International Journal of Academic Research and Development
ISSN: 2455-4197
Impact Factor: RJIF 5.22
www.academicsjournal.com
Volume 2; Issue 6; November 2017; Page No. 315-321

Prevalence of osteopenia and osteoporosis among young adult girls residing in the hostels of Panjab University, Chandigarh

[1] Sonam Chadgal, [2] Indu Talwar
[1] Research Scholar, Department of Anthropology, Panjab University, Chandigarh, Punjab, India
[3] Professor, Department of Anthropology, Panjab University, Chandigarh, Punjab, India

Abstract
The present study has been conducted to examine the prevalence of osteopenia and osteoporosis among 190 adult girls ranging in age between 20 and 31 years, residing in the hostels of Panjab University, Chandigarh. T-scores of subjects were calculated utilizing Calcaneal Quantitative ultrasound (QUS) as diagnostic tool. Anthropometric variables namely height, weight, waist circumference, hip circumference were also taken on each subject by using standard techniques. Percent body fat, BMI and Visceral fat were measured by using body fat analyzer. ANOVA showed significant age group differences in all the parameters except for hip circumference, percent body fat, fat mass, fat mass index and BMI. The results revealed that the prevalence of osteoporosis and osteopenia among subjects was 7.37% and 64.21% respectively. According to the nutritional status of the subjects, maximum numbers of osteopenia cases were observed in normal (69.72%) category whereas, maximum numbers of osteoporotic cases were noticed in underweight (42.86) category and only 4.59% cases belonged to normal category. An improvement in bone density was observed in girls with increase in age. In the present study, BMD was found to be positively correlated with all the anthropometric measurements and indices except for height. Chi-square test showed that nutritional status and fracture in past, significantly affected bone mineral density of the girls included in the present study. Regression analysis revealed significant prediction of BMD by WC, WHtR, BMI, Weight, FM, VFA, FMI, FFMI, HC, FFM, PBF and WHR. Of all the variables, waist circumference (10.3%) is found to be the best predictor of BMD followed by WHtR (9.1%). Results of the present study are quite alarming and indicate towards an increase in the prevalence of osteoporosis if not checked at younger ages.

Keywords: bone mineral density, osteopenia, osteoporosis, body mass index

Introduction
Osteoporosis and osteopenia are two major public health problems characterized by low bone mass and density, which make bones more fragile and lead to increased fracture rates. A rapid bone loss occurs in females during menopausal transition and is responsible for substantial morbidity and socio-economic burden. Due to life style changes body mass density is decreasing in the early years much before menopause. So an early detection of this disease can help not only in reducing the fracture rates but also overall socio-economic burden in the nation.

Osteoporosis is a widely prevalent disease in India. Osteoporosis is known as a silent progressing metabolic bone disease that leads to loss of bone mass. Osteoporotic fractures are common cause of morbidity and mortality in adult Indian women and men [1]. Bone strength is a composite of bone density and bone quality. The latter is not fully understood but includes aspects of bone architecture, damage accumulation (example micro-fractures), and mineralization [2]. Bone metabolism is a dynamic and continuous process that maintains a balance between the resorption of old and injured bone initiated by osteoclasts and the formation of new bone by osteoblasts [3]. These two processes maintain homeostasis in the adult skeleton. Adequate intake of Calcium and Vitamin D is the most important requisition for the bone health. During puberty and adolescence, the skeleton takes up calcium avidly and builds up its reserves [4]. This uptake of calcium into the bone is largely dependent on calcium and vitamin D nutrition, as well as exercise. To avoid osteoporosis efforts should be made to attain maximum peak bone mass (PBM), defined as the amount of bone present in the skeleton at the end of its maturation process, during early adulthood [5]. It is well documented that Peak bone mass is normally attained at about 30 years. During adolescence, approximately 40% of the peak bone mass is accumulated which protects against post-menopausal osteoporosis [6]. A general trend of a gradual, progressive bone loss sets in from the mid-thirties which continues throughout life and gets accelerated at the time of menopause in women. Therefore, to prevent fractures it is necessary to take care of bone health right from early childhood by incorporating a healthy life style consisting of regular exercise during adolescence and a balanced diet rich in micronutrients for increasing peak bone mass in the growing years and reducing subsequent bone loss throughout life. It is extremely important to achieve and maintain good bone health. It is well documented that during early childhood and adolescence bone formation predominates bone resorption, resulting in steady and continued growth of skeletal mass causing intense remodeling. After 30 years, this process slows down. Resorption begins to exceed bone formation with the advancing age and, bone loss occurs at an average of 0.7 % per year. The rate at which bone loss occurs at the time of

menopause is considerably more, at an average of 2-5 % per year and it continues for about 10 years [7, 8]. Hereditary factors primarily regulate peak bone mass besides race, sex and the amount of production of various hormones like growth hormone, thyroid hormone, growth factors and sex steroids but it may be modified to a considerable extent by extrinsic factors like physical activity, calcium intake, vitamin D, smoking, alcohol, illnesses, and medications [9, 10]. The level of peak bone mass achieved at puberty is a major determinant of bone mass in later life and hence an important factor in the ultimate development of osteoporosis. A study by Jha *et al*. [11] on patients admitted with hip fractures reveal that increased body mass index, higher physical activity levels and calcium intake played a significant protective effect on hip fractures in urban North Indian population. At the same time the risk of hip fracture increased with excessive caffeine intake and decreased agility. A review of literature showed that despite abundant sunshine, different subgroups of Indian populations demonstrated a high prevalence of vitamin D deficiency [7, 12, 13, 14, 15, 8, 16, 17, 18].

Dual energy X-ray absorptiometry (DXA) is the "gold standard" diagnostic tool for BMD measurement [19]. However, DXA testing cannot be done in the field and requires going to multispecialty hospital or a referral centre and is quite expensive. The ultrasound based bone densitometer (QUS) does not measure BMD directly but estimates bone density and architecture with speed of sound (SOS) and/or broadband ultrasound attenuation (BUA) at the heel. It is relatively cheaper and is not associated with radiation exposure. Being portable, it can be taken to the field and can be operated easily and is gaining popularity [20, 21]. The aim of this study is to study the prevalence of osteopenia and osteoporosis among young girls residing in the hostels of Panjab University and identify factors responsible for reduced bone mineral density.

Material and Methods

The present study is based on a cross sectional study of 190 girls ranging in age from 20 to 31 years residing in the hostels of Panjab University, Chandigarh. Decimal age was calculated by using decimal age calendar given by [22]. They were categorized into four age groups i.e. 20 to 22; 23 to 25; 26 to 28 and 29 to31years of age. Study was conducted in the month of March, 2015 and both purpose and procedure were explained to the participants and pre-test informed consent was taken from the participants. Girls having age above 31 years or below 20 years, previous history of bone disease, illness and drug use that could affect bone mass were excluded from this study. The data collection included personal interviews, relevant anthropometric measurements and the measurements related to osteoporosis with the help of quantitative ultrasound densitometer. Anthropometric measurements taken on each subject were height, weight, waist circumference and hip circumference using standard techniques [23]. Percent body fat, visceral fat and BMI were also measured with the help of body fat analyzer. All the measurements were taken by the same investigator (first author) so, there was no inter-observer technical error of measurement (TEM) and the intra observer technical error of measurement was observed to be less than 1%. Intra observer error for stature was 0.3-0.6 cm. For body weight, it was between 0 and 0.5 kg; for circumferences values ranged from 0.1 to 0.2 cm. BMD was calculated using calcaneal quantitative ultrasound based machine (Mc Cue Bone densitometer). All enrolled subjects before taking bone mineral density were evaluated about their detailed history like age, educational status, diet, menstrual history, physical activity, sun exposure, milk and curd intake with the help of questionnaire. Bone mineral density was measured in left calcaneum with bone densitometer. BMD values were measured in terms of T-score and Z-score. 'T' score represents a BUA value of 53dB/MHz and is found to have discriminatory ability of 90% [24]. Z score is the number of standard deviations away from the mean value of the reference group. Z score can be obtained by comparing the subject's mean value with the mean value of the reference group. This reference group includes people of the same age and sex. Similarly T-score obtained by comparing individual's bone density with the average bone density of the young adult population (30 years old). The standard deviations above or below the average value is termed as T-score. Both Z-score and T-score are expressed in units of standard deviations from the reference value. According to World Health Organization [25] the established diagnostic guidelines include the T-score -1.0 or greater to be categorized as "normal"; T-score between -1.0 and -2.5 as "osteopenia" (low bone mass) while T-score -2.5 or below as osteoporosis.

Statistical Analysis

The recorded data (quantitative and qualitative) collected were subjected to appropriate statistical univariate and multivariate analysis such as mean, standard deviation, ANOVA, Chi-square test, Correlation, Regression by using both excel 2010 and SPSS 16.0 to study the prevalence of osteoporosis.

Results

Table 1 represents the mean, standard deviation and ANOVA for stature, weight, circumferences (waist and hip), percent body fat, VFA, fat mass, fat free mass, indices (which includes BMI, FMI, FFMI) and ratios (WHR, WHtR) of young adult girls residing in the hostels of Panjab University, Chandigarh. The mean value in stature remains almost static with an increasing age except for age group 23-25 years in which the mean age was 157.27 cm. The mean minimum value of 157.27 cm has been observed at age group 23-25 years and the maximum value of mean 159.67 cm was observed at age group of 20-22 years. The net increase of 2.40 cm was observed through all ages. Mean stature of pooled sample was 158.86 cm. Girls showed the minimum mean value of 55.12 kg for weight at 20-22 years of age and the maximum mean value of 58.54 kg at 29-31 years of age. A total gain of 3.42 kg was observed during 20 to 31 years of age. Mean values of weight also increased with increasing age. Pooled sample exhibited mean weight of 56.12 kg through all ages. Waist and Hip circumferences showed minimum mean value of 68.27 cm and 90.95 cm at 23-25 years and 26-28 years of age and the maximum mean value of 73.16 cm and 92.69 cm at 26-28 and 20-22 age groups respectively. Net increase of 4.89 cm in waist circumference and 1.74 cm in hip circumference respectively was observed

through all age groups. Pooled data exhibited the mean value for waist and hip circumference was 70.62 cm and 91.96 cm respectively. VFA also increased with increase in age. The minimum mean value was recorded at 20-22 years of age (3.29 kg) and the maximum mean value at 29-31 years (5.27 kg). The maximum gain of 1.98 kg was observed between 20 and 31 years of age. Mean value of VFA in pooled data was 4.08kg. Fat and fat free mass increased with advancing age but with minor fluctuations. The minimum mean value in fat mass (15.31 kg) and fat free mass (38.18 kg) was observed at 20-22 and 23-25 years of age respectively and their maximum mean value (16.99 kg and 41.74 kg) was observed at 26-28 and 29-31 years of age. Pooled data presented the mean values for fat mass and fat free mass were 16.18 kg and 39.94 kg respectively. Percent body fat also increased with increasing age till 28 years of age and in 29- 31 years of age, it again showed decreasing trend registering minimum mean value of 27.39% at 20-22 years and the maximum mean value of 29.37% at 26-28 years of age. The net increase 1.98% was observed over all ages. Mean value of Percent body fat in pooled data was 28.50%.

A continuous rise in Body Mass Index of young girls was witnessed between the age group of 20 to 31 years. The minimum mean value (21.71kg/m²) was observed at 20-22 years of age and the maximum mean value (23.14 kg/m²) at 29-31 years of age. The total increase in BMI in all ages is 1.43 kg/m². In pooled data, BMI exhibited mean value of 22.26 kg/m². FMI and FFMI show a gradual increase with advancing age. The minimum mean value of FMI and FFMI were 6.06 kg/m² and 15.43 kg/m² at 20-22 years and 23-25 years and the maximum mean values of 6.68 kg/m² and 16.50 kg/m² at 26-28 and 29-31 years. Pooled data of FMI and FFMI showed mean value of 6.43 kg/m² and 15.83 kg/m². Waist Hip ratio showed minimum value at 23-25 years of age (0.74) and the maximum value (0.81) at age group 29-31 years. Waist height ratio of young girls showed the minimum mean value of 0.43 at 23-25 years of age and the maximum mean value (0.46) at 26-28 years which is less than 0.5 which shows that the young girls are not obese but on the verge of obesity if not controlled. Both these ratios i.e. WHR and WHtR exhibited mean value of 0.77 and 0.45 in the pooled data. Single tailed ANOVA showed that the differences between age groups were significant for height, weight, WC, VFA, WHR, FFM, FFMI and WHtR.

Table 2 represents the mean, SD and ANOVA of T-score, Z-score, BUA and Separation which are calculated by using bone densitometer among young girls residing in the hostels of Panjab University, Chandigarh. The minimum mean value of T-score and Z-score are -1.26 and -1.12 observed at 26-28 years of age and the maximum mean value of -1.58 and -1.57 at 20-22 years of age. BUA increased with increasing age with minimum mean value of 62.27 at 20-22 years and the maximum value of 68.75 at 26-28 years. Separation decreased with increasing age. Their maximum mean value of 46.08 is seen at 20-22 years and the minimum mean value 45.30 at 29-31 years of age. In the pooled data, mean values of T-score, Z-score, BUA and separation were -1.43,-1.33, 65.77 and 45.62 respectively. Single tailed ANOVA revealed significant relation only with Z-score.

Table 3 presents the age wise and total distribution of BMD of young girls of Panjab University hostels. According to WHO criteria, T-score ≤-2.5 are considered as osteoporotic condition and T-score value between -1 and -2.5 as osteopenic condition and the value of T-score ≥ -1.0 are termed as normal. In the present study, out of 190 girls, girls having low BMD in age group 20-22 were 28.68%, age group 23-25 years were 26.47%, in age group 26-28 years were 24.26% and in last age group 29-31 the percentage of girls was 20.59%. In the total sample, 71.58% younger girls have low BMD and 28.42% have normal BMD.

Table 4 represents the correlation coefficients (r) between BMD and various anthropometric variables and indices among young adult girls of hostels of Panjab University, Chandigarh. The total correlation of the young girls residing in the hostels demonstrated significant association of BMD with all variables (Weight, HC, WC, PBF, FM, FFM, VFA, WHR, FMI, FFMI, BMI and WHtR) except for height. In age group 20-22 years, correlation of BMD showed significant relation with weight, WC, HC, FM, FFM, VFA, BMI, WHtR, FMI and FFMI. The correlation of BMD with other anthropometric variables and indices demonstrated significant association at age group 23-25 years with weight, WC, HC, FM, FFM, VFA, BMI, FFMI. In age group 26 -28 years, all variables and indices exhibited non-significant relations with BMD. The significant correlation of BMD at age group 29-31 years was observed with WC and rest of all shows non-significant associations with BMD.

Table 5 displays the relation of BMD with the factors like exercise, menarcheal age, vitamin/calcium supplements, diet, fracture in past, BMI classification, milk and curd intake. This table showed the value of chi square, degrees of freedom and p-value. The p value of factors like fracture in past and BMI classification showed significant difference with the BMD.

Table 6 represents the regression analysis of BMD with anthropometric variables and indices. All variables and indices were best predictor except for height. Waist circumference was the best predictor of BMD (Adjusted R SQUARE= 0.103) predicting 10.3% variance.

Discussion

Osteoporosis is a major silent disease which has many significant effects on public health and the growth of a nation. Osteoporosis make bones more fragile that even minor injuries can cause fractures. This silent disease is widely prevalent all over the world and many experts predict that by 2025, osteoporosis alone is the only major factor responsible for many fractures i.e. approximately three million fractures every year [26].

The prevalence of osteoporosis in India is equally found in men and women, specifically in urban population and they may occur at a younger age as compared to western counterparts [8]. The present cross-sectional study was undertaken to study the bone health in young adult girls to see the recent trends and to suggest appropriate interventions to improve their bone mass which would reduce the risk of osteoporosis in the later life. There are many screening tests to predicting the bone mineral density but all are cost effective and non-portable. DEXA is an advanced bone densitometer known as gold standard for measuring for measuring BMD but due to its non-portability we cannot use this in the field so

in the present study we use QUS (an ultrasound based bone densitometer) which is relatively cheaper, portable and easy to carry in the field [27, 28, 29, 30, 31]. Many studies showed that the youngsters have a decreased bone density tend to develop osteopenia which make them prone to osteoporosis in later life [32, 33, 34, 30].

Majority of studies have been conducted on women above the age of 30 years. There is paucity of literature or standards for the young population for the prevalence of osteoporosis and osteopenia using QUS as a screening tool for comparison.

National osteoporosis risk assessment study showed that the risk of fragility fractures i.e. osteoporosis was 1.56 times greater for Asians than Caucasian women [35]. In Asian countries, the prevalence of osteoporosis and osteopenia is more now a days and the reason behind this is may be because of their low calcium intake in the diet and vitamin D insufficiency. 64% of young women in Karachi aged less than 30 years showed a low BMD level [36]. The girls of the present study showed low bone density when compared with the adult women from Karachi. 43.4% adult Pakistani women over the age of 20 years had osteopenia and 12.9% were osteoporotic [37] and in the present study the percentage of women with osteopenia (64.21%) was higher than them but they had lower percentage (7.37%) of osteoporosis.

Present study revealed that 71.58% girls (136 out of 190 girls) had low bone mineral density. The results of the present study showed similar findings as that of Masood study [31] which depicts that in age less than 30 years 73.35% girls have low bone mineral density.

The findings of the study point towards low bone mineral density in young adult girls which is a matter of great concern and may be attributed to their lifestyle. Lack of Vitamin D and Calcium intake, low physical activity and nutritional status. Emphasis on awareness and education regarding bone health should be laid to reduce the prevalence of osteopenia and osteoporosis.

Table 1: Mean, standard deviation (SD) and ANOVA of Stature, Weight, Circumferences, VFA, Percent Body fat, Fat mass, Fat free mass, Indices and Ratios among young girls residing in the hostels of Panjab University, Chandigarh.

Age in years Variables		**20-22 (48)**	**23-25 (50)**	**26-28 (55)**	**29-31 (37)**	**Pooled data (190)**	**ANOVA *F*-ratio**
Stature (cm)	Mean	159.67	157.27	159.45	159.08	158.86	2.92*
	SD	6.42	4.91	2.63	2.94	4.59	
Weight (kg)	Mean	55.12	53.82	57.45	58.54	56.12	4.37*
	SD	6.80	8.75	6.31	4.65	7.08	
Circumferences (cm) Waist	Mean	69.25	68.27	73.16	71.77	70.62	6.11*
	SD	6.91	6.89	6.43	5.27	6.74	
Hip	Mean	92.69	91.97	90.95	92.51	91.96	0.68
	SD	5.99	7.63	6.74	6.43	6.74	
% Body Fat	Mean	27.39	28.58	29.37	28.53	28.50	1.84
	SD	4.41	4.65	3.98	3.95	4.30	
VFA	Mean	3.29	3.54	4.47	5.27	4.08	8.21*
	SD	2.18	2.48	1.78	1.66	2.18	
Fat Mass	Mean	15.31	15.64	16.99	16.79	16.18	2.05
	SD	4.15	4.77	3.77	3.23	4.01	
Fat Free Mass	Mean	39.81	38.18	40.45	41.74	39.94	6.51*
	SD	3.49	4.76	3.81	2.28	4.02	
FMI	Mean	6.06	6.36	6.68	6.64	6.43	1.42
	SD	1.83	2.00	1.44	1.31	1.69	
FFMI	Mean	15.56	15.43	15.90	16.50	15.83	237.64*
	SD	1.56	1.78	1.31	1.08	1.51	
BMI	Mean	21.71	21.78	22.58	23.14	22.26	2.50
	SD	3.18	3.57	2.26	1.86	2.87	
Waist Hip Ratio	Mean	0.75	0.74	0.81	0.78	0.77	16.16*
	SD	0.06	0.05	0.05	0.05	0.06	
Waist Height Ratio	Mean	0.44	0.43	0.46	0.45	0.45	3.70*
	SD	0.05	0.05	0.04	0.04	0.05	

Table 2: Mean, standard deviation (SD) and ANOVA of T-score, Z-score, BUA and Separation among young girls residing in the hostels of Panjab University, Chandigarh.

	Age in years Variables	**20-22 (48)**	**23-25 (50)**	**26-28 (55)**	**29-31 (37)**	**Pooled Data (190)**	**ANOVA *F*-ratio**
T-score	Mean	-1.58	-1.48	-1.26	-1.42	-1.43	1.40
	SD	0.89	0.73	0.86	0.83	0.83	
Z-score	Mean	-1.57	-1.39	-1.12	-1.24	-1.33	2.80*
	SD	0.88	0.73	0.85	0.84	0.83	
BUA	Mean	62.27	64.78	68.75	67.22	65.77	2.18
	SD	13.76	12.15	14.07	15.21	13.87	
Separation	Mean	46.08	45.66	45.4	45.30	45.62	0.69
	SD	2.60	3.16	2.97	2.57	2.85	

Table 3: Age wise and total distribution of BMD (n=190)

Variable Age(Years)	Osteoporosis (n=14) (T-score≤-2.5)		Osteopenic (n=122) (T-score<-1.0to-2.5)		OsteoporosiS and Osteopenic (n=136) (T-score≤-1.0)		Normal (n=54) (T-score≥-1.0)	
	No.	%	No.	%	No.	%	No.	%
20-22	5	35.71	34	27.87	39	28.68	9	16.67
23-25	5	35.71	31	25.41	36	26.47	14	25.93
26-28	2	14.29	31	25.41	33	24.26	22	40.74
29-31	2	14.29	26	21.31	28	20.59	9	16.67
Total 20-31(n=190)	14	7.37	122	64.21	136	71.58	54	28.42

Table 4: Correlation coefficients (r) between BMD and various anthropometric variables and indices among young girls of hostels of Panjab University, Chandigarh

Correlation combinations	20-22	23-25	26-28	29-31	Total
BMD Vs Height	-0.201	0.232	-0.030	-0.016	-0.020
BMD Vs Weight	0.369*	0.396*	0.151	0.196	0.293*
BMD Vs WC	0.455*	0.342*	0.121	0.350*	0.328*
BMD Vs HC	0.351*	0.330*	0.160	0.264	0.249*
BMD Vs PBF	0.203	0.145	0.203	0.188	0.203*
BMD Vs FM	0.300*	0.304*	0.198	0.226	0.273*
BMD Vs FFM	0.362*	0.425*	0.055	0.063	0.238*
BMD Vs VFA	0.430*	0.273*	0.142	0.142	0.272*
BMD Vs BMI	0.430*	0.309*	0.172	0.186	0.296*
BMD Vs WHR	0.272	0.108	-0.029	0.124	0.170*
BMD Vs WHtR	0.447*	0.250	0.127	0.316	.309*
BMD Vs FMI	0.332*	0.244	0.206	0.213	0.265*
BMD Vs FFMI	0.489*	0.334*	0.071	0.063	0.264*

Table 5: Table showing Chi square, degree of freedom and p value between various factors and the three categories of BMD (normal, osteopenic and osteoporotic)

	Factors	Total Number Of Girls	Normal		Osteopenic		Osteporotic		χ^2, df, p
			N	%	N	%	N	%	
Exercise	No	166	46	27.71	106	63.86	14	8.43	2.283, 2, .319
	Yes	24	8	33.33	16	66.67	0	0	
Menarche	12	14	3	21.43	9	64.29	2	14.28	14.184, 10, .165
	13	53	14	26.41	35	66.04	4	7.55	
	14	56	13	23.21	42	75	1	1.79	
	15	43	16	37.21	23	53.49	4	9.30	
	16	22	6	27.27	13	59.09	3	13.64	
	17	2	2	100	0	0	0	0	
Vitamin/Calcium Supplement	No	172	49	28.49	110	63.95	13	7.56	0.110, 2, .946
	Yes	18	5	27.78	12	66.67	1	5.55	
Diet	Veg	135	35	25.92	90	66.67	10	7.41	1.461, 2, 0.482
	Non Veg	55	19	34.55	32	58.18	4	7.27	
Fracture in past	No	160	43	26.88	108	67.5	9	5.62	6.741, 2, 0.034
	Yes	30	11	36.67	14	46.67	5	16.66	
Milk Comsumption	No	79	21	26.58	55	69.62	3	3.80	3.117, 2, 0.210
	Yes	111	33	29.73	67	60.36	11	9.91	
Curd Comsumption	No	23	6	26.09	15	65.22	2	8.69	0.117, 2, 0.943
	Yes	167	48	28.74	107	64.07	12	7.19	
BMI Classification	Underweight	14	0	0	8	57.14	6	42.86	34.111, 6, .000
	Normal	109	28	25.69	76	69.72	5	4.59	
	Overweight	60	23	38.33	34	56.67	3	5	
	Obese	7	3	42.86	4	57.14	0	0	

Table 6: Regression between BMD and various anthropometric variables and indices among young girls of hostels of Panjab University, Chandigarh

Relation	Multiple R	R Square	Adjusted R Square	Se	p-valve
Height	.020	0.000	-0.005	8.36	.689
Weight	0.293	0.09	0.081	0.79	.000
WC	0.328	0.108	0.103	0.79	.000
HC	0.249	0.062	0.057	0.81	.000
PBF	0.203	0.041	0.036	0.82	.000
FM	0.273	0.075	0.070	0.80	.000
FFM	0.238	0.057	0.052	0.81	.000
VFA	0.272	0.074	0.069	0.80	.000
BMI	0.296	0.087	0.083	0.80	.000
WHR	0.170	0.029	0.024	0.82	.000
WHtR	0.309	0.096	0.091	0.80	.000
FMI	0.265	0.070	0.065	0.81	.000
FFMI	0.264	0.070	0.065	0.81	.000

Acknowledgements
Sincere thanks are due to UGC for providing funding for this research work and also to respondents who actively participated in this study.

References

1. Gupta A. Osteoporosis in India-the nutritional hypothesis. Natl Med J India. 1996; 9(6):268-274.
2. NIH Consensus Panel on Osteoporosis Prevention, Diagnosis, and Therapy. Osteoporosis prevention, diagnosis, and therapy. JAMA. 2001; 285:785-795.
3. Simsek B, Karacaer O, Karaca I. Urine products of bone breakdown as markers of bone resorption and clinical usefulness of urinary hydroxyproline: an overview. Chin Med J. 2004; 117(2):291-295.
4. Heaney RP, Abrams S, Dawson-Hughes B, Looker A, Marcus R, Matkovic V, *et al.* Peak bone mass. Osteoporosis International. 2000; 11:985-1009.
5. Matkovic V, Weaver C. Peak bone mass. Osteoporosis International. 2000; 11:985-1009.
6. Malkovic V, Jelic T, Wardlaw GM, Ilich JZ, Goel PK, Wright JK, *et al*. Timing of peak bone mass in Caucausian females its implication for the prevention of osteoporosis. J Clin Invest. 1994; 93:799-808.
7. Campos L, Liphaus BL, Silva CA, Pereira RM. Osteoporosis in childhood and adolescence. Jornal de pediatria. 2003; 79(6):481-488.
8. Malhotra N, Mithal A. Osteoporosis in Indians. Indian J Med Res. 2008; 127(3):263-268.
9. Francis RM, Harrington F, Turner E, Papiha SS, Datta HK. Vitamin D receptor gene polymorphism in men and its effect on bone density and calcium absorption. Clinical endocrinology. 1997; 46(1):83-86.
10. De Smet S, Michels N, Polfliet C, D'Haese S, Roggen I, De Henauw S, *et al*. The influence of dairy consumption and physical activity on ultrasound bone measurements in Flemish children. J Bone Miner Metab. 2015; 33:192-200.
11. Jha R, Mithal A, *et al*. Pilot case control investigation of risk factors for hip fractures in the urban Indian population. 2nd Joint Meeting of the European Calcified Tissue Society and the International Bone and Mineral Society, Geneva. 2005, 25-29.
12. Sachan A, Gupta R, Das V, Agarwal A, Awasthi P K, Bhatia V. High prevalence of vitamin D deficiency among pregnant women and their newborns in northern India. Am J Clin Nutr. 2005; 81:1060-4.
13. Marwaha RK, Tandon N, Reddy DR, Aggarwal R, Singh R, Sawhney RC, *et al.* Vitamin D and bone mineral density status of healthy schoolchildren in northern India. Am J ClinNutr. 2005; 82(2):477-482.
14. Harinarayan CV. Prevalence of vitamin D insufficiency in postmenopausal south Indian women. Osteoporos Int. 2005; 16:397-402.
15. Harinarayan CV, Ramalakshmi T, Prasad UV, Sudhakar D, Srinivasarao PV, Sarma KV, *et al*. High prevalence of low dietary calcium, high phytate consumption, and vitamin D deficiency in healthy south Indians. Am J Clin Nutr. 2007; 85:1062-7.
16. Maletia D, Venkatesan K, Rana S, Anburajan M. Screening Rural and Urban Indian Population for Osteoporosis Using Heel Ultrasound Bone Densitometer. In Communication Systems and Network Technologies (CSNT). International Conference. 2011, 629-633.
17. Dutta N, Saikia AM, Saikia, AM, Das AK. Status of bone mineral density in adult population using calcaneal ultrasound bone densitometer: A study from Assam, India. Int J Appl Basic Med Res. 2015; 4: 150-158.
18. Gupta R, Mahajan S, Dewan D, Gupta R. Screening of osteoporosis using calcaneal quantitative ultrasound in a rural population of Jammu, Jammu and Kashmir, India. International Journal of Community Medicine and Public Health. 2017; 4(4):940-943.
19. Kanis JA. Diagnosis of osteoporosis and assessment of fracture risk. The Lancet. 2002; 359(9321):1929-1936.
20. Ahuja SP, Greenspan SL, Lin Y, Bowen AD, Bartels D, Goyal RK. A pilot study of heel ultrasound to screen for low bone mass in children with leukemia. Journal of pediatric hematology/oncology. 2006; 28(7):427-432.
21. Bauer DC, Ewing SK, Cauley JA, Ensrud KE. Cummings S R, Orwoll E S, *et al*. Quantitative ultrasound predicts hip and non-spine fracture in men: the MrOS study. Osteoporosis International. 2007; 18(6):771-777.
22. Tanner JM, Whitehouse RH, Takaishi M. Standards from Birth to Maturity for Height, Weight, Height Velocity, and Weight Velocity: British Children, I965. Arch. Dis.

Childh. 1966; 41:454.
23. Weiner JS. Lourie. Practical Human Biology. Academic Press Inc. Ltd., London, 1981.
24. Greenspan SL, Bouxsein ML, Melton ME, Kolodny AH, Clair JH, Delucca PT, *et al*. Precision and discriminatory ability of calcaneal bone assessment technologies. Journal of Bone and Mineral Research. 1997; 12(8):1303-1313.
25. Report of a WHO Study Group. Assessment of fracture risk and its application to screening for post-menopausal osteoporosis. World Health Organization: Geneva. 1994, 843.
26. Riggs BL. Overview of osteoporosis. Western journal of medicine. 1991; 154(1):63.
27. Bauer DC, Gluer CC, Cauley JA, Vogt TM, Ensrud KE, Genant HK, *et al*. Broadband ultrasound attenuation predicts fractures strongly and independently of densitometry in older women. A prospective study of osteoporotic fractures research group. Arch Intern Med. 1997; 157:629-634.
28. Pluijm SM, Graafmans WC, Bouter LM, Lips P. Ultrasound measurements for the prediction of osteoporotic fracture in elderly people. Osteoporosis Int. 1999; 9:550-556.
29. Khow KT, Reeve J, Luben R, Bingham S, Welch A, Wareham N, *et al*. Prediction of total hip fracture risk in men and women by quantative ultrasound of the calcaneus: EPIC-Norfolk prospective population study. Lancet. 2004; 363:197-202.
30. D'Almeida VR, Shetty MB, Adiga KR, Latheesh L, Nazareth, EL. Prevelance of Osteoporosis in Younger Population - An Indian Perspective. International Journal of Recent Trends in Science and Technology. 2013; 8(2):119-121.
31. Masood Z, Shahzad S, Saqib A, Ashraf K. Osteopenia and Osteoporosis; Frequency among females. Professional Medical Journal. 2014; 21(3).
32. Marshall D, Johnell O, Wedel H. Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. BMJ. 1996; 312:1254-1259.
33. Miller PD, Siris ES, Barrett-Connor E, *et al*. Prediction of fracture risk in postmenopausal white women with peripheral bone densitometry: evidence from the National Osteoporosis Risk Assessment. J Bone Miner Res. 2002; 12:2222-2230.
34. Bow CH, Tsang SWY, Loong CHN, Soong CSS, Yeung SC, Kung, AWC. Bone mineral density enhances use of clinical risk factors in predicting ten-year risk of osteoporotic fractures in Chinese men: the Hong Kong Osteoporosis Study. Osteoporosis international. 2011; 22(11):2799-2807.
35. Siris ES, Miller PD, Barrett-Conner E. Identification and fracture outcomes of undiagnosed loe bone mineral density in post-menopausal women results from the National Osteoporosis Risk Assessment. JAMA. 2001; 286:2815-22.
36. Jaleel F, Nasrullah FD, Khan A. Osteopenia in the young females. Journal of Surgery Pakistan (International). 2010; 15(1).
37. Fatima M, Nawaz H, Kassi M, Rehman R, Kasi PM, Kassi M, *et al.* Determining the risk factors and prevalence of osteoporosis using quantitative ultrasonography in Pakistani adult women. Singapore Med J, 2009; 50(1):20-28.