ORIGINAL ARTICLE

COMPARATIVE STUDY OF BONE MINERAL DENSITY IN HIGH AND LOW INCOME SCHOOL CHILDREN

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ABSTRACT

Objective: To compare the bone mineral density [B M D] and associated dietary and physical activity factors in low and high socio economic status (SES) groups of children.

Design: This is a cross sectional, prospective, descriptive study.

Setting: This study was conducted at two different socio-economic level schools. The low socio-economic school was Major Sultan Shaheed Primary School in North Nazimabad, Karachi, while the high socio-economic school was Horizon School in Gulshan-e-Iqbal Karachi.

Material and Methods: This study was conducted in September 2007. The performas were filled & the tests were done during one week. One hundred children of age 10—12 years of both sexes were selected randomly from two schools of Karachi representing the two different socioeconomic classes. Fifty children each were recruited from either school. Each group included 25 from either sex. A questionnaire was designed to include basic demographic features, weight, height, BMI, dietary habits and physical activities. BMD was measured at the heel using a portable quantitative ultrasound (QUS) densitometry machine. The results were expressed as T-score. The data was analysed on SPSS version 11.5. For data comparison and calculation of significance ANNOVA and ETA were used.

Result: The mean T-scores in high SES group were significantly lower at -2.82 than the low SES group which was -2.36 (p- value < 0.05). This is despite the fact that the high SES group had a significantly higher BMI and better overall dietary calcium and other minerals consumption. However, the high SES group children also consumed significantly higher quantities of carbonated soft drinks and chocolates. The high intensity activities were comparable in both groups (p-value 0.83). However, the moderate intensity activities were observed 2.5 folds more frequently in low SES than in high SES group.

Conclusion: Lower BMD values were noted in high SES group of children despite having higher BMI and better overall mineral consumption. This could be because of concomitantly higher consumption of carbonated soft drinks and other junk food that may hinder calcium and minerals absorptions and sedentary lifestyle observed in high SES group children.

Keywords: Bone mineral density, Children, Physical activity, dietary factors.

INTRODUCTION

Bone mineral density (BMD) reflects the strength of the bones in the body. It increases during childhood and adolescence until peak bone mass is reached at maturity - usually until the age of 25-30 years. Peak bone mass and subsequent bone losses are important determinant of osteoporosis later in life especially in the postmenopausal women and elderly people of either sex. Due to this reason osteoporosis is also sometimes regarded as a 'paediatric disease with geriatric consequences'. Many factors adversely affect the BMD in early life such as bad dietary habits, lack of physical activity, low weight, less exposure to sunlight. Effective awareness programmes highlighting these factors could help

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to achieve the optimum peak BMD at an early age thereby reducing the future risk of osteoporosis.

In adults, BMD is often measured to diagnose osteoporosis and is the only reliable test available to predict future fracture risk in an individual. In children, however, BMD measurement is generally restricted as a research tool. Rarely, though it can be clinically required to diagnose rare childhood osteoporotic states.

Different devices can be used to measure BMD.[1] These include quantitative ultrasound (QUS), quantitative computed tomography (QCT).[2-4] dual energy X-ray absorptiometry (DEXA) and peripheral DEXA etc. DEXA scan is currently the gold standard method for clinical use for the diagnosis and monitoring of osteoporosis due to its high precision, reproducibility and low radiation exposure. The QUS although has limited clinical application, could be useful for research and in situations where mass screening is required as it is radiation free and has a convenient portable instrument. The heel QUS has close correlation with DEXA scan especially at hip[2, 3] and to a lesser extent at lumber spine[4] QCT on the other hand is expensive and uses higher radiation.[5-7]

Dietary nutrients that play an important role in bone health are calcium, phosphorus, magnesium, potassium and some vitamins such as vitamin D and vitamin K.[8-11]

Many research studies showed that physical activities positively affects bone mineralization in children. Recent health guidelines suggest that children should indulge in 60 minutes of moderate to severe physical activity every day.[12-16] On the other hand, certain factors adversely affect bone mass e.g. anticonvulsant and steroid medicines[17-19] diseases like Crohn's disease[20-24] and Celiac disease and genetic factors.[25-27]

SUBJECTS AND METHODS

A total of 100 children of age 10—12 years of both sexes were selected randomly from two schools of Karachi on the basis of convenience. The low SES children were represented by a school in North Nazimabad area which provides free education to the children of labour class. The high SES group children were represented by another school in the Gulshan-e-Iqbal area which caters affluent class children & had a fee structure of Rupees 1500 per month. Fifty children each were selected from both schools. Each group included 25 from either sex. A questionnaire was designed to include basic demographic features, weight, height, BMI, dietary habits and physical activities. The questionnaire was filled by a single interviewer, spending approximately 15 minutes for each interview. Different food and beverages were quantified by using photographs of food items and other house hold measures. High intensity activities were classified as those sports which require running, jumping and high impact activities such as cricket, football and athletics etc. The moderate intensity activities included casual strolling, racquet games, hide and seek, marble games etc .Every child's bone mineral density was measured at the heel using Hologic Sahara 'Quantitative Ultrasonic Densitometry' (QUS). . This instrument uses calcaneal QUS measurements of broadband ultrasound attenuation (BUA) and speed of sound (SOS). A stiffness index is calculated from BUA and a SOS value, which is then converted to a T-score, technically termed as-'estimated-T-score'. Pre-interview verbal consents were obtained from the parents. The study was approved by the ethical review board. For data transformation and analysis SPSS version 11.5 was used. For data transformation of dietary habits selected commands were used to calculate the mineral (calcium, phosphorus, potassium and magnesium) consumed during a week in milligram (mg) which was then divided by seven to calculate the mineral consumption in mg per day.

Physical activity data was transformed into SPSS as high intensity activities and moderate intensity activities in minutes per day (again this was calculated by summing up activities during a whole week and dividing by seven). The data was analysed by comparing mean values of mineral consumption, consumption of carbonated drinks and chocolate (as servings per day), BMI, BMD and physical activities using ETA. The significance was calculated by ANNOVA table.

RESULTS

The mean T-scores was significantly lower at -2.82 in high SES group than the low SES group which was -2.36 (p- value < 0.05). This is despite the fact that the mean BMI in high SES group was higher at 16.49 as compared to low SES group which was 15.01. (Table I).

Table 1: Mean weight, height, BMI and BMD in both groups of 10-12 years age.

Variables	Socio-Economic Status		
	High SES (Mean)	Low SES (Mean)	Significant
Standard – Weight for age 81.4 (kg)	79.2	61.3	.000
Standard – Height for age 56.8 (inch)	57.6	53.5	
BMI*** (kg/m2)	16.49	15.01	.004
BMD** (T-score)	-2.82	-2.36	.006

* S.E.S = Socio Economic Status
** BMD = Bone Mineral density
*** BMI = Body Mass Index

The consumption of mineral intake in both groups was generally lower than the RDA (recommended daily allowance) except for phosphorus intake in either sex and calcium intake in girls in both groups which were above the RDA recommendations. The mean consumption of all minerals was, in general, better in high SES group than in the low SES group. The mean calcium intake was $602.30 \pm$ mg/day and $484.79 \pm$ mg/day respectively for boys and 734.42 mg/day and 574 mg/day respectively for girls of high and low SES groups. The mean phosphorus consumption was 1165.67 mg/day and 837.96mg/day respectively for boy and 1013.79 and 1073.89 for girls in high and low SES groups. Table 2 shows complete details of other minerals consumed in different subgroups

Table 2: Mineral Consumption

	Gender	RDA** (mg).	High S.E.S*	Low S.E.S*	Significance
Total Calcium (mg)/day	Boys	700	602.30	484.79	.023
	Girls	500	734.42	574.77	
Total Phosphorus(mg)/day	Boys	700	1165.67	873.96	.228
	Girls	500	1013.39	1073.89	
Total Potassium (mg)/day	Boys	2000	2022.60	1538.42	.001
	Girls	2000	1889.99	1672.09	
Total Magnesium (mg)/day	Boys	300	265.61	251.46	.546
	Girls	300	247.18	243.18	

* S.E.S = Socio Economic Status
** RDA = Recommended Dietary Allowances

The mean consumptions of carbonated soft drinks and chocolate were 0.32 and 0.16 servings per day respectively in high SES group whereas none consumed in low SES group which was a highly significant finding (Table 3).

Table 3: Intake of food items that hinder mineral absorption

Food items	High S.E.S.* (mean)	Low S.E.S* (mean)	Significant
Total Carbonated soft drink's serving / day	0.32	.00	.000
Total Chocolates serving / day	0.16	.00	.000

* S.E.S = Socio Economic Status

The high intensity activities were 50.90 min/day in high SES group and 48.71 min/day in low SES group which were not statistically different (p-value 0.83). However, the duration of moderate intensity activities were 13.81 min/day in high SES group as compared to 33.41 min/day in low SES group (Table 4).

Table 4: Mean duration of physical activities.

Physical Activity	High S.E.S*	Low S.E.S*	Significant
High Intensity activities	50.90 minutes / day	48.71 minutes / day	0.83
Moderate Intensity activity	13.81 minutes / day	33.41 minutes / day	0.00

* S.E.S = Socio Economic Status

This means that high SES group children were two and a half fold less active than their low SES counterparts– again a highly significant finding.

DISCUSSION

This study shows lower BMD in high SES group children - a result that is somewhat unprecedented. The higher BMI in high SES group was expected to be positively associated with BMD as observed in Lebanese[28] and Indian[29] studies. Similarly, high dietary mineral contents, as observed in the high SES group, were expected to be associated with a higher BMD.[8-11] But our results are contrary to that. There could be several reasons for these contradictory results. Firstly, the high SES group also consumed carbonated drinks which are known to hinder calcium absorption from the gut. Mc Gartland C et al. have shown that carbonated soft drinks consumption is inversely related to BMD in adolescence.[30] Secondly, the 2.5 fold lesser duration of physical activity (in moderate category) in high SES group could have resulted in diminished bone mineralization and consequently lesser BMD.[31-34]

Thirdly, the high SES children were less exposed to sunlight by being relatively more house bound due to sedentary activities such as computer and TV watching etc.

Another interesting observation was that the high SES group had a standard mean height whereas low SES children had a below standard mean height. This could be because of ethnic differences i.e. majority (54%) of the children in high SES group were from 'Urdu speaking' families as opposed to low SES group in which majority (54%) were from 'Punjabi speaking' families.

Another important point noted in this study was that the children of both the groups were not consuming recommended dietary allowances (RDA) of minerals except phosphorus intake which was above the RDA in both groups and calcium intake of girls which was

also above the recommended dietary allowances in both groups. This means that further efforts are required to educate all concerned regarding blending a balanced diet for the children especially boys. It is however encouraging to note that the calcium intake in girls was adequate in both groups.

For reasons of general familiarity and popularity we expressed the BMD values as a 'T-score' rather than gm. per cm^2 T-score is automatically calculated by an in-built programme in the QUS machine. Contrary to the adult population the T-score values of osteoporosis and osteopenia do not apply to children because of a different quality of bone which is more resilient, flexible and posses a normal architecture. However it does represent the overall current bone mineral deposits which could have implications for the future.

This study has some limitations. Although the true scientific approach demands to find the relation between dependent and independent variables by considering one at a time while others are kept constant. This ideal approach was not practically possible for this study as the number of independent variables were quite high as compared to samples collected. A good approximation was made by taking the means of the results and ignoring the less significant factors. The results thus obtained were satisfactory enough for this level of research and can be confidently used in future studies. We recommend that serum levels of mineral i.e. calcium, phosphorus, magnesium, alkaline phosphatase and vitamin D levels be measured along with markers of bone turnover be used to correlate with BMD changes in different groups.

CONCLUSION

The low SES group children had a significantly higher BMD values despite having a lower BMI, lower calcium and mineral and similar high intensity activities. This could possibly be attributed to a two and a half folds more frequent physical activities in

moderate cadre and lack of consumption of carbonated drinks and chocolates which may hinder calcium absorption from the gut. School administration should actively discourage consumption of carbonated drinks within their premises. They should organise events such as seminars, debates and health awareness walks etc. To encourage activity levels amongst the children. Further studies are recommended using serum levels of bone biochemistry including serum vitamin D levels and markers of bone turnover.

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