Why to evaluate bone mineral density in children and adolescents?

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The article published by Silva et al.[1] in this issue of the *Jornal de Pediatria* could provoke our readers to ask this question. These authors assessed, in a cross-sectional study, the bone mineral density measurements (BMD) obtained through (DEXA) from 47 healthy male adolescents (10 to 19 years). However, before we turn our attention to the question above, we must consider certain factors.

Dual emission x-ray absorptiometry is method with high precision and accuracy for the measurement of mineral content that employs low levels of radiation and, for this reason its utility has already been consecrated for the diagnosis and follow-up of bone disease in adult populations. It is based on the attenuation of the x-rays as they pass through different types of body tissue. The two types of standardized x-ray energy make it possible to differentiated between several body tissues and divide the organism into its content of mineral, fatty and lean mass (free of fat). With respect of the mineral fraction, the method is capable of determining the mineral quantity in g (bone mineral content) contained in a given projection of bone . Dividing this mineral content by the bone area of the location obtains what is conventionally known as density, although the measurement is in g/square cm^2. It is at this point that the first difficulties with interpreting BMD as determined by DEXA come in pediatrics. Because the density obtained is based on area and not volume and because the area does not increase in the same proportion as the volume during growth, large bones are overestimated and small bones are underestimated in terms of BMD, as a result of a technical limitation of the method. Infancy and adolescence are periods during which the organism is growing rapidly and, therefore, the size of bones vary intensely. Therefore a proportion of the change observed in area-based BMD during these periods is not a real increase in mineralization, but, in fact reflects the volumetric growth of the skeleton. This can be discerned when methods capable of measuring the real volumetric density are used, such as quantitative computerized tomography.[3] On the other hand, the increase in BMD is observed to persist for some years after the end of longitudinal growth and peak bone mass is attained during the third decade of life. At this point bone mass is considered "ideal", i.e. it has greatest resistance and, therefore, least risk of fracture.

The primary objective, however, for discovering BMD is its current or future correlation with the risk of bone fractures. The criteria applied to post-menopausal women to calculate the risk of fracture are always based on this "ideal" standard, which is the BMD measurement obtained from a population of young adults (20 to 30 years old). The greater the number of standard deviations (T score) below this average the greater the risk of fracture as confirmed by epidemiological studies of this post-menopausal population. From criteria defined in 1995 by experts convened by the WHO, osteoporosis is defined as a T score below -2.5 and osteopenia when the T score is between -1 and -2.5.[4] It is at this point that the second problem with BMD interpretation for children and adolescents comes up. The reasons why the same WHO criteria cannot be used to interpret BMD comparing children or adolescents with young adults are obvious. The article written by Silva et al. draws attention to this problem. The most common error made by doctors in bone densitometry interpretation in children and adolescents is to use the T score for diagnosis.[5]

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Nowadays the manufacturers of densitometry equipment provide BMD curves obtained from American children and adolescents divided by sex and age group and the results of BMD are presented as z scores (the number of standard deviations away from this average for the same age and sex as the patient). Silva et al., however, in addition to offering bone densitometry values for a healthy Brazilian population, point out other important factors when interpreting these results. The authors observed the expected progressive increase in weight, stature and body mass index (BMI) with advancing chronological age, with differences more accentuated from 14-15 years of age. At this point a significant increase is detected in BMD at the lumbar spine and proximal femur. The increase in bone mass is also

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progressive with respect of pubertal evolution, with significant differences from Tanner stage 3 onwards. These findings were comparable with others already described with respect of other populations[6-7] and demonstrate that chronological age is not the only variable that should be taken into consideration when setting norms for bone mass in childhood and adolescence, but that other factors such as stature, weight and pubertal stage. At this point, we come up against a third problem with densitometry interpretation in children and adolescents: how to establish an adequate pattern of normality. This aspect acquires even greater importance when we wish to evaluate children or adolescents suffering from chronic diseases, which potentially retard growth and development. Horlick et al. in a recent study concerned themselves with developing a model for evaluating bone mass by DEXA in children and adolescents, and concluded that the variables sex, ethnic origin, weight, height and bone area accounted for 89 to 99% of BMD. Furthermore, they pointed out that the behavior of BMD was specific to different clinical conditions, suggesting that, in addition to all the variables quoted above, the patient's diagnosis must also be taken into account when the results of bone densitometry are interpreted.[8]

Now that all of these considerations about densitometry interpretation in children and adolescents have been stated, we return to the initial question: why measure the BMD of children and adolescents? Finding out the physiology of bones during growth and development could be motive enough fop this. However, our interest as clinicians is focused on bone fragility and predisposition towards fractures, which do not only occur with aging, but also at earlier stages. A series of drugs and diseases are associated with forms of osteoporosis during childhood and adolescence. An excellent review of the theme was published in this Journal by Campos et al.,[9] in which the most frequent causes of osteoporosis in childhood and adolescence were explained. These include a large number of genetic, endocrinal, rheumatic and hematological disorders, among others. A greater number of fractures are observed among chronic users of corticoids, post-transplant patients, after oncological or anti-viral treatments.[10] Therefore BMD measurements in cases of fracture due to pre-existing fractures or in the presence of diseases known to be associated with fractures or bone losses would be of great use when following up these patients.

In addition there are a large number of diseases or treatments that, if affecting an individual at this period that is so critical to peak bone mass acquisition, greatly increase their risk of osteoporosis in the future.[11,12]

Taking account of the limitations of the technique and using normality curves that take account of the main variables (origin, age, sex, anthropometric measurements and pubertal development), BMD can be of great utility in daily clinical practice both to assess current and future risk of fracture and to plan suitable therapy for those at greatest risk of osteoporosis.

References

1. Silva CC, Goldberg TBL, Teixeira AS, Dalmas JC. Mineralização óssea em adolescentes do sexo masculino: anos críticos para a aquisição de massa óssea. J Pediatr (Rio J). 2004;80:461-7.
2. Leonard MB, Shore RM. Radiologic evaluation of bone mineral in children. In: Favus MJ, editor. Primer on the metabolic bone diseases and disorders of mineral metabolism. 5th ed. Washington (DC): American Society for Bone and Mineral Research; 2003. p. 173-189.
3. Schönau E. Problems of bone analysis in childhood and adolescence. Pediatr Nephrol. 1998;12:420-8.
4. World Health Organization study group. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. World Health Organ Tech Rep Ser. 1994;843:1-129.
5. Gafnai RI, Baron J. Overdiagnosis of osteoporosis in children due to misinterpretation of dual-energy x-ray absortiometry (DEXA). J Pediatr. 2004;144:253-7.
6. Southard RN, Morris JD, Mahan JD, Hayes JR, Toch MA, Sommer A, et al. Bone mass in healthy children: measurement with quantitative DEXA. Radiology. 1991;179:735-8.
7. Glastre C, Brasillon P, David L, Cochat P, Meunier PJ, Delmas PD. Measurement of bone mineral content of the lumbar spine by dual energy X-ray absorptiometry in normal children: correlations with growth parameters. J Clin Endocrinol Metab. 1990;70: 1330-3.
8. Horlick M, Wang J, Pierson Jr RN, Thornton JC. Prediction models for evaluation of total-body bone mass with dual-energy X-ray absorptiometry among children and adolescents. Pediatrics. 2004;114:e337-45.
9. Campos LMA, Liphaus BL, Silva CAA, Pereira RMR. Osteoporose na infância e adolescência. J Pediatr (Rio J). 2003;79:481-8.
10. Saggese G, Baroncelli GI, Bertelloni S. Osteoporosis in children and adolescents: diagnosis, risk factors and prevention. J Pediatr Endocrinol Metab. 2001;14:833-59.
11. Carvalho CNM, Sdepadian VL, Morais MB, Fagundes Neto U. Doença celíaca em tratamento: avaliação da densidade mineral óssea. J Pediatr (Rio J). 2003;79:303-8.
12. Kaste SC. Bone-mineral density deficits from childhood cancer and its therapy. A review of at-risk patient cohort and available imaging methods. Pediatr Radiol. 2004;34:373-8.