

# AMENORRHEA AND STRESS FRACTURES IN FEMALE NEW JERSEY DIVISION III COLLEGIATE RUNNERS: AN OPPORTUNITY FOR INCREASED HEALTH EDUCATION

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**BACKGROUND:** In the National Collegiate Athletic Association (NCAA), 9.1% of the injuries reported by women's cross-country athletes between 2014-2019 were fractures. Both history of amenorrhea and prior stress fractures have been found to predict incidence of subsequent bone stress injuries among female athletes. Although excessive exercise is a major contributor to the development of amenorrhea, there are currently no studies on the association between amenorrhea and stress fractures in New Jersey (NJ) National NCAA Division III Women's cross country or track athletes. This study aims to determine if there is an association between incidence of amenorrhea and subsequent occurrence of stress fractures among this population, and to identify a possible area for increased reproductive health education.

**METHODS:** This is a survey-based study. Participants were female athletes over the age of 18 who currently participate in collegiate cross country or track running at a NJ Division III school. Coaches of the Division III cross country and track teams in NJ distributed the survey to their female athletes to gain participants for this study. Survey data included information on participant menstrual history, stress fracture history, and athletic involvement. Participants also indicated if their school's staff had ever educated them on the importance of menstrual regularity and athletics. Descriptive statistics and comparison between groups were analyzed.

**RESULTS:** In total, 68 survey responses were collected. Survey respondents included female NJ cross country and track athletes ages 18-23, from a total of eight institutions. During training or competition, 58.8% of the study participants missed at least one menstrual cycle and 45.6% experienced a stress fracture. There is a significant association between having missed at least one menstrual cycle during training or competition and the number of stress fractures experienced by the athlete ( $p = 0.044$ ). Only 30.9% of respondents indicated that someone from their school's staff spoke to them about the importance of maintaining regular menstruation during training.

**CONCLUSION:** This study confirms that both amenorrhea and stress fractures are commonly seen among NJ NCAA Division III female cross country and track athletes. Our data also highlights a need for increased education of NJ Division III female athletes regarding the importance of maintaining regular menstruation as a means of stress fracture prevention. Further investigation of the role of amenorrhea on the incidence of stress fractures may shine light on an important area for prevention and increased health education.

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## INTRODUCTION

Among the three National Collegiate Athletic Association (NCAA) divisions, female athletes participating in repetitive-impact sport training are at a higher risk for bone stress injuries.<sup>1</sup> The sports

at the highest risk for bone stress injuries are women's cross country, women's track and women's gymnastics.<sup>1</sup> Across the three NCAA divisions, Division II and Division III athletes show

higher rates of bone stress injuries compared to Division I athletes.<sup>1</sup>

Among young women, amenorrhea resulting from low weight, excessive exercise, or high stress levels is common.<sup>2</sup> Specifically, the risk of developing amenorrhea among young, high-level runners may increase due to excessive exercise and the inability to meet the body's energy needs.<sup>2</sup> This is most impactful for young-adult, female athletes with menstrual irregularities who show higher risk for stress fractures compared to eumenorrheic athletes.<sup>3,4</sup> In a 2021 study by Hutson et al., incidence of bone stress injury was 2.25 times higher in amenorrhoeic runners compared to eumenorrheic runners.<sup>4</sup> Both history of amenorrhea and prior stress fracture predict incidence of subsequent bone stress injuries among female athletes.<sup>5</sup>

The Female Athlete Triad describes the impact of energy availability, menstrual function, and bone mass on female athletes.<sup>6</sup> Dysfunction in any of these Triad categories leads to increased risk of bone stress injuries.<sup>6</sup> In a study of female athletes assessed based on the Female Athlete Triad Cumulative Risk Assessment Score, cross country runners contributed the majority of bone stress injuries reported (64%).<sup>5</sup> In the NCAA, 9.1% of the injuries reported by women's cross-country athletes between 2014-2019 were fractures.<sup>7</sup>

While the Female Athlete Triad seems to be linked to high rates of stress fractures in collegiate female runners, current research indicates that there is an overwhelming lack of Triad education among female cross-country athletes and coaches.<sup>8,9</sup> A lack of education on the relationship between Triad components and risk for stress fractures may be driving the high rates of both outcomes among this population.

Although previous research has shown that excessive exercise is a major contributor to the development of amenorrhea and possible subsequent stress fractures in collegiate runners, there are currently no studies on the association between amenorrhea and stress fractures in New Jersey (NJ) NCAA Division III women's cross country or women's track athletes. This population is of interest due to the higher rates of bone stress injuries in Division III female runners, as well as the current lack of substantial research focusing on Division III athletes at large. Focusing on a single state allows us to better address a particular population that may benefit from increased

education regarding athletic training habits and reproductive health.

This study aims to determine if there is an association between incidence of amenorrhea and subsequent occurrence of stress fractures among NJ NCAA Division III women's cross country and track athletes. Understanding the presence of amenorrhea as a risk factor for stress fractures can help to guide interventions to aid in decreasing the high prevalence of stress fractures among collegiate female runners. Secondly, this study also aims to determine if our target population is receiving education surrounding the importance of maintaining a regular menstrual cycle in athletics.

## METHODS

This is a retrospective, survey-based study. The study was approved by the Institutional Review Board of Rowan University. The survey was implemented between June and August 2022. All participants voluntarily completed the survey and responses remained anonymous. Written informed consent was obtained from all participants in this study. The survey was conducted via Qualtrics, and all data was securely stored on the Qualtrics website. Survey data included information on participant menstrual history, stress fracture history, and athletic involvement. Participants also indicated if their school's staff had ever educated them on the importance of menstrual regularity and athletics (Appendix 1).

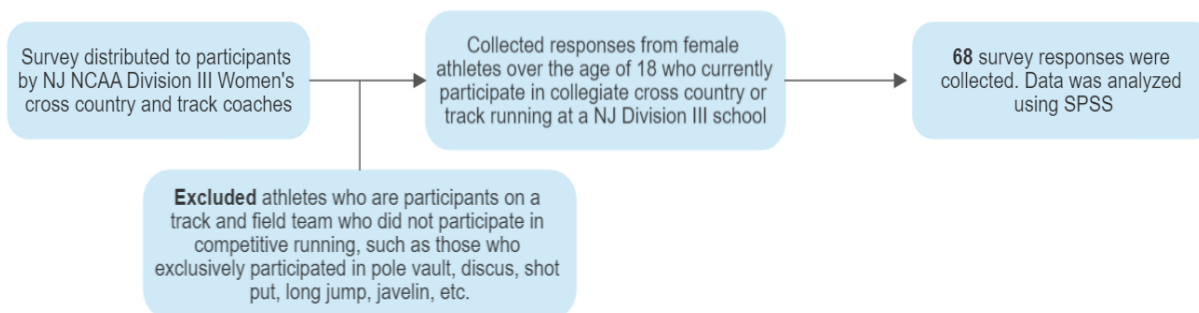
To participate in this study, participants needed to meet the following inclusion criteria: female college athlete over the age of 18 who currently participates in collegiate cross country or track and field running at a New Jersey Division III school. Fulfillment of inclusion criteria was self-reported by participants. Survey responses were screened by study personnel to confirm that the inclusion criteria were adequately fulfilled. Participants were excluded from the study if they were participants on a track and field team who did not participate in competitive running, such as those who exclusively participate in pole vault, discus, shot put, long jump, javelin, etc. (Figure 1).

The study survey was distributed via email to all of the NJ Division III women's cross country and/or track and field coaches. Coaches of these teams were asked to distribute the survey to their female athletes to gain participants for this study. Among the 13 schools with Division III cross country and/or track teams in NJ, female athletes from Montclair State University, New Jersey City

University, Ramapo College of New Jersey, Rowan University, Rutgers University Camden, Stevens Institute of Technology, Stockton University, and The College of New Jersey elected to participate in this study.

At the conclusion of the study, the survey was closed to participation and data was exported for

statistical analysis to IBM Statistical Package for Social Sciences (SPSS) for Windows, Version 28.0 (Armonk, NY). Data was analyzed using descriptive statistics, and independent samples t-tests were used to compare means. A significance level of  $p < 0.05$  was used.



**Figure 1.** Schematic representing survey distribution method and study inclusion/exclusion criteria

## RESULTS

In total, 68 survey responses were collected. Survey respondents included female NJ cross country and track athletes ages 18-23 from a total of eight different institutions. It is estimated that the total size of our population of interest is 225 female collegiate runners from a total of 13 institutions. Therefore, we received about a 30% response rate from our intended population of NJ Division III female cross country and track runners.

Out of the 68 participants, 58.8% missed at least one menstrual cycle during a period of competition or training. The lapse in menstrual cycle could have occurred during any period of time in which the

athlete was participating in competition or training for cross country or track and field. No missed menstrual cycles were due to pregnancy. Of those who missed their menstrual cycle, 50% missed their menstrual cycle for 3 or more consecutive months and 75% experienced menstrual irregularity more than once. Additionally, out of the 68 participants, 45.6% experienced a stress fracture during training or competition. Of those who experienced a stress fracture, 32.3% experienced more than one stress fracture and 32.3% experienced their stress fracture within 6 months of missing their menstrual cycle (Table 1).

**Table 1.** Frequency (%) of athletes experiencing menstrual irregularity and stress fractures during training or competition. Participant responses to the listed survey questions are reported in number of respondents

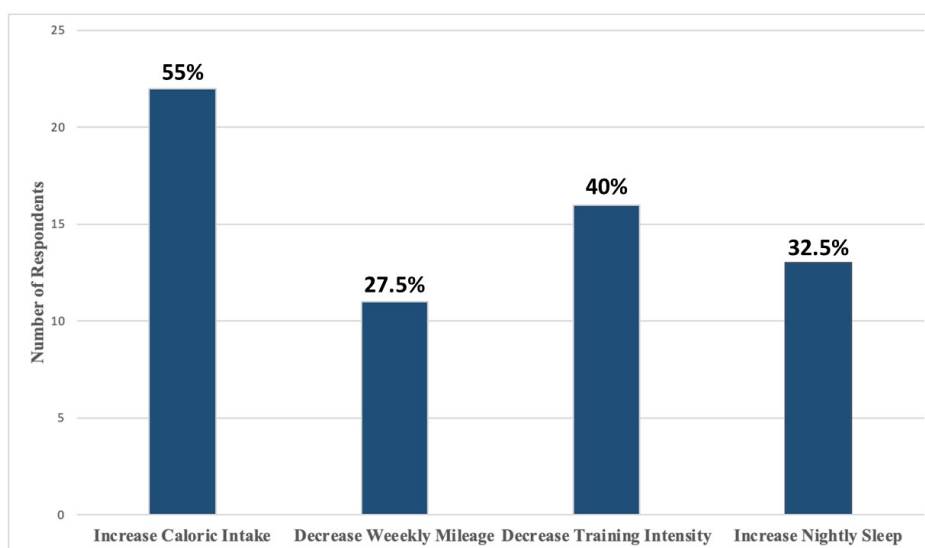
	Yes	No
Have you ever missed your menstrual cycle during a period of training or competing?	40 (58.8%)	28 (41.2%)
Of those who missed their menstrual cycle (n=40), did you experience menstrual irregularity more than once?	30 (75%)	10 (25%)
Have you ever experienced a stress fracture when training or competing?	31 (45.6%)	37 (54.4%)
Of those who experienced a stress fracture (n=31), did you experience more than one stress fracture?	10 (32.3%)	21 (67.6%)
Of those who experienced a stress fracture (n=31), did this stress fracture(s) occur during or within 6 months of missing your menstrual cycle?	10 (32.3%)	21 (67.6%)

Statistical analysis revealed that there is no significant difference between rate of stress fractures and age ( $p=0.971$ ), academic year ( $p=0.537$ ), or weekly mileage ( $p=0.462$ ). We found no significant difference among the rates of stress fractures and participation in short-distance ( $p = 0.803$ ) or long-distance ( $p = 0.841$ ) running events. There is also no significant difference among the rates of stress fractures occurring within 6 months of missed menstruation and participation in short-distance ( $p = 0.145$ ) or long-distance ( $p = 0.157$ ) running events. Alternatively, there is a statistically significant association between having missed at least one menstrual cycle during training or competition and the number of stress fractures experienced by NJ Division III female cross country and track athletes ( $p = 0.044$ ).

Among the respondents who had missed at least one menstrual cycle during competition or training, restoration of the athlete's monthly

menstrual cycle was reported after increasing caloric intake in 55% of respondents, decreasing weekly mileage in 27.5% of respondents, decreasing training intensity in 40% of respondents, and increasing nightly sleep in 32.5% of respondents (Figure 2). Selection of multiple responses was allowed in this survey question. A combined selection of increasing caloric intake, decreasing weekly mileage, and decreasing training intensity was the most common response among participants.

In regard to athletic staff communication on this topic, only 30.9% of respondents indicated that someone from their school's staff, including coaches and athletic trainers, spoke to them about the importance of maintaining regular menstrual cycles during training. Responses varied based on the collegiate university attended by the athlete (Figure 3).

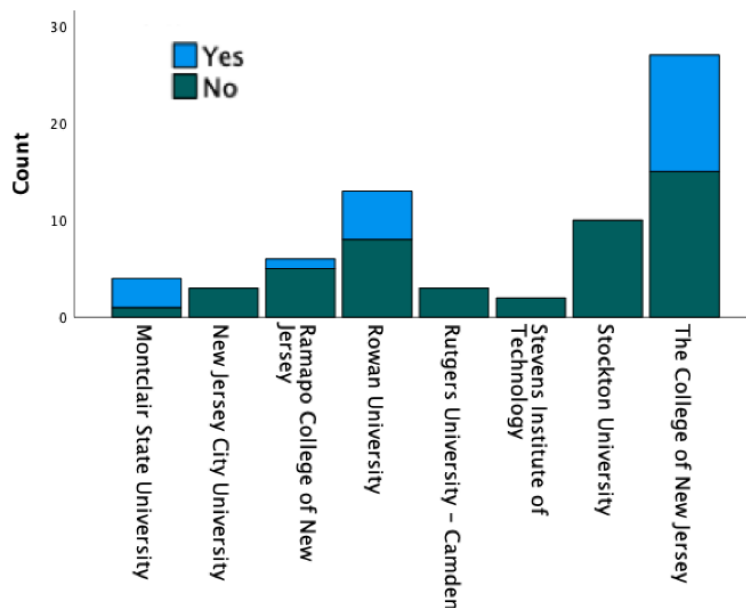


**Figure 2.** Self-reported behavioral changes that led to restoration of a regular menstrual cycle among respondents who had lapses in their menstrual cycle during times of training or competition. Percentages are based on the 40 out of 68 athletes who indicated a lapse in their menstrual cycle during a period of training or competition

## DISCUSSION

In accordance with prior research, our study demonstrates that amenorrhea and stress fractures are commonly seen among NJ NCAA Division III female cross country and track athletes, indicating a population in need of interventions to decrease the high prevalence of both outcomes.<sup>4,5</sup> We found a significant association between incidence of

amenorrhea for at least one menstrual cycle and the number of stress fractures experienced by the female athletes in our study. These findings further support the associations described in the Female Athlete Triad, which outlines the impact of energy availability, menstrual function, and bone mass on female athletes. Dysfunction in any of the Triad categories leads to increased risk of bone stress



**Figure 3.** Number of respondents indicating if someone from their school’s staff, including coaches and athletic trainers, had spoken to them about the importance of maintaining a regular menstrual cycle during training. Responses are organized based on the collegiate institution attended by the athlete

injuries.<sup>6</sup>

Data from this study may also help to identify behavioral changes that could be recommended to athletes experiencing lapses in their menstrual cycle. About a quarter to a half of our survey respondents who experienced lapses in the menstrual cycle found restoration of a regular menstrual cycle after increasing caloric intake, decreasing weekly mileage, decreasing training intensity, and/or increasing nightly sleep. These behaviors can also become incorporated in strategies to prevent the development of both amenorrhea, as well as stress fractures, in female athletes competing in collegiate cross country and track.

Our data also suggests a need for increased education of NJ Division III female cross country and track athletes regarding the importance of maintaining regular menstrual cycles during their athletic training. In a study of high school female athletes at large, it is reported that almost half of these athletes believe that lack of menstruation is a “normal” consequence of high athletic training demand.<sup>10</sup> We feel that this perception remains true for collegiate female runners, thus indicating a population in need of increased health education. Since more than half of our respondents reported experiencing missed menstruation during

competition or training, athletes may see these trends as a “normal” occurrence. Without education on the negative effects of missed menstruation during athletic training, athletes may be unable to identify and rectify the problem before it leads to stress fractures or other adverse health outcomes.

Current literature indicates that education is needed for both athletes and coaches regarding the Female Athlete Triad.<sup>8</sup> In a study of Female Athlete Triad recognition among NCAA cross country coaches, more Division I coaches demonstrated recognition of Triad components compared to Division II and Division III coaches.<sup>8</sup> The lack of education and recognition of Triad components among coaches of Division III female runners may contribute to the lack of menstrual education seen among our study participants.

In addition to coaches, athletic training staff should be an important source of health education for female collegiate runners. Lodge et al. found that almost 90% of collegiate athletic trainers reported training about the Female Athlete Triad, while less than 40% of collegiate women’s cross country coaches and about 30% of collegiate female cross country athletes reported training on this topic.<sup>9</sup> The reported percentage of athletes receiving Triad training is similar to our study’s percentage of athletes who reported hearing from their school’s



athletic staff about the importance of maintaining a regular menstrual cycle during training. Although education on the Female Athlete Triad among athletic trainers is high, there does not seem to be strong dissemination of this knowledge among women's cross-country coaches and athletes. This likely contributes to the lack of Triad recognition among athletes and coaches, compared to NCAA athletic trainers.<sup>8,11</sup>

While Triad recognition is high among athletic trainers throughout Division I - III institutions, referral to outside resources, such as nutritionists or dietitians, for support of athletes in Division II and III was significantly less common compared to the referrals from Division I athletic trainers.<sup>11</sup> In conjunction with the current literature and the data from our study, we see that Division III athletes are lacking both menstrual education, as well as external resources for prevention of the development of Triad characteristics. This can further perpetuate the high rates of both amenorrhea and stress fractures among Division III female cross country and track athletes.

Therefore, we suggest the implementation of reproductive health education programs for NJ Division III female athletes, which can help to highlight the importance of maintaining regular menstrual cycles as a means of stress fracture prevention. We also support the training of coaches and athletic support staff in communicating with athletes regarding maintaining their menstrual health throughout training and competition. By educating the coaches and athletic support staff who interact with these female athletes, we can positively impact both the current cohort of NJ female cross country and track runners, as well as the future generations of runners who will join these programs.

#### *Limitations*

Specific limitations impacting this study include the small sample size and low response rate from specific Division III schools. This study would benefit from an increased sample size, which may allow for more expansive statistical correlations to arise. A greater sample size would also allow for more confidence in the generalizability of the frequencies measured among our sample population compared to the at large population of NJ Division III female cross country and track athletes. Our study also failed to receive participation from female athletes attending five of the 13 NJ NCAA Division III schools with a cross

country or track and field team. Our study would benefit from participation from athletes attending these schools, which may help to increase our understanding of amenorrhea and stress fracture rates among the entire NJ NCAA Division III female cross country and track athlete population.

Among those who elected to participate in our study, there may be a selection bias from athletes with previous history of amenorrhea or stress fractures. We acknowledge that those experiencing amenorrhea or stress fractures in the past may have been more likely to participate in our survey, which could skew our study results.

Additionally, our study highlights specific behavioral changes that resulted in restoration of a regular menstrual cycle among our study participants, but we recognize that there are other factors that may have played a role in this outcome, which were not evaluated in this study. For example, correction of the abnormal menstrual cycle may have been influenced by the use of hormonal contraception rather than specific changes in behavior among these athletes.

#### *Future Directions*

This work prompts the need for future investigation of the rates amenorrhea and stress fractures among female cross country and track athletes not only in NJ Division III schools, but also among Division III athletes at large. With the high rates of stress fractures experienced by runners on NCAA Women's cross country and Women's track and field teams, further investigation of amenorrhea as a risk factor for stress fractures may shine light on an important area for prevention and increased health education.

#### **CONCLUSION**

Amenorrhea and stress fractures are seen in high numbers among female New Jersey Division III collegiate runners. Missing at least one menstrual cycle is linked to an increase in the number of stress fractures experienced by these athletes. Although amenorrhea is a significant risk factor for bone stress injuries, education of these athletes regarding the maintenance of a regular menstrual cycle is lacking. Increasing education of NJ Division III cross country and track athletes, as well as their coaches, is crucial to addressing this health concern for our collegiate female athletes.

### Conflict of Interest Statement

This study was financially supported by the Rowan University Summer Medical Research Fellowship (SMRF) Program. The authors report no conflict of interest with the contents of this manuscript.

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## APPENDIX 1. Study Survey

### Participant Information:

1. Gender (Male/Female/Other)
2. Age
3. Academic year (Freshman, Sophomore, Junior, Senior, 5th Year Senior)
4. School (Centenary University, Drew University, Fairleigh Dickinson University, Montclair State University, New Jersey City University, Ramapo College of New Jersey, Rowan University, Rutgers University-Camden, Rutgers University-Newark, Saint Elizabeth University, Stevens Institute of Technology, Stockton University, The College of New Jersey)
5. Athletic Event (Select all that apply)
  - a. Long distance (3,000m - 10,000m race)
  - b. Middle distance (800m - 3,000m race)
  - c. Short distance (<800m)
6. Average Weekly Mileage
  - a. <20 miles per week
  - b. 20-30 miles per week
  - c. 30-40 miles per week
  - d. 40-50 miles per week
  - e. >60 miles per week

### Medical History:

1. Age of menarche (first menstrual cycle)
2. How many menstrual periods have you had in the past 12 months?
3. Have you ever used a form of birth control? (Yes/no)
  - a. If yes, what form of birth control? (Oral birth control, IUD, hormonal ring, patch, implant)
  - b. If yes, when did you start?
  - c. If yes, are you currently using this form of birth control? (Yes/no)
  - d. If not, when did you stop?
4. Have you ever missed your menstrual cycle during a period of training or competing? (Yes/no)
  - a. If yes, for how many consecutive months?
  - b. If yes, have you experienced menstrual irregularity more than once? (Yes/no)
5. Was the missed menstrual cycle due to pregnancy? (Yes/no)
6. Did any of the following help to restore monthly menstruation? Select all that apply.
  - a. Increased caloric intake
  - b. Decreased weekly mileage
  - c. Decreased training intensity
  - d. Increased nightly sleep
7. Have you ever experienced a stress fracture when training or competing? (Yes/no)
  - a. If yes, how many stress fractures?
  - b. If yes, where were the stress fractures?
  - c. In what year(s) did the stress fracture(s) occur?
  - d. Did this stress fracture(s) occur during or within 6 months of missing your menstrual cycle? (Yes/no)
8. Has anyone in your school's athletic staff spoken with you about the importance of regular menstrual cycles during training?