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## **Body Composition and Perceived Stress through a Calendar Year in NCAA I Female Volleyball Players**

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### ABSTRACT

*International Journal of Exercise Science* 12(5): 433-443, 2019. The aim of the study was to track changes of perceived stress and body composition across an entire calendar year in National Collegiate Athletic Association (NCAA) division I female volleyball players. We hypothesized that perceived stress and body composition would vary between the competitive season and off-season, with the largest changes occurring during time points prior to the onset and after the end of the competitive season. Eight female volleyball players participated in a longitudinal study. Body mass, body mass index (BMI), percent body fat, fat mass, and fat free mass were obtained during the early, mid, late, and off season and during the pre, early, mid, and late competitive season. The perceived stress scale-10 was used to appraise stress levels. BMI and body mass were significantly higher in pre-season compared to early-offseason. Changes in BMI between these points were due to increase in fat mass. Fat mass and percent body fat were significantly higher in pre-season compared to late off-season, mid-season, and late season. Perceived stress was significantly higher at the mid-season compared to early offseason. A significant positive correlation existed between BMI and body fat ( $p<0.05$ ,  $r=0.69$ ), while a significant negative correlation existed between percent body fat and perceived stress ( $p<0.05$ ,  $r=0.34$ ). Tracking body composition and perceived stress in collegiate female volleyball players can provide informative feedback on the training status and well-being of female collegiate athletes. Interestingly, it appears stress in these athletes may be more dependent upon the school session rather than participation in competitive sports.

**KEY WORDS:** Body fat, body mass, fat free mass, stress score

### INTRODUCTION

Collegiate athletics provide a unique environment in which athletes must divide their attention between performance on the court and in the classroom, while also managing their own personal lives. As such, optimizing performance in these individuals is a multi-factorial task that trainers and coaches must address in order to provide their athletes with the best opportunity to be successful. While many training tools can be utilized to assess an athlete's competitive status, such as measurements of anaerobic capacity or strength, measurements of stress levels and body composition are often overlooked.

College attendance serves as an arbiter in today's society for professional and personal development, however this growth is often acquired by the overcoming of new life challenges that appear during this time. When considering this for college athletes, these challenges could lead to stress that may impact their ability to perform in a competitive environment. In this regard, stress can be considered the condition in which an individual's means of coping with stressors is outweighed by the situational demands placed upon them (24, 29). Indeed, collegiate athletics require the ability to develop, perform, and maintain a high-capacity of athletic prowess that may serve as a source of stress in athletes (13). When this is coupled with the balancing act collegiate athletes must undergo in order to manage stress with academic pursuits on top of athletic performance (6), understanding the fluctuations and extent that athletes may be experiencing stress can provide critical information for coaches and trainers so that strategies may be implemented to prevent stress capable of hindering performance. Specifically, self-reported stress has been linked with overtraining and injury (8, 16). In addition, stress has been related to alterations in body composition which could negatively impact performance (26, 27).

Body composition can have a critical impact on athletic performance (11, 15, 19). For instance, an increase in fat mass during the competitive season could result in performance decrements by serving as dead weight that would increase energy expenditure for activities such as jumping (23). Furthermore, tracking changes in body composition can be indicative of nutritional status, as well as providing insight to the effectiveness of the training program being implemented (1). In this regard, body composition is a valuable training variable to be considered by coaches and trainers in order to finesse the goals and training regimen implemented in order to provide an optimal training environment conducive of success. While BMI is an easy measurement to acquire and is demonstrated to correlate with body fat percentage in normal adult populations, its usefulness in athletic populations has been questioned in athletes (7, 12, 22). For instance, increases in fat free mass can indicate a growth of muscle mass, thus yielding an increase in the potential to produce force during exercise (5). However if BMI alone was utilized as a training status metric, the resulting increase in BMI could be incorrectly interpreted as an increase in fat mass indicating that the program should be adjusted to encourage weight loss. Therefore, understanding how changes in BMI over time relates to changes in body composition in athletes is required to select and utilize the appropriate metric in a training environment.

The purpose of the current study was to evaluate the body composition and perceived stress level of female National Collegiate Athletic Association (NCAA) Division 1 volleyball players across an entire year. We hypothesized that perceived stress and body composition would vary between the competitive season and off-season, with the largest changes occurring during time points prior to the onset and after end of the competitive season. Our findings support our hypothesis and could be utilized by trainers and coaches to optimally select strategies and adjust training programs to provide athletes with the highest likelihood of success.

## METHODS

### *Participants*

Eight females of a NCAA division I women's volleyball team participated in this study, and prior to the study, participants signed a statement of informed consent. All 8 participants played throughout the season. All experimental procedures were reviewed and approved by the Institutional Review Board prior to the initiation of the study and follow Helsinki Declaration of Human Rights related to research.

### *Protocol*

The participants reported to the laboratory a total of 7 times at the same time of the day. Data collection was performed three times in the offseason: 1) early-offseason (first week of the Spring academic semester (early January)), 2) mid-offseason (middle of the Spring academic semester (middle of March)), and 3) late-offseason (last week of the Spring academic semester (late April)). Data collection was also performed in 4) pre-season (summer break (early July)), 5) early-season (first week of the Fall academic semester (late August)), 6) mid-season (middle of the Fall academic semester (middle of October)), and 7) late-season (last week of the Fall academic semester (late November)). During the experimental period, the training of the participants consisted of the following phases. Seven weeks before the regular season started, participants performed five hours of weight training and four hours of aerobic activities (running and/or volleyball training) per week for one month (July). The next three weeks (first weeks in August), participants performed 90 minutes of weight training per week, and twenty hours of aerobic activities per week. During the regular season (late August to late November), participants performed one hour of weight training per week. Also, aerobic training and/or participation in games consisted of twenty hours per week. The aforementioned training schedule was supervised by the coaches and trainers of the team. Once the regular season had ended, participants did not partake in any organized training activities until the final post season data were collected.

Participants wore single-layer compression shorts, lightweight jog bras, and swim caps during data collection. Participant's height was measured on a physician's scale. Participant's body mass and percent body fat were measured using the BOD POD (Life Measurement, Inc., Concord, CA). For body mass measurements, the BOD POD's digital scale was used and the scale was calibrated before measurements were made. Percentage body fat was determined by using air displacement plethysmography. The percent body fat was then used to calculate fat mass and fat free mass (i.e., fat mass = percent body fat x body mass; fat free mass = body mass - fat mass). Body mass index was calculated for each participant by dividing body mass (kg) by height (m<sup>2</sup>).

The perceived stress scale-10 is a ten item, self-report inventory that assesses the degree to which situations in an individual's life are appraised as stressful (3, 4, 28). The instrument is designed to measure the degree to which respondents find their lives unpredictable, uncontrollable and overloading; which are three issues that have repeatedly been found to be central components of the stress experience (3). Specifically, the participants were asked to indicate how often they

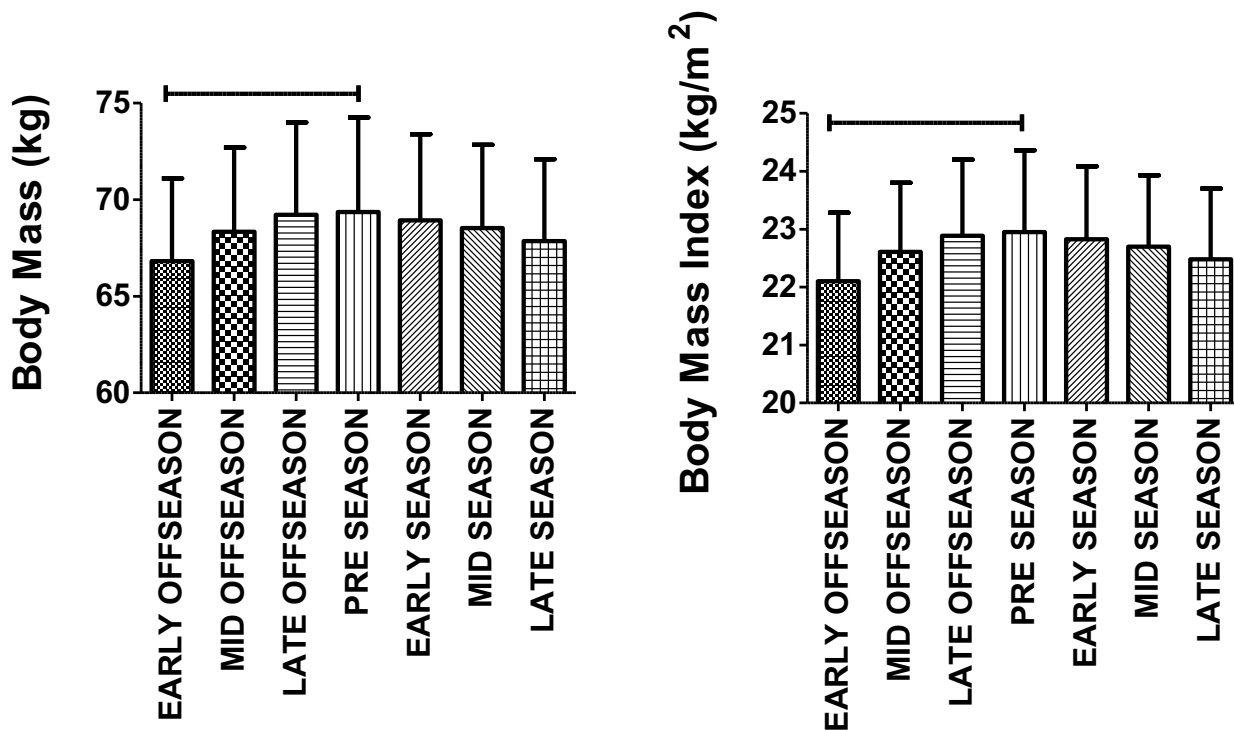
have felt or thought a certain way on a five point Likert scale (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often). A score ranging from 0 to 40 was determined based on the ten answers on the questionnaire, with a higher score indicating more stress.

*Statistical analysis*

Statistical analyses were performed by using the GraphPad Prism (GraphPad Software, Inc., La Jolla, CA) or PASW Statistics 20 (SPSS, Inc., Chicago, IL). Data for body mass, body mass index, percent body fat, fat mass, fat free mass were analyzed using one way repeated measures analysis of variance (ANOVA), followed by least square difference post hoc test. The Pearson’s product moment correlation coefficient was calculated to evaluate the association between variables. Significance was established at  $p < 0.05$ . Data are reported as mean  $\pm$  SD.

**RESULTS**

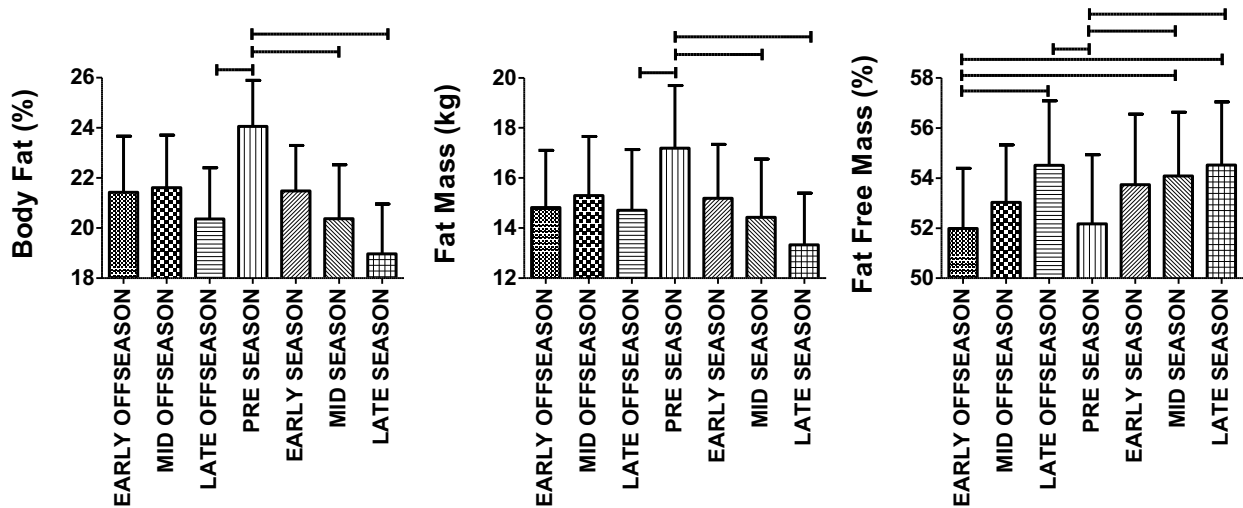
Both body mass and body mass index were significantly increased in pre-season compared to the early-offseason ( $p < 0.05$ ) (Figure 1). There were no other significant differences in body mass or body mass index at any other time point across the year.



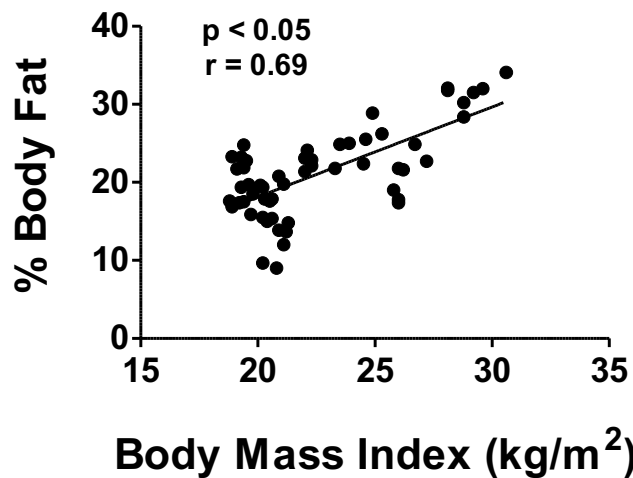
**Figure 1.** Body mass and body mass index of female volleyball players. Data are mean  $\pm$  standard deviation. Line indicates significant differences between the two time points indicated ( $p < 0.05$ ).

Analysis of body composition yielded several significant differences in absolute fat mass (fat mass reported in kg), relative fat mass (% of fat mass relative to total body mass), and relative fat free mass. Relative and absolute fat mass was highest during the pre-season and was significantly greater than late-offseason, mid-season, and late-season ( $p < 0.05$ ) (Figure 2).

Conversely, relative fat free mass was lowest during early-offseason and pre-season. Relative fat free mass was significantly lower during the early-offseason compared to the late-offseason, mid-season, and late-season time points ( $p < 0.05$ ) (Figure 2). Pre-season relative fat free mass was also significantly lower than late-offseason, mid-season, and late-season time points ( $p < 0.05$ ) (Figure 2). A significant correlation existed between BMI and relative body fat ( $p < 0.05$ ,  $r = 0.69$ ) (Figure 3).

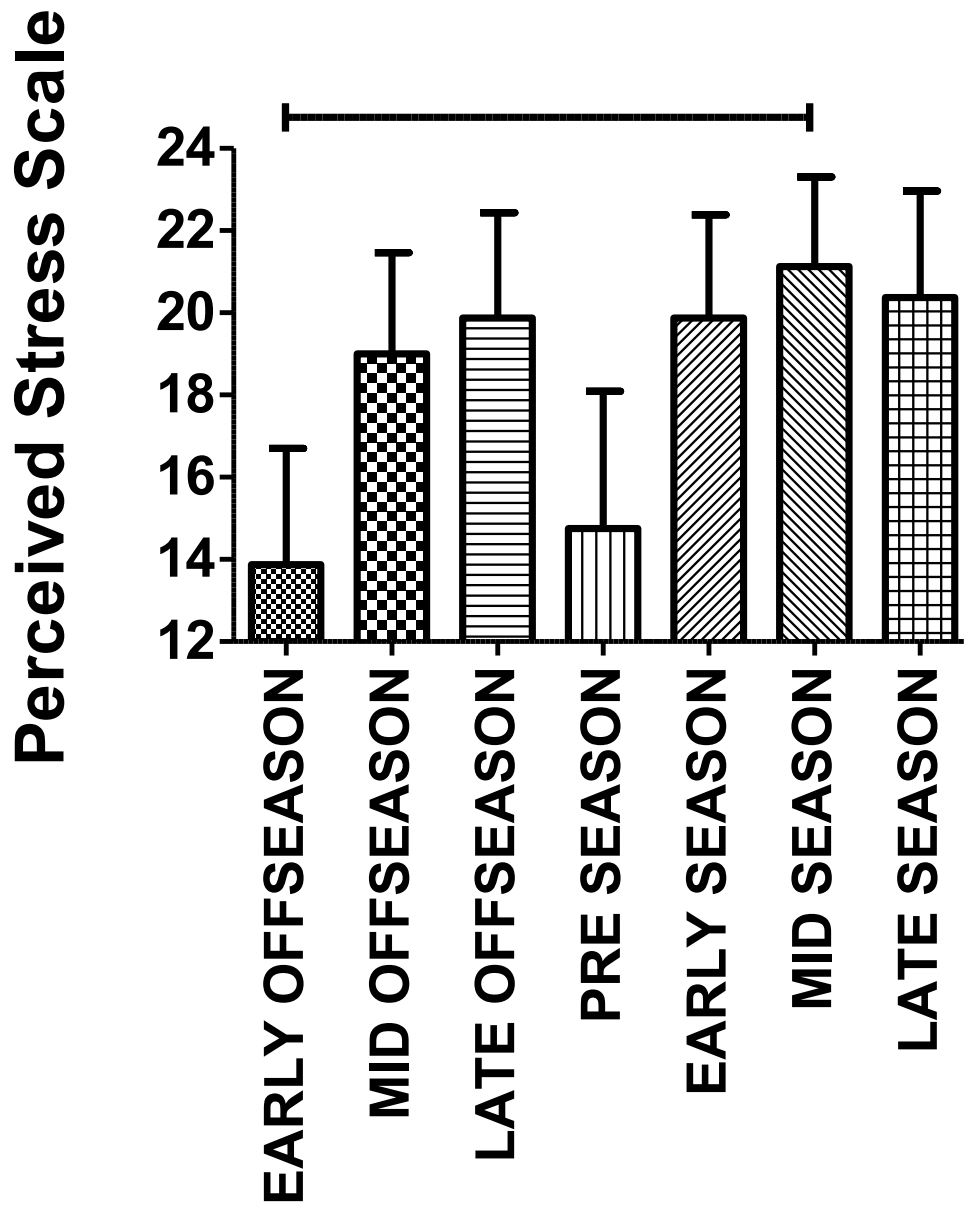


**Figure 2.** A) Percent body fat, B) fat mass, and C) fat free mass of female volleyball players. Data are mean  $\pm$  standard deviation. Line indicates significant differences between the two time points indicated ( $p < 0.05$ ).



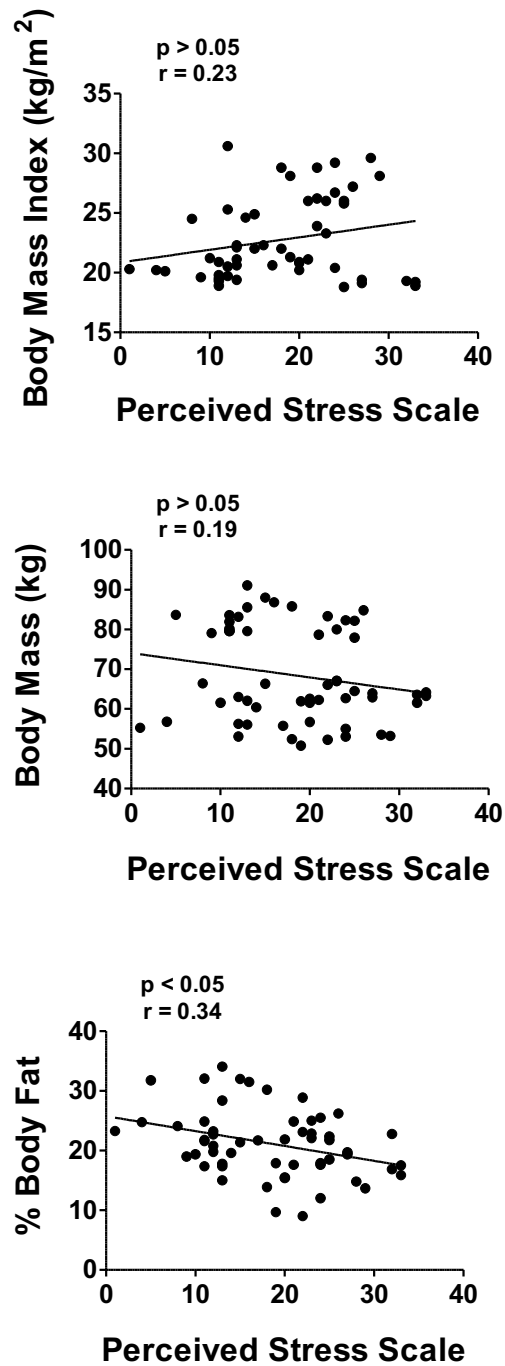
**Figure 3.** A significant correlation exists between measurements of BMI and percent body fat in female volleyball players.

Measurement of perceived stress peaked during the mid-season, however was only significantly different when compared to early-offseason ( $p < 0.05$ ) (Figure 4). No other significant differences were detected between time points in perceived stress.



**Figure 4.** Perceived stress scale of female volleyball players. Data are mean  $\pm$  standard deviation. Line indicates significant differences between the two time points indicated ( $p < 0.05$ ).

No significant correlations were detected when BMI and body mass were plotted against the perceived stress scale (Figure 5). Interestingly, a weak but significant correlation was present between relative body fat and perceived stress ( $p < 0.05$ ,  $r = 0.34$ ) (Figure 5).



**Figure 5.** Perceived stress plotted against A) body mass index, B) body mass, C) percent body fat. No significant differences existed between BMI and body mass, however a significant negative correlation was present between perceived stress and percent body fat.

## DISCUSSION

Tracking parameters of health in collegiate athletes across the calendar year poses the opportunity to observe the consequences of the varying stressors imposed upon athletes due to

the combination of high-performance athletics and academic pursuits. In the current study, we hypothesized that body composition and perceived stress scale scores in NCAA division I female volleyball players would change between the offseason and competitive season, however it appears that while body composition may differ between the seasons, perceived stress changes may more closely coincide with university schedules than the competitive season itself. Further discussion of our findings follows.

Body composition has been demonstrated to correlate with success in collegiate volleyball players, such that sport-specific performance is increased with a higher presence of fat-free mass and absence of fat mass (2, 17). Thus, manipulation of body composition serves as an important training variable that should be considered by trainers and coaches in order to optimize athletic performance. Indeed, the athletes observed in the current study demonstrated lower fat mass and increased relative fat free mass during the mid and late season compared to pre-season, likely aiding in their competitive success. Interestingly however, no significant changes were observed between these time points in body mass or BMI. Although measurements of body mass and BMI are easily obtained and can give insight about the status of body composition, their usefulness in a training setting may be limited due to the inability to reliably predict body composition values in female athletes (12, 14). For instance, our results show a positive correlation between body fat percentages and increasing BMI, however this correlation was not effective in explaining BMI and body composition changes when tracked over time. While BMI and body mass were higher when measured during the pre-season compared to the early off-season, there were no significant differences in body composition parameters between these two time points. Importantly however, significant differences were observed in fat mass, relative fat mass, and relative fat free mass between several time points that were not also accompanied by alterations in BMI or body mass. This is demonstrated by a decrease in body fat percentage and fat mass from pre-season to the mid and late season time points with a concurrent increase in relative fat free mass. Due to a lack of concomitant changes in BMI or body mass with body composition parameters, our findings support previous conclusions that BMI and body mass should not be used as a reliable means to infer on body composition parameters. Thus despite our findings that BMI and body fat are positively correlated, accurate measurements of body composition parameters themselves are required in order to be utilized for predictive means of performance and training status.

Due to the health risks of stress that can occur in competitive athletes (e.g. overtraining and injury), trainers should be knowledgeable of the stress imposed upon their athletes during competitive periods (8, 16). In this context, stress is considered the psychological condition that results from the relationship between demands placed upon a person and that person's resources to meet those demands (20). While certain degrees of stress can be beneficial to an individual's performance, negative emotions (anxiety, anger, etc.) can result if the demands exceed coping resources and detract from the ability to focus on performance. Our findings show that perceived stress in this cohort of athletes was significantly higher in the mid-season compared to the early-offseason time point. Of note, the lowest stress measurements were found immediately following winter break and during the summer break. Interestingly, no significant differences exist in perceived stress between time points in which athletes are participating in



competition as well as school (i.e. early, mid, and late season) compared to just in school (i.e. mid and late off season). This finding lends itself to the idea that perceived stress in these athletes may not be as heavily influenced by athletic events during the season and may be more a consequence of the temporal relation to the academic school year. This finding may be of interest, because the competitive season can be viewed as having additive potential stressors such as team travel and competition (20). It is plausible that the added stressors may be offset by the participation in physical activity, as physical activity has been demonstrated to alleviate stress (21, 25). Specifically, sport participation has also been demonstrated to be more effective in reducing stress levels than leisure-time physical activity (31). Overall, these findings agree with previous findings in our lab (12), and further enforce the conclusion that changes in perceived stress may be more due to the challenges that occur in social and academic settings, or are offset by stress relieving outlets provided by sport participation.

Previous reports have sought to determine the association between psychological states and impact on body composition (10, 30). While mixed evidence exists for the association between stress and adiposity, reports that demonstrate this association often find a positive correlation between the two (30). Indeed, a recent study by Jackson et al. observed a positive correlation between physiological markers of stress and adiposity in a large population of both men and women (9). Interestingly, we show a small but significant negative correlation between body fat percentage and perceived stress, suggesting that stress may have an opposite effect in collegiate athletes than what may be expected in a normal population. While the current study does not control for the multiple variables that could be affecting this observation, a negative correlation in these athletes between stress and body fat may be explained by pressure to maintain or lose weight by coaches or fellow athletes (18). Another possibility is that these athletes implement different stress relieving habits to combat stress. While eating is an often cited strategy to manage stress, perhaps these athletes turn toward physical activity as a combative strategy. Thus, an increase in caloric expenditure could result in a greater degree of fat loss helping to explain this negative correlation.

In conclusion, understanding how stress and body composition fluctuate throughout a year may provide important insight to the condition of athletes that undergo large degree of alterations in their everyday life schedule due to participating in collegiate athletics. Our results further support the idea that while body composition is an important tool to assess training status, BMI is not a good indicator of body composition and should likely be avoided for training purposes in athletes. It also appears that added stressors during the competitive season are either not strong enough to increase perceived stress in female volleyball athletes, or that the benefits reaped for participation in the sport provides a successful counter-measure for dealing with the stressors. Finally, our finding of a negative correlation with body fat and perceived stress suggests that the environment or the athletes themselves respond differently to stress than what may be expected in normal populations. Further research is needed to validate our findings and assess the impact on performance.

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