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Associations between life stress and athlete burnout: the chain mediation role of mindfulness and cognitive emotion regulation strategies

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Abstract

Background Athlete burnout, characterized by emotional and physical exhaustion, reduced accomplishment, and devaluation of sport, is a growing concern in sports psychology. Life stress has been identified as a significant factor associated with athlete burnout, yet the underlying mechanisms remain unclear. This study explores the relationship between life stress and athlete burnout, with a focus on the chain mediation roles of mindfulness and cognitive emotion regulation strategies.

Methods A total of 453 athletes from China were surveyed using convenience sampling. Participants completed four questionnaires: the College Student-Athletes' Life Stress Scale, Five Facet Mindfulness Questionnaire, Cognitive Emotion Regulation Questionnaire, and Athlete Burnout Questionnaire. Data were analyzed using SPSS 22.0 for descriptive statistics and Amos 24.0 for structural equation modeling to explore mediating effects.

Results Life stress was positively correlated with athlete burnout. Cognitive emotion regulation strategies were a significant mediator in this relationship. A chain mediation effect was found, where mindfulness influenced cognitive emotion regulation, which in turn reduced athlete burnout.

Conclusion Life stress is significantly associated with athlete burnout, and cognitive emotion regulation strategies play a crucial role in mitigating this effect. Interventions to reduce burnout should emphasize improving cognitive emotion regulation, potentially through mindfulness training.

Keywords Life stress, Athlete burnout, Mindfulness, Cognitive emotion regulation strategies

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Introduction

Athlete burnout has aroused great concern in sports psychology [1]. As competitive sports is rival, challenging and confrontational, athletes inevitably remain in a state of high pressure for a long time, which will probably lead to burnout [2]. Studies have suggested that more than 10% of athletes suffer from severe burnout sometime during the season, and there is even still an upward trend [3]. Athlete Burnout refers to that athletes remain in a state of physical and mental fatigue and emotional exhaustion led by long-time high stress and load [4]. Raedake defines Athlete Burnout (AB) as a syndrome of physical and emotional exhaustion, athletic devaluation and decreased achievement [5]. The state of burnout is usually caused by a combination of factors, including over-training, competition pressure, excessive personal expectations, difficult life balance, and insufficient support systems. Athlete burnout not only affects the competition performance and result, but also may have a negative impact on their physical and mental health [6].

The relationship between life stress and athlete burnout

Stress refers to a response to the threat or challenge to individual physical and mental balance [7]. This reaction may come from external environmental stress, such as work pressure, interpersonal problems, life pressure, etc., or from internal stress, such as self-expectation, fear, anxiety, etc [8].

According to the Athlete Burnout Stress Model, athlete burnout is often linked to internal pressure, and factors that increase pressure may be associated with burnout [9]. Previous studies have shown that athlete burnout also increases when pressure gets higher [10]. Therefore, pressure may be associated with athlete burnout. Life Stress (LS), as one of the external pressures faced by athletes, may also have an impact on athlete burnout.

From the perspective of Cognitive Load Theory (CLT) [11], individuals have limited cognitive resources, and when these resources are overly consumed by stressors, their ability to effectively regulate emotions and cope with challenges is impaired. In the context of athletes, high levels of life stress consume substantial cognitive resources, making it difficult for them to manage emotional distress effectively. This depletion of cognitive resources can result in an over-reliance on maladaptive coping strategies, such as rumination and catastrophizing, which further exacerbate burnout [12]. Additionally, CLT suggests that under high stress, individuals struggle to engage in complex cognitive processes that require self-reflection, emotional regulation, and adaptive coping strategies [13]. For athletes, constant exposure to life stress may limit their capacity to utilize positive coping mechanisms, increasing their vulnerability to burnout.

Therefore, the following hypothesis was proposed in this study:

H1 LS positively predicts AB.

The mediation role of mindfulness

Some researchers believe that burnout is not a simple response of individuals to pressure, but a social phenomenon. Burnout does not necessarily occur when an individual experiences pressure [14]. Therefore, third variables need to be considered to better explain the mechanism between stress and burnout. The Job Demands-Resources (JD-R) Model suggests that an individual's motivation and behavior are influenced by the balance between job demands and the resources available to support them [15]. In the context of athletes, job demands may include factors such as high-intensity training, frequent competitions, psychological pressure, and time management challenges, while job resources encompass coach support, team collaboration, personal skills, social support, and psychological regulation tools such as mindfulness practices [15]. According to the JD-R model, when athletes face high job demands, a lack of sufficient resources to cope with these demands may contribute to the development of burnout.

Mindfulness refers to a specific state of attention and awareness, and often described as a non-judgmental, present, focused attention [16]. Studies have shown that stress can reduce the attention of individuals [17]. When individuals are under pressure, they tend to focus on the stress source and ignore the current feelings and experiences, which has been associated with a decline in the level of mindfulness. Although there is no direct evidence indicating that mindfulness can significantly reduce athlete burnout, mindfulness helps individuals better recognize their internal needs, improve self-determination and intrinsic motivation, and thus relieve burnout caused by external pressures and environmental constraints. Moreover, studies have shown that mindfulness can significantly reduce learning burnout [18]. Both learning burnout and athlete burnout belong to psychological burnout and have many similarities. Therefore, it is reasonable to speculate that mindfulness can significantly negatively predict athlete burnout. Therefore, the following hypothesis was proposed in this study:

H2 Mindfulness plays a mediating role between LS and AB.

The mediating role of cognitive emotion regulation

Cognitive Emotion Regulation (CER) refers to an individual's ability to regulate his or her emotional experience and emotional response through cognitive processes [19], which reflects the individual internal and external

processes of monitoring, evaluating, and modifying the occurrence, experience, and expression of emotional responses to realize goals [20], CER are divided into adaptive strategies (acceptance, active concern, concern planning, rational analysis, and positive reappraisal) and non-adaptive strategies (self-blame, rumination, blaming others, and catastrophizing) [21].

According to Cognitive-Behavioral Theory, emotion regulation involves the cognitive appraisal of stressful situations, which determines how individuals respond emotionally to these events [22]. This theory emphasizes that under prolonged stress, individuals often fail to regulate their emotions adaptively, leading to greater emotional distress. When faced with long-term or persistent stress, individuals' ability to regulate their emotions may decline, limiting their use of adaptive CER, which further impacts the experience and expression of emotions [23]. In other words, the greater the stress, the lower an individual's ability to effectively use adaptive CER, and when facing negative life events, they are more likely to rely on maladaptive CER strategies [24]. When individuals regulate their emotions using non-adaptive cognition, CER may be related to AB. Especially in stressful situations, individuals are more inclined to adopt non-adaptive CER, thus increasing the risk of burnout. Therefore, it is reasonable to speculate that CER can significantly negatively predict AB. Therefore, the following hypothesis was proposed in this study:

H3 CER play a mediating role between LS and AB.

The chain mediation effect of mindfulness and cognitive emotion regulation

In the study of the relationship between LS and AB, incorporating both mindfulness and CER as sequential mediators provides a comprehensive understanding of the underlying mechanisms. According JD-R Model [25], an individual's motivation and behavior are influenced by the balance between job demands and the available resources. In the context of athletes, high job demands such as intense training, frequent competitions, and psychological pressures can lead to burnout, especially when resources like coach support, team collaboration, and psychological regulation tools are insufficient [26, 27]. While mindfulness alone may not directly reduce burnout, it plays a crucial role in enhancing CER, which in turn mitigates the effects of stress on burnout [28]. Specifically, LS has been shown to reduce individual mindfulness levels [29, 30], and lower mindfulness impairs the ability to employ adaptive CER strategies [31]. Adaptive CER strategies, such as cognitive reappraisal and positive restructuring, are essential for managing negative emotions and reducing burnout, whereas non-adaptive strategies like rumination and catastrophizing exacerbate burnout [32]. Therefore, mindfulness enhances the capacity to adopt effective CER strategies, which subsequently decreases the likelihood of burnout. This sequential arrangement—where mindfulness first influences CER, which then affects burnout—aligns with Emotion Regulation Theory and Self-Regulation Theory [19], which suggest that enhanced emotional awareness and regulation lead to better psychological outcomes. Unlike models that treat mindfulness and CER as independent mediators, the chain mediation model underscores the interdependent relationship between mindfulness and CER, providing a more nuanced explanation of how mindfulness indirectly influences burnout through its impact on CER. For instance, a professional basketball player experiencing high training stress may find that mindfulness practices enable better emotional awareness and acceptance, facilitating the use of cognitive reappraisal to view training challenges as opportunities for growth rather than threats, thereby reducing the risk of burnout. This integrated approach not only highlights the sequential influence of mindfulness and CER but also demonstrates how their combined effect offers a more robust framework for understanding and mitigating athlete burnout. Consequently, the chain mediation model offers a deeper theoretical insight and practical guidance for interventions aimed at enhancing psychological resilience and preventing burnout in high-stress athletic environments. Therefore, the following hypothesis was proposed in this study:

H4 Mindfulness and CER play a chain mediation role between LS and AB.

To sum up, in order to better explain the specific mechanism between LS and AB. This study will build a chain mediation model (as shown in Fig. 1) to explore the impact of LS on AB, and examine the independent mediating role and chain mediation role of mindfulness and CER to provide references for the prevention and intervention of AB.

Research method

Subject

A total of 453 athletes were tested using a convenient sampling method. The sample size was determined based on the criteria for minimum statistical power, and we used the classic sample size calculation formula to estimate the required sample size. The estimation indicated that at least 384 samples were needed, ensuring that the study could detect significant effects with sufficient reliability. The final sample consisted of 439 valid questionnaires, resulting in an effective rate of 96.91%.

The questionnaires were distributed through multiple channels to ensure a broad and diverse participant pool. Distribution was carried out in collaboration with

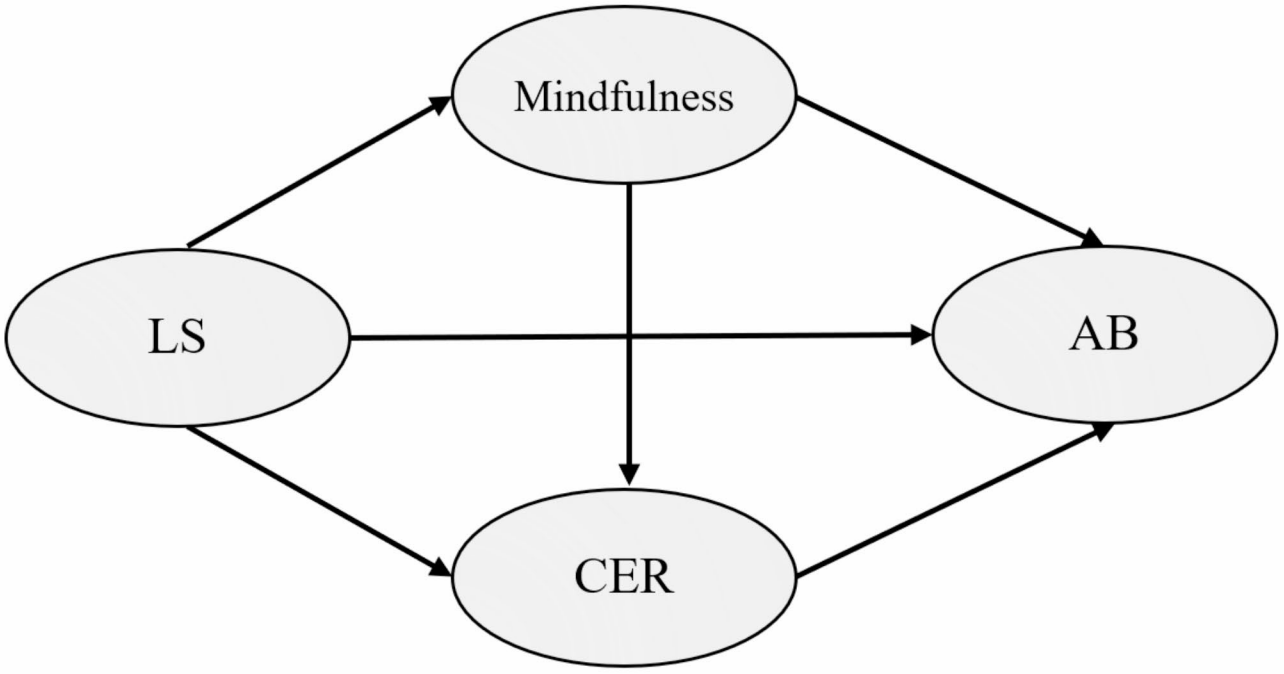

Fig. 1 Chain mediation model of Mindfulness and CER in LS with AB. (LS = Life stress, cer = cognitive emotion regulation, ab = athlete Burnout)

coaches and team leaders in various sports programs, as well as through social media platforms such as WeChat and Weibo to reach participants from different regions and backgrounds. Participants were recruited from four sports universities and four comprehensive universities in China, and they participated in various sports such as athletics, basketball, and tennis.

Demographic information collected included age, gender, years of participation in sports, and average daily training hours. The age range of participants was from 17 to 23 years old, with an average age of 19.28 ± 1.28 years. Among the 439 valid responses, 272 were male (61.96%) and 167 were female (38.04%). Participants had been engaged in sports for an average of 4.56 ± 1.83 years, with an average of 3.54 h of training per day (SD = 1.32) and 5.02 days per week of training.

The effective questionnaire return rate was calculated by dividing the number of valid responses by the total number of questionnaires distributed (439 valid responses out of 453 total distributed), resulting in an effective rate of 96.91%.

The study design adheres to the Declaration of Helsinki and was approved by the Ethics Committee of Guangdong Technology College. All participants provided informed consent, and personal information was strictly kept confidential.

Research tool

College student-athletes' life stress scale

Developed by Lu et al. [33], the College Student-Athletes' Life Stress Scale (CSALSS) was used to assess participants' perceptions of their daily life stress classified as general-life (includes sports injury, performance demand, coach relationships and training adaptation) and sport-specific stress (includes interpersonal relationships, romantic relationships, family relationships and academic requirements). The CSALSS is a six-point Likert scale ranging from 1 (Never) to 6 (Always) consisting of 24 items and 8 subscales: (a) Sports injury (e.g., "I am annoyed by my injury because it has still not yet fully recovered"); (b) Performance demand (e.g., "I worry about my unstable competitive performance"); (c) Coach relationships (e.g., "I am annoyed by my coach's bias against me"); (d) Training adaptation (e.g., "I am annoyed by my training load because it is too much for me"); (e) Interpersonal relationships (e.g., "I am annoyed with being friendless"); (f) Romantic relationships (e.g., "I am annoyed with not getting along with my romantic partner"); (g) Family relationships (e.g., "I am annoyed by my parents' high expectations"); and (h) Academic requirements (e.g., "I am annoyed when preparing for exams"). A higher score means more stress in life. In previous studies, this scale has a reliable reliability and validity in Chinese college athletes [6]. In the present study, the Cronbach's α for these subscales ranged from 0.78 to 0.91, and the overall reliability of the scale was 0.88, indicating high internal consistency. For the model fit indices, we

conducted Confirmatory Factor Analysis (CFA), which showed excellent fit indices: CFI = 0.98, TLI = 0.97, and RMSEA = 0.05, confirming the construct validity of the CSALSS in this study.

Five facet mindfulness questionnaire

The Five Facet Mindfulness Questionnaire (FFMQ) was compiled by Baer et al. [34]. Deng et al. translated and revised the Chinese version [35]. This study adopted revised Chinese version of FFMQ (Ch-FFMQ) by Deng et al. to measure Mindfulness. The Ch-FFMQ consists of 39 items and 5 dimensions: Observing (e.g., "I notice the smells and aromas of things"), Describing (e.g., "I am good at finding words to describe my feelings"), Act aware (e.g., "I find myself doing things without paying attention"), Non-judging (e.g., "I think some of my emotions are bad or inappropriate and I should not feel them"), Non-reacting(e.g., "I perceive my feelings and emotions without having to react to them"). Items are rated on 5-point Likert scale ranging from 1 (never or very rarely true) to 5 (very often or always true), use total score to represent the degree of mindfulness and a higher score shows a higher level of mindfulness. Previous research has confirmed that Ch-FFMQ has good reliability and validity among Chinese people [35]. In the present study, the Cronbach's α for these factors ranged from 0.72 to 0.88, indicating good internal consistency. For model validation, CFA showed satisfactory fit indices: CFI = 0.96, TLI = 0.94, and RMSEA = 0.06, confirming the reliability and validity of the Ch-FFMQ in the context of Chinese athletes.

Cognitive emotion regulation questionnaire

The Cognitive Emotion Regulation Questionnaire (CERQ) was compiled by Garnefski and Kraaij [20]. Dong et al. translated and revised to measure the CER of Chinese adults [36]. This study adopted revised CERQ-Short by Dong et al. to measure CER. The CERQ-Short is a 5-point-Likert scale consisting of 18 items and 9 dimensions: Self-blame (e.g., "I think that basically the cause must lie within myself"), Acceptance (e.g., "I think that I have to accept that this has happened"), Rumination (e.g., "I am preoccupied with what I think and feel about what I have experienced"), Positive refocusing (e.g., "I think of pleasant things that have nothing to do with it"), Refocus on planning (e.g., "I think about a plan of what I can do best"), Positive reappraisal (e.g., "I look for the positive sides to the matter"), Putting into perspective(e.g., "I think that other people go through much worse experiences"), Catastrophizing(e.g., "I often think that what I have experienced is the worst that can happen to a person"), Blaming others(e.g., "I feel that basically the cause lies with others"). Each item is rated from 1 (never) to 5 (always), use total score to represent the degree of CER and a higher score shows a better level of CER [37]. Previous research has confirmed that CERQ has good reliability and validity among Chinese adults [38]. In the present study, the Cronbach's α for the subscales ranged from 0.82 to 0.93, indicating good internal consistency. To assess the model fit, we conducted CFA, which provided excellent fit indices: CFI = 0.97, TLI = 0.96, and RMSEA = 0.04, indicating that the CERQ-Short demonstrated robust construct validity and reliability in this sample.

Athlete burnout questionnaire

The Athlete Burnout Questionnaire (ABQ) was compiled by Raedeke and Smith [5]. Zhang and Mao translated and revised the Chinese version [39]. This study adopted revised Chinese version of ABQ by Zhang and Mao to measure AB. The ABQ consists of 15 items and 3 dimensions: Devaluation (e.g., "I'm not into sport like I used to be"), Emotional Exhaustion (e.g., "I feel overly tired from my sport participation"), Reduced sense of accomplishment (e.g., "I am not achieving much in sport"). Items are rated on 5-point Likert scale ranging from 1 (never) to 5 (always), use total score to represent the degree of AB and a higher score shows a higher level of AB [2]. Previous research has confirmed that ABQ has good reliability and validity among Chinese college students [40]. In the present study, the Cronbach's α of these factors ranged from 0.81 to 0.89, indicating good internal consistency. Confirmatory Factor Analysis (CFA) was conducted to assess the model fit, with results showing CFI = 0.95, TLI = 0.94, and RMSEA = 0.06, confirming the reliability and construct validity of the ABQ in the current study.

Data processing

Data analysis was conducted using SPSS 22.0 and Amos 24.0. First, descriptive statistical analysis was performed using SPSS 22.0 to summarize the means, standard deviations, and correlation coefficients of key variables, including demographic characteristics, life stress, mindfulness, cognitive emotion regulation strategies, and athlete burnout. Independent samples t-tests were used to investigate gender differences in these four variables.

A structural equation model (SEM) was established using Amos 24.0 to examine the relationships between life stress, mindfulness, cognitive emotion regulation strategies, and athlete burnout. These four constructs were modeled as latent variables, with their respective dimensions serving as indicators. Specifically, the model specified paths from life stress to mindfulness, cognitive emotion regulation strategies, and athlete burnout, as well as from mindfulness and cognitive emotion regulation strategies to athlete burnout. Additionally, the relationship between mindfulness and cognitive emotion regulation strategies was also modeled.

Table 1 Results of correlation analysis

Variables	M	1	2	3	4	5
1. Age	19.28 ± 1.28	1				
2. LS	2.12 ± 0.82	−0.08*	1			
3. Mindfulness	3.02 ± 0.76	−0.10**	−0.40***	1		
4. CER	2.90 ± 0.74	−0.11***	−0.38**	0.56***	1	
5. AB	1.92 ± 0.66	0.01	0.26***	−0.46***	−0.26***	1

Table 2 Results of demographic difference

Variables	Gender(M ± SD)		t
	Male	Female	
LS	50.16 ± 14.42	51.6 ± 14.58	-0.48
Mindfulness	124.02 ± 26.48	111.54 ± 21.53	3.81***
CER	51.84 ± 13.86	52.56 ± 14.05	-1.21
AB	29.85 ± 7.47	27.75 ± 7.23	1.32

Note: *$p < 0.05$,**$p < 0.01$,***$p < 0.00$, LS = Life stress, CER = Cognitive emotion regulation, AB = Athlete burnout, the same below

To assess the mediation effects, the mediating roles of mindfulness and cognitive emotion regulation strategies between life stress and athlete burnout were tested. Model fit was evaluated using indices such as chi-square, RMSEA, CFI, and TLI. Furthermore, gender and age differences were explored to examine whether these demographic factors influenced the relationships between the key variables.

Result

Common method deviation test

Amos24.0 was used to test the common method bias of the two-factor model. The bias between the chi-square 685.17($df = 98$) of the control model and chi-square 687.15($df = 99$) of the baseline model was 1.98($df = 1$), which did not reach a significant level ($p > 0.05$), indicating that there was no serious common method bias in the data of this study.

Descriptive statistics

Table 1 shows the mean number of age, standard deviation and correlation coefficient of variables, as well as the mean scores of each variable except age. Table 2 presents the results of using the independent sample t test to investigate the gender differences of the four variables. The total scores of life stress, mindfulness, CER and athlete burnout were 25 ~ 121, 49 ~ 190, 24 ~ 87 and 17 ~ 70 respectively.

Mediating effect test

In this study, the main focus was on the relationships between life stress, mindfulness, cognitive emotion regulation (CER), and athlete burnout. While demographic variables such as age and gender were collected, they were not included as covariates in the primary analyses. However, to account for the potential influence of these variables, post-hoc analyses were conducted to examine whether age or gender significantly affected the primary relationships in the study. These analyses were performed using analysis of covariance (ANCOVA) to control for demographic factors, and we found that neither age nor gender had a significant impact on the relationships between life stress, mindfulness, CER, and athlete burnout.

This study tests the direct prediction effect of LS on AB, and the results showed that the model fit well ($\chi^2/df = 1.75$, NFI = 0.997, IFI = 0.999, TLI = 0.997, CFI = 0.999, RMSEA = 0.027). LS significantly positively predicted AB ($\beta = 0.26$, $p < 0.001$), supporting Hypothesis 1 (LS positively predicts AB). Following this, a mediation model was tested to explore the role of mindfulness and CER as mediators in the relationship between LS and AB. The results of the mediation model indicated a good fit (NFI = 0.960, IFI = 0.967, TLI = 0.953, CFI = 0.967, RMSEA = 0.067). To test the significance of the mediation effects, 5000 bootstrap samples were extracted, and the 95% confidence interval (CI) of the indirect effects was calculated. The results revealed that the overall mediation effect of mindfulness and CER was significant, with a standardized effect size of 0.20 and a 95% confidence interval of [0.16, 0.25], supporting Hypothesis 4(Mindfulness and CER play a chain mediation role between LS and AB). However, while the chain mediation effect was significant, mindfulness did not significantly mediate the relationship between LS and AB, as the 95% confidence interval was [− 0.09, 0.004], indicating that the effect was not significant and not supporting Hypothesis 2 (Mindfulness plays a mediating role between LS and AB). In contrast, CER significantly mediated the relationship between LS and AB, with a standardized effect size of 0.08 and a 95% confidence interval of [0.04, 0.12], supporting Hypothesis 3 (CER plays a mediating role between LS and AB). The specific path coefficients for each mediation effect are shown in Fig. 2.

Post-hoc analyses were conducted to examine the potential effects of age and gender on the primary relationships in the study. Using ANCOVA, we tested whether controlling for age or gender affected the relationships between life stress, mindfulness, CER, and athlete burnout. The results indicated that neither age nor gender significantly influenced the relationships between life stress, mindfulness, CER, and athlete burnout (F(1,

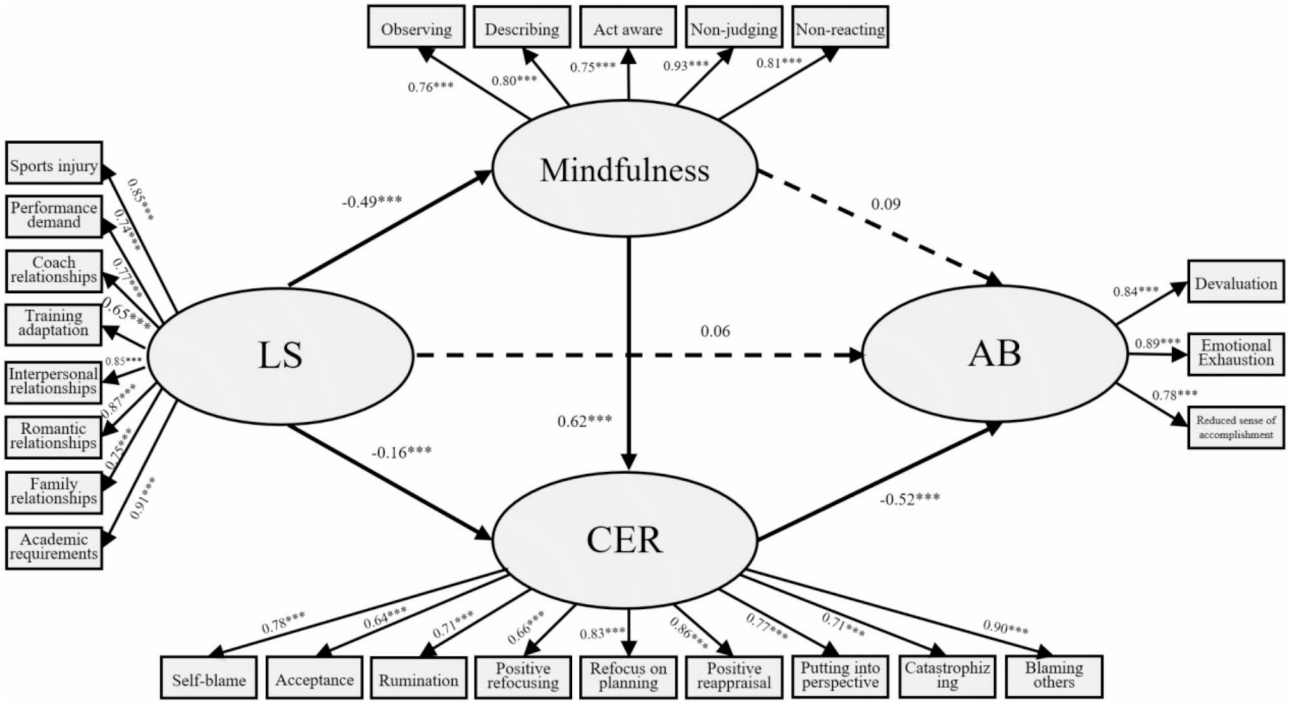

Fig. 2 Mediating analysis path coefficient. (LS = Life stress, CER = Cognitive Emotion Regulation, AB = Athlete Burnout)

437) = 0.34, $p = 0.56$ for age; F(1, 437) = 0.12, $p = 0.73$ for gender), suggesting that these demographic factors did not confound the primary findings.

Discussion

The direct effect of life stress on athlete burnout

The results of this study show that Life stress (LS) is significantly positively correlated with athlete burnout (AB), which verifies hypothesis H1: LS positively predicts AB. This result aligns with the stress-burnout model, which suggests that chronic stress is linked to individual emotional and physical exhaustion, dehumanization, and reduced sense of accomplishment [41]. For athletes, the constant stress of life is associated with the depletion of emotional and physical resources, which may contribute to a sense of burnout.

This finding is consistent with many previous studies showing that the more stress athletes face, the more likely they are to experience burnout [42–44]. The daily life of athletes are mainly training and competition, and they devote a lot of time and energy to improving their competitiveness [45]. Due to the excessive focus on the career of sports, athletes have relatively insufficient experience and skills in dealing with the day-to-day affairs of life, such as financial management, interpersonal relationships, and family responsibilities [46].

When the life stress arises, athletes often feel at a loss because they lack the experience and skills. This can affect an athlete's concentration, motivation and physical condition, resulting in reduced training effectiveness and unstable performance. Therefore, the continuous life pressure and the resulting negative emotions will gradually exhaust the athletes' mental and physical energy, and eventually lead to emotional exhaustion, loss of motivation and decreased sense of achievement, which is manifested as athlete burnout.

The mediating role of cognitive emotion regulation

This study also focuses on the mediating mechanism between LS and AB. The results show that Cognitive Emotion Regulation (CER) plays a mediating role between LS and AB, which verifies hypothesis H3: CER plays a mediating role between LS and AB.

Cognitive emotion regulation strategy refers to the method by which individuals manage and regulate emotional responses by changing their cognitive style when facing emotional events [47]. According to the Cognitive Load Theory, individual cognitive resources are limited. In a state of high stress, a large number of individual cognitive resources are used to deal with stress sources, resulting in a decrease in available cognitive resources [11]. This makes it difficult for individuals to effectively carry out emotion regulation strategies that require more cognitive resources for cognitive reevaluation under high stress, and they turn to non-adaptive regulation strategies that are more automatic and consume less resources [48].

On the other hand, according to Self-Regulation Resource Theory, non-adaptive emotion regulation strategies make it difficult for athletes to effectively manage

emotions and behaviors in the face of stress [25]. The depletion of resources can cause athletes to feel tired and weak during training and competition, thus burnout increases. Therefore, when athletes face stressful events in life, a lot of cognitive resources will be consumed to adjust the pressure, which will make athletes unable to focus on the current training or competition, and increase the probability of athlete burnout.

The chain mediation role of mindfulness and CER

In this study, we found that mindfulness and CER play a chain mediation role between LS and AB, confirming hypothesis H4. On the one hand, stress in life will consume more energy, making athletes unable to focus on the present moment and significantly reducing their level of mindfulness [49]. On the other hand, the decline of mindfulness will have a significant negative impact on cognitive emotion regulation strategies [50].

This decline in mindfulness is reflected in the decrease ability to detect emotions, the increase of negative emotional responses, the depletion of cognitive resources, the decrease of the effectiveness of emotion regulation strategies, and the weakening of emotional acceptance and non-judgmental attitudes. Mindfulness can enhance individuals' awareness of current emotions and thoughts, enabling them to perform cognitive reappraisal and positive reconstruction more effectively [51]. However, when levels of mindfulness decline, individuals may have more difficulty recognizing and understanding their emotional states, leading to the adoption of non-adaptive strategies such as rumination and catastrophizing [52].

For example, when an athlete makes a mistake in a competition, if he or she lacks mindfulness, he or she may ruminate on his mistake (rumination), and even expect the worst result (catastrophizing), thinking that he will continue to fail, and thus cannot concentrate on the next competition, resulting in emotional exhaustion or loss of motivation mentally, resulting in athlete burnout.

Mindfulness alone does not mediate between LS and AB

This study found that mindfulness had no significant mediating effect between LS and AB, and the hypothesis H2 was not confirmed. According to the results of mediating effect analysis, LS significantly negatively predicted mindfulness, indicating that the insignificant mediating effect may be caused by the insignificant direct predictive effect of mindfulness on AB.

When the two mediating variables of CER and mindfulness were considered together, CER masked the predictive effect of mindfulness on AB. This phenomenon indicates that mindfulness has no significant mediating effect between life stress and athlete burnout, but when cognitive emotion regulation strategies and mindfulness are taken into consideration at the same time, they produce a significant chain mediating effect between life stress and athlete burnout.

Mindfulness is the state of being aware and attentive to the present moment without judgment [53]. Although it can enhance an individual's ability to manage emotions and reduce stress responses, mindfulness alone may not be sufficient to significantly ease athlete burnout, as mindfulness primarily reduces stress by improving an individual's ability to be aware and receptive [54], rather than directly changing stress sources or coping strategies [55].

Cognitive emotion regulation strategies include specific methods such as cognitive reappraisal, positive reconstruction, rumination and catastrophizing, which directly affect how individuals deal with and respond to emotional events [56]. Adaptive cognitive emotion regulation strategies can effectively alleviate the negative effects of stress, while non-adaptive strategies will exacerbate feelings of stress and emotional distress [57].

When mindfulness and cognitive emotion regulation strategies are considered at the same time, it can be understood that mindfulness first promotes the adoption of more adaptive emotion regulation strategies by enhancing the individual awareness of emotion and cognition. Mindfulness makes it easier for individuals to identify when cognitive reappraisal or positive remodeling is needed, and these adaptive strategies directly influence the impact of stress on burnout. For example, if an athlete is in a high-pressure training or competition environment, mindfulness exercises alone may help him or her reduce stress for a short period of time, but if he or she has not learned how to regulate emotions effectively in stressful situations, his or her burnout may remain high. However, if the athlete not only practices mindfulness, but also learns and applies cognitive emotion regulation strategies (such as cognitive reappraisal) at the same time, he or she can cope with stress more comprehensively. Through mindfulness, he or she becomes aware of his or her anxiety before the competition, and then through cognitive reappraisal, treats the anxiety as a motivation to make preparation and focus on the competition, rather than a negative emotional response. This integrated coping style more effectively alleviated athletes' sense of burnout.

In summary, the mediating role of mindfulness between life stress and athlete burnout is not significant in isolation, possibly because mindfulness primarily affects awareness and acceptance rather than emotion regulation strategies directly. However, when mindfulness and cognitive emotion regulation strategies are included at the same time, mindfulness enables individuals to apply adaptive regulation strategies more effectively by improving cognitive emotion regulation ability, thus significantly affecting the relationship between life stress and athlete

burnout. This chain mediation effect explains how the co-existence of the two factors can affect the psychological state of athletes through a step-by-step mechanism.

Implication

Practical interventions The study highlights the importance of incorporating cognitive emotion regulation strategies into athlete training programs. Coaches and sports psychologists should focus on enhancing these strategies among athletes to mitigate the impact of life stress on burnout. This could involve training in adaptive cognitive strategies like positive reappraisal and planning.

Mindfulness training Although mindfulness alone did not show a significant mediating effect between life stress and athlete burnout, it plays a crucial role when combined with cognitive emotion regulation strategies. Therefore, integrating mindfulness practices into athlete training programs could enhance their ability to manage stress, particularly when these practices are combined with cognitive emotion regulation training.

Targeted support for athletes Given the positive correlation between life stress and athlete burnout, sports organizations should consider providing targeted support for athletes, particularly in managing life stressors that extend beyond sports-related pressures. This could include life skills training, psychological support, and stress management workshops.

Comprehensive mental health programs The study suggests the need for comprehensive mental health programs that address both the cognitive and emotional aspects of athlete well-being. By fostering both mindfulness and effective emotion regulation strategies, such programs can help reduce the risk of burnout among athletes.

Further research The study's findings suggest that future research could explore the specific conditions under which mindfulness becomes more effective in preventing burnout, perhaps by investigating different sports, levels of competition, or cultural contexts. Additionally, exploring other potential mediators or moderators could provide a deeper understanding of how to protect athletes from burnout.

These implications suggest actionable steps for reducing athlete burnout by addressing both life stress and its psychological impacts through targeted interventions.

Limitations

This study has several limitations that should be acknowledged. First, the sample was limited to athletes from specific universities in China, which may not be representative of all athletes globally. This limitation affects the generalizability of the findings to other populations or cultural contexts. Second, the cross-sectional design of the study does not allow for the establishment of causality between life stress, mindfulness, cognitive emotion regulation strategies, and athlete burnout. Longitudinal studies are needed to confirm these relationships over time. Third, the reliance on self-reported data may introduce bias, as participants might have provided socially desirable responses. Finally, while the study explored mindfulness and cognitive emotion regulation strategies, other potential mediating or moderating variables, such as social support or personality traits, were not considered, which could provide a more comprehensive understanding of the relationship between life stress and athlete burnout.

Conclusion

In conclusion, this study highlights the significant relationship between life stress and athlete burnout, emphasizing the roles of cognitive emotion regulation strategies and mindfulness as mediators. The findings suggest that while life stress directly contributes to athlete burnout, the way athletes regulate their emotions through cognitive strategies significantly impacts the extent of burnout. Mindfulness, although not an independent mediator, plays a crucial role when combined with cognitive emotion regulation, forming a chain mediation effect that mitigates the impact of life stress on burnout. These insights provide a theoretical foundation for developing interventions aimed at reducing burnout in athletes, emphasizing the importance of enhancing cognitive emotion regulation and mindfulness practices. Future research should explore these relationships in diverse populations and consider additional factors that may influence the stress-burnout dynamic.

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Author contributions

Ma, Yao, and Chun conceived and designed the study. Ma, and Yao helped with data collection. Ma, Yao, and Chun provided statistical advice on study design and performed data analysis. Ma, Yao, and Chun contributed to the manuscript preparation and revision. All authors read and approved the final manuscript.

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Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study followed the ethical principles related to work with humans as outlined in the Declaration of Helsinki. Prior to data collection, the study design and procedures were reviewed and approved by the Ethics Committee of Guangdong Technology College. Participants were provided with a detailed explanation of the study and a consent form to read and sign. At the beginning of the survey, participants were asked if they had any questions regarding the study, data anonymity, and the confidentiality of their information. They were also asked to confirm that they had read the consent form carefully and signed it, ensuring that informed consent was obtained. Additionally, verbal consent was obtained from each participant, ensuring both written and verbal consent were secured. The anonymity of the participants was preserved through the anonymization of data during the transcription process. We adhered to the guidelines recommended by the National Research Ethics Committees.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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