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Opinion Article

Peak Bone Mass and Bone Fragility Fractures

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DESCRIPTION

A major factor in bone mass and fragility fractures later in life is Peak Bone Mass (PBM). Instead of changes in volumetric bone density, the increase in bone mass during childhood and adolescence is mostly connected to an increase in bone size. The key variables for PBM success are race, gender, and genetics. Nevertheless, environmental factors that affect the accumulation of bone mass during growth include physical activity, calcium and protein consumption, weight, and age of menarche. As a result, optimizing calcium and protein intakes as well as weight-bearing exercise is crucial for the best development of PBM and bone strength as well as reducing the risk of fractures later in life.

A major factor in osteoporosis and fragility fractures is bone mass. The amount of bony tissue present at the conclusion of skeletal development is known as Peak Bone Mass (PBM). With the frequent use of non-invasive quantitative technology allowing the measurement of the amount of minerals contained in various areas of the skeleton, this concept of PBM first emerged to the public's attention about 35 years ago. Epidemiological studies suggest that a 10% increase in PBM in the female population, or one standard deviation, would be comparable to delaying menopause by 14 years and lowering the incidence of fracture by 50% in later life. Non-invasive techniques that can precisely measure Areal (a) or Volumetric (v) Bone Mineral Density (BMD) at various sites of the skeleton by either dual X-ray Absorptiometry (DXA) or Quantitative Computed Tomography (QCT), respectively, can be used to evaluate bone mineral accumulation from infancy to post-puberty. There are additional noninvasive specialized analyses of the trabecular microstructure as well as the cancellous and cortical bone compartments. These methods make it possible to partially capture changes in the macro architecture or geometry of the bones, which, coupled with the mineral mass, have a significant impact on the bones' ability to resist mechanical strain.

The mechanical strength of bone is influenced by a number of structural factors. The size of the bone; the amount of bony tissue within the periosteal envelope and its spatial distribution, also known as the micro and macro architecture, or geometry; and the level of mineralization and structural organization of the organic matrix (material level properties) are the most important factors influencing mechanical loading resistance. In fact, it has been demonstrated that aBMD is directly correlated with bone strength, or the skeleton's resistance to mechanical stress both *in vivo* and *in vitro*. The incidence of osteoporotic fractures and aBMD levels are inversely correlated. Additionally, cortical and trabecular BMD can be measured separately using Quantitative Computed Tomography (QCT), a technique that is less common than DXA. It is also possible to acquire the geometric/structural characteristics that affect bone strength as well as volumetric BMD (as opposed to "areal" DXA-BMD). Finite Element Analysis (FEA) and High-Resolution peripheral Quantitative Computed Tomography (HR-pQCT) have recently become increasingly popular, and they can provide us more details on the subtler elements of bone's structural mechanical resistance.

There is no proof of a sex difference in bone mass at birth. From infancy through the conclusion of the growing phase, vBMD rises very little in comparison to bone size. Up until the start of pubertal maturation, there is no significant gender variation in bone mass. During puberty, the gender difference in bone mass is manifested, with males experiencing a longer period of bone maturation than girls, as well as a greater rise in bone size and cortical thickness. In both males and females, the rate of bone mass growth in the lumbar spine and femoral neck increases four to six times over the course of three and four years, respectively, during puberty. Through periosteal apposition in males and endosteal resorption inhibition in females, pubertal maturation results in an increase in cortical thickness.

The increase in standing height and the development of bone mineral mass during pubertal development occur at different times. When the dissociation between the rate of statural growth and mineral mass accrual is at its greatest, it is known that there is a higher incidence of fracture. This phenomenon may be the cause of this temporary fragility. It is more challenging to interpret changes in bone biochemical indicators during growth than during adulthood. When the rate of bone mineral accumulation is at its peak, the plasma concentrations of the indicators of bone formation are at their highest. After the growth spurt, the high urinary excretion of bone resorption indicators, such as collagen pyridinium cross-links, that is seen in childhood declines until it reaches adult levels at the conclusion

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of pubertal maturation. At the time of puberty, behavioral changes in lifestyle, including eating patterns, are seen. Additionally, a lot of research was paid to understanding how different ways of consuming certain nutrients can affect how much PBM a person can acquire.