Perceived stress, competitive state anxiety, depression and sleep quality in Chinese athletes During the COVID-19 Pandemic

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Research Article

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Abstract

Background: The 2019 coronavirus disease (COVID-19) has spread worldwide, and its associated stressors have resulted in decreased sleep quality among athletes. This study aimed to test the correlation between perceived stress and sleep quality and to figure out whether competitive state anxiety and depression mediate this association.

Methods: The Perceived Stress Scale, Self-rating Depression Scale, CSA Inventory-2, and Pittsburgh SQ Index were administered in 590 Chinese athletes (275 females, age = 19.93±2.90 years). Mediation analyses were used to investigate whether competitive state anxiety and depression mediate the correlation between perceived stress and sleep quality in athletes.

Results: The results indicated that perceived stress was positively related to poor sleep quality ($r = 0.232$, $p < 0.001$). Moreover, competitive state anxiety (ab = 0.0347, Boot SE =0.0179, Boot 95% CI = [0.0252, 0.1091]) and depression (ab = 0.0235, Boot SE = 0.0120, Boot 95% CI = [0.0032, 0.0502]) mediated the correlation between perceived stress and sleep quality in athletes.

Conclusions: These findings contributed to a better understanding of how perceived stress related to sleep quality in athletes during the COVID-19 pandemic and indicated that perceived stress, competitive state anxiety, and depression are risk factors in the development of athletes' poor sleep quality.

Introduction

Coronavirus disease 2019 is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), it is a serious infectious disease with cough, fever, and fatigue as its main clinical manifestations [65–66]. SARS-CoV-2 has been designated a global disease epidemic by the World Health Organization [67]. Coronavirus disease 2019 has negatively affected individual physical and psychological health [68–70]. Numerous empirical studies further support those adverse effects impact athletes' mood and sleep quality [71], but may also lead to poor athletic performance [72]. In addition, an array of recent studies has shown that the COVID-19 pandemic has adversely affected sleep quality in athletes, introducing health risks related to poor sleep [73]. Therefore, it is essential to study the impact of COVID-19 pandemic restrictions on athletes' sleep quality.

Sleep is one of the basic needs of human beings for survival and development. Poor sleep quality has become an especially common problem for athletes [1, 2]. The reason might be that athletes experience many stressors such as high training loads, competition demands, early morning training, and altitude exposure [3, 4]. These stressors from training and competition make their lives different from those of ordinary people [5]. Additionally, often athletes cannot obtain a consistent 7–9 hours of recommended adult night sleep time [6]. As such, athletes' sleep quality may be sub-optimal compared to that of the general population. Studies [3, 7] have shown that athletes often have sleep-related problems during competitions, such as insomnia symptoms, poor sleep quality, sleep difficulties, and daytime sleepiness [5, 8, 9]. Prior studies also showed that sleep is crucial for athletes' daily recovery and performance [10],

and good sleep quality is the basis of good athletic performance. Sleep is also a key factor in maintaining athletes' mental health [11, 12].

Thus, it is important to know the risk factors contributing to poor sleep quality in athletes. One of the possible risk factors is perceived stress. Perceived stress refers to an individual's cognitive evaluation that determines the impact of an "objective" stressor on individuals [13]. According to the theory of sleep disturbance, stressful events can disturb normal sleep processes and affect the quality of sleep [14]. Research indicates that there is a close connection between perceived stress and poor sleep quality [15, 16] such that the higher the level of perceived stress, the worse the sleep quality [17–19].

For athletes, empirical studies also found that perceived stress was positively associated with poor sleep quality [20, 21]. The stress process model posits that stress not only directly but also indirectly affects the individual by reducing psychological resources [22, 23]. The indirect relationship between perceived stress and sleep quality in athletes, however, remains unclear.

Therefore, this study explores the direct and indirect links between perceived stress and sleep quality in athletes to better understand how perceived stress relates to sleep quality. Based on prior studies [24], we examined the potential mediating effects of competitive state anxiety and depression as they relate to sleep.

Anxiety is defined as an aversive motivational state that occurs in threatening situations [25]. Anxiety can induce changes and result in poor athletic performance [26–29]. State anxiety is a temporary state of unease that arises in certain situations such as sports competition, which is one of the key factors influencing sports performance [30–32]. According to the cognitive theory of emotion [33], anxiety arises when individuals are stressed. Previous studies have shown that there is a significant positive correlation between perceived stress and sleep quality [34–36]. Likewise, studies found that competitive state anxiety was positively related to athletes' poor sleep quality [37]. As a result, it can be inferred that competitive state anxiety may be a mediating variable in the association between perceived stress and athletes' sleep quality.

Depression is another important risk factor. It has become the second most common disease in humans as of 2020 [38]. Depression is also a common psychological problem among athletes [39, 40]. Some studies found, for example that athletes have a higher level of depression than the general population [41]. According to the diathesis-stress model, stress can lead to a series of negative health outcomes including depression [42]. Statistics showed that nearly 70% of primary depression is caused by stress. The role of stress in the onset of depression accounts for 20–50% [43, 44]. Also, many empirical studies have confirmed that there is a positive correlation between perceived stress and depression [45–47]. In addition, according to the cognitive model of insomnia [48], individuals who experience depression tend to selectively pay attention to stressful external events and apply cognitive biases. When they detect sleep threats or experience lack of sleep, they will further engage in negative cognition and false beliefs, eventually leading to sleep loss or even, in the long-term, sleep disorders. Studies have confirmed that depressed individuals have more difficulty in falling asleep and have worse sleep quality [49–51]. In this

case, depression may be a mediating variable in the relationship between perceived stress and poor sleep quality.

The Present Study

Considering the above, we investigated the influence of perceived stress on athletes' sleep quality during COVID-19 in China. Overall, our goal was to examine the relations between perceived stress, competitive state anxiety, depression, and sleep quality in Chinese athletes. Based on the above literature, we proposed the following hypotheses: (H1) perceived stress is positively associated with poor sleep quality; (H2) competitive state anxiety mediates the correlation between perceived stress and sleep quality; and (H3) depression mediates the correlation between perceived stress and sleep quality.

Methods

Participants and Procedure

This study was conducted in classrooms or sports training centers between October 1 and November 30, 2020. At first, we posted our participants recruitment in WeChat groups of coaches who came from different sports universities or departments or centers in China. If they are interested in our study, they can help us collect data and thus they will receive our feedback about the results. We also trained them as eligible data collectors such as informed consents, instructions, and times. For participants who under 18, we contacted their parents or guardians to obtain their informed consents. Participants can withdraw anytime without punishment. After that, six hundred and twenty questionnaires were distributed by these coaches and 97% of them (600) were collected. However, ten questionnaires were removed as they were incomplete resulting in 590 valid questionnaires.

Participants were 590 Chinese athletes (275 females, *M*age = 19.93, *SD* = 2.90, ranging from 14 to 37 years). The mean value of training year is 7.20 ± 3.66. The other characteristic information was presented in **Table 1**.

Table 1 Characteristics of participants. Notes: *M* = mean, *SD* = standard deviation.

Measures

Perceived Stress Scale (PSS)

We used a 14-item Chinese PSS to determine the PS levels over the last 30 days [13]. This scale evaluated the extent that individuals believed their lives were overloaded, unpredictable, and uncontrollable (e.g., in the last month, feeling unable to control the important things in my life). The items on a 5-point Likert scale were rated by the participants (0 = never, 4 = very often). A higher score represents

a higher level of perceived stress. This scale has been validated and used in Chinese samples [74], showing good psychometric properties. In the present study, The Cronbach's α was 0.75.

The Self-rating Depression Scale

We adopted the Self-rating Depression Scale [52] to measure individuals' depression. The scale includes 20 items. Participants rated on a four-point rating scale (1–4) according to how they felt during the preceding week. Higher scores indicate higher levels of depression. This scale has been validated and used in Chinese samples [75], showing good psychometric properties. Cronbach's alpha for this Scale was 0.77 in our sample.

Csa Inventory-2

CSA Inventory-2 [53] is composed of 27 items grouped into three dimensions: somatic state anxiety (9 items; my body feels tense), state self-confidence (9 items; I feel physically comfortable.), and cognitive state anxiety (9 items; I am worried that I can achieve my goal of the game). The answers were collected on a Likert scale of 4 points ranging from "not at all" (1) to "very much so" (4). This scale has been validated and used in Chinese samples [76], showing good psychometric properties. The Cronbach's alpha was 0.81in the current study.

Pittsburgh Sq Index

We used a 19-item Chinese PSQI to determine global sleep quality over the last 30 days [54]. A global score was calculated based on the sum of the seven subscale scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction). The scores on the PSQI ranged from 0 to 21, with higher scores indicating poorer sleep quality. This scale has been validated and used in Chinese samples [77], showing good psychometric properties. Cronbach's α was 0.82 in this study.

Statistical Analyses

The data were conducted by SPSS 22.0. We first performed the primary analysis such as *M*, *SD*, and correlations. Then, the mediation model was analyzed via PROCESS macro (Model 6). The PROCESS macro was developed by Hayes [55] and was widely used in prior studies [56, 57]. According to Hayes [55], we determined the significance of indirect effects via bootstrapping (5000 bootstrap samples) with 95% CIs. The 95% CIs exclude 0 indicating significant effects. We used Cohen's [64] guidelines to describe the size of the relation between a independent variable and a dependent variable. That is, small (r = 0.10), medium (r = 0.30), and large (r = 0.50).

Results

Descriptive analysis

Table 2 showed the results of descriptive analysis. The competitive state anxiety had a significant positive correlation with perceived stress ($r = 0.317$, $p < 0.001$), sleep quality ($r = 0.173$, $p < 0.001$), and depression ($r = 0.111$, $p < 0.01$). Depression had a significant positive correlation with perceived stress ($r = 0.118$, $p < 0.01$), and sleep quality ($r = 0.256$, $p < 0.001$). Perceived stress was positively associated with sleep quality ($r = 0.232$, $p < 0.01$).

Table 2 Descriptive analysis of main variables ($N = 590$). Notes: M = mean, SD = standard deviation. ** $P < 0.01$; *** $P < 0.001$.

Mediation Analysis

In the PROCESS, we regarded perceived stress as the independent variable, sleep quality as the dependent variable, and competitive state anxiety and depression as the mediating variables. Considering gender (male = 1, female = 0) and age can affect individuals' sleep quality [7, 20] in athletes, we controlled them in the mediation analysis. Perceived stress was positively related to competitive state anxiety ($\beta = 0.226$, $t = 8.013$, 95% CI = [0.171, 0.282]), depression ($\beta = 0.071$, t = 2.037, 95%CI= [0.004, 0.138]), and sleep quality ($\beta = 0.222$, t = 4.810, 95%CI= [0.132, 0.313]). Competitive state anxiety was not related to depression ($\beta = 0.090$, t = 1.897, 95% CI = [-0.003, 0.183]), and positively related to sleep quality ($\beta = 0.154$, t = 2.394, 95% CI = [0.028, 0.279]). Depression was positively related to sleep quality ($\beta = 0.330$, t = 5.907, 95% CI = [0.220, 0.439]). Moreover, the mediation effects of both competitive state anxiety (ab = 0.0347, Boot SE = 0.0179, Boot 95% CI = [0.0252, 0.1091]), and depression were significant (ab = 0.0235, Boot SE = 0.0120, Boot 95% CI = [0.0032, 0.0502]). However, the chain mediation effect of competitive state anxiety and depression was not significant (ab = 0.0067, Boot SE = 0.0042, Boot 95% CI = [-0.0032, 0.0502]). The results indicated that competitive state anxiety and depression had a mediating effect on the correlation between perceived stress and sleep quality among athletes, as shown in **Fig. 1**.

Figure 1 The mediating effects of competitive state anxiety and depression in athletes.

Notes

*$P < 0.05$; *** $P < 0.001$.

Discussion

The present study examined the relationship between perceived stress and sleep quality as well as the mediating effects of competitive state anxiety and depression in Chinese athletes during the COVID-19 pandemic in China. The results showed that perceived stress was positively related to poor sleep quality.

Competitive state anxiety and depression mediated the relationship between perceived stress and poor sleep quality.

In supporting Hypothesis 1, we found that there was a significantly positive correlation between perceived stress and sleep quality in athletes. That is, the higher the level of perceived stress, the worse was the sleep quality of athletes, indicating that perceived stress is an important factor affecting athletes' sleep quality. This finding supported the "unsteady state" model of stress and the theory of sleep disturbance process.

This study also found that the relationship between perceived stress and sleep quality was mediated by competitive state anxiety and depression, which supported Hypotheses 2 and 3. First, these findings align with those of prior studies indicating that there is a significant positive correlation between perceived stress and state anxiety [34, 58, 59]. Furthermore, prior research indicated that competitive state anxiety was significantly positively correlated with athletes' sleep quality [60]. These results supported the theoretical model of the correlation between stress and sleep quality, suggesting that perceived stress could directly and indirectly affect sleep quality via competitive state anxiety. Second, in terms of the mediating role of depression, the results showed that perceived stress was significantly positively correlated with athletes' depression, which is consistent with the results of studies conducted with other groups [46, 47]. Likewise, depression was positively related to sleep quality in athletes, which is consistent with previous research [45, 50]. For instance, depression is a risk factor for sleep quality, and individuals with higher depression will have worse sleep quality under stress [61–63]. The results of this study are consistent with the cognitive model of insomnia, which may cause selective attention and cognitive bias in athletes facing stressful events, leading to poor sleep quality.

Prior studies mainly focused on the direct relationship between perceived stress and depression. In this study, we expanded on prior research by examining the mediating roles of competitive state anxiety and depression in athletes. We found that perceived stress was positively associated with poor sleep quality and that this link was mediated by competitive state anxiety and depression in athletes. These findings contribute to our understanding of the mechanisms underlying the association between perceived stress and sleep quality among athletes. Additionally, these results indicate that perceived stress, competitive state anxiety, and depression are important risk factors in the development of athletes' poor sleep quality. Reducing the impact of these factors may be a potential avenue to improve athletes' sleep quality.

Limitations

First, the data in this study comes from the subjective reports of the participants, and there may be exist social desirability. Future research could consider collecting data from multiple sources to obtain more objective results. Second, this study used a cross-sectional design based on the questionnaire method, falling to determine the causal correlation between the variables. Future research can consider using longitudinal designs.

Conclusion

The present study examined the interplays between perceived stress, competitive state anxiety, depression, and sleep quality in athletes during the 2019 COVID-19 pandemic. We found that perceived stress was positively related to poor sleep quality and this link was mediated by competitive state anxiety and depression. These findings indicated that athletes' sleep quality during the COVID-19 pandemic may benefit from reducing anxiety and depression when they are experiencing stress.

Declarations

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Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Authors' contributions

XC designed this study and draft the manuscript. CC and DXW collected data. JW supervised the project and supported funding. XC and XLH processed the data. XC, XLH, CC, and LZ revised the manuscript. DXW and JW made critical revisions to this paper. All authors have read and approved the final manuscript.

Authors' information

Not applicable

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Ethics approval and consent to participate

Informed consent was obtained from all the participates and also from parents/guardians of the minors. The study protocol complied with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of Shanghai University of Sport.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interest.

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Tables

Tables 1 to 2 are available in the Supplementary Files section

Figures

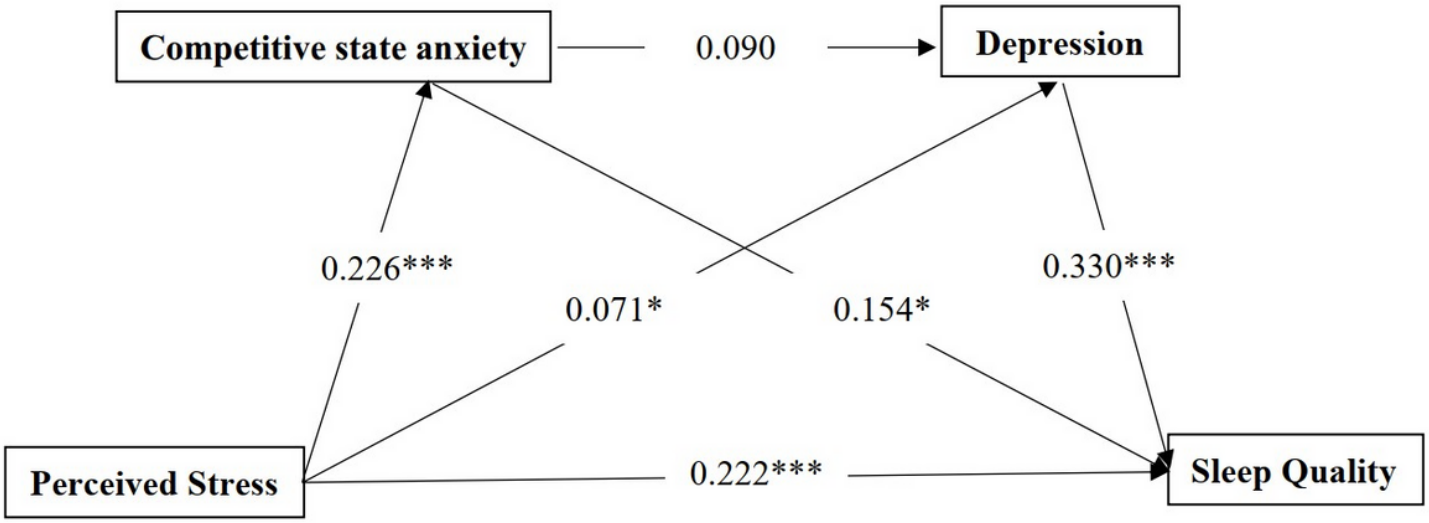

Figure 1

The mediating effects of competitive state anxiety and depression in athletes.

Notes: *$P < 0.05$; *** $P < 0.001$.

Supplementary Files

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- Table1.jpg
- Table2.jpg