# Sleep Dysfunction and Mood in Collegiate Soccer Athletes

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**Background:** Sleep and mood are critical factors that contribute to health and wellness and are of particular interest to collegiate athletes who are juggling high physical, academic, and social demands. The aim of this study was to examine how psychological measures, player status, and sex-related factors were associated with perceived sleep quality.

**Hypothesis:** Higher levels of global sleep dysfunction will be related to poor mood and increased anxiety, and there will be differences in sleep dysfunction in male compared with female athletes as well as regarding playing status.

**Study Design:** Prospective cohort study.

**Level of Evidence:** Level 4.

**Methods:** During the 2016 through 2018 National Collegiate Athletic Association (NCAA) seasons, the Pittsburgh Sleep Quality Index (PSQI), Profile of Mood States, and Sports Anxiety Scale–2 questionnaires were administered to 230 soccer athletes at 6 separate time points throughout each season.

**Results:** PSQI results yielded scores ≥5 in 54% of observations. Increased sleep dysfunction was significantly related to decreased vigor and increased tension, depression, anger, fatigue, somatic anxiety, worry, and concentration disruption, although effect sizes (ES) were trivial (ES, –0.03 to 0.15). The odds ratio (OR) of reporting global sleep dysfunction increased by 8%, 9%, and 25% for every 1-unit increase in tension (OR, 1.08; 95% CI, 1.02-1.16; $P = 0.015$), fatigue (OR, 1.09; 95% CI, 1.03-1.16; $P = 0.002$), and concentration disruption (OR, 1.25; 95% CI, 1.09-1.45; $P = 0.002$), respectively. The odds of reporting global sleep dysfunction were 55% lower for males than females (OR, 0.45; 95% CI, 0.25-0.79; $P = 0.006$).

**Conclusion:** Global sleep dysfunction was prevalent in NCAA soccer players and was related to negative mental health outcomes. Female participants experienced increased odds of reporting global sleep dysfunction.

**Clinical Relevance:** Regular monitoring allows for a greater understanding of the interrelatedness between sleep and mental health in athletes.

**Keywords:** recovery; athlete monitoring; stress; well-being; school

National Collegiate Athletic Association (NCAA) athletes are exposed to a variety of stressors to the body, both internal and external, such as sleep loss,[16] travel fatigue,[20] academic demands,[24] and social and economic pressures. Sleep quality is not only recognized as critical to an athlete's mental and physical recovery,[16] but decrements may place student-athletes at risk for negative mental health outcomes, athletic and academic underperformance, and negative short- and long-term well-being.[21,34] In addition to mental health, other factors such as sex (male vs female) and playing status (starter vs reserve) may influence sleep and therefore place specific student-athletes at a greater risk of negative mental health outcomes.[12]

Several studies have reported associations between poor sleep quality, exercise, and sport performance.[16,35] It has been determined that sleep duration and quality are related to

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incremental maximal exercise test performance and that sleep, tension, and anger predict performance, as measured by wins and losses.[2,9] Similar to performance, a comprehensive review determined that the mental processes related to skill memory consolidation are also influenced by sleep and have been linked to improved performance in sport.[34] Furthermore, these findings demonstrated how a night of high-quality sleep is needed for an athlete to fully incorporate motor sequence learning. Similarly, intense training exercises in military personnel revealed the detrimental effect that sleep loss had on reaction time, mood (vigor, fatigue, confusion, depression, and tension), and attention.[21] Despite the evidence supporting the need for high-quality sleep, athletes have difficulty achieving this sleep prior to competition due to feelings of nervousness and to thoughts of the upcoming competition.[18]

In addition to performance on the field, poor sleep quantity and quality have been linked to poor health quality and academic struggles, which are important considerations for this population. For example, lower health quality, increased stress, and increased confusion have been related to poor sleep in elite Gaelic athletes.[6] Furthermore, poor sleep quality has also resulted in increased depression, confusion, and fatigue in elite athletes of various individual and team sports.[1] While many are under the impression that athletics protects individuals from depression, evidence suggests that student-athletes are just as likely to experience depression as nonathletes,[36] and poor sleep quality may be a factor that contributes to this. The prevalence of depression and other mental health concerns has led to an increased focus on improving health care models at the NCAA institutional level.[31] Taken together, these findings suggest that sleep has a large influence on various aspects of an athlete's health-related quality of life and, as such, demands close attention by those whose job it is to optimize the performance and well-being of these athletes.

Apart from athletics, poor sleep quality has been observed in the general collegiate student body. A survey of 1125 college students revealed that over 60% of students were categorized as poor sleepers due to emotional and academic stressors.[23] A significant negative relationship was observed between sleep and grade point average in a healthy student population.[17] Similarly, a strong relationship was found between a consistent sleep routine and improved grade point averages at Harvard University.[26]

These findings have prompted elite athletic teams, programs, and researchers to invest time and money specifically in the improvement of athlete sleep habits. Currently, limited research exists on sleep and mental health in a large cohort of college athletes. Understanding the relationships between sleep and mental health in this college population can guide future education and implementation of sleep hygiene and mental health improvement programs. Therefore, the purpose of this study was to examine the global sleep dysfunction and psychological measures such as mood and anxiety by playing position (starters vs nonstarters) and sex (male vs female). We hypothesized that players who report higher levels of global sleep dysfunction will also report poor mood and increased anxiety and that female athletes and nonstarters will report increased sleep dysfunction.

## METHODS

A total of 110 male (mean ± SD age, 20 ± 2 years; height, 179.9 ± 6.5 cm; body mass index, 77.4 ± 5.1 kg; $VO_{2max}$, 53.8 ± 4.1 $mL \cdot kg^{-1} \cdot min^{-1}$) and 120 female (mean ± SD age, 20 ± 1 years; height, 166.8 ± 6.2 cm; body mass index, 64.7 ± 6.1 kg; $VO_{2max}$, 46.8 ± 4.0 $mL \cdot kg^{-1} \cdot min^{-1}$) NCAA Division I soccer athletes were recruited from 11 NCAA Division I universities (6 female teams, 5 male teams) to participate in this study during the 2016 (1 team), 2017 (6 teams), and 2018 (4 teams) competitive seasons. Athletes completed the questionnaires in this study at 6 separate time points throughout each season (prior to preseason, postpreseason, 4 weeks into regular season, 8 weeks into regular season, at the completion of regular season, and [if eligible] at the completion of postseason play) via paper-based surveys that were distributed and collected by on-site investigators. Time-point data and analysis were not included in the present study because these data are being reported elsewhere. Athletes who did not wish to participate were not included in this study. Written informed consent was obtained by all included participants according to the institutional review board at the University of Connecticut, in accordance with the Declaration of Helsinki.

### Pittsburgh Sleep Quality Index

The validated Pittsburgh Sleep Quality Index (PSQI) (range, 0-21), which is composed of 7 component scores of questions related to sleep duration, sleep onset latency, sleep symptoms, and sleep disturbances was used to assess global sleep dysfunction.[10] To classify sleep quality, the global sleep dysfunction score was dichotomized. A score ≥5 indicated global sleep dysfunction (poor sleep quality) and a score ≤4 indicated good sleep quality.[10]

### Profile of Mood States

The validated Profile of Mood States (POMS) is a 65-item questionnaire that assesses 6 mood states, including tension (score range, 0-36), anger (score range, 0-48), vigor (score range, 0-32), depression (score range, 0-60), fatigue (score range, 0-28), and confusion (score range, 0-28).[32,33] A composite score called *total mood disturbance* (score range, 0-200) is calculated by the addition of the 5 negative mood states (tension, depression, anger, fatigue, and confusion) subtracted by vigor. A recent study of elite multisport athletes demonstrated that mood disturbance from this survey was associated with poor sleep.[7]

### Sports Anxiety Scale–2

The Sports Anxiety Scale–2 (SAS-2) is a 15-item questionnaire (total score range, 15-60; subscale score range, 5-20) that assesses somatic anxiety, worry, and concentration disruption. The questions are asked on a 4-point Likert-type scale anchored by 1 = not at all and 4 = very much so.

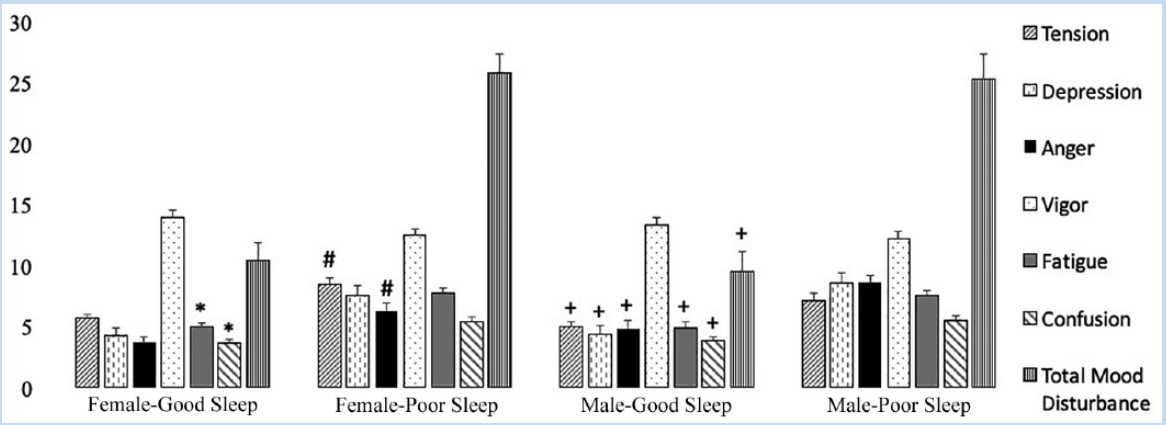


Figure 1. Sleep quality and Profile of Mood States (POMS) subscales. Differences in POMS subscales between male/female and sleep quality group. Good sleep = Pittsburgh Sleep Quality Index Score ≥5. Poor sleep = Pittsburgh Sleep Quality Index Score ≤4. *Indicates differences in POMS subscales between good and poor sleep quality in female patients. +Indicates differences in POMS subscales between good and poor sleep quality in male patients. #Indicates differences in POMS subscales between female and male patients who reported poor sleep quality. Statistical significance set at $P < 0.05$ a priori.

### Statistical Analysis

Players were classified by playing status (starter vs reserve) and sex (male vs female). Starters were classified as those individuals who started in 60% or more of the matches throughout the entire season. Multilevel linear mixed models were used to assess relationships between the 6 POMS subscales (tension, depression, anger, vigor, fatigue, and confusion) derived from the POMS, 3 SAS-2 subscales (somatic, worry, and concentration disruption), starters versus nonstarters, and male versus female athletes with global sleep dysfunction. Questionnaire results were analyzed at the same (not subsequent) time points, meaning that the PSQI that was completed during preseason was only analyzed with POMS and SAS-2 responses from that time point. A multinomial generalized multilevel model was used to assess the odds of being classified as a poor sleeper (PSQI ≥5) and reported as odds ratio (OR) and 95% CI. A 1-way analysis of variance (ANOVA) was performed to assess mean differences between male versus female participants and sleep quality in all POMS subsets. The Levene test of homogeneity yielded significant results ($P < 0.001$) in the ANOVA; therefore, the Tamhane test was utilized for the multiple comparisons. Data are reported as mean ± SD, mean difference (MD), SE, and Cohen *d* effect size (ES). ES was interpreted according to the following thresholds: <0.2, trivial; 0.2 to 0.6, small; 0.7 to 1.1, moderate; 1.2 to 2.0, large; and >2.0, very large.[4] Statistical significance was set at $P < 0.05$ a priori.

## RESULTS

The mean reported PSQI was 4.99 ± 2.68, with 54% of participants yielding scores ≥5, indicating poor sleep. The POMS subscales and total mood disturbance scores were calculated (mean ± SD tension, 6.78 ± 5.21; depression, 6.33 ± 8.57; anger, 5.86 ± 7.38; vigor, 12.94 ± 6.47; fatigue, 6.44 ± 4.75; confusion, 4.68 ± 3.95; total mood disturbance, 18.56 ± 26.99). The POMS subcategories for the male and female "good" and "poor" quality sleepers can be seen in Figure 1.

Female athletes with poor sleep quality reported significantly higher levels of tension, depression, anger, fatigue, confusion, and total mood disturbance and lower levels of vigor than female athletes with good sleep quality (MD ± SE tension, 2.88 ± 0.42; depression, 3.37 ± 0.73; anger, 2.57 ± 0.56; fatigue, 2.84 ± 0.35; confusion, 1.79 ± 0.32 [$P < 0.001$]; total mood disturbance, 15.37 ± 2.12 [$P < 0.001$]; vigor, −1.45 ± 0.58 [$P = 0.08$]). Male athletes with poor sleep quality also reported significantly higher levels of tension, depression, anger, fatigue, confusion, and total mood disturbance (MD ± SE tension, 2.25 ± 0.51; depression, 4.20 ± 0.81; anger, 3.77 ± 0.76; fatigue, 2.62 ± 0.49; confusion, 1.68 ± 0.40; total mood disturbance, 15.74 ± 2.68; $P < 0.001$ for all) than male athletes with good sleep quality; however, there were no differences in vigor between sleep quality groups (MD ± SE vigor, −1.06 ± 0.64; $P = 0.46$). There were no differences in any POMS measures between male and female participants with good sleep quality (MD ± SE tension, 0.72 ± 0.43 [$P = 0.45$]; depression, −0.18 ± 0.69 [$P > 0.99$]; anger, −1.16 ± 0.62 [$P = 0.31$]; vigor, 0.66 ± 0.65 [$P = 0.89$]; fatigue, −0.02 ± 0.40 [$P > 0.99$]; confusion, −0.24 ± 0.33 [$P = 0.97$]; total mood disturbance, −0.93 ± 2.53 [$P = 0.98$]). Female athletes with poor sleep quality reported significantly higher levels of tension (MD ± SE, 1.35 ± 0.50 [$P = 0.04$]) and lower levels of anger (MD ± SE, −2.37 ± 0.72 [$P = 0.01$]) than males with poor sleep quality. There were no statistically significant differences in reported levels of

Table 1. Factors associated with PSQI global score

| Factor | Estimate[a] | SE | *P* | ES |
|---|---|---|---|---|
| POMS | | | | |
| Tension | 0.10 | 0.02 | <0.001* | 0.05 |
| Depression | 0.05 | 0.01 | <0.001* | 0.03 |
| Anger | 0.06 | 0.01 | <0.001* | 0.03 |
| Vigor | –0.06 | 0.01 | <0.001* | –0.03 |
| Fatigue | 0.13 | 0.02 | <0.001* | 0.07 |
| Confusion | 0.12 | 0.02 | <0.001* | 0.07 |
| Total mood disturbance | 0.03 | 0.00 | <0.001* | 0.02 |
| SAS-2 | | | | |
| Somatic trait anxiety | 0.11 | 0.04 | 0.01* | 0.06 |
| Worry | 0.08 | 0.03 | 0.001* | 0.04 |
| Concentration disruption | 0.27 | 0.05 | <0.001* | 0.15 |
| Player sex (male) | –0.99 | 0.28 | <0.001* | –0.52 |
| Player role (starter) | 0.14 | 0.29 | 0.62 | 0.07 |

ES, effect size; POMS, Profile of Mood States; PSQI, Pittsburgh Sleep Quality Index; SAS-2, Sports Anxiety Scale–2.
[a]Estimate is the response in PSQI global score for every 1-unit increase in each factor.
*$P < 0.05$.

depression, vigor, fatigue, confusion, or total mood disturbance between male and female participants with poor sleep quality (MD ± SE depression, 1.02 ± 0.84 [$P = 0.79$]; vigor, –0.28 ± 0.56 [$P > 0.99$]; fatigue, –0.25 ± 0.45 [$P = 0.99$]; confusion, 0.13 ± 0.39 [$P > 0.99$]; total mood disturbance, –0.56 ± 2.61 [$P = 0.99$]).

In the presence of increased global sleep dysfunction, decreased vigor and increased tension, depression, anger, and fatigue were also reported, although effects were trivial (Table 1).

The odds of reporting global sleep dysfunction increased by 8% and 9% for every 1-unit increase in tension (OR, 1.08; 95% CI, 1.02-1.16; $P = 0.015$) and fatigue (OR, 1.09; 95% CI, 1.03-1.16; $P = 0.002$), respectively (Table 2).

The season and male versus female combined SAS-2 subcomponents were recorded (mean ± SD somatic trait anxiety, 7.22 ± 2.51; worry, 10.11 ± 3.91; concentration disruption, 6.07 ± 2.03). An increase in global sleep dysfunction was significantly associated with somatic anxiety, worry, and concentration disruption, although the effects were trivial (Table 1). The odds of reporting global sleep dysfunction increased 25% for every 1-unit increase in concentration disruption (OR, 1.25; 95% CI, 1.09-1.45; $P = 0.002$) (Table 2).

The odds of reporting global sleep dysfunction were 55% lower for male than female participants (OR, 0.45; 95% CI, 0.25-0.79; $P = 0.006$) (Table 2). Playing status was not significantly associated with global sleep quality (Table 1).

## DISCUSSION

This study aimed to examine psychological, position (starters vs nonstarters), and sex-based (males vs female) factors and their association with global sleep dysfunction. These findings surrounding global sleep dysfunction and mental health are of importance in the collegiate athlete population, as these factors are known to affect performance, risk of illness or injury, overall well-being, and academic success.[3,8,23,26]

All POMS subscales (tension, depression, anger, vigor, fatigue, and confusion) were significantly related with global sleep dysfunction (PSQI global score, $P < 0.001$); however, the small ES associated with these relationships indicates that there were several confounding factors that were influencing the sleep quality of these athletes. The higher odds of global sleep dysfunction with higher levels of reported tension were expected, as previous research found that tension and stress accounted for 24% of the variance seen with the PSQI in a US college population.[23] In fact, collegiate athletes are expected to experience greater levels of stress than nonathletes due to the balance of high physical and

Table 2. Multinomial generalized multilevel logistic regression on the odds of global sleep dysfunction (PSQI ≥ 5)

| | PSQI (≥5) | | |
|---|---|---|---|
| | Odds Ratio | CI | *P* |
| Fixed parts | | | |
| (Intercept) | 0.45 | 0.14-1.42 | 0.174 |
| POMS | | | |
| **Tension** | **1.08** | **1.02-1.16** | **0.015*** |
| Anger | 1.00 | 0.95-1.05 | 0.895 |
| Depression | 1.01 | 0.97-1.06 | 0.629 |
| Vigor | 0.97 | 0.94-1.01 | 0.139 |
| **Fatigue** | **1.09** | **1.03-1.16** | **0.002*** |
| Confusion | 0.98 | 0.90-1.07 | 0.711 |
| SAS-2 | | | |
| Somatic trait anxiety | 1.00 | 0.89-1.12 | 0.955 |
| Worry | 0.94 | 0.87-1.02 | 0.134 |
| **Concentration disruption** | **1.25** | **1.09-1.45** | **0.002*** |
| **Sex (male)** | **0.45** | **0.25-0.79** | **0.006*** |
| Role (starter) | 0.98 | 0.58-1.68 | 0.952 |
| Random parts | | | |
| $\tau_{00,\ Subject}$ | | 2.181 | |
| $N_{Subject}$ | | 227 | |
| $ICC_{Subject}$ | | 0.399 | |
| Observations | | 931 | |
| Deviance | | 764.844 | |

Boldfaced text indicates statistical significant outcomes. ICC, intraclass correlation coefficient; POMS, Profile of Mood States; PSQI, Pittsburgh Sleep Quality Index; SAS-2, Sports Anxiety Scale–2.
*$P < 0.05$

academic demands.[25,31] Also, as expected, the odds of global sleep dysfunction increased with higher levels of reported fatigue.[28] While fatigue has been typically measured daily in previous studies, one unique finding from the current investigation is the effect of poor sleep quality on fatigue measured by the POMS intermittently throughout the season.

All SAS-2 subscales (somatic trait anxiety, worry, and concentration disruption) were significantly related to global sleep dysfunction ($P < 0.001$). Similarly, the small ES of these outcomes indicates that these findings should be interpreted with caution, as there are most likely several other factors that contribute to global sleep dysfunction not accounted for in this study. An additional major finding from this analysis was that the odds of reporting global sleep dysfunction increased by 25% for each additional 1-unit increase of concentration disruption. This finding is of interest, particularly in this population in which concentration is critical for sport and academic performance. In a study examining collegiate football players, concentration disruption was negatively related to player performance.[30] While player performance was not directly assessed in the current study, previous research points to the importance of optimal concentration to achieve peak performance in team sports. Skills such as passing the ball to the correct player at the right time or knowing when to make a

tackle take high levels of concentration, making this finding relevant to the population at hand. Performance in a standard field fitness test (Yo-Yo Intermittent Recovery Test, Level 1), as measured by total distance covered and rating of perceived exertion, and soccer ball shot speed and accuracy were negatively affected by increased mental fatigue, despite similar heart rates between groups.[29] Minimizing athlete sleep dysfunction may be an important strategy for promoting maximal concentration and therefore on-field performance.

In agreement with previous literature regarding differences in male and female sleep patterns, the odds of reported global sleep dysfunction was 55% lower for male than female athletes.[19] There are known physiological differences that may explain this finding. For example, female participants experience lower internal body temperature and earlier melatonin release than their male counterparts, even when bedtime is controlled for. Therefore, collegiate female athletes may be at a disadvantage for sleep when they play a night game or have academic demands that result in late-night schoolwork.[11,15,22] While the findings from this investigation clearly point to differences between male and female participants with regard to global sleep dysfunction, another study investigating a general population did not demonstrate these differences.[14] Perhaps there are specific considerations that should be investigated at the collegiate athlete level, such as sport stress, academic demands, and social life, that could assist in explaining the discrepancy in these results. One unexpected finding from this study was that global sleep dysfunction was not different in starters compared with reserves, even though training load and match workloads differ throughout the season.[13] We speculate that this finding is indicative of other outside factors (such as stress, anxiety, and sex) that explain differences in global sleep dysfunction.

This study has many limitations. This study used a subjective measure to assess sleep and mental health, which may differ from objective measurements. The data from this study were only collected during the regular competitive season, making it difficult to extrapolate these findings to other parts of the academic year. Several other components known to influence sleep and mental health, including training load, academic demands, and social life, were not included in the current analysis. For example, previous research has demonstrated that early morning training affects sleep duration.[5,27] Additionally, because of the multisite nature of this study, various sleep education strategies and sleep monitoring at each university were not accounted for. Findings from this study should be interpreted with caution outside of collegiate soccer athletes, as there may be specific factors that influence sleep and mental health in these populations.

## CONCLUSION

This study demonstrates the many relationships between sleep and mental health in Division I collegiate soccer athletes. Additionally, concentration disruption specific to sport anxiety was lower in the presence of higher global sleep dysfunction. While the findings from this investigation are noteworthy, the small effects of poor sleep quality on psychological well-being and sport anxiety measures speaks to the multifaceted nature of athlete monitoring. Females hold the greatest risk of reporting global sleep dysfunction, and global sleep dysfunction was reported with several negative mental health parameters that could be improved with interventions.

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