**Article Full Title**

Preventive Osteopathic Manipulative Treatment and Stress Fracture Incidence Among Collegiate Cross-Country Athletes

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**Paper Abstract**

Stress fractures occur often among athletes, particularly distance runners, and many theories have been offered regarding the etiologic process of this condition. The authors applied a preventive osteopathic manipulative treatment protocol for cross-country athletes to evaluate the protocol's effect on the incidence of stress fractures over the course of several years. Stress fracture of the lower extremity is a common injury among athletes, particularly distance runners. Track-and-field sports account for up to 50% of all stress fractures in male athletes and 64% in female athletes.1 Most of the literature in this area is retrospective and comes from studies of cross-country and track- and-field athletes, as well as military recruits. Studies of athletes have reported incidence of stress fracture from 3.9% to 31.3%.2-5 Similarly, studies of military recruits report the incidence of stress fracture from 1% to 31%.6-8 In military studies,7-10 stress fractures are more often diagnosed in women. In studies of male and female athletes, however, the data have been inconclusive. Goldberg and Pecora11 and Hickey et al12 reported a higher incidence of stress fractures in women compared with men, although Bennell et al3 reported a similar incidence of stress fractures among male and female athletes. The etiologic process of stress fracture is widely debated in the literature. Romani et al13categorized stress fracture as a chronic overuse injury due to accelerated bone remodeling. Giladi et al14 and Milgrom et al,15 however, have questioned this distinction, with diagnosis most prevalent in the first month of activity. There are many competing theories for the development of a stress fracture. In the most prominent theory in the literature, osteoblast activity lags behind osteoclast activity and leaves a bone susceptible to microfractures.16 Other researchers have theorized different causes for stress fracture, including repetitive stress at the insertion point of a muscle,16 an initial prolonged focal impaired perfusion of the bone seen in prolonged activity,17 and smaller cross-sectional area that decreases bone strength.14,16,18 Researchers16 have proposed and studied a variety of risk factors for stress fractures, including previous diagnosis of stress fracture, participation in sports involving running and jumping, rapid increase in a physical training program, poor preparticipation physical condition, running on irregular or angled surfaces, inappropriate footwear,19 inadequate muscle strength, poor flexibility, and type A personality. An increased incidence of stress fracture was observed in athletes with high longitudinal arch, excessive forefoot varus, increased hip abduction, and peak rearfoot eversion compared with athletes without these biomechanical traits.20,21 Edwards et al22(using a probabilistic model based on published relationships of bone damage, repair, and adaptation) and Milner et al23 reported a lower incidence of stress fracture with decreased running speed and average vertical loading rate. In addition, women who developed a stress fracture had a statistically significant difference in the following categories: greater leg length difference, later age of menarche, lower fat intake, higher calcium intake, and decreased calf girth.24 Other contributing factors to stress fracture development in women have been noted in the literature, including low bone mineral density, nutritional deficiencies, eating disorders, menstrual disturbances, and amenorrhea.4,16,24 One complication that arises for any investigator is that stress fracture is not consistently defined in published research. In previous studies, stress fracture was diagnosed after clinical presentation and confirmed by means of radiography or triple-phase bone scintigraphy24 or by means of clinical presentation and confirmation by triple-phase bone scintigraphy and computed tomography.19 Only 50% of radiographs, however, reveal a known stress fracture.16 Magnetic resonance (MR) images convey stress fracture and stress reaction better than bone scans.25 Given the multifactoral nature of stress fracture and lack of agreement among authors for given risk factors, prevention of stress fracture is not effectively described in the literature. Suggestions for preventive measures have included adequate stretching during warm-up, gradual increase in exercise intensity, lightweight footwear in good condition, level running surfaces, custom orthotics to address biomechanical concerns, and shock-absorbing insoles.16 The objective of the present study was to investigate the relationship between somatic dysfunction and the incidence of stress fracture in collegiate student-athletes. Somatic dysfunction is defined as impaired or altered function of related components of the somatic system including skeletal, arthrodial, and myofascial structures and related vascular, neural, and lymphatic elements.26 Specifically, we set out to assess the impact of regular, preventive osteopathic manipulative treatment (OMT) on stress fracture incidence in a group of collegiate student-athletes who had not previously engaged in regular preventive OMT. To the authors' knowledge, there are no studies to date that examine the relationship between somatic dysfunction and stress fracture incidence. We conducted the present study to apply a preventive OMT protocol for cross-country athletes, which we hypothesized would reduce the incidence of stress fractures in this population.

**NIH Risk of Bias Tool**

Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies

**Was the research question or objective in this paper clearly stated?**

Yes

**Was the study population clearly specified and defined?**

Yes

**Was the participation rate of eligible persons at least 50%?**

Yes

**Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?**

Yes

**Was a sample size justification, power description, or variance and effect estimates provided?**

Cannot Determine, Not Reported, Not Applicable

**For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?**

Yes

**Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?**

Yes

**For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?**

No

**Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?**

Yes

**Was the exposure(s) assessed more than once over time?**

Yes

**Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?**

Yes

**Were the outcome assessors blinded to the exposure status of participants?**

Yes

**Was loss to follow-up after baseline 20% or less?**

Yes

**Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?**

No

**Key Finding #1**

The study’s results indicate implementation of a preventive osteopathic manipulative treatment protocol for cross-country athletes resulted in a statistically significant decrease in the cumulative annual incidence of stress fractures for men.

**Key Finding #2**

There was no statistically significant decrease in the incidence of stress fractures for women who received osteopathic manipulative treatment in this study.

**Key Finding #3**

The study hypothesizes that the lack of a statistically significant decrease in the incidence of stress fracture in women when compared to men may be due to somatic dysfunction contributing less to the etiologic process of stress fracture development in females. The study hypothesizes that the etiologic process of stress fracture in female athletes may be complicated by the “female athlete triad.” Ultimately, this decreases the influence of somatic dysfunction on the development of stress fractures, making the impact of osteopathic manipulative treatment decreased compared to the male athletes. However, this hypothesis requires additional research to make conclusive statements.

**Please provide your summary of the paper**

This study was conducted over the course of five consecutive academic years on NCAA Division I cross-country athletes. Researchers utilized data from the 8 academic years prior to the start of the study to better understand the effects of osteopathic manipulative treatments on male and female cross-country runners. The study utilized a standardized protocol that consisted of evaluation and treatments of the pelvis, sacrum, and lower extremity. Techniques used consisted of muscle energy and articulatory techniques, as well as 3 high-velocity and low-amplitude techniques, which were used to treat cuboid, navicular, and superior innominate shear dysfunctions. Participants continued their usual training throughout the course of the study.

The results of the study indicated that there was a statistically significant decrease in stress fracture incidences in the male athletes when comparing pre to post osteopathic manipulation treatment data. Male stress fracture incidences decreased from 13.9% before intervention to 1.0% after intervention. However, female stress fracture incidence decreased from 12.9% to 12.0%, which was not statistically significant.

The researchers acknowledged the complexity of stress fractures and indicated a continued need to study the factors contributing to the development and treatment of stress fractures to improve patient’s outcomes. Researchers hypothesized an increase in the complexity of the development of female stress fractures influenced by the female athlete triad, which may have contributed to the lack of response to the osteopathic manipulative treatments. Overall, research should continue to investigate this topic.

**Please provide your clinical interpretation of this paper. Include how this study may impact clinical practice and how the results can be implemented.**

This study indicates the possibility of osteopathic manipulative treatments aiding in the prevention of stress fracture development in NCAA Division I cross-country male athletes. This finding is significant as “track-and-field sports account for up to 50% of all stress fractures in male athletes.” Implementing these techniques to prevent stress fractures may reduce the overall usage of curative medical services by these athletes. Additionally, avoidance of stress fracture development may enable male athletes to achieve long-term goals due to years of continued health, which is in the best interest of the athletes, coaches, and universities.

This research may influence clinical care by encouraging professionals in the sports world to utilize these techniques for prevention of stress fractures in male cross-country athletes. Unfortunately, this study does not indicate a statistically significant decrease in stress fracture incidences in female athletes, which will likely not influence usage of these techniques for female cross-country runners.

The study indicates there is a lack of understanding of factors contributing to stress fracture development and treatment. This study may help renew interest on the topic, influencing the development of future studies. The results of this study indicate there may be additional complexity in the development of stress fractures in the female athlete, which may prompt future researchers to develop studies to better understand these factors and the role of osteopathic manipulative therapy in the prevention of stress fracture development.