Vertebra and femur neck bone mineral density values in healthy Turkish children

Alev Hasanoğlu, Leyla Tümer, Fatih Süheyl Ezgü
Department of Pediatrics, Gazi University Faculty of Medicine, Ankara, Turkey

SUMMARY: Hasanoğlu A, Tümer L, Ezgü FS. Vertebra and femur neck bone mineral density values in healthy Turkish children. Turk J Pediatr 2004; 46: 298-302.

The bone mineral density (BMD) of the lumbar spine and femoral neck was measured by dual energy X-ray absorptiometry (DEXA) in 102 healthy Turkish children, aged 3-15, and values were correlated with age, height, weight and pubertal status. BMD increased with age in children of both sexes. The increase was steeper at the time of puberty. There were no significant differences between boys and girls until the age of 10. After the age of 10, lumbar BMD was higher in girls than in boys, probably because of the earlier onset of puberty in females. BMD was also highly correlated with height and weight. Because of low irradiation exposure, rapid scanning and high precision, DEXA is a non-invasive method, which is well adapted to children with diseases impairing bone metabolism.

Key words: bone mineral density, children.

Osteoporosis is a growing health problem, and it is generally accepted that those who achieve a higher peak bone mass are less at risk of having an osteoporotic fracture later in life. Recent studies have shown that peak bone mass can be achieved by the early 20s, it is therefore of interest to study the pattern of bone mineralization in children[1-4].

Many therapies and systemic disorders reduce bone mineralization in childhood. Identifying children at risk in general clinical practice requires standardized bone mineral density (BMD) reference data. The lack of this data has necessitated the use of institution-specific norms. Moreover, ethnic differences in the incidence and prevalence of osteoporosis have been shown throughout the world, which has also necessitated the use of race-and ethnic-specific norms[5,6].

The purpose of this study was to obtain BMD data on healthy Turkish children 3 to 15 years of age, and to examine the relationship of these values with age, sex, body weight, height and pubertal status. To our knowledge this is the first study reporting normal values of BMD measured by dual energy X-ray absorptiometry (DEXA) in Turkish children.

Material and Methods

A population of 102 subjects (56 females and 46 males) aged 3-15 years was studied. Children were included in the study if their height and weight were within 2 standard deviation scores of the mean of the general population and if they did not have any documented medical disease. Age was determined precisely to the decimal age. The age groups were then constructed based on the midpoint values. Because of the relatively low number of cases in the age groups, we pooled every two ages in a single-age category. Height and weight were measured according to the standard procedures. Subject characteristics according to gender and age group are shown in Table I. The weight for height centiles of all cases were over 90. Pubertal staging was made according to Tanner's criteria. A DEXA (Norland XR-35) scanner was used to perform DEXA measurements on all subjects. The same examiner performed all procedures. During the measurements, the child was supine and the physiologic lumbar lordosis was flattened by elevation of the knees. Bone mineral content was evaluated per surface area (g/cm^2).

Table I. Body Weight and Height of the Cases (Mean±SD)

Age (years)	Boys			Girls		
	n	Weight (kg)	Height (cm)	n	Weight (kg)	Height (cm)
3	–	––	––	2	15.000±1.414	97.500±0.707
4-5	11	18.545±3.357	108.545±5.584	8	18.250±2.315	109.125±5.083
6-7	10	22.500±3.779	123.800±11.952	8	21.625±2.134	118.000±5.880
8-9	7	35.714±5.678	130.000±7.829	6	26.633±6.653	126.833±9.432
10-11	5	39.833±4.579	149.000±7.014	7	43.714±8.321	148.714±8.200
12-13	6	41.400±6.066	157.000±3.873	11	48.364±4.760	154.364±6.682
14-15	7	54.000±14.944	164.429±8.942	14	49.929±10.852	159.429±10.074

Statistical Analysis

The statistical analysis was done using SPSS 9.0 Software for Windows. The data was expressed as mean ± standard deviation unless otherwise stated. The statistical difference between the groups was evaluated by either Student's t test or Mann-Whitney U test. The relationship between age, height, weight, pubertal stage and BMD was evaluated by regression analysis.

Results

The lumbar vertebra and femur neck BMD values according to age in boys and girls are shown in Table II. A statistically significant increase in BMD in both regions according to age was noticed ($p<0.00001$ and $p<0.00001$).

The relationship between age, weight, height and BMD according to sex is shown in Table III when age, weight and height were assumed as independent variables for BMD. A significant positive correlation was noticed between all independent variables and BMD.

Table III. Correlation Coefficients Between BMD Values and Age, Weight and Height (r^2)

	Boys		Girls	
	Vertebra	Femur neck	Vertebra	Femur neck
Age	0.751	0.837	0.837	0.710
Height	0.710	0.785	0.806	0.745
Weight	0.838	0.874	0.857	0.789

In all correlations $p<0.00001$.
BMD: bone mineral density.

When the study group was evaluated according to the developmental stages, a significant increase in BMD was noticed during puberty (Table IV). A significant positive correlation was also found between BMD and Tanner stage. When the cases having Tanner stage 0; stages 1, 2 and 3; and stages 4 and 5 were pooled and evaluated as three distinct groups, a significant statistical difference was found ($p<0.00001$).

No significant relationship was noticed between boys and girls up to 10 years. In the age groups 10-11, 12-13 and 14-15, the lumbar vertebra

Table II. BMD Values of the Cases (Mean±SD)

Age (years)	Boys			Girls		
	n	L2-L4 (g/cm^2)	Femur neck (g/cm^2)	n	L2-L4 (g/cm^2)	Femur neck (g/cm^2)
3	–	––	––	2	0.377±0.025	0.437±0.033
4-5	11	0.461±0.038	0.520±0.055	8	0.458±0.031	0.494±0.040
6-7	10	0.504±0.051	0.568±0.056	8	0.540±0.039	0.632±0.078
8-9	7	0.576±0.027	0.699±0.066	6	0.556±0.084	0.582±0.058
10-11	5	0.584±0.071	0.774±0.062	7	0.740±0.143	0.779±0.053
12-13	6	0.685±0.047	0.806±0.048	11	0.799±0.059	0.791±0.081
14-15	7	0.818±0.144	0.899±0.118	14	0.925±0.088	0.877±0.110

BMD: bone mineral density.

Table IV. BMD Values of the Cases According to Pubertal Stage

Tanner stages	Boys			Girls		
	n	L2-L4 (g/cm²)	Femur (g/cm²)	n	L2-L4 (g/cm²)	Femur (g/cm²)
0	27	0.501±0.057	0.576±0.087	23	0.496±0.069	0.554±0.089
1-2-3	11	0.631±0.073	0.700±0.056	10	0.742±0.123	0.786±0.086
4-5	8	0.805±0.139	0.881±0.120	23	0.876±0.100	0.835±0.108

In all correlations $p<0.00001$, $r=0.99999$.
BMD: bone mineral density.

BMD of girls was significantly higher than for boys ($p<0.05$ for all) (Fig. 1a). In the evaluation from the femur neck, there was no significant difference between boys and girls (Fig 1b).

Discussion

The main purpose of the current study was to determine the normal values of BMD for healthy Turkish children. The present data could be used as a reference for those studies using the same evaluation methods.

Bone mineral content depends not only on the amount of mineral deposited in the bone matrix, but also on the height of the patient and the diameter of the area where the evaluation is made[9]. For this reason, direct determination of the bone mineral content to evaluate changes in bone mineralization would

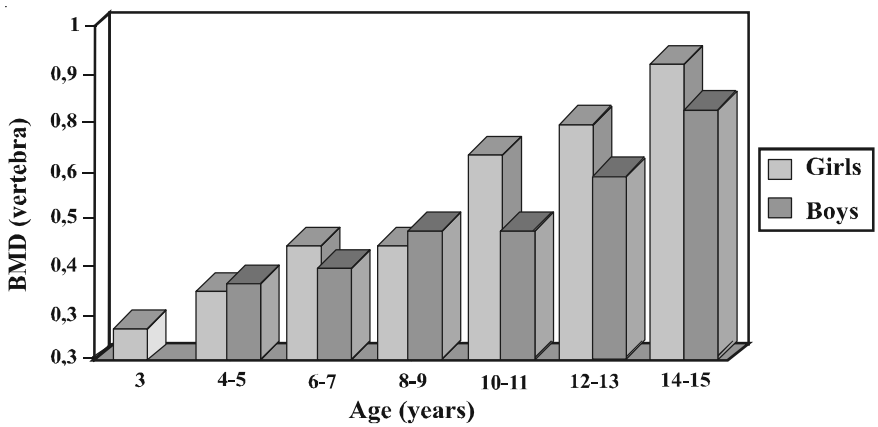

Fig. 1a. Vertebra bone mineral density values for girls and boys according to age.

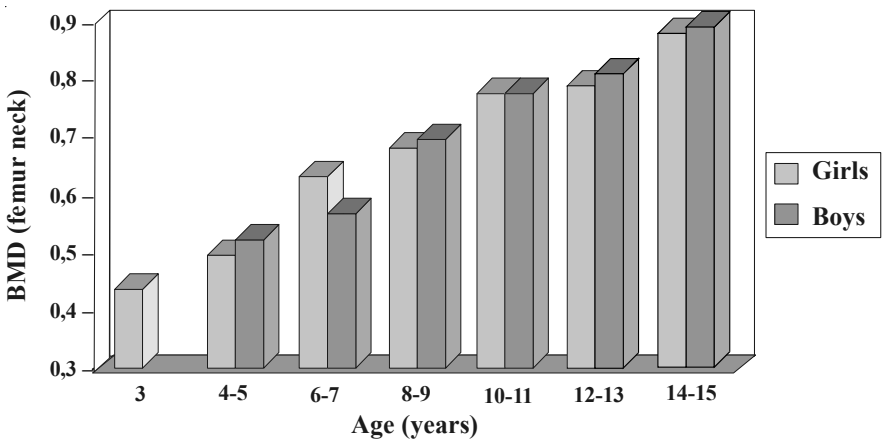

Fig. 1b. Femur neck bone mineral density values for girls and boys according to age.

not be appropriate in childhood where an accelerated growth is seen. In this study, the bone mineral content was corrected by the area of the region from which the measurement was done, as this method better reflects the matrix mineralization in cases with different heights.

In this study, BMD was found to have a positive correlation with age, pubertal stage, height and weight in both sexes. Our results are also compatible with the other reports in which different measurement techniques were used[2,6,10-14]. When multiple regression analysis was used, it was seen that age and weight have more importance than height in the determination of the BMD. In one study, weight lifting training was shown to increase BMD[15]. Although no significant difference was seen in BMD between girls and boys until the age of 10, between 10 and 16 years of age, girls were shown to have greater vertebral BMD. The early beginning of puberty in girls would account for this differences. The same humoral factor are responsible for both accelerated height growth and accelerated bone mineralization. As 75% of femur neck consists of cortical bones, which are known to be more vulnerable to mineral changes and to have a slower bone turnover time compared to trabecular bone, such a difference between the measurements taken from the femur neck was not seen[16]. As vertebral bones are made up of trabecular bone, they are more sensitive to increased bone turnover in puberty. Similar results were reported from the studies which used cortical radius for measurement[17,18]. The most important increase inn BMD in both sexes was found to exist in Tanner stage 4-5, as in the other studies[10,11,18,20,22].

In conclusion, the determination of normal BMD values for the diagnosis and treatment of children with osteopenia is of great importance. The results of this study could be used to observe skeletal mineralization in children or as a standard for other studies. Childhood osteoporosis can be seen as a result of many systemic and metabolic bone diseases. As the majority of the children are asymptomatic, early diagnosis could be done by BMD. With low radiation dose and short analysis period, DEXA is an appropriate technique for the determination of BMD in children.

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