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Bone mineral density & bone mineral content in Saudi children, risk factors and early detection of their affection using dual-emission X-ray absorptiometry (DEXA) scan

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ABSTRACT

Objectives: Optimization of bone health is a very important concern now a day. Achievement of optimal peak bone mineral mass is the best means of preventing osteoporosis in adulthood. Dual-energy X-ray absorptiometry (DXA) has become the basis for the evaluation of skeletal health in all ages.
The aim of the work: This work aims to assess bone parameters in Alhasa children, Saudi Arabia.
Patient & methods: A Cross-sectional survey study involves 126 healthy children (83) boys & (43) girls. Their ages range from (3–15 years).
Results: The mean of Bone mineral density (BMD) and bone mineral content (BMC) were (0.915 ± 0.34 & 0.795 ± 0.133) (43.93 ± 29.4 & 37.63 ± 11.2) in boys and in girls respectively. These values were lower than other areas in Saudi Arabia. BMD & BMC are statistically significant positive correlation with age in both sex, ($r = 0.567$ $P = 0.000$ & $r = 0.57$ $P < 0.001$) and ($r = 0.831$, $P = 0.000$ & $r = 0.818$ $P < 0.001$) respectively. Level of BMD & BMC acquisition were more in boys than girls in all age groups especially group (12–15 years). The mean Z score shows significant steady decrease with age in both sexes. Height, Weight, BMI, showed significant positive correlations with changes in BMD & BMC. While Calcium level and Vitamin D level showed negative correlations.
Conclusion: The average BMD & BMC in Saudi children is less than that of other races. It shows no significant difference with other Saudi population. Height, weight, BMI Calcium level and Vitamin D level can predict the changes in the BMC & BMD.

Introduction

Bone is a highly "dynamic" and specialized connective tissue; its main function is to provide a mechanical support & mineral homeostasis to the human body.[1] Over the last decade, the bone health monitoring is increasingly important, especially in the pediatric population.[2]

Bone mass shows a progressive increase from the birth, until the third decade of life, when it reaches a maximum value defined "peak bone mass.[3] Peak bone mineral accrual occurs during early puberty while peak bone mass is achieved in young adulthood.[4] Achievement of optimal peak bone mineral mass is the best means of preventing osteoporosis in adulthood.[5] The accrual of Bone Mineral Density (BMD) during growth has therefore arise interest; there is an ongoing debate on whether a low BMD in childhood predicts a low BMD in adulthood.[6]

As bone properties change rapidly during growth, making a prediction on adult BMD from childhood measurements is difficult. Serial measurements cover both the pre-pubertal and post-pubertal phases is important for accurate predictions.[7] Several factors influence the mineralization of bones in childhood and adolescence, including genetic factors, sex, nutrition, endocrine factors, and mechanical factors.[8]

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Low bone mineral density is the primary cause of compromised bone health. Many factors can contribute to low bone mineral density. Unfortunately, in Saudi Arabia genetic background, customs, diet, and geographical location is identified as predisposing factors for osteoporosis.[9] In children Low bone mass is usually suspected after X-rays demonstrate osteopenia, after a low-trauma fracture, or when a child has a known disorder associated with low bone mass.

Nowadays, the widest method to assess BMD& Bone mineral contents (BMC) is Dual-energy X-ray absorptiometry (DXA). It becomes the basis for the evaluation of skeletal health in all ages. It assesses BMD, BMC, and body composition.[10] The International Society for Clinical Densitometry recommends a skeletal status evaluation in children and adolescents based on age-, sex-, and ethnicity-specific normative Ref. [11] DXA scan is now considered the standard reference for defining the rate of mineralization in the total skeleton in different regions.

The dose of the DXA radiation is extremely low (5–10 u Sv). It generally takes 5–10 min to be performed, rarely needs sedation and low cost.[8] DXA scan can identify bone-density losses of as little as 3%.[12] It is by far, the most widely used unique technique for measuring BMD in children .[11]

The interpretation of DXA values in children is much more difficult than in adults because the skeleton is continuously changing and there is no precise point of reference. It has some limitations, especially in children. Bone size varies less in adults than in growing children. Particularly during the rapid growth phase of puberty, thus age and puberty maturation are important considerations.[3,13] Most bone Densitometers in children report BMD as a Z score, related to an age-matched (and sometimes gender or ethnic group matched population.[14]

This study is designed to screen for BMD and BMC in Saudi children. To detect their relation with anthropometric measure. Study factor affecting their changes especially the serum Calcium, Vitamin D level.

Patients & methods

This cross-sectional study performed in King Feisal university polyclinic, in a period from 2012–2014, 126 patients were included in this study. They were 82 (65.9%) males and 44 (34.1%) females.

Inclusion criteria

Age more than 3 years of age, and apparently healthy children.

Exclusion criteria

Children whom Parents refuse to scan and Children with any chronic illness.

Dean of scientific affairs & Ethical comities in the university and polyclinic approved the study

Parent's verbal consent to perform DEXA scan to their children was also obtained.

Complete history with special inquire about age, sex, history of previous fracture, blood transfusion, lifestyle and receiving drugs was obtained.

Complete examination with comment in the weight, height, and any manifestation of chronic illness was done.

A Blood sample was taken for estimation of serum calcium, and active Vitamin D level.

DXA scan was using (**GE Excel DXA – compact pencil beam axial scanner)** present in the polyclinic, BMC measured in grams bone area (BA), and BMD (in gram/square centimeter) from the lumbar spine **(LS) (L1–L4).** The position size and location of the region were the same for all children. The machine that is adjusted to specific age- and sex- reference data calculates Z-scores automatically. The scan was analyzed and diagnosed by an experienced consultant of radiology, with more than 20 years' experience.

Statistical analysis

Results were analyzed using SPSS program version 21 for Windows. Statistical descriptive data were reported as mean ± SD. Association of variables was tested with Pearson or Spearman correlation. Simple regression analysis was first performed to screen potential predictors for BMD & BMC and a multivariate stepwise linear regression model was used to identify and determine significant predictors for bone mass. A P-value of less than 0.05 was considered statistically significant.

Results

This study include 126 healthy children, they were 65.1% (n: 82) males and 34.9% (n: 44) females. Their anthropometric parameters are shown in the Table 1. The children grouped according to gender and age into 4 groups. The mean ±SD of BMC & BMD in the studied group are demonstrated in Table 2. A comparison between Bone parameters in our cases and other areas in Saudi Arabia shows that our cases have BMD&BMC means less than other in Jeddah study done by Al-Ghamdi et al. 2012,[15] these difference is not significant in BMC while there is a significant difference in their BMD in all age groups.

The estimated BMD in both boys & girls Table 3. BMD changes shows significant positive correlation with age in both sexes, (boys $r = 0.57$ $P > 0.001$) (girls $r = 0.818$ $P > 0.001$). Maximum annual increase in BMD in boys was in age (13–15 yrs.), it was 52.7%

Table 1
Anthropometric parameters for study groups.

Age Groups	Numbers (%)		Height (cm)				Weight (kg)				BMI (kg/m^2)			
			Mean + SD		C V%		Mean + SD		C V%		Mean + SD		C V%	
	Boys 82 (65.1)	Girls 33 (34.9)	Boys (119.2 ± 15.73)	Girls (127.4 ± 20.3)	Boys	Girls	Boys (22.3 ± 10.1)	Girls (26.6 ± 10.8)	Boys	Girls	Boys (14.9 ± 2.4)	Girls (15.4 ± 2.2)	Boys	Girls
1 (3–5)	33 (40.2)	13 (29.5)	108.1 ± 7.1	107.15 ± 4	6.6	4.3	17.25 ± 2.5	17.6 ± 0.7	14.3	10.0	14.40 ± 1.4	14.77 ± 1.2	9.3	8.9
2 (6–8)	27 (32.9)	14 (31.8)	118.2 ± 9	121.3 ± 11.7	7.7	9.7	20.55 ± 3.8	23.15 ± 9.0	16.8	25.9	14.46 ± 1.3	14.6 ± 1.2	7.3	16.8
3(9–11)	19 (23.2)	7 (15.9)	132.8 ± 10.88	134.3 ± 7.9	10.4	6.4	26.7 ± 4.8	28.2 ± 3.8	23.3	15.0	14.86 ± 2.23	15.68 ± .9	13.3	5.6
4 (12–15)	3 (3.7)	10 (22.7)	164.66 ± 12.7	157.4 ± 4.9	10.4	3.3	66.33 ± 9.8	41.9 ± 5.3	21.9	13.0	24.07 ± .0.46	16.8 ± 2.3	2.4	13.4

Coefficient of Variation %.