

Bone Mineral Density and Grip Strength: Association Versus Relationship and Site-Specific or Systemic?

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Abstract

Bone mineral density (BMD) and grip strength (GS) are two commonly employed clinical orthopedic examination procedures, where the former is laboratory-based and the latter clinically performed. The aim of this review article was to update the evidence for inter-relationship between BMD and GS through a preliminary search of PubMed. Of the total 11 studies, there were six population-specific studies on normal healthy population (adolescents, adults, men, women, older adults, older women), two studies on healthy athletes (young athletes, combat athletes), and three studies on postmenopausal women (Japanese, Thai, Turkish). Whilst the question of site-specific or systemic still remains unanswered, the answer was reported to be influenced by many other variables such as gender, body weight, hand dominance and menopausal status. Albeit, there is a positive association and strong correlation existing between grip strength and bone mineral density, with grip strength being an independent predictor of BMD in some population. There is need for controlled clinical trials on interventions aimed at improving grip strength and their effects on BMD in osteoporotic men and women.

Keywords: Muscle-Bone Inter-Relationship; Starling's Law; Orthopedic Examination; Osteoporosis.

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Healthy Adolescents

Chan et al (2008) assessed relationship between grip strength, bone mineral density (BMD) and bone mineral content (BMC) in 169 boys and 173 girls and found that grip strength was correlated well with bone mass at hip, spine and whole body for both

sexes. Grip strength was an independent predictor of bone mass, except hip BMD in boys and whole body BMD in girls. The relationship between muscle strength and bone mass was thus found to be systemic.

Healthy Adults

Kaya et al (2005) assessed the site-specific relationship of hand bone mineral density (BMD) with hand size, pinch and grip strength in healthy adults comprising of 106 women and 37 men. Whilst there was no correlation found between hand BMD and grip, pinch strength or hand size in

premenopausal women, a significant correlation was found between hand BMD and grip strength was found in men. Their findings suggested a gender-specific interaction on the relationship.

Healthy Men

Aydinet al (2006) studied 234 male subjects and investigated the predictive role of grip strength on bone mineral density (BMD) of lumbar spine, femoral neck, proximal radius-ulna (PRU) and distal radius-ulna (DRU) in males. Grip strength of the same side was the best predictor of the BMD of the dominant and non-dominant PRU with a ratio of 8.5 and 10.2%, respectively, whereas grip strength of the same side, age and weight were the best predictors of the BMD of the dominant and non-dominant DRU with a ratio of 25 and 24.6%, respectively. Their findings suggested a site specific rather than systemic BMD.

Healthy Women

Ozgoemet al (2000) studied 29 healthy housewives (12 premenopausal and 17 postmenopausal) and determined site-specific relationship between grip strength and hand bone mineral density (BMD) and found that hand BMD moderately correlated with grip strength in postmenopausal women, but not in premenopausal women.

Older Adults

Foley et al (1999) critically reviewed previously published studies on relationship between grip strength and BMD of proximal femur in older adults to report the challenges in appropriateness of research methods. They found that failure to control for the concomitant influence of body weight on both BMD and muscle strength was present in most of the studies; and absence of allometric scaling in analyses for the relationship between a physiological variable and a body dimension variable which can be nonlinearly and simultaneously influenced by other body dimension variables were not considered in the analysis and therefore are statistically uncontrolled in the previous studies.

Older Women

Kritz-Silverstein and Barrett-Connor (1994) studied 649 postmenopausal elderly women and examined the association of grip strength with bone

density at distant sites, such as the spine and hip, as well as at the wrist and radius. Their study findings concluded that only exercising women had significant associations of grip strength with bone mineral density, and overall, grip strength was an independent indicator of general bone density.

Young Athletes

Tsuji et al (1995) studied 10 male college wrestlers, 16 female college basketball players, and 12 female college tennis players to evaluate the relationship between radial BMD and grip strength in young athletes. A significant positive correlation was found between radial BMD and grip strength in the dominant forearm, which suggested that grip strength could be one of the determinant factors of radial BMD in the dominant forearm of young college athletes.

Adolescent Combat Athletes

Nasri et al (2013) compared 50 combat sport athletes with 30 sedentary subjects to investigate the correlation between bone parameters and grip strength (GS) in hands, and found that grip strength of non-dominant arm significantly correlated with BMD of both spine and legs, and it was also the best predictor for BMD at different sites in combat athletes.

Postmenopausal Women

Osei-Hyiamanet al (1999) studied 1168 postmenopausal Japanese women to examine the influence of grip strength on BMD of the metacarpal (index finger) and found that grip strength significantly correlated with BMD and subjects with stronger grip strengths had a decreased risk for low BMD.

Rattanachaiyanontet al (2002) studied 177 healthy peri/post-menopausal Thai women and determined the relationship between distal radius bone mineral density (BMD) and grip strength (GS) and found that BMD had statistically significant but weak, positive correlation to GS in both dominant and non-dominant sides, with a stronger correlation of BMD to the contralateral dominant GS than to the ipsilateral non-dominant GS.

Sahinet al (2002) studied 187 postmenopausal Thai women and assessed the relationship of grip strength to site-specific BMD of the metacarpal bone and also axial BMD. Grip strength was correlated positively with the BMD of the nondominant hand, and also correlated positively with femoral neck

BMD. This study provided support for a site-specific and also systemic relationship between muscle and bone.

Of the total 11 studies, there were six population-specific studies on normal healthy population (adolescents, adults, men, women, older adults, older women), two studies on healthy athletes (young athletes, combat athletes), and three studies on postmenopausal women (Japanese, Thai, Turkish). Whilst the question of site-specific or systemic still remains unanswered, the answer was reported to be influenced by many other variables such as gender, body weight, hand dominance and menopausal status. Albeit, there is a positive association and strong correlation existing between grip strength and bone mineral density, with grip strength being an independent predictor of BMD in some population.

There is need for prospective longitudinal studies to explore the cause-effect inter-relationship, and there were no studies found on older men, and on patient population with osteoporosis, which is the dearth scientific need of the hour in evidence for orthopedic examination. There is need for controlled clinical trials on interventions aimed at improving grip strength and their effects on BMD in osteoporotic men and women.

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