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MEETING REPORTS

Bone Acquisition/Pediatric Bone: Meeting Report from the 33rd Annual Meeting of the American Society for Bone and Mineral Research

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A number of high-quality pediatric bone abstracts were presented at the 2011 Annual Meeting of the American Society for Bone and Mineral Research in San Diego, California. Similar to previous meetings (1-2), studies addressed a variety of research questions pertaining to skeletal health and development during different phases of growth. In this report, we summarize evidence presented at the meeting with regard to vitamin D; physical activity models and maintenance of exercise-induced bone benefits; and risk factors for fracture.

Vitamin D and Pediatric Bone Health

Optimal serum vitamin D requirements for supplementation during pregnancy and lactation was one of the most widely discussed topics at this year's meeting. According to new Institute of Medicine (IOM) guidelines, the recommended dietary allowance (RDA) of vitamin D is 600 IU/day for pregnant and lactating women (3). The RDA provides an estimate of an average daily intake that meets the needs of 97.5% of the population (3). This recommendation was challenged by Bruce Hollis (Department of Pediatrics, Medical University of South Carolina). At the Vitamin D Working Group meeting, Dr. Hollis presented evidence from a recent randomized controlled trial (RCT) (4). Results from this study indicated that circulating vitamin D (25OHD) at serum levels between 40-60 ng/ml (100-150 nmol/L) were needed to optimize the concentration of the physiologically active form of vitamin D (1,25OHD) in the mother and her child, and a daily intake of 4000 IU vitamin D_3 was required to attain 40 ng/mL of 25OHD (5). A related ASBMR abstract lent credence to the concern regarding vitamin D insufficiency during pregnancy by showing vitamin D deficiency in 82% of mothers and 63% of their neonates at the time of parturition (6). Mothers who gave birth during winter months had lower vitamin D levels, highlighting the importance of sunlight for vitamin D status (6).

Immigrants in the Northern Hemisphere have a higher risk of vitamin D deficiency and related diseases, such as rickets (7). This is likely due to limited sun exposure, low vitamin D intake from dietary sources and darker skin color. A study from Sweden indicated that 78% of immigrant mothers had 25OHD serum levels <25 nmol/L while only 4% of non-immigrant mothers had levels <24 nmol/L (8). Nevertheless, the newborns of vitamin D-insufficient mothers were healthy with normal birth weight and Apgar scores. These children received 10 micrograms (400 IU) of daily vitamin D3 supplementation from 2 weeks of age. At 6-12 months of age, these children's 25OHD ranges were considered normal (38-142 nmol/L) and the authors concluded that the current supplementation of vitamin D3 seems sufficient for children of immigrant women with vitamin D deficiencies. In contrast, of immigrant and refugee children (N=72) who had been living in Saskatoon, Canada for more than 5 years, 29% were vitamin D-deficient and 44% were vitamin D-insufficient (9). Vitamin D intake was inadequate in 89% of these children aged 7-11 years. Total body bone mineral content

(BMC) was lower than predicted for age, sex and ethnicity in 14% of these children, indicating a need for preventive actions focused on immigrant/refugee children living in the Northern Hemisphere.

According to a recent meta-analysis, it seems unlikely that vitamin D supplementation is beneficial for bone accrual in children and adolescents with normal vitamin D levels (10). Epidemiological evidence from the Avon Longitudinal Study of Parents and Children (ALSPAC) supports this conclusion (11). Vitamin D levels at 10 years of age showed no associations or weak negative associations with peripheral quantitative computed tomography (pQCT)-measured cortical bone outcomes at the tibia midshaft at 16 years of age (after adjusting for confounders).

Physical Activity Models and Maintenance of Exercise-Induced Bone Benefits

Gymnastics provide an attractive model to characterize the site-specific associations between loading and bone development, especially at different skeletal sites. Site-specific skeletal adaptation to gymnastics training during growth was assessed from radius and proximal femur dual-energy x-ray absorptiometry (DXA) scans in 173 young gymnasts and non-gymnasts (12). Across the maturity groups, at the radius gymnasts had greater bone mass, estimated width and cortical thickness, while at the proximal femur only the cortical thickness differed in favor of gymnasts. Gymnastic loading during growth appears to be beneficial, especially for upper extremity bones.

Another gymnast study assessed changes in the forearm bones and muscle in early pubertal non-gymnasts and gymnasts categorized to ‘low’ (≤5 hours/week) and ‘high’ (≥ 6 hours/week) training groups (13). After a 6-month follow-up, ‘low’ and ‘high’ groups of gymnasts had 8% and 15% greater increases, respectively, in total density at the distal radius when compared to non-gymnasts. ‘High’ training gymnasts also had 28% and 45% greater increases in the estimated bone strength than low gymnast and control groups, respectively, at the distal radius. Although the ‘high’ training group seemed to benefit the most from the training, it is important to note that ‘low’ non-elite gymnastics training was associated with significant musculoskeletal benefits in the fracture-prone forearm in early pubertal girls. The accumulating evidence of bone benefits from non-elite and recreational gymnastics (14) needs to be translated to RCTs to assess if similar training could be beneficial to bone strength development in the general population of children.

Two ASBMR abstracts also addressed critical questions pertaining to whether exercise during growth provides benefits for bone strength in later life. A longitudinal follow-up study of former competitive gymnasts showed similar benefits (13%-19%) in total body, lumbar spine and femoral neck BMC between former gymnasts and their controls at 14-year follow-up when compared to pre-menarcheal baseline data (15). Meanwhile, a cross-sectional comparison of unilateral differences between the dominant and non-dominant upper extremities of former major league baseball pitchers and catchers and their controls (age range 30-86 yrs.) supported these findings (16). The authors plotted unilateral %-differences between bone properties of the humeri of former throwers and controls against age, and subsequently assessed the regression lines for convergence to represent the age when exercise benefits were predicted to be lost. Recently retired (30-year-old) throwers had 30% greater side-to-side differences in bone size and mass in the loaded humerus and 61% greater estimated ability to resist torsional loading (polar moment of inertia; I_P) than their controls. Benefits in bone mass seemed to be lost with age as regression lines converged by 83 years of age. In contrast, bone size and estimated strength differences were maintained in former baseball players, with regression lines converging with control lines at 168 and 112 years, respectively. On average, 80-year-old former throwers had a 2.5-times greater bone strength benefit in their throwing arm than controls. These data indicate that exercise when young may have long-term benefits, especially on cortical bone structure and estimated strength.

Risk Factors for Fracture

New evidence of the risk factors for pediatric fracture was also provided at the meeting. A U.S. multicenter study followed 1,470 healthy boys and girls (ages 6 to 16 years) for six years and found that children of European descent had 2.7-times the hazard ratio for fracture than children of other backgrounds (17). This difference in fracture risk may be related to racial differences in skeletal strength. This assumption was supported by another U.S. multicenter study that reported 20%-35% greater estimated bone strength at the tibia in black adolescents when compared to their white peers (18). Whether the strength difference is similar at the fracture-prone upper extremity remains to be seen. In addition to male sex, other reported risk factors for pediatric fracture included younger age, advanced maturity, lower body fat percentage and greater sports participation (17). These factors may relate to greater exposure to injury while participating in specific sports. The evidence for low body fat percentage as a risk factor for pediatric fracture contradicts some earlier evidence of higher fracture risk in overweight children (19). However, overweight/obesity may predispose to specific types of pediatric fracture. In 185 pediatric fracture cases, the number of growth plate injuries was greater in overweight/obese than in healthy weight children (20).

Conclusion

In summary, the evidence from the above studies presented at the 2011 Annual Meeting of the ASBMR provided further support for the importance of optimal vitamin D status in pediatric bone growth and highlighted site-specific adaptation to (mechanical) loading during specific physical activities, with possible life-long benefits on bone structure. On the other hand, sports participation appears to increase the risk of fracture in active children.

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