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Adolescent Female Athletes With Menstrual Dysfunction Report Worse Sleep and Stress Than Those Without Menstrual Dysfunction

Rachel Meyers, PT, DPT*; Madison L. Brna, BS*†‡; Catherine Donahue, PhD, ATC*†; Emily Sweeney, MD*†; David R. Howell, PhD, ATC*†; Aubrey Armento, MD*†

*Sports Medicine Center, Children's Hospital Colorado, Aurora; †Department of Orthopedics, University of Colorado School of Medicine, Aurora; ‡University of North Carolina School of Medicine, Chapel Hill

Context: Menstrual dysfunction among adolescent female athletes is associated with both an increased musculoskeletal injury risk and poor psychological health.

Objective: To examine if adolescent flag football athletes with menstrual dysfunction report different levels of energy, mood, sleep, and stress during the season than those without menstrual dysfunction.

Design: Prospective cohort study.

Setting: A series of preseason, in-season weekly, and postseason questionnaires to athletes in the Denver Metro Area.

Patients or Other Participants: Female athletes with and without self-reported menstrual dysfunction who participated in a high school flag football season.

Main Outcome Measure(s): Quality-of-life measures (energy, mood, sleep, and stress) rated weekly from 0 (low energy, poor mood, poor sleep, and low stress) to 10 (high energy, best mood, great sleep, and high stress).

Results: Of the 60 adolescent female flag football athletes enrolled, 15 (25%) reported menstrual dysfunction. The groups were not significantly different in mean ratings for energy (5.3 ± 1.1 versus 5.1 ± 1.4; $P = .70$) or mood (5.6 ± 1.1 versus 6.0 ± 1.5; $P = .32$). However, the menstrual dysfunction group reported significantly worse sleep (4.2 ± 1.3 versus 5.2 ± 1.4; $P = .02$) and more stress (7.0 ± 1.0 versus 5.9 ± 1.3; $P = .005$) than those without menstrual dysfunction. When adjusting for school year, body mass index, and injuries sustained during the season, menstrual dysfunction was significantly associated with worse sleep ($\beta = -0.98$; 95% CI = $-1.82, -0.13$; $P = .03$) and more stress ($\beta = 1.11$; 95% CI = 0.35, 1.87; $P = .005$).

Conclusion: Flag football athletes with menstrual dysfunction reported worse sleep and more stress than those without menstrual dysfunction. These findings contribute to the importance of monitoring and addressing menstrual dysfunction and its association with quality-of-life factors in female adolescent athletes.

Key Words: adolescence, mental health

Key Points

- Adolescent female athletes participating in flag football reported significantly worse sleep and significantly more stress in-season than those without menstrual dysfunction.
- Weekly ratings of energy and mood were not significantly different between adolescents with and without menstrual dysfunction participating in flag football.
- These findings contribute to the importance of monitoring and addressing menstrual dysfunction and its association with quality-of-life factors in female adolescent athletes.

There are numerous health benefits to sport participation for female adolescents.[1–3] Participating in sports helps promote female adolescents' confidence, self-esteem, resilience, and academic performance and improves emotional health by fostering social interactions.[1–4] However, up to 70% of female adolescents may drop out of sports by the age of 13.[5] One of the reasons for premature dropout in sports participation is female athletes have a greater tendency to be more self-conscious of their bodies, be more self-critical, and compare themselves with others more than their male athlete peers.[4,6,7] These concerns become more apparent with the many physical and psychological changes that occur with puberty during adolescence.[4,6,7] Therefore, it is imperative to understand ways in which individuals can encourage female adolescents to participate in sports. One growing avenue for female sports participation is flag football. Flag football is a noncontact version of American football that can include both boys and girls, representing an emerging and understudied sport.

Although sports participation is associated with a myriad of health benefits, it may also lead to detrimental effects such as sport-related injuries or relative energy deficiency in sport.[1–3,8,9] Relative energy deficiency in sport was introduced in 2014, with the intention to expand the previous diagnosis of the female athlete triad.[8] Relative energy deficiency in sport refers

to a condition in which energy imbalance leads to impaired physiological function of multiple organ systems.[8,9] One of the components of relative energy deficiency is menstrual function, and when there is a disruption to this component, it is referred to as menstrual dysfunction.[8] Menstrual dysfunction is often defined as menarche $\geq$15 years of age, 3 consecutive months without a menstrual period in the past year, and/or $\leq$9 menstrual periods in the last 12 months in those who are not taking hormonal contraceptives.[9,10] As such, female athletes who participate in lean sports (such as gymnastics, wrestling, and running; 35.6%, $P = .01$) and who are younger (ages 15–24; 35%, $P = .033$) are at highest risk for menstrual dysfunction.[11,12] Furthermore, menstrual dysfunction is also associated with more missed participation days in sport (odds ratio = 1.79; 95% CI = 1.05–3.07).[12] As flag football typically represents a younger age group of female adolescent athletes, it is important to better understand the prevalence of menstrual dysfunction in flag football, which is currently unknown.

Previous work has suggested associations between poor quality of life, poor psychological health (eg, stress and mood), poor perceived sleep quality, and menstrual dysfunction among adolescent females and adolescent female athletes.[13–15] Elite female athletes with menstrual dysfunction had worse quality-of-life ratings, such as mood and energy, and higher levels of stress.[16] Additionally, out of 235 female adolescents with menstrual dysfunction and 60 adolescents with a regular menstrual cycle, the group with menstrual dysfunction had significantly lower quality-of-life scores in the domains of general health and social functioning than the controls.[17] Menstrual dysfunction was also associated with shorter perceived sleep duration and poor perceived sleep quality in adolescent females.[18–20] Thus, menstrual health, mental health, and sleep health may interact among adolescent female athletes. It is reasonable to anticipate that menstrual dysfunction among adolescent athletes may be associated with poor perceived sleep quality or reduced quality of life during a season of athletic participation.

The purpose of this study was to examine if female adolescent athletes participating in flag football with menstrual dysfunction report different levels of energy, mood, sleep, and stress during the season than those without menstrual dysfunction. We hypothesized that adolescent athletes participating in flag football with menstrual dysfunction would report worse levels of energy, mood, perceived sleep quality, and stress during the season than those without menstrual dysfunction.

METHODS

Study Participants

We conducted a longitudinal prospective cohort study of female adolescents who were participating in flag football throughout the Denver Metro Area during the fall season of 2023. Study participants were included if they were active participants on a flag football team at one of the local high schools offering the sport and had no injury that limited physical activity participation at the time of enrollment. The study protocol was approved by the Colorado Multiple Institutional Review Board before study commencement, and all participants and their parents (if under 18 years of age) provided consent/assent before completing any study procedures.

Study Design

Study participants were recruited through flyers provided by the research team and disseminated by high school coaches. Participants enrolled in July/August 2023 and were followed throughout the 10-week season, which ended in October/November 2023. All participants completed a study visit before the beginning of the fall season. At this preseason visit, participants completed several assessments that detailed demographics, medical history, and other baseline characteristics. Menstrual history was obtained, which included whether they had their first menstrual period, age at menarche if so, number of periods in the prior 12 months, and the date of their most recent menstrual period. Participants were also asked if they were currently taking any hormonal contraceptives and were excluded from the analysis if they reported any hormonal contraceptive use. Following the preseason visit, participants completed weekly online surveys throughout the season. These surveys were sent via text message or email (dependent on participant preference) each week and were completed by the participant to assess physical activity levels, engagement in flag football games and practices, perceived sleep quality, mood, stress, and energy levels and any injuries sustained.

Weekly Surveys

During each week of the fall season, athletes completed a brief questionnaire. The questionnaires were distributed electronically via email or text message at the same time each week. Information collected within the weekly questionnaire included physical activity levels, athletic competition participation volume, any injuries sustained, and a brief rating of mood, stress, perceived sleep quality, and energy levels. These ratings were individually performed using a 10-point slider visual analog with the scale including 0, 5, and 10 as verbal anchors.[21] The slider could move anywhere along 0 to 10 with the software calculating the severity of the perceived ratings. A score of 0 indicated very low energy, very poor mood, very poor perceived sleep quality, and no stress, whereas a 10 indicated very high energy, very good mood, very good perceived sleep quality, and very high stress. Each week, participants completed the 0 to 10 rating scale for all 4 domains of interest. For analysis, we used participants' self-reported averages throughout the season of mood, energy level, perceived sleep quality, and stress ratings. On average, participants completed 6.9 (SD = 1.5) out of 8 possible surveys during the season (86% adherence rate). We excluded those who completed not 1 of the of the surveys throughout the season.

Menstrual Dysfunction

Participants were classified as having menstrual dysfunction if they reported age of menarche of $\geq$15 years of age, 3 or more consecutive months without a menstrual period up to the point of the preseason visit/initial assessment, and/or $\leq$9 menstrual periods in the last 12 months. Additionally, if participants were $\geq$15 years of age and never had a menstrual period, they were classified as having menstrual dysfunction. Participants taking any hormonal contraceptives were excluded.

Table 1. Participant Characteristic Comparisons Between Female Flag Football Participants Who Did and Did Not Report Menstrual Dysfunction

Variable	Menstrual Dysfunction ($n = 15$)	No Menstrual Dysfunction ($n = 45$)	*P* Value
Age (years)	16.3 (1.2)	16.3 (1.1)	.90
Number of weekly surveys completed during season	7.2 (1.1)	6.9 (1.7)	.54
Race			.56
American Indian or Alaska Native	0 (0%)	1 (2%)	
Asian	1 (7%)	3 (7%)	
Black or African American	0 (0%)	5 (11%)	
White	11 (73%)	30 (67%)	
Native Hawaiian or Pacific Islander	0 (0%)	2 (4%)	
More than 1 race	3 (20%)	4 (9%)	
Ethnicity (Hispanic/Latino/a/x)	4 (27%)	7 (16%)	.44
Height (cm)	167.8 (8.4)	164.8 (6.6)	.16
Weight (kg)	61.5 (13.2)	59.0 (8.5)	.40
BMI, (kg/m^2)	21.6 (3.0)	21.7 (2.6)	.96
School year, (grade)	10.8 (1.0)	10.9 (1.0)	.84
History of anxiety	2 (13%)	9 (20%)	.56
History of depression	1 (7%)	3 (7%)	.95
Average physical activity (hours/week) at baseline	6.7 (4.7)	8.2 (6.5)	.43
Average time playing flag football (hours/week) during season	6.4 (3.2)	8.7 (5.3)	.14

Abbreviation: BMI, body mass index.

Statistical Analysis

Descriptive statistics are presented as mean (SD) for continuous variables and number of participants within group (corresponding percentage) for categorical variables. We calculated descriptive statistics for demographic variables, medical history, and menstrual dysfunction. Independent *t* tests and Cohen *d* effect sizes (0.00–0.19 = no effect, 0.20–0.49 = small effect, 0.50–0.79 = moderate effect, and ≥0.80 = large effect) were used to compare average weekly ratings during the season for energy levels, mood, perceived sleep quality, and stress between those who did and did not report menstrual dysfunction. Additionally, we constructed 4 separate linear regression models to determine the association between group (menstrual dysfunction or normal menstrual function: predictor variable) and weekly rating of energy, mood, perceived sleep quality, and stress (outcome variable). We adjusted each model to include school year, body mass index (BMI), and whether a sport-related, time-loss injury occurred during the season as covariates. All statistical analyses were 2-sided and were performed using Stata Statistical Software (version 16; StataCorp, LLC).

RESULTS

We enrolled 83 participants into the study and excluded 14 participants who reported active hormonal contraceptive use and 9 who completed none of the surveys (Table 1). Therefore, we monitored 60 adolescent female flag football athletes over the course of a season, 15 (25%) of which reported menstrual dysfunction at the start of the season. Those who did and did not report menstrual dysfunction demonstrated similar baseline characteristics and in-season survey adherence, including age (mean = 16.3 ± 1.1 years of age), number of weekly surveys completed (7.0 ± 1.6), BMI (21.7 ± 2.7 kg/m^2), and hours/week of time playing flag football during the season (8.0 ± 4.9 hours/week). Following univariable examination, the groups were not significantly different in weekly ratings of energy (Figure A, no effect) or mood (Figure B, small effect). However, the menstrual dysfunction group reported significantly worse weekly perceived sleep quality (Figure C, moderate effect) and significantly more stress (Figure D, large effect) during the season than the no menstrual dysfunction group. After adjusting for school year, BMI, and injuries sustained during the season, menstrual dysfunction was significantly associated with worse perceived sleep quality and worse stress (Table 2).

DISCUSSION

We examined if female adolescent athletes participating in flag football with menstrual dysfunction report different levels of energy, mood, perceived sleep quality, and stress during the season than those without menstrual dysfunction. We found no significant differences in weekly ratings of energy or mood between groups. However, the menstrual dysfunction group reported significantly worse perceived sleep quality and significantly more stress in-season than those without menstrual dysfunction. When adjusting for school year, BMI, and injuries sustained during the season, menstrual dysfunction was significantly associated with worse perceived sleep quality and more stress. These findings partially support our initial hypothesis, as adolescent athletes participating in flag football with menstrual dysfunction reported worse levels of perceived sleep quality and stress during the season than those without menstrual dysfunction. However, we identified that adolescent athletes with menstrual dysfunction did not report different mood and energy levels than adolescent athletes without menstrual dysfunction.

Of the 60 adolescent female flag football athletes we monitored over the course of a season, a quarter (25%) reported menstrual dysfunction at the start of the season. The prevalence of menstrual dysfunction in our study was higher than

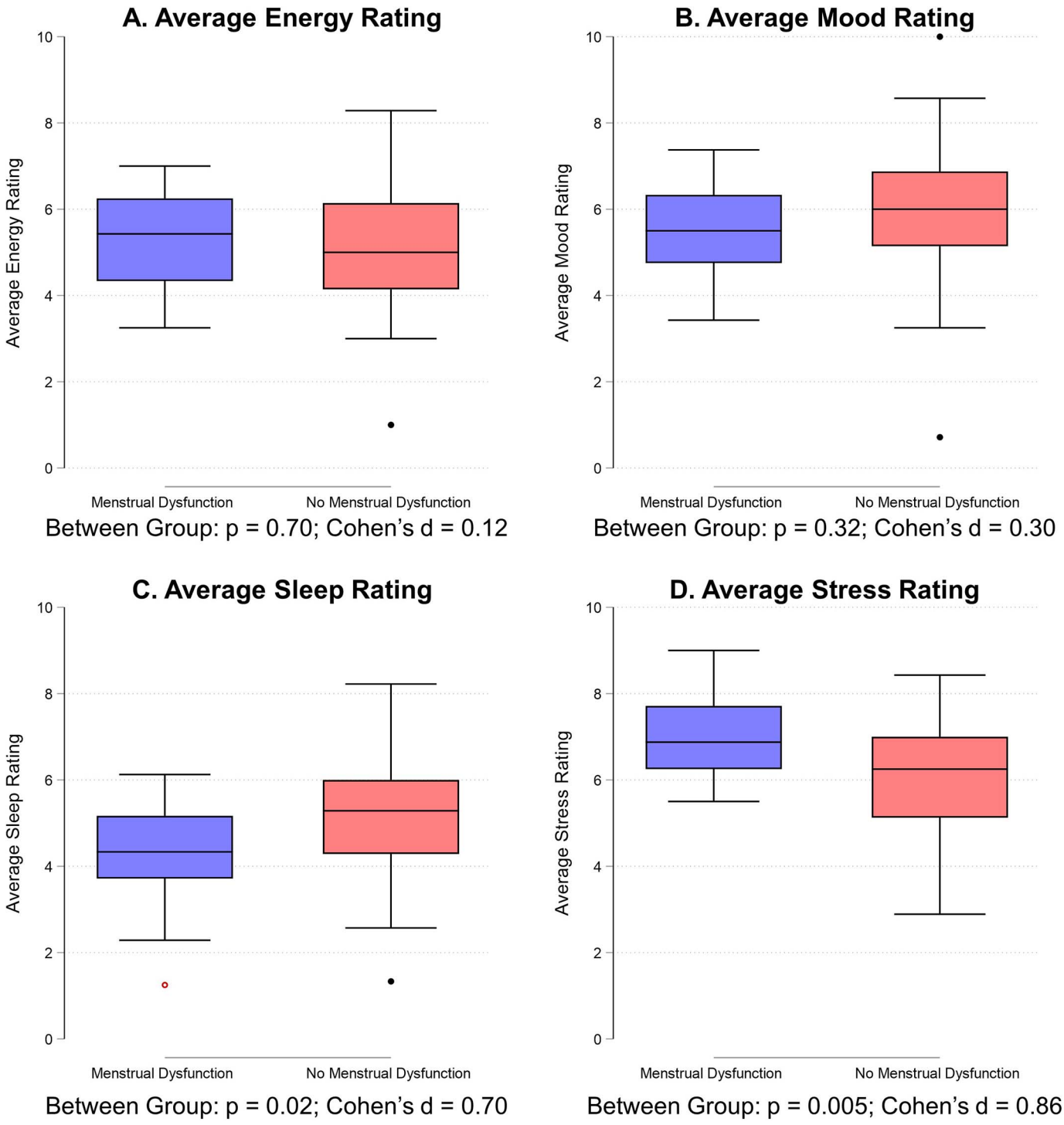

Figure. Comparison of participants who did and did not report menstrual dysfunction on ratings of energy (A), mood (B), sleep (C), and stress (D) during the flag football season.

other studies that report a prevalence between 15% and 18% in adolescent female athletes.[22,23] The higher prevalence of menstrual dysfunction in our study may reflect the high prevalence of menstrual dysfunction specifically in flag football rather than across a variety of different sports. Although menstrual dysfunction is most common in endurance, aesthetic, and weight-based sports, it is imperative to also monitor for menstrual dysfunction in team sports, such as flag football.[11] Additionally, the higher prevalence may also reflect a rise of menstrual dysfunction among youth athletes over the years with the rise of female adolescents participating in sports.[24] Our findings emphasize the importance of monitoring for menstrual dysfunction among adolescent athletes of all sport types, including flag football.

Adolescent female athletes with menstrual dysfunction reported significantly worse weekly perceived sleep quality during the season than the no menstrual dysfunction group. Our findings are consistent with previous work that suggest that menstrual dysfunction is associated with poor perceived sleep quality among adults, adolescent females, and

Table 2. Multivariable Linear Regression Model Results Evaluating the Association Between Reported Average Weekly Mental Health Ratings (Outcome in Each Model) and Menstrual Dysfunction (Predictor Variable), Adjusting for the Independent Effect of School Year, BMI, and Whether They Reported an Injury During the Season (Covariates)

Model Predictor (Adjusted for Covariates)	β Coefficient	95% Confidence Interval	*P* Value
Energy	0.20	−0.63, 1.03	.64
Mood	−0.41	−1.26, 0.44	.34
Sleep	−0.98	−1.83, −0.13	.03
Stress	1.11	0.35, 1.87	.005

Abbreviation: BMI, body mass index.

adolescent female athletes.[18–20,25,26] A systematic review including adult women found that worse sleep quality is associated with menstrual dysfunction, and each sleep characteristic, including perceived sleep quality, efficiency, and duration, is independently associated with menstrual disturbances.[25] Specifically, in adolescent females between the ages of 15 and 18, 194 participants reported poor sleep quality. Of those 194 participants, 19% had menstrual dysfunction, indicating that there was a significant relationship between perceived poor sleep quality and menstrual dysfunction in adolescent females.[20] Menstrual dysfunction may be characterized by hormonal fluctuations (ie, increased or decreased) of estrogen and/or progesterone, which may in turn affect sleep.[27] For example, elevated progesterone levels can impact sleep-regulating neurotransmitters such as gamma-aminobutyric acid and serotonin.[27] Changes in these neurotransmitters can influence sleep quality, ultimately leading to negative changes in sleep efficiency and subjective sleep quality.[27] Additionally, mental health factors, such as heightened anxiety or stress, can cause sleep disturbances, such as falling and staying asleep.[28] In female college students, going to bed later as well as irregular sleep/wake times (ie, 1 or more hours of deviation from regular sleep/wake times) was associated with greater depressive symptoms and more severe menstrual symptoms, regardless of sleep duration.[28] This suggests that going to bed earlier and maintaining a consistent sleep schedule may be beneficial for those with menstrual irregularities.

We also found that athletes with menstrual dysfunction reported more stress during the season than those without menstrual dysfunction. Previous studies suggest that female adolescents are more likely to experience more stress than male adolescents and that stress is associated with menstrual dysfunction.[13–15,29,30] High stress levels, depressive mood, and participation in psychological counseling have previously been linked to greater risks of menstrual cycle irregularity in Korean female adolescents.[31] Another study found that 235 female adolescents with menstrual dysfunction reported significantly lower quality-of-life scores in the domains of general health and social functioning than adolescents without menstrual dysfunction.[17] Although the association between stress and menstrual dysfunction has been less researched among adolescent athletes specifically, menstrual dysfunction is associated with higher levels of stress among adult, elite athletes.[16] Thus, our finding is in line with other work that suggests that menstrual dysfunction is associated with more stress in female adolescents, and further research should examine this association specifically in adolescent female athletes.

We found no significant differences in weekly ratings of energy or mood between those with and without menstrual dysfunction. Research is scarce on the associations between menstrual dysfunction and energy and mood, particularly among adolescent athletes, compared with perceived sleep quality and stress. To the best of our knowledge, no studies have compared ratings of energy and mood in adolescent athletes with and without menstrual dysfunction. However, 1 study found that menstrual dysfunction was associated with higher levels of anxiety, fatigue, and pain interference among adolescent female athletes.[13] Other studies demonstrate an association between menstrual dysfunction and depression, but we did not find a significant difference in self-reported history of depression or anxiety between groups.[31–33] Our findings may suggest a protective effect of sport participation on mood and energy despite the presence of menstrual dysfunction. Research shows that participating in sports or physical activity for at least 60 minutes daily improves mood.[34–36] All athletes in our study participated in weekly physical activity that exceeded the recommended amount (9.6 ± 4.7 hours/week) in an organized sport environment, which likely positively impacted mood.

Due to the higher prevalence of menstrual dysfunction in our study than in other studies, it is possible that we saw more stress in these athletes due to poor perceived sleep quality. On the other hand, poor perceived sleep quality could have led to more stress in these athletes. During adolescence, there is also an abundance of outside stress that is individual to each athlete, such as parental pressure, pressure from peers and friends, academic goals, and pressure to conform to societal norms that could be heightened from a myriad of outside variables. Thus, future research should further identify specific stressors in adolescent female athletes and track these variables over time with specific perceived sleep quality ratings.

Limitations of this study include a small sample size, particularly in the menstrual dysfunction group, which could limit detection of statistically significant findings between groups. Additionally, we used a 10-point slider visual analog scale for ratings of weekly perceived stress, mood, sleep quality, and energy, which provides objective data points for subjective information and thus can vary across individuals. For example, an athlete might perceive a higher rating as more or less severe than another individual. Furthermore, the visual analog scale was used as a brief and feasible method to obtain well-being data through the season but has not yet been validated. However, strengths of our study include the prospective study design and examination of quality-of-life measures in the growing sport of flag football among adolescent female athletes.

CONCLUSION

Adolescent female athletes participating in flag football reported significantly worse perceived sleep quality and significantly more stress in-season than those without menstrual dysfunction. We found no significant differences in weekly ratings of energy or mood between those with and without menstrual dysfunction. We recommend health care providers regularly monitor for and address menstrual dysfunction and be aware of how menstrual dysfunction may

relate to stress and perceived sleep quality in adolescent female athletes. It is imperative to identify screening practices preseason to help improve quality of life in all female adolescent athletes, including those who participate in flag football. As flag football grows in popularity, future directions include prospectively examining the relationships between menstrual dysfunction, quality-of-life measures, and injury risk in female athletes who participate in flag football.

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Address correspondence to David R. Howell, PhD, ATC, Sports Medicine Center, Children's Hospital Colorado, Department of Orthopedics, University of Colorado School of Medicine, 13123 East 16th Avenue, B060 Aurora, CO 80045. Address email to david.howell@CUAnschutz.edu.