

# Assessment of Bone Mineral Density in Forearms of Collegiate Ten-Pin Bowlers

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**Abstract.** This study assessed the BMD of the bowling arm compared to the non-bowling arm and the distal forearm BMD of the bowling arm compared to the non-bowling arm of elite collegiate ten-pin bowlers. Dual Energy X-ray Absorptiometry Unit (DXA) was used to assess the BMD of bilateral arms (whole body scan) and bilateral distal forearms (forearm scan) of 25 (N=13 males, N=12 females) collegiate bowlers (20.72 ± 1.46 yrs). The forearm scans showed significantly greater ( $p < 0.05$ ) BMD in the bowling arm ( $0.635 \pm .05 \text{ g}\cdot\text{cm}^{-2}$ ) compared to the non-bowling arm ( $0.618 \pm .06 \text{ g}\cdot\text{cm}^{-2}$ ) of both the male and female ten-pin bowlers.

## 1. Introduction

The ability of bone to respond and adapt to mechanical loads has been known for over a century (Warden, Bogenschutz, Smith, & Gutierrez, 2009). Physical activities involving high impact weight bearing or high peak forces have been shown in many studies to be beneficial and necessary to building greater bone masses, especially in childhood and young adult years (Pikkarainen, et al., 2009). The weight-bearing and dynamic sports with high magnitude of strains exerted on the skeleton are positively influential on bone mass and architecture than unloaded or partly unloaded sports (Elloumi, et al., 2009). Athletes participating in unilateral dominant sports have demonstrated these skeletal responses to the mechanical loading related to the specific sport (Warden, et al., 2009). Studies on hand preference have been shown to influence bone mineral density (BMD) differences in contralateral arms in sports such as gymnasts, racquet sport players, and other athletes who are involved in habitual mechanical loads on both their upper and lower extremities, (Akar, Sivrikaya, Canikli, & Varoglu, 2002; Bareither, Grabiner, & Troy, 2008). In 2009, the Wichita State University (WSU) Shocker Bowling team was National Champions in both the men and women divisions. The WSU bowling team performs a high volume of repetitive use (~ 400-500 movements/day) of their bowling arm on a regular basis. The purpose of this study is to assess the BMD of the forearms of elite collegiate ten-pin bowlers and compare their bowling arm BMD to their non-bowling arm BMD.

## 2. Experiment, Results, Discussion, and Significance

**Methods and Materials:** The elite level collegiate ten pin bowling team consisted of 13 young adult males and 12 young adult females, of whom 23 were right-hand dominant and the other two were left-hand dominant. 22 of the 25 bowlers used their dominant hand to bowl and the remaining three bowlers used their non-dominant hand. The mean age of the collegiate bowlers was 20.72 ± 1.46 yrs. The control group comprised of age-matched seven healthy females and seven healthy males, who are not involved in physical activity affecting the dominant or non-dominant upper extremity only, with a mean age of 20.43 ± 2.10 yrs. DXA (Hologic QDR 4500W Elite Series, Bedford, Massachusetts, and Software Version 12.3) was used to assess bmd of bilateral arms (whole body scan) and bilateral distal forearms (forearm scan).

**Results:** Forearm scans showed significantly greater ( $p < 0.05$ ) bmd in the bowling arm ( $0.635 \pm .05 \text{ g}\cdot\text{cm}^{-2}$ ) compared to the non-bowling arm ( $0.618 \pm .06 \text{ g}\cdot\text{cm}^{-2}$ ) of both male and female bowlers. However, when separated by gender, the females bowling arm showed a significantly greater difference between arms ( $4.06 \pm 3.11\%$  difference,  $p < 0.05$ ) and compared to the males ( $1.48 \pm 2.62\%$  difference,  $p < 0.05$ ). Total-body scans of the left and right arms were also assessed and similar results were observed in the bowling arm compared to the non-bowling arms of females ( $4.15 \pm 2.54\%$ ,  $p < 0.05$ ) and males ( $3.81 \pm 5.19\%$ ,  $p < 0.05$ ).

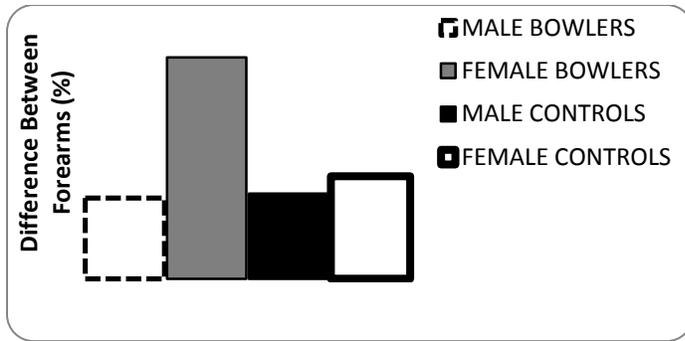


Fig 1 Relative differences between bowling and non-bowling forearm BMD:  $\Delta = [(bowling\ forearm - non-bowling\ forearm)/non-bowling\ forearm] \times 100$ .

**Discussion:** The effects of physical activity on bone density has been widely documented and researchers agree that participation in weight-bearing activities and impact loading are more osteogenic than those with no contact or performed in a weightless environment (Elloumi, et al., 2009). The results seen in this study are consistent with those who reported on baseball and tennis players, and volleyball; sports for which upper limbs are subject to high impact loading forces and involve asymmetrical loading patterns (Bareither, et al., 2008; McClanahan, et al., 2002). With these elite collegiate ten-pin bowlers' high volume of high intense, repetitive movements involving their bowling arm with the addition of the added impact from the bowling ball, the contralateral differences observed between their bowling arm and non-bowling arm in this study was not as high of a difference as was hypothesized. These results suggest a correlation between high volume and high intense activities and overuse of the skeleton with lower BMD (suppressed osteoblast function), which has been observed in elite cyclists and long distance runners (Kerschman-Schindl, et al., 2009; Medelli, Shabani, Lounana, Fardellone, & Campion, 2009).

**Significance:** This is the first study assessing the effects of ten-pin bowling at an elite collegiate level on bmd of the bowling arm compared to the non-bowling arm.

### 3. Conclusions

The bowling arm of elite level collegiate ten-pin bowlers demonstrates the increased response of BMD in the bowling arm and forearm when compared to the non-bowling arm.

### 4. Acknowledgements

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