The Effects of Heel Strike Loading Magnitude on Hip and Lumbar Spine Bone Mineral Density in Male Distance Runners

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INTRODUCTION

- Despite the common misconception that osteoporosis only affects postmenopausal women, two million men in the United States have the disease and 25% of men over the age of 50 have osteoporotic fractures (Strope et al., 2014).
- Small loses in bone mineral density (BMD) can greatly increase one's risk of osteoporosis and related fractures, which are particularly threatening at the hip and spine.
- Previous research has reported that while male long-distance runners have normal BMD at their hip, their lumbar spine BMD values are lower than that of the general population (Fredericson et al., 2007; Hind et al., 2006).
- An understanding of how the early loading characteristics of ground reaction forces (GRFs) and tibial stress fractures may influence lumbar spine BMD is lacking.

PURPOSE

To examine the effects of early impact loading rates on hip and lumbar spine BMD in male long-distance runners (LDRs).

METHODS

Subjects

- 40 injury-free male long-distance runners aged 18-30 years who ran at least 30 miles per week were recruited (Table 1).
- Each subject filled out an IRB authorized consent form in addition to health and training questionnaires.

Data Collection

Dual-Energy X-Ray Absorptiometry (DXA)

- Proximal femur BMD, lumbar (L1-L4) spine BMD, and body composition values were obtained using a Hologic Discovery W.

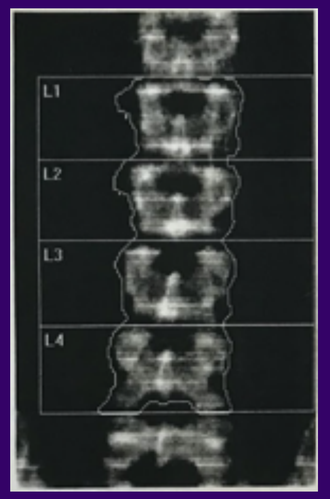
Running Kinematics

- Subjects ran barefoot at a self-selected pace, striking their right foot on a Kistler force plate (1000 Hz) with each foot making contact for three trials per foot.
- Bioware software was used to calculate braking and propulsive forces as well as vertical ground reaction forces (GRFs).

METHODS (continued)

Statistical Analysis

- Participants who consistently exhibited a heel-striking pattern were divided into two groups (n = 16 each) based on their average early loading rate (ELR) values obtained with Bioware software.
- Two sample, two-tailed, unequal variance t-tests were performed to compare average RFD groups for each variable measured ($p < 0.05$).



RESULTS AND DISCUSSION

- 6 subjects were excluded from the groupings because they were midfoot strikers, and two subjects with middle values were excluded to better separate the groups.

Table 1. Anthropometric data between average ELR groups.

	Height (m)	Mass (kg)	Age (yrs)	Weekly Mileage
Low Avg ELR	1.743±0.056	65.831±5.983	22.000±3.967	50.063±15.282
High Avg ELR	1.791±0.054	67.156±7.204	21.375±2.57	49.875±15.624

- The Low and High group ELR values were statistically different (86.0 ± 18.3 kN/s vs. 175.3 ± 48.9 kN/s; $p < 0.001$).
- There was no difference between the two group's mass, weekly mileage, or normalized peak active vertical force.

RESULTS AND DISCUSSION (continued)

- The normalized peak impact force, stance time, time to peak vertical impact force, and time to peak vertical active force were different between the two groups.
- The lumbar spine T-scores for the Low group were significantly different than the High group (-1.4 ± 0.6 vs. -0.4 ± 1.0; $p = 0.003$) with 14 subjects in the Low group and 2 subjects in the High group having T scores < -1.0.
- The High ELR group had greater BMD values at all anatomical locations analyzed, significantly so at the Ward's triangle and total lumbar regions ($p = 0.023$ and $p = 0.002$, respectively, Figure 1).

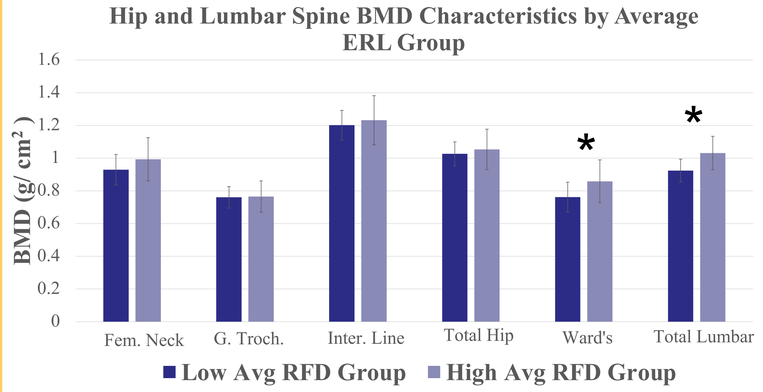


Figure 1. Bar graph comparing BMD by anatomical location between groups.

CONCLUSIONS

- There is a bone injury risk to all runners, regardless of gender, due to repetitive loading for extended periods of time.
- Though runners with low ELR do not tend to create as much force as those with high ELR, they do spend more time doing so.
- Male LDRs with low ELR values may have a greater risk of osteoporic injury at the lumbar spine and Ward's triangle region than those with high ELR.
- The results suggest that a higher ELR may be desirable to obtain adequate BMD for the spine and thus prevent future osteoporic injuries.