Original Article

The relationship between stress, resilience, and quality of life in Chinese high school students

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Background: Stress is an important factor affecting the dynamic process of resilience. This study aimed to explore the role of stress levels in the relationship between resilience and health consequences by investigating high school students undergoing the National College Entrance Examination (CEE), which often involves intense stressful conditions for students in China, at different stages.

Methods: The CD-RISC [Conner-Davidson Resiliency Scale] and SF-36 [the short form 36 health survey questionnaire, one measurement of the quality of life (QoL)] were used to investigate 435 high school students, including 208 students in grade two (low stress group) and 227 students in grade three (high stress group).

Results: This study found that the SF-36 scores under high-stress conditions were significantly lower than those under low-stress conditions, however there were no significant differences in the mental resilience scores. Additionally, under low-stress conditions, mental resilience was found to be significantly correlated with various factors of SF-36, but no significant correlation was observed under high-stress conditions. It was also discovered that stress levels can mediate the relationship between psychological resilience and QoL (the quality of life).

Conclusions: Stress level is an important factor affecting the expression of resilience. This study also discussed the integration of the concept of resilience.

Keywords: Resilience; quality of life; stress; College Entrance Examination; China

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Introduction

Resilience is an important field of research for the well-being of the adolescent population. It refers to the recovery ability of an individual who has experienced extreme trauma or stress (1), and helps adolescents to positively adapt to stressful events (2), such as academic performance (3), chronic pain (4), and hearing loss (5). Therefore, stress is considered to be an important prerequisite for resilience research (6), and resilience has thus been studied as a health consequence of trauma or a stressful life event (7).

Currently, the evidence indicates that there exists a

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complicated interaction among resilience, stress, and well-being (8). Resilience is considered to be a context- and time-specific dynamic process. Some studies have shown that resilience seems to be the determinant factor of perceived stress and the intensity of stressful events (9). In a study of burns patients, Chen *et al.* found that perceived stress was the key predictor of resilience (10). Furthermore, Ma *et al.* found that stress levels could effectively predict resilience in chronic kidney disease patients (11). These results indicate that the extent of exposure may be an important factor in understanding resilience (12).

The performance of resilience under highly stressful conditions has been a matter of particular concern in recent years. It has been discovered that the positive effect of resilience seems to be weakened in high-stress situations. Fu *et al.* reported that emotional intelligence plays an important role in low-stress conditions; however, this has been found to disappear under highly stressful conditions (13). Also, Vanderbilt-Adriance *et al.* concluded that resilience would be rare at the highest levels of risk (14), which indicates that resilience will primarily have a positive impact in low-stress environments, but will be restrained in high-stress circumstances. However, there is still a lack of relevant research, especially comparative studies on the differences under different stress conditions.

At the same time, data has shown that accumulated stress can also lead to a decline in resilience. In a long-term follow-up study of former child soldiers in Sierra Leone, traditional protective factors, such as family acceptance, family economic situation, and mother's education level, were not related to positive health consequences (15). A UK study examining maltreatment in a representative sample of 1,116 twin pairs reported that some protective factors, such as high intelligence and positive characteristics, disappeared when family stress became cumulative (16). Another study showed that family resilience declined with longer parental survival from the time of cancer diagnosis (17). These findings indicate that resilience factors tend to decrease with an increase in environmental adversity (18). In fact, at a certain stress level, even the most protective factors may lose their ability to resist (19). In other words, under high-stress levels, the positive effect of resilience will be restrained.

A U-shaped model was suggested to explain the relationship between resilience and life trauma (20). It hypothesized that the role of resilience will gradually increase with an elevation in the incidence of trauma, but will show a downward trend when this incidence exceeds the average level. Moreover, an individual's depression, functional impairment, and posttraumatic stress disorder (PTSD) symptoms will increase rapidly after the life trauma accumulation exceeds the average level. This means that if we consider stress as a spectrum having both low and high levels, the role of resilience will gradually increase to promote health outcomes on the low side, however will slowly reduce or even disappear on the high side of stress following the gradual decline of trauma. This hypothesis was confirmed by previous studies; however, such studies are few in number.

In general, current studies on the impact of stress on resilience show that high-stress environments and stress accumulation will weaken the function of resilience, which suggests that stress levels may act as a mediator in the relationship between resilience and health consequences. Recently, the impact of stress on the function of psychological resilience has attracted increasing attention. However, few studies have examined such high-stress conditions as well as their long-term effects.

At the same time, previous studies on resilience have focused primarily on short-term health consequences, such as anxiety and depression, but have largely overlooked the possible impact of long-term physical consequences, such as the ability for activity, physical function, and bodily pain. Nevertheless, continuous stress will not only have a significant impact on an individual's psychology, but also inevitably on their physical health (21). This has been confirmed also by studies regarding the quality of life (QoL) of patients, such as those investigating the QoL of breast cancer survivors (22).

Therefore, this study attempts to explore the following: (I) whether stress levels affect the relationship between resilience and psychophysiological consequences; and (II) whether resilience may have different effects on an individual's body and mind under persistent stress. We selected students who are going to take the college entrance examination (CEE) in China as study participants, as this group faces severe stress due to the CEE, which lasts for three years. Furthermore, this study used SF-36 to explore the long-term health consequences of resilience.

It is estimated that about one in six students, especial in final two years of secondary school, experience severe academic stress around the world (23). Academic resilience played an important mediating role in the relationship between test anxious and some related factors, such as family conversation orientation (24). In Asian, the CEE causes significantly higher levels of anxiety among Asian teenagers

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than those observed in their European counterparts (25). In China, the national CEE is considered to be the most important examination that could decide the future success of an adolescent (26), and thus is considered with high interest in society. This stress commences from the time these adolescents enter high school until they complete the CEE. Therefore, for most Chinese adolescents, the CEE induces the highest stress level, which could have an inevitable negative impact on the health of these adolescents. Evidence shows that life event in the past year of middle school would influence the relationship between negative emotion and academic performance of youth (27). And at the same time, CEE would bring other problem in adolescences. It has been found that 94.4% of high school students spend fewer than eight hours sleeping (28), and as such, their mental health situation is relatively worse (29). A study of Chinese adolescents shows that stressful life events has significantly associated with sleep quality, and resilience played a moderate role in this relationship (30).

Some evidence shows that the resilience would help avoiding negative consequences in the context of frustration, and improve quality of life of high school students in China (31). For example, resilience was found benefit for mental health of Chinese adolescents during the COVID-19 pandemic (32), and having strong and stable protective effects against Internet addiction and rise Life satisfaction (33).

Thus, the CEE is not only a one-time stressor, but is rather a three-year progressional problem. Inevitable life changes that occur after entering high school cause severe stress in all Chinese high school students. Considering this, the QoL scale was selected to evaluate the long-term influence of CEE. QoL is a widely accepted concept for assessing long-term health consequences, such as physical health, psychological state, and other health-related issues. Many factors have found influenced QoL of youth, such as attachment style (34), livelihoods and income fortification (35), coping style (36). At the same time, previous studies have found that resilience was the predictors of QoL in high school students (37). Previous studies have found that a high resilience score could predict a better mental QoL (38) as well as better QoL scores more generally (39) in students. Some researchers have reported that resilience could be helpful for understanding QoL (40), and it has been found to positively impact aspects of QoL (41).

Thus, we may infer that that an individual has pre-formed resilience characteristics based on their experiences. However, once the stress level increases beyond a certain degree, their resilience could be damaged and reduced. In other words, resilience is the integration of stability and uncertainty, and is most impacted by stress levels. To validate this statement, several condition need to be fulfilled: (I) the individual is suffering from high stress (activation of resilience); (II) the stress is increasing and exceeds the average (high stress level situation); and (III) the individual will continuously oscillate between low stress and high stress levels (continuous stress series).

In this study, the change in resilience under different kinds of stress was considered as the starting point, which could reveal the bi-dimensional nature of resilience. This research compared the resilience of grade 2 and grade 3 high school students under different stress levels 4 weeks prior to China's national CEE. It should be noted that although all students will face the high stress levels of the CEE, the stress faced by grade 2 students is lower than that faced by grade 3 students. This is because while grade 2 students have just begun to encounter the related stress, grade 3 students have already passed the initial phases of stress and thus experience a higher overall level of stress. This study design helps to observe the changes in resilience under different stress levels.

According to the conditions described above, we hypothesize the following:

(I) The resilience score will decline in the high-stress situation;
(II) The correlations between resilience and SF36 factors will disappear under the high-stress situation; and
(III) The stress level will mediate the relationship between resilience and SF36 factors.

We present the following article in accordance with the SURGE reporting checklist (available at http://dx.doi.org/10.21037/apm-21-929).

Methods

Participants

A total of 480 questionnaires were sent out and 450 were recovered. After deleting the questionnaires with similar answers, regular answers and too many missing values, a total of 435 valid questionnaires were obtained (the recovery rate was 90%). In this group of 435 Chinese high school students were selected, of which 208 belonged to grade 2 (47.8%) and 227 to grade 3 (52.2%). The ages of the participants ranged from 15–20 years [M=17.60, standard

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deviation (SD) =1.30]. Most participants (408, 93.8%) were from the Han race, while the remaining students belonged to minority groups (nine, 2.1%). Similarly, most were single children (335, 77%), while others belonged to families with more than one child (100, 23%). The economic situation of the students' families was classified as worse (115, 26.4%), normal (224, 51.5%), and good (92, 21.1%). The students were selected from two high schools in Jiangsu Province, and were evaluated 4 weeks prior to the CEE.

Procedure

All questionnaires were completed during classes by the participants' psychology teachers. The students were informed that their participation was voluntary and that their responses would remain anonymous. All participants completed their questionnaires independently and submitted them upon completion. Written informed consent was obtained from all participants prior to completing the questionnaires. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). And the research protocol was approved by the ethics committee of East China Normal University (No. HR 043-2017).

Measures

Resilience

A revised Chinese version of CD-RISC (Conner-Davidson Resiliency Scale) (1) was used in this study (42), which comprised five dimensions: tenacity, adaptability, autonomy, adventurousness, and resource utilization. Participants responded to 25 items using a 5-point Likert scale, with scores ranging from 0 (not true) to 4 (true), nearly all of the time. Higher scores indicated a better resilience state. In this study, Cronbach's α was 0.898.

Quality of life

Developed by the American Institute of Health, the SF-36 Health Survey is a concise health measurement scale for QoL (43). The Chinese version of the SF-36 was used in this study (44); it involved 36 items and covered eight aspects of health-related QoL: physical function (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (VT), social function (SF), role-emotional (RE), and mental health (MH). Based on these scales, a Physical Component Summary (PCS) and Mental Component Summary (MCS) were calculated as measures of physical and mental functioning and well-being, with higher scores indicating better health. The SF-36 has been shown to have good reliability and is arguably the most widely used measure of QoL. In the current study, Cronbach's α was 0.730.

Stress level

This study was carried out 4 weeks before the CEE, which was the most stressful time for grade 3 high school students. Based on the time gap from the time of the study until the CEE, we divided these students into two groups: a low-stress group (grade 2) and a high-stress group (grade 3).

Statistical analyses

SPSS 22.0 (Statistical Package for Social Sciences) was used for replacing missing values, common method bias tests, reliability and validity tests, *t*-test, and bivariate correlation. PROCESS 3.3 (45) was used to test the mediating effect.

Results

Common method bias

Common method bias was assessed using a single-factor test (46). The data showed 15 factors with eigenvalues greater than 1. The first factor explained 9.90% of the total variance, which was below the critical value of 40%. This signified that that the common method bias was not significant.

T-test results

A *t*-test was used to examine the differences in SF-36 and resilience between the high- and low-stress conditions groups (*Table 1*). A significant difference was found in all SF-36 factors barring RE (t=0.803, P=0.423); this was not observed in resilience or its subscales.

Correlations analysis results

Pearson's correlation analysis was used to examine the relationship between the factors of resilience and QoL. The following correlations were observed: (I) a significant positive correlation between resilience and SF36 factors,

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Table 1 T-test results for different stress levels

Factors	Low stress (n=208)		High stress (n=227)		t	Cohen's d
	M	SD	M	SD		
Resilience	2.532	0.527	2.569	0.523	−0.732	–
R1	2.516	0.729	2.573	0.667	−0.839	–
R2	2.751	0.569	2.750	0.593	0.013	–
R3	2.449	0.707	2.467	0.730	−0.264	–
R4	2.397	0.724	2.486	0.689	−1.308	–
R5	2.128	0.709	2.200	0.808	−0.977	–
SF36						
PF	88.846	15.168	93.767	8.950	−4.074***	0.395
RP	72.356	37.255	79.736	32.283	−2.199*	0.210
BP	72.288	17.304	49.423	5.436	18.250***	1.783
GH	68.538	21.708	47.330	8.380	13.217***	1.290
VT	61.106	18.958	53.480	10.077	5.170***	0.501
SF	81.611	14.429	53.910	11.899	21.732***	2.095
RE	52.244	42.661	49.046	40.435	0.803	–
MH	63.538	16.932	53.322	9.763	7.619***	0.739
PCS	75.507	15.539	67.564	8.936	6.459***	0.627
MCS	64.625	16.274	52.439	11.146	9.031***	0.873

*P<0.05, ***P<0.001. R1, tenacity; R2, adaptability; R3, autonomy; R4, adventurousness; R5, resource utilization; PF, physical function; RP, role-physical; BP, bodily pain; GH, general health; VT, vitality; SF, social function; RE, role-emotional; MH, mental health; PCS, Physical Component Summary; MCS, Mental Component Summary; SD, standard deviation.

except BP (r=0.023, P>0.01) and SF (r=0.09, P>0.01) (*Table 2*); (II) a significant positive correlation between resilience and SF36 factors, except for RE, in the low-stress conditions group; and (III) significant correlations only between resilience and PF (r=0.228, P<0.001), BP (r=−0.158, P<0.05), and PCS (r=0.131, P<0.05) in the high-stress conditions group (*Table 3*).

Moderating effect analysis

Bootstrapping analysis (47) was used to examine the moderating effect of stress levels on resilience (CD-RISC) and QoL. The confidence interval (CI) was 95%, and number of resamples was 5,000. We found that stress levels significantly moderated the relationship between resilience and PCS (B=−7.712, SE =2.197, 95% CI: −12.030, −3.394). The direct effect of resilience on PCS was significant in the low-stress environment (unstandardized simple slope =9.940, SE =1.582, 95% CI: 6.830, 13.049), but not in the high-stress situation (unstandardized simple slope =2.228, SE =1.525, 95% CI: −0.769, 5.224).

The same results were also found for MCS (B=−8.475, SE =2.436, 95% CI: −13.264, −3.678). The direct effect of resilience on MCS was significant in the low-stress conditions group (unstandardized simple slope =10.511, SE =1.754, 95% CI: 7.063, 13.959), however this effect was not significant in the high-stress conditions group (unstandardized simple slope =2.036, SE =1.691, 95% CI: −1.287, 5.359).

Discussion

It is interesting to note that we found no significant difference in the resilience scores under the different stress level conditions; this was only observed in QoL factors (except RE) in this study (*Table 1*). As such, the

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Table 2 Descriptive statistics and bivariate correlations

Variable	M	SD	1	CD-RISC	R1	R2	R3	R4	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
CD-RISC (resilience)	2.55	0.52	1															
R1	2.55	0.70	0.868**	1														
R2	2.75	0.58	0.905**	0.675**	1													
R3	2.46	0.72	0.805**	0.644**	0.718**	1												
R4	2.44	0.71	0.557**	0.336**	0.437**	0.413**	1											
R5	2.17	0.76	0.541**	0.381**	0.383**	0.280**	0.161**	1										
SF36 (QoL)																		
PF	91.41	12.55	0.188**	0.111*	0.196**	0.156**	0.124**	0.131**	1									
RP	76.21	34.90	0.197**	0.192**	0.176**	0.131**	0.031	0.165**	0.419**	1								
BP	60.36	17.00	0.023	0.016	0.048	0.053	−0.057	−0.005	−0.227**	−0.044	1							
GH	57.47	19.33	0.117*	0.108*	0.143**	0.058	0.066	−0.002	−0.089	0.115*	0.597**	1						
VT	57.13	15.45	0.191**	0.096*	0.248**	0.197**	0.093	0.052	0.048	0.053	0.311**	0.403**	1					
SF	67.16	19.10	0.090	0.048	0.156**	0.088	−0.004	−0.023	0.006	0.032	0.519**	0.473**	0.315**	1				
RE	50.57	41.50	0.117*	0.096*	0.122*	0.080	−0.019	0.127**	0.025	0.228**	0.064	0.092	0.043	0.110*	1			
MH	58.21	14.58	0.169**	0.150**	0.200**	0.104*	−0.016	0.110*	0.021	0.113*	0.366**	0.408**	0.561**	0.375**	0.194**	1		
PCS	71.36	13.13	0.227**	0.199**	0.232**	0.163**	0.056	0.138**	0.411**	0.792**	0.460**	0.616**	0.296**	0.364**	0.212**	0.348**	1	
MCS	58.27	15.10	0.198**	0.142**	0.245**	0.159**	0.006	0.120*	0.037	0.208**	0.376**	0.414**	0.520**	0.563**	0.779**	0.636**	0.421**	1

*P<0.05, **P<0.01. R1, tenacity; R2, adaptability; R3, autonomy; R4, adventurousness; R5, resource utilization; PF, physical function; RP, role-physical; BP, bodily pain; GH, general health; VT, vitality; SF, social function; RE, role-emotional; MH, mental health; PCS, Physical Component Summary; MCS, Mental Component Summary.

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Table 3 Descriptive statistics and bivariate correlations of different stress levels

Variable	PF	RP	BP	GH	VI	SF	RE	MH	PCS	MCS
Low stress										
CD-RISC (resilience)	0.167*	0.256**	0.150*	0.289**	0.338**	0.235**	0.133	0.394**	0.337**	0.340**
R1	0.059	0.232**	0.123	0.251**	0.198**	0.163*	0.099	0.302**	0.275**	0.237**
R2	0.208**	0.224**	0.177*	0.305**	0.402**	0.298**	0.148*	0.432**	0.341**	0.392**
R3	0.122	0.201**	0.175*	0.119	0.312**	0.237**	0.116	0.315**	0.241**	0.302**
R4	0.111	−0.015	−0.011	0.215**	0.168*	0.025	−0.019	0.118	0.090	0.073
R5	0.158*	0.305**	0.048	0.113	0.167*	0.090	0.136	0.242**	0.274**	0.220**
High stress										
CD-RISC (resilience)	0.228**	0.130	−0.158*	−0.084	0.003	0.092	0.104	−0.109	0.131*	0.096
R1	0.191**	0.140*	−0.122	−0.048	−0.048	0.050	0.097	−0.034	0.144*	0.083
R2	0.208**	0.131*	−0.216**	−0.074	0.051	0.152*	0.099	−0.096	0.120	0.120
R3	0.223**	0.059	−0.132*	0.011	0.059	0.041	0.049	−0.181**	0.092	0.029
R4	0.126	0.068	−0.060	−0.080	0.024	0.102	−0.014	−0.180**	0.066	−0.020
R5	0.095	0.030	0.027	−0.138*	−0.077	−0.057	0.125	0.005	0.023	0.082

*P<0.05, **P<0.01. R1, tenacity; R2, adaptability; R3, autonomy; R4, adventurousness; R5, resource utilization; PF, physical function; RP, role-physical; BP, bodily pain; GH, general health; VT, vitality; SF, social function; RE, role-emotional; MH, mental health; PCS, Physical Component Summary; MCS, Mental Component Summary.

first hypothesis could not be verified; self-assessment of resilience was quite stable under the different stress conditions. However, there was a significant difference in the QoL factors, except for RE, between the low and high stress conditions (*Table 1*). This confirms the second hypothesis, as it implies that the health status of the low-stress group was better than that of the high-stress group.

Our data indicated that the evaluation of resilience in participants was of steady during the entire stressful period of the CEE. However, their QoL declined as a consequence of their elevated stress levels. Oshio *et al.* demonstrated a moderate correlation between psychological resilience and personality, and reported that resilience is at least partly an individual characteristic (48). Furthermore, Smith and Yang showed that senior nursing students (fourth year, under high-stress conditions) experienced poorer psychological wellbeing scores than those in earlier years (49). These findings imply that resilience is a dynamic process (2). Our findings are a combination of the aforementioned results; that is, while reported stability in resilience, observed variability in it also. Therefore, it is important to bridge the gap between trait and process views of resilience in the future.

Similar patterns were observed in the correlation analysis. A significant correlation was found between resilience and the factors of QoL, except for BP and SF (*Table 2*), which is consistent with previous studies that reported a significant correlation between resilience and QoL factors in elderly patients who underwent an orthotopic liver transplant more than 10 years previously (50), had inflammatory bowel diseases (51), and so on. Our study, therefore, reinforces the view that resilience is helpful for improving QoL under stressful conditions.

However, when we distinguished between stress levels, the correlation between resilience and QoL disappeared (except for PF, BP, and PCS; *Table 3*). Researcher found that resilience did not protect students from high levels of stress leading to burnout or wanting to quit; however, it helped to reduce the intention to quit (52). Other researchers, such as Chen *et al.*, reported that family resilience declined with longer parental survival from the time of cancer diagnosis (17), which is similar to our findings. This further implies that resilience has different effects under different stress conditions. Future studies must include stress levels, and not only stress, to deepen our understanding of this matter.

This study found a significant moderating effect of stress

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in the relationship between resilience and QoL. Numerous studies have focus on the moderating and mediating effects of resilience (53); however, few studies have focused on the moderating and mediating effects of stress itself. Our data showed a predictive effect of resilience on MCS and PCS under low-stress conditions, however this effect was not present under high-stress condition. This validates the third hypothesis and suggests that more focus must be placed on stress in resilience research.

Some studies have found that the effects of resilience tend to decline or even disappear in high-stress environments (18). For example, the follow-up study of former child soldiers in Sierra Leone found that traditional protective factors had no link with positive impact (15). Positive personal characteristics disappeared when family stress became cumulative (16). In an investigation of the resilience of caregivers of individuals with mild and moderate Alzheimer's disease, researchers found that caregivers' resilience was driven by disease severity (54). All of this evidence suggests that stress plays an important role in the relationship between resilience and symptoms. The results of the present study confirm this view.

Our findings also demonstrate that resilience is a combination of being a trait as well as a dynamic process. According to our results, the predictive effect of resilience on physical and mental health consequences was observed in low-stress situations; however, it tended to decline or disappear under high-stress conditions. These results are consistent with the dynamic process theory (55). At the same time, this study also found that the resilience scale score did not change significantly under different stress situations, which suggests that resilience may also have some stabilizable characteristics (48). Hence, this research supports the view that resilience can be both a characteristic and a process. In effect, this means that the characteristic and dynamic process views of resilience may, by definition, involve different aspects of the same phenomenon. The characteristic view may be the individual experience accumulation before each individual enters a certain traumatic scene, while the process view is the exercise of an individual facing a traumatic scene. When the process is over, the individual will form a new characteristic, which is self-evaluation of their resilience. In short, individuals could accumulate the experience in the process of facing stressful conditions; when this experience reaches a certain degree, it could alter the dispositional characteristics of resilience and increase the individual's level of resilience (56).

In summary, this study demonstrates the mediating effect of stress levels on the relationship between resilience and health outcomes. More attention should be paid to stress and its interaction with resilience in future studies. In addition, as demonstrated in this study, there were no significant differences in the scores of mental resilience under different stress conditions, which provides some new perspectives for integrating the characteristic and process definitions of psychological resilience in the future. Finally, from a clinical point of view, this also means that we need to adopt different flexible intervention strategies for individuals experiencing different stress levels in order to help them achieve better health outcomes.

The advantage of this study is that take stress level as an important variable to explore the function of resilience, and CEE, a serious stress scene that most Chinese teenagers will face, as the research background. But the shortcomings exist in it also. Firstly, this study could not track these students, and so did not get some dates for before and after comparison of CEE; secondly, if being verified in other groups, these results would be more powerful.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Written informed

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consent was obtained from all participants prior to completing the questionnaires. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). And the research protocol was approved by the ethics committee of East China Normal University (No. HR 043-2017).

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