted by taking cognitive reappraisal as independent variable X, resilience and strength as mediating variables M1 and M2, and test anxiety as dependent variables Y to examine the mediating role of resilience. Bootstrapping was conducted

to test the mediating effects, as it can yield more accurate estimates of the indirect effect standard errors than alternative approaches to testing mediation [35]. We adopt Bootstrapping to test mediation effects and the 95% confidence interval (CI) based on 5000 bootstrap samples with replacement. When the indirect effects as represented here by confidence intervals, did not include zeros, we can infer that mediation occurred. The results presented that, *ab* was statistically significant. Therefore, there was a mediation occurred of resilience and strength on emotion regulation and test anxiety. In other words, the path model going from emotion regulation to resilience to test anxiety was significant. As shown in Table 5, the indirect effects of resilience and strength on emotion regulation and test anxiety did not include a zero (95% CI: -0.189, -0.091; 95% CI: -0.162, -0.048, respectively), thereby indicating resilience and strength as a mediator. Moreover, controlling for mediating variables, the direct effects of cognitive reappraisal on test anxiety include a 0 (95% CI: -0.027, 0.112). It indicated that resilience and strength performed a completely mediating role in the relation between emotion regulation and test anxiety.

Table 4 The regression analyses for the test anxiety, emotion regulation and resilience (N = 231)

Independent variable	Equation 1 (dependent variables: test anxiety)				Equation 2 (dependent variables: test anxiety)			
	B*	SE*	β^*	<i>t</i>	B	SE	β	<i>t</i>
Constant	24.046	1.079		22.290***	27.879	0.821		33.941***
Cognitive reappraisal	-0.213	0.031	-0.191	-6.900***				
Resilience					-0.209	0.046	-0.235	-4.506***
Strength					-0.244	0.079	-0.160	-3.078
R ² *				0.036				0.146
F				47.611***				108.230***

*B= regression coefficient, SE= standard errors, β = standardized regression coefficient, R²= coefficient of determination

Table 5 Mediation model of resilience between emotion regulation and test anxiety

Roadmap	Category	Effect ratio	95% CI (lower, upper)	Relative mediation effect(%)
Cognitive reappraisal→Test anxiety	Total effect	-0.213	-0.273, -0.152	100%
Cognitive reappraisal→Test anxiety	direct effect	0.043	-0.027, 0.112	14.40%
Cognitive reappraisal→Resilience→Test anxiety	indirect effect	-0.146	-0.189, -0.091	48.76%
Cognitive reappraisal→Strength→ Test anxiety		-0.110	-0.162, -0.048	36.84%

Discussion

The population characteristics of medical students' test anxiety, emotion regulation, and psychological resilience

Findings from the present study demonstrated that the prevalence of high test anxiety among medical students to be 33.7%, higher than 32.64% in that of 2015. Literature shows that the magnitude of high test anxiety for students was 27.52% in 2015 [5], for 21.8% college students in 2001 [28]. Our results thus confirm previous reports showing that the odds of developing test anxiety was higher among medical students as compared to other majors in China [6-7]. The possible reasons are described as follows. From the perspective of the knowledge to be mastered, medical students have to take many abstract and difficult major courses. Meanwhile, they cannot just make up the number in class since their future careers are related to human life, and medical schools have very strict requirements for their academic performance. From the perspective of employment pressure, the employment situation is not optimistic for medical students. Practicing medicine requires extremely high professional skills, which makes it impossible to find a job in a highly-ranked hospital without adequate professional skills. At present, the demand from society for technical personnel has increased dramatically. Compared with the theoretical knowledge acquired in school, practical skills acquired at work are more important for engineering students. Moreover, we found that more than half of the medical students (71.4%) had problematic test anxiety. The result of the current study was higher than the study conducted at USA (55%). This

difference may be due to the variations in several factors that have an impact on anxiety, such as curriculum evaluation methods, different requirements about students' physical ability and other factors. Universities in the US adopt flexible teaching and performance assessment methods, with a focus on the improvement of students' self-efficacy. Universities in China generally adopt a single final examination with formatted content for the evaluation of academic performance [36, 37].

Our study results demonstrate that test anxiety, resilience and emotion regulation are closely associated with both academic performance and genders. As the research data show, female students have higher levels of test anxiety while male students represent a higher level of resilience as well as emotion regulation. With regard to gender differences, most researchers report higher levels of test anxiety in females [38, 39]. This may be attributed to the fact that women are under the pressure from society to develop their own competitiveness. In addition, some scholars have shown that women use negative cognitive emotion regulation strategies more often than men [40]. Parents usually teach boys to control emotions, which makes boys have higher expectations for their ability to control emotions. When encountering emotional problems, men tend to be resilient and finally master the skills to control emotions in silence. In contrast, women are likely to distract their attention owing to their emotional personality traits and psychological characteristics, and tend to adopt immature and negative coping styles when dealing with stressful events, which makes them inferior to men in emotional control and psychological resilience [41]. Students with poor academic performance suffer from more severe test anxiety and less emotion regulation and psychological resilience than those with moderate to excellent academic performance.

This result is consistent with data from student samples in different countries. Researchers reported that students with moderate to excellent academic performance had developed learning abilities and strategies to easily cope with examinations. While some less capable students may experience such expectations due to the unrealistic expectations of parents, peers, or teachers. These expectations may increase their anxiety in exam situations and cause performance problems [42].

The relationships between test anxiety, emotion regulation, and psychological resilience

Correlation analyses showed significantly negative correlations of test anxiety with emotion regulation strategies, cognitive reappraisal, and expressive suppression among medical students. This was slightly different from previous studies [10, 43, 44], which had relatively consistent results on cognitive reappraisal that cognitive reappraisal was an adaptive strategy. However, no consistent conclusion was reached in studies on expressive suppression. Some scholars believed that expressive suppression was not adaptive. Nevertheless, whether a strategy is good and adaptive depends on personal experience, scenarios, and personal goals. One-third of the students in this study showed relatively high levels of test anxiety. In high-intensity negative scenarios, individuals were more inclined to choose avoidance-oriented strategies such as expressive suppression, which had better effects in the short term. This was consistent with previous studies [45, 46, 47] that subjects tended to adopt cognitive reappraisal strategy for low or moderate-intensity stimuli, and expressive suppression strategy in high-intensity negative scenarios. A correlation analysis showed that the coefficient of positive correlation between cognitive reappraisal and expressive suppression reached 0.476, which means that medical students who were used to adopting the cognitive reappraisal may frequently adopt the expressive

suppression, and the two strategies may coexist instead of contrast each other. However, subsequent regression analysis found that cognitive reappraisal had a direct negative predictive effect on test anxiety (cognitive reappraisal reduced test anxiety, while expressive suppression did not reduce test anxiety), which indicates that the function of cognitive reappraisal generally shows cross-cultural consistency and medical students can effectively reduce the negative stimuli and emotions such as test anxiety by managing their emotions with cognitive reappraisal. Interestingly, in terms of expressive suppression, studies with American, Australian, and Belgian college students as subjects found that [48, 49] the individuals were less likely to adopt expressive suppression to regulate positive emotions, and expressive suppression was associated with reduced positive emotions and psychological adaptation and increased negative emotions. However, in countries with Eastern cultures such as China [50], expressive suppression has a role in social adaptation and not necessarily has a direct negative impact on individual psychological adaptation. In the scenario of academic failure, college students in China would have reputation-based emotions (e.g., shame and embarrassment) and tended to cope with the emotions by themselves [51]. The results of this study exemplify the cross-cultural consistency of cognitive reappraisal adaptiveness and the cultural differences of expressive suppression.

According to the regression equation of data, According to the regression equation, cognitive reappraisal, resilience, and strength were negative predictors of test anxiety. This indicates that individuals with high levels of emotion regulation and psychological resilience can quickly recover from severe stress and danger and successfully response to corresponding changes, which were reflected in reduced test anxiety levels in this study. Meanwhile, we also found a significantly positive correlation between psychological resilience and emotion regulation

strategies in the sampled medical students. This was consistent with previous studies conducted with a intervention was an effective method, by emotion regulation to enhance the psychological resilience of adolescents [52, 53]. Due to the impact of positive psychology, a large number of studies have focused on the relationship between psychological resilience and positive emotions. Many studies agreed that individuals with high psychological resilience had higher levels of positive emotions than those with low psychological resilience. Individuals with high psychological resilience could use cognitive reappraisal to cultivate their positive emotions and effectively induce others to use positive emotion regulation, thus creating a supportive social environment for themselves. In later studies, researchers also focused on the relationship between negative emotion regulation and psychological resilience.

However, studies on the negative emotion levels of individuals with different levels of psychological resilience showed inconsistent results. Some scholars believed that there were no significant differences in negative emotion regulation between individuals with high and low psychological resilience [21], and other suggested that individuals with higher psychological resilience had lower levels of depression [54]. Ong [55] emphasized that individuals with high psychological resilience evoked positive emotions while experiencing negative emotions, but those with low psychological resilience only regulated negative emotion in adversity or emergencies. It can be seen that researchers' conclusions were divided on the relationship between psychological resilience and the level of negative emotions, which may be attributed to the different subject populations selected by researchers or the fact that there are numerous psychosociology factors that affect negative emotions. In our study, we found that individuals with higher psychological resilience had higher levels of emotion regulation, including cognitive

reappraisal and expressive suppression, which was in agreement with several previous studies.

The mediating role of psychological resilience

One of the key findings of this study was that emotion regulation indirectly affected test anxiety through the mediating effect of psychological resilience. When medical students felt lower stability of emotion regulation, they would alleviate the impact of emotion regulation on test anxiety through the resilience and strength of psychological resilience. This reflected that the close relationship between emotion regulation and psychological resilience, and supported previous results that psychological resilience can buffer the crisis. Hence, psychological resilience as a positive psychological quality may be an important regulating variable in the face of stress. Bandura [56] pointed out that enhancing individual abilities through experience was the most reliable way to develop strong and resilient self-efficacy. College students with high psychological resilience were not defeated by negative emotions, making them more confident that they can effectively regulate their emotions. Therefore, compared with interfering with emotion regulation, strengthening frustration education and cultivating their psychological qualities such as resilience and strength to resist stress are more effective ways to reduce test anxiety and help medical students to adapt to campus and society in the long run.

Conclusions

Our empirical research suggests that gender and academic performance significantly affected medical students' test anxiety, emotion regulation, and psychological resilience. The test anxiety experienced by medical students would be reduced when their psychological resilience and emotion regulation increased, especially when their control of cognitive reappraisal, resilience, and strength was improved. Emotion regulation indirectly affected test anxiety through the

mediating effect of psychological resilience. This may provide insight for clinical psychologists and raise awareness of the importance of cultivating and improving the psychological resilience of medical students. Investigation of the continuous psychological development of subjects was limited due to the cross-sectional study design. A deeper understanding of the background of the subject population and exclusion of irrelevant variables that may impair data reliability, such as environmental factors, are needed to improve the reliability of data in future research.

List of abbreviations

TAS: Test Anxiety Scale; ERQ: Emotion Regulation Questionnaire; CDRS: Connor-Davidson Resilience Scale; CI: confidence interval; SPSS: Statistical Software for Social Science

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Guangdong Medical University (ref. YJYS2019027). Written informed consent was obtained from all participants prior to the survey administration.

Consent for publication

Not applicable.

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

Authors declare no conflict of interests for this article.

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Authors' contributions

LYG conceived and designed the study, wrote the paper. WXJ, RJW and ZXS performed the investigation and carried out data collection. YRH and PHY contributed to analyze the data. LYG and PCC drafted and edited the manuscript. PHY reviewed the manuscript. All authors read and agreed to the published version of the manuscript.

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