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# A 1-Year Longitudinal Study of Bone Mineral Density of Division I College Distance Runners


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## Abstract

PURPOSE: The purpose of this investigation was to examine the changes in bone mineral density (BMD) in a Division I cross-country team over a 1-year period.
METHODS: Fourteen men (66.8 ± 4.6 kg; 178.7 ± 5.0 cm; 20.4 ± 1.0 yrs; 20.9 ± 1.1 BMI) and nine women (52.1 ± 5.9 kg; 161.8 ± 6.9 cm; 20.2 ± 1.0 yrs; 20.3 ± 1.1 BMI) collegiate distance runners volunteered for bone scans using dual-energy x-ray absorptiometry (DXA). Initial scans were conducted at the beginning of the cross-country season, a second scan at the beginning of the spring track season and a third scan was conducted at the beginning of the following cross-country season. Scan sites included the lumbar spine, proximal femur, and non-dominant forearm. A repeated measured analysis of covariance was utilized to determine any differences between BMD at the three time points. Lean body mass was the co-variant during the statistical analysis. A p-value of 0.05 was used for significance.
RESULTS: The results of the statistical analysis show a significant increase (p = 0.039) in whole body lean mass for the group between the first scan and the third scan. When whole body lean mass was accounted for, there were no significant differences in BMD across the three scans or between the sexes for anterior-posterior spine, lateral spine, femoral neck, radius/ulna ultra-distal, or whole body analyses. There was a significant interaction between scan and sex for total hip BMD (p = 0.023). The males had a significant (p = 0.025) decrease in total hip BMD between scans 1 and 2 and a significant increase (p = 0.004) in total hip BMD between scans 2 and 3. The females showed a trend (p = 0.086) toward an increase in total hip BMD between scan 1 and 2 and a trend (p = 0.057) toward a decrease in total hip BMD between scans 2 and 3.
CONCLUSIONS: The results of this investigation indicate that runners may experience small changes in BMD at the hip over the course of a training year with no measureable changes at other bone sites. Even though whole body lean mass increased in this group over the one year training period, BMD was maintained. Further investigation is needed to explore reasons for annual BMD maintenance in young-adult, male and female collegiate runners experiencing seasonal fluctuations in skeletal health.


## Background

It is estimated in the United States that 9% of adults over the age of 50 years have osteoporosis at the femoral neck or lumbar spine and the prevalence of low bone mass at the femoral neck or lumbar spine is nearly 50% of the adults over the age of 50 years[2]. There are a number of factors that lead to osteoporosis including increased age, smoking, obesity, low vitamin D intake, low caloric intake, and inadequate physical activity[4,5].

With proper energy availability, physical activity has been shown to provide protection against low bone mineral density[6]. Although studies of women endurance athletes have shown a loss of bone mineral density due to a number of factors including low energy availability and low calcium intake[1].

There is a lack of BMD data on male endurance runners[3]. In a recent study, Deene et al. showed that there was no change in BMD in a group of men cross-country runners from pre- to post-season. However, the women in the study had a significant decrease in BMD in the lumbar spine across the season. In addition, approximately 50% of the runners had lower total BMD than age-based reference values.

The purpose of this investigation was to examine the changes in BMD in a Division I cross-country team over a one year period.

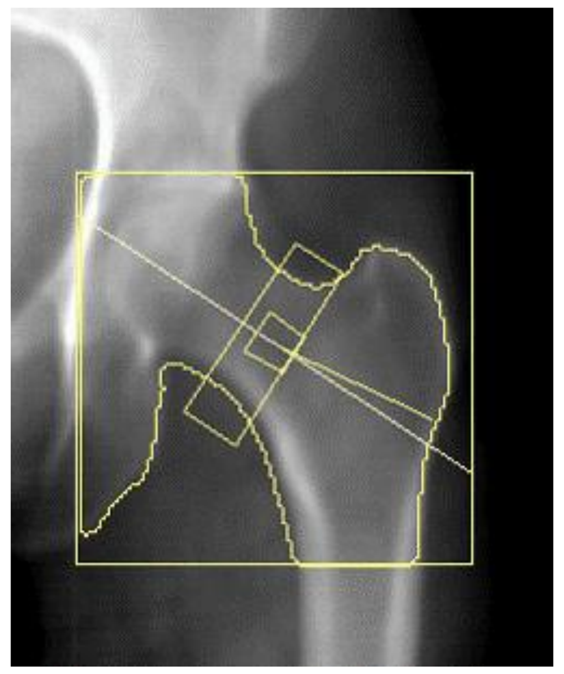
## Methods

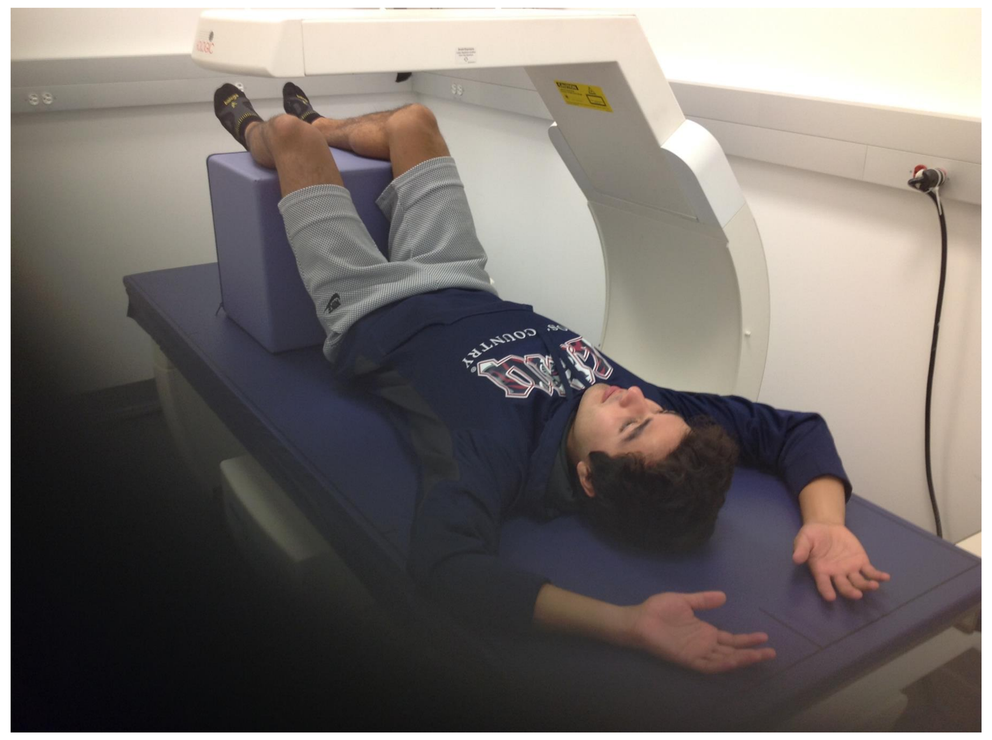
Fourteen men (66.8 ± 4.6 kg; 178.7 ± 5.0 cm; 20.4 ± 1.0 yrs; 20.9 ± 1.1 BMI) and nine women (52.1 ± 5.9 kg; 161.8 ± 6.9 cm; 20.2 ± 1.0 yrs; 20.3 ± 1.1 BMI) collegiate distance runners volunteered for this investigation. All testing was approved by the University Institutional Review Board and all participants signed an informed consent prior to participation. Volunteers reported to the human performance lab at the beginning of the fall cross-country season, at the beginning of the track season (beginning of spring semester) and the next cross-country season, for a total of three scans over a one year period.

Height (cm) and weight (kg) were measured using a Health-O-Meter Professional (Neosho, MO) scale. Body Mass Index was calculated using the participant's mass in kg divided by their height in meters squared. All participants were running in excess of 100 km per week and performing 2 resistance training sessions per week.

Dual-energy x-ray absorptiometry (DXA, Hologic Discovery A, Waltham , MA) scans were completed on the lumbar spine, proximal femur, and non-dominant forearm for each participant. All scans were performed by the same certified individual utilizing standard procedures for the specific sites. The machine was calibrated daily during the testing period. Participants removed all metal objects prior to scans.

A repeated measured analysis of covariance was utilized to determine any differences between BMD at the three time points. Lean body mass was the co-variant during the statistical analysis. A *p*-value of 0.05 was used for significance.





## Results

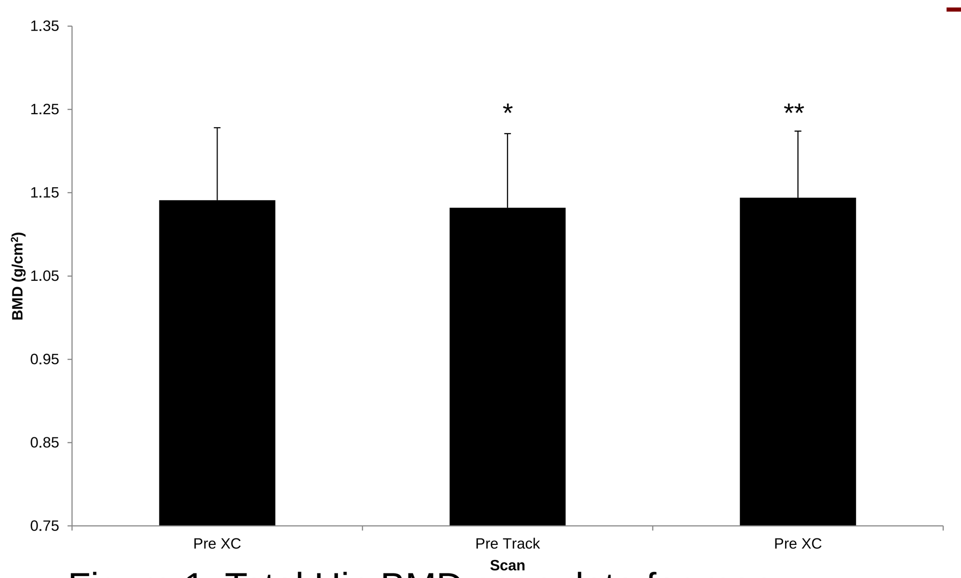



Figure 1. Total Hip BMD scan data for men.

(* Decrease from scan #1; ** Increase from scan #2)

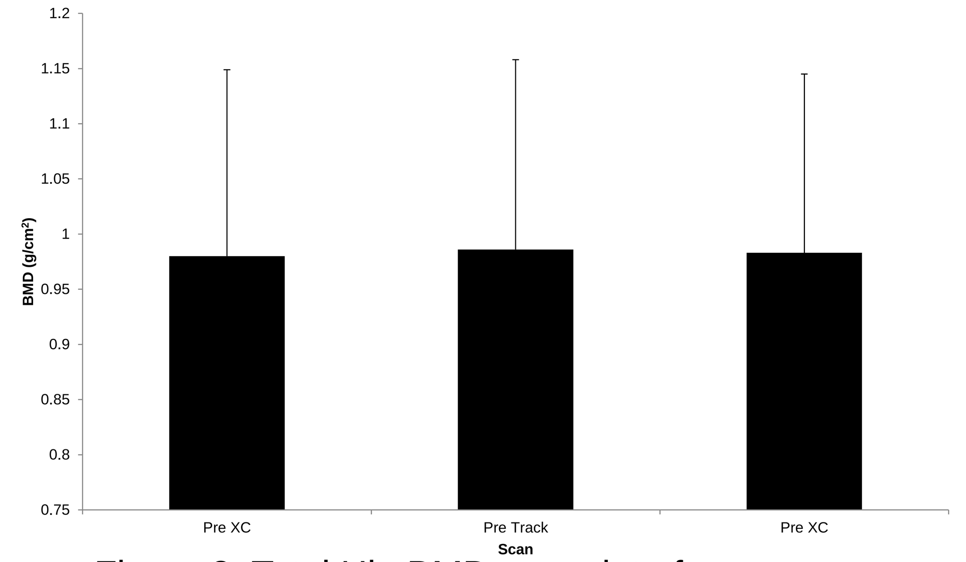



Figure 2. Total Hip BMD scan data for women.

The mean number of months between Pre XC scan one and the Pre Track scan was 3.9 ±0.4 months, the mean number of months between the Pre Track scan and Pre XC scan two was 7.4 ±0.5 months. The results of the statistical analysis show a significant increase (p = 0.039) in whole body lean mass for the group between the first scan (47.66 ±8.96 kg) and the third scan (48.40 kg ±8.89 kg). When whole body lean mass was accounted for, there were no significant differences in BMD across the three scans or between the sexes for anterior-posterior spine, lateral spine, femoral neck, radius/ulna ultra-distal, or whole body analyses. There was a significant interaction between scan and sex for total hip BMD (*p* = 0.023). The males had a significant decrease (*p* = 0.025) in total hip BMD between scans 1 (1.1414±0.087) and 2 (1.1320 ±0.089) and a significant increase (*p* = 0.004) in total hip BMD between scans 2 and 3 (1.1444 ±0.080) (Figure 1). The females showed a trend (*p* = 0.086) toward an increase in total hip BMD between scan 1 (0.9799 ±0.169) and 2 (0.9860 ±0.172) and a trend (*p* = 0.057) toward a decrease in total hip BMD between scans 2 and 3 (0.9830 ±0.162) (Figure 2).

## Discussion

The main finding of this year long examination of BMD in Division I distance runners is there was no change in BMD between the initial scan and the one year scan. However, within the year the men had significant changes in total hip BMD, while the women had changes in total hip BMD that trended toward significance. The decrease in total hip BMD in the men occurred across the cross-country season and Christmas break. This loss could be explained by low energy availability, low vitamin D or calcium intake. The men then had a significant increase in total hip BMD across the track season and summer training period. This increase could be explained by an increased energy availability, increased vitamin D and calcium intake. This may be influenced by dietary habits while at school and away from school, eating more at home during the summer and not as well during the school year.

The women responded opposite to the men, with an increase in total hip BMD across the cross-country season and a decrease across the track season and summer training period, although neither of these changes reached statistical significance.

There were 8 runners (3 men and 5 women) that were below age-matched reference values for Whole Body BMD. This is less than that reported by Deene et al.

There are limitations to this abstract. We did not collect data on training surface. There may be a difference in the primary training surface between the fall cross-country season and the spring track season, as well as the summer training period where the runners are typically home for three months. In addition, there may be some differences in the training sessions between the cross-country season, track season, and summer training. The small sample size, especially in women participants may have influenced the statistical outcomes. Also, the women have large standard deviation values which could have affected the statistics. There was a wide range of BMD values in the women, with a couple of the women having very low BMD.

## Conclusions

In this cohort of young adult distance runners, there appears to be seasonal alterations in BMD. Additionally, endurance training does not necessarily provide protection for all endurance athletes. Too many factors affect BMD, indicating that further research needs to be completed to better define BMD issues in young adult distance runners.

## References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