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Perspective Article

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Summary - Bone growth and exercise in children

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Skeletal development in children is an important and timely issue. The NIH is emphasizing the inclusion of children in human studies and the FDA is requiring expanded testing of drugs in children. This requires investigators and reviewers to understand the pattern of human skeletal growth and potential interactions of co-factors such as exercise intervention. As pointed out by all speakers, the first step in preventing osteoporosis is to maximize skeletal development, and exercise has the potential to increase bone mass and strength. Don Bailey pointed out that humans are unique in that no other animal demonstrates growth spurts. Each person has a unique path from conception to maturity and body size in childhood or adolescence is a poor indicator of an individual's mature body size. Although the order of Peak Height Velocity, Peak BMC accrual, and pubertal stage is consistent, the ages for each are variable making chronological age a poor means of standardization. Peak Height velocity is a consistent marker of skeletal development, but impossible to ascertain in short studies. In addition, current growth and maturation data have limited generalizability to today's children since it is based on Caucasians from previous generations. There is a strong need for a low radiation direct measure of skeletal maturity by either DEXA or pQCT. The interaction of growth with exercise is difficult to determine because of the variability in growth rates within and among children, nutrition, and normal activity patterns. Bonnie Specker demonstrated the interaction of calcium and exercise in infants and pre-school children. In infants with high calcium intake exercise had no effect on BMC accrual, whereas in young children the combined effect was greater total body bone gains. However, exercise in low calcium groups resulted in the smallest gains in BMC. The interpretation of these results was limited by the measurement methods, DEXA, which did not allow for assessment of structural changes that might predict differences in strength. In young children, the exercise group showed continued advantages in bone gain after exercise intervention ended, but this was associated with greater continued physical activity. In school age children, Heather McKay, showed advantages to short, focused jumping activities conducted as part of regular physical education training. She also presented preliminary data that showed gains in femoral neck strength from as few as 10 jumps, three times a day in these children. The importance of structural measurements during growth was well demonstrated by Shona Bass. MRI demonstrated regional apposition with exercise to increase bending stiffness with the least bone gain. She found that exercise enhances normal growth patterns of periosteal apposition in boys and premenarchial girls. However, with the onset of estrogen, both growth and exercise have the greatest effects on endocortical bone. The greatest gains in bone size and mass appear to occur in athletes that begin training at pre-pubertal ages when periosteal apposition can be maximized. DEXA measurements of BMD or even BMC can lead to the misinterpretation of exercise effects during growth. A primary unanswered question is the long-term benefits of exercise on prevention of osteoporosis. Magnus Karlsson presented data that show athletes have greater bone mass during active years, but greater rates of loss in retirement. Although his retired athletes showed a higher lifetime risk of fracture, they had a lower risk of osteoporotic fractures with aging. The next question is if BMC is not preserved in retired athletes, then does training induce structural adaptations that have lifetime benefits for bone strength or is the reduced fracture risk due solely to better physical ability and agility. Given that exercise is good or even necessary for bone health, little is known about exercise prescription. Jeremy Bauer presented data that showed forces 2-5 times body weight generated by jumping from platforms can be beneficial at the hip. However, discussion of forces, muscle power, repetitions, and initiation and saturation of responses all demonstrated that there are far more questions about exercise than answers, even at the animal level, let alone in growing children.

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