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INTRODUCTION

Stress fractures account for 10-20 % of all injuries in sports medicine.^{1,2} Characterized as an overuse injury, stress fractures are caused by repeated trauma during which the bones attempt to remodel themselves to adapt to the stresses placed upon them. Physiologically, the remodeling process weakens the bone resulting in microfractures which eventually lead to the development of stress fractures.¹

Consequently, in high-risk populations such as military trainees and collegiate track and field and other high-risk sports, stress fractures represent a significant time loss and a financial cost. Therefore, prevention by way of vitamin D supplementation has been investigated in military and athletic organizations alike.

CLINICAL QUESTION

In high-risk, physically active adults, does the effect of vitamin D supplementation on serum 25-hydroxyvitamin D [25(OH)D] concentrations affect the occurrence of stress fractures?

METHODS

Search Terms:

- Stress fractures, supplementation, vitamin D, 25OHD, athletes, military

Sources of Evidence:

- Pubmed
- Google Scholar
- ClinicalKey
- ScienceDirect
- EBSCO Host

Inclusion Criteria:

- Studies that investigated vitamin D supplementation as an intervention
- Studies that include athlete and military populations
- Limited to English language studies
- Studies within the last 10 years (2012-present)
- Limited to studies with a level of evidence of 2 or higher

Exclusion Criteria:

- Studies that did not assess the rate of stress fractures
- Studies that did not investigate vitamin D supplementation
- Studies that assessed other prevention measures (biomechanics, footwear, etc.)

Table 1 Summary of Best Evidence

Characteristic	Williams et al. ³	Millward et al. ⁴
Study Design	Prospective Cohort Study	Prospective Cohort Study
Participation	118 collegiate athletes (30 males and 88 females; mean age 19.7±1.19) from six NCAA Division 1 teams from a single university. Data from 453 unknown subjects from 2010-2015 seasons were used in the retrospective component of the study. No subjects were excluded.	802 college athletes (497 male; mean age 18.7±1.2 and 305 female; mean age 18.6±1.2) from a single NCAA Division 1 university from 2012-2018. Participants must be on a team for a minimum of 4 months and have no evidence of a past history of stress fractures. All participants had blood drawn to measure serum Vitamin D to determine supplementation.
Intervention	Participants completed a questionnaire to record data for demographics, health perceptions, current supplementation, and menstruation (female participants only). Blood samples were taken in August and February to examine seasonal effects on vitamin D status. Participants with 25(OH)D levels of <30 ng/mL during the August, February or both testing periods were provided with an 8 week, once daily 50,000 IU oral vitamin D capsule. Capsules were distributed by their respective athletic trainer. Participants were monitored throughout their season and stress fractures were recorded.	Participants provided blood samples that were analyzed for serum 25(OH)D levels. A lower limit of 40 ng/mL was chosen and those with a level <20 ng/mL and between 20-39 ng/mL were provided with 50,000 and 30,000 IUs of vitamin D supplements for 8 weeks. A second blood sample was taken at the time of diagnosis for stress fractures and stress reactions by a university physician.
Outcomes (Primary)	The incidence of diagnosed stress fractures assessed by an athletic trainer and confirmed by a physician using their choice of imaging modality.	Diagnosed stress fractures and stress reactions as recorded in participant medical records and confirmed by either radiographs or MRI scans.
Main Findings	1.69% of the current sample were diagnosed with stress fractures. Retrospective data revealed 7.51% of 453 developed stress fractures. A significant reduction (p=.01) in stress fracture incidence was found compared to the 2010-2015 seasons.	Baseline serum 25(OH)D was 37.5 and 43.5 ng/mL for males and females respectively. A significant difference in the rate of stress fractures in those who did not improve their vitamin D levels compared to those who did improve or maintained their levels was found. Furthermore, the rate of stress fractures and stress reactions was 12% and 19% higher in those who did not improve their levels (P<.001). No significant difference was found in those who improved or maintained their vitamin D levels ≥40 ng/mL. However, a statistically significant correlation between stress fractures and vitamin D levels was not found.
Level of Evidence	2	2
Evidence Quality	N/A	N/A
Support for the Answer	Yes	Yes
Conclusion	The results of this study indicate that correcting vitamin D insufficiency (hypovitaminosis D) can reduce the risk of bone injury and increase bone health in collegiate athletes. Compared to historical data from the same institution, there was an overall reduction in the occurrence of stress fractures. The use of vitamin D supplementation in this cohort and the reduction in occurrence can partially be attributed to the intervention.	While a significant association between vitamin D levels and stress fractures was not revealed, a protective effect of higher serum vitamin D levels was identified. Simply improving serum vitamin D levels to normal in insufficient individuals demonstrated a significantly lower rate of stress fractures meaning there is a reduced risk of stress fracture in those who improve their levels. Furthermore, the study suggests a difference in risk of vitamin D deficiency between indoor and outdoor sports.

EVIDENCE QUALITY ASSESSMENT

After a thorough online search, two studies were identified that met all inclusion criteria and were selected for appraisal in this review.^{3,4} The level of evidence of these studies was determined using the 2011 OCEBM Levels of Evidence through which both studies were assessed as being level 2.⁵ Strength of recommendation was determined using SORT.⁶

RESULTS

Of the two studies included in this review, only one found a statistically significant correlation between vitamin D supplementation and the reduction of stress fractures.³ However this correlation was found using uncontrolled retrospective data. The other study, while not finding a correlation between vitamin D levels and the reduction of stress fractures, did discover a significant difference in stress fracture rate between subjects who maintained low vitamin D levels compared to those who improved to or maintained normal levels resulting in a 12% higher risk.⁴ An additional study, excluded due to its age, supports the findings in finding a 20% reduction of stress fractures after vitamin D supplementation.⁷

CLINICAL BOTTOM LINE

There is moderate evidence supporting the use of supplemental vitamin D to prevent stress fractures in high-risk, physically active adults. Further research on the relationship between vitamin D supplementation and the reduction of stress fractures is warranted.

RECOMMENDATION

The collective body of level 2 evidence has a strength of recommendation of B.

REFERENCES

1. Saunier J, Chapurlat R. Stress fracture in athletes. *Joint Bone Spine*. 2018;85(3):307-310. doi:10.1016/j.jbspin.2017.04.013
2. May T, Marappa-Ganeshan R. Stress Fractures. In: *StatPearls*. StatPearls Publishing; 2022. Accessed November 19, 2022. <http://www.ncbi.nlm.nih.gov/books/NBK554538/>
3. Williams K, Askew C, Mazoue C, Guy J, Torres-McGehee TM, Jackson III JB. Vitamin D3 supplementation and stress fractures in high-risk collegiate athletes – a pilot study. *Orthop Res Rev*. 2020;12:9-17. doi:10.2147/ORR.S233387
4. Millward D, Root AD, Dubois J, et al. Association of serum vitamin D levels and stress fractures in collegiate athletes. *Orthop J Sports Med*. 2020;8(12):2325967120966967. doi:10.1177/2325967120966967
5. OCEBM Levels of Evidence – Centre for Evidence-Based Medicine (CEBM), University of Oxford. Accessed December 11, 2022. <https://www.cebm.ox.ac.uk/resources/levels-of-evidence/ocbml-levels-of-evidence>
6. Ebell MH, Siwek J, Weiss BD, et al. Strength of Recommendation Taxonomy (SORT): A Patient-Centered Approach to Grading Evidence in the Medical Literature. *afp*. 2004;69(3):548-556.
7. Lappe J, Cullen D, Haynatzki G, Recker R, Ahlf R, Thompson K. Calcium and vitamin D supplementation decreases incidence of stress fractures in female navy recruits. *J Bone Miner Res*. 2008;23(5):741-749. doi:10.1359/jbmr.080102