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Original Research Article

Assessment of Nutritional Intake and Bone Mineral Density in College-Going Young Adults

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ABSTRACT

Background: Bone health is an important concern because of a great increase in longevity and bone related issues faced later in life. To ensure a healthy bone structure the younger populations have to be assessed for a timely intervention to improve the bone health to avoid the associated morbidities later in life.
Methodology: A cross sectional study was conducted in year 2016-17 at local colleges in and around Batala town of distt. Gurdaspur, Punjab. The data was obtained using interview schedule to acquire information regarding nutritional intake and anthropometric measurements were taken. Bone health was measured through bone densitometer.
Results: Stratification of data on gender basis, although revealed a significantly higher intake of nutritional components in males compared to females but energy intake was lower than the recommended dietary allowances while consumption of protein, calcium and phosphorous was higher than recommended level in both groups whereas calcium-phosphorous ratio was lesser. Mean values of anthropometric variables (height, weight, waist circumference and hip circumference) and obesity indicators (BMI, WC, WHR and WHtR) were significantly higher in males than females. T-score and Z-score for bone density indicated a significantly higher mean in males. Osteopenia and osteoporosis was much pronounced in females (44.9%; 6.4%) than males (37.5%; 5.1%).
Conclusion: Male respondents were better in their nutritional intake, anthropometric parameters and indices as well as in the bone density measurements. Energy, fat, phosphorus, waist circumference, hip circumference had significant positive correlation with T-score. Energy, carbohydrate, phosphorous and waist height ratio was positively correlated with Z-score and height was negatively correlated with a significant difference.

Key words: Bone mineral density, Quantitative ultrasound bone densitometer, Nutritional intake, Anthropometric variables.

INTRODUCTION

Bone health in an individual can be quantified through assessment of bone mineral density, a measure of bone mineral per volume of bone. Low bone mineral density manifests itself as bone fragility and is predictive of osteopenia and osteoporosis. [1] Osteoporosis is a disease that affects millions of people around the world and it is characterised by low bone mass and micro architectural deterioration of bone tissue, leading to enhanced bone fragility and consequent increase in fracture risk. [2,3] The fragility fractures are hallmark of osteoporosis and are particularly common in the spine, hip and forearm but may affect other sites. [4] Reduction in bone mass and disruption in bone architecture results in reduced bone strength and increase in bone fractures. With the increase in age

expectancy bone fragility and osteoporotic fractures due to it has become a major global public health problem. [5] The risk of osteoporosis is 1.56% times greater among Asian women as compared to Caucasian women [6] and the burden of osteopenia at a younger age is considerably high in Asian countries including India. [7-11] Epidemiological studies indicate that in Indian population the prevalence of low bone density is highest in the world [12] and osteoporotic fractures tend to occur about ten to twenty years earlier than their western counterparts and are common in men. [13] Low calcium intake, extensive prevalence of vitamin deficiency, increasing longevity, sex inequality, early menopause, genetic predisposition and poor knowledge of bone health are contributing factors towards high prevalence of osteoporosis in India. Bone health may be optimized by creating an environment to achieve peak bone mass during adolescence and maintenance of healthy bone throughout life cycle. [14] There is paucity of data on osteoporosis in India for young age group of 20-40 years when the peak bone mass is achieved. [14] The present study was designed to assess bone mineral density in young adults in relation to their nutritional intake and anthropometric measurements.

METHODOLOGY

Normal healthy male and female subjects studying in local institutes were picked up for the study. An ethical clearance was sorted out for the project and an informed written consent was procured from each and every subject. 1000 healthy subjects, 394 males and 606 females, between age group 16-23 years with an average age of 19.17±2.28 yrs in boys and 19.53±2.25 yrs. in girls were undertaken for this investigation. Exclusion criteria included any kind of chronic or infectious ailment. The subjects were evaluated for their dietary intake of calories, carbohydrates, proteins, fats, iron, calcium, phosphorous, and calcium-phosphorous ratio through 24 hour recall method. [16] Standard methodology [17] provided was implied for obtaining anthropometric measurements including height, weight, waist circumference and hip circumference. Obesity indicators viz. Body Mass Index (BMI), Waist Circumference (WC), Waist-Hip-Ratio (WHR) and Waist-to-Height-Ratio (WHtR) were used to assess the level of obesity.BMI was calculated as per WHO [18] criteria, with BMI ≤18.5 being underweight, 18.5-22.9 as normal, 23.0-24.9 as overweight,25.0-29.9 to be obese I and >30as obese II,WC≥85 cm in men and ≥80 cm in women, [19] WHR ≥0.89 cm in males and ≥0.81 cm in females, [19] and WHtR>0.50 cm is [20] considered as abdominal obesity. Bone mineral density (BMD) measurements were taken out on right calcaneum with bone densitometer (Furno's CM-200 light ultrasound bone densitometer; Furno Electric Co. Ltd., Japan) in terms of T-score and Z-score. T-score is expressed as the number of standard deviation relative to standard speed of sound value of the young agegroup whereas Z-score is the number of standard deviation with respect to the standard speed of sound value of the matched age group. According to WHO definition, [21] T-score ≥ -1 is normal bone density, T-score between -1 and -2.5 is osteopenia and T-score ≤ -2.5 is osteoporosis.

Statistical analysis: Statistical analysis was performed using standard descriptive statistical tests with the help of SPSS software through chi-square, Anova and Pearson's correlation coefficient.

RESULTS

Dietary parameters: Diet pattern showed a significantly (P<0.000) higher intake of all nutrients (energy, carbohydrates, proteins, fats, calcium, phosphorous, iron) in male respondents compared to females (Table1). Intake of energy in studied males (2153.51±578.78 kcal) and females (1877.62±461.11 kcal) was low compared to the recommended ICMR [22] dietary requirements of 2677 kcal and 2061 kcal respectively. Protein intake on the other

hand was higher in males as well as females than the recommended level of 75g per day for males and 60g per day for females. Suggested fat intake for male and female individuals is 20g per day whereas in the observed males and females subjects it did exceed the recommended limit. Calcium intake in the observed population both for males (1088.20±553.72) and females (786.20±498.34) was higher than the recommended intake of 500g for young adults. Likewise intake of phosphorus too exceeded the suggested level of 500g in both males (1861.86±540.76) and females (1515.67±376.56g). However, ICMR suggested that elemental Ca:P ratio of 1:1 may be maintained in all ages which was observed to be lesser in both males (0.602±0.514) and females (0.530±0.373).

Table 1: Mean, S.D. of college-going boys and girls with respect to nutritional intake, anthropometric variables and obesity indicators.

Variables	Distribution of sex				F-value	p-value
	Male (n=394)		Female (n=606)			
	Mean	S.D.	Mean	S.D.		
Energy (kcal.)	2153.51	578.78	1877.62	461.11	69.682	0.000*
Carbohydrates (g.)	370.26	120.77	342.41	105.39	14.842	0.000*
Protein (g.)	108.19	60.47	87.94	41.03	39.779	0.000*
Fat (g.)	32.50	16.63	23.03	29.24	34.148	0.000*
Calcium(mg.)	1088.20	553.72	786.20	498.34	80.268	0.000*
Phosphorus (mg.)	1861.86	540.76	1515.67	376.56	142.285	0.000*
Ca:P ratio	0.602	0.514	0.530	0.373	6.557	0.011*
Height (cm)	169.22	7.418	156.40	6.185	875.609	0.001*
Weight (kg.)	62.636	11.337	50.925	9.817	302.869	0.000*
HC	88.91	9.662	83.758	10.022	65.088	0.000*
WC	71.93	9.903	63.957	9.358	165.501	0.000*
BMI(Body Mass Index)	21.868	3.574	20.804	3.760	19.851	0.000*
WHR(Waist-to-hip ratio)	0.811	0.088	0.776	0.248	7.102	0.000*
WHtR(Waist-to-Height ratio)	0.425	0.058	0.409	0.059	18.09	0.000*
T-score	0.002	0.882	-0.360	0.890	40.071	0.000*
Z-score	-0.051	0.890	-0.526	0.866	30.752	0.000*
**. Correlation is significant at the 0.01 level .						
*. Correlation is significant at the 0.05 level .						

Table 2: Number and percentage distribution of college-going boys and girls with respect to obesity indicators and BMD (Bone mineral density).

Variables	Distribution of sex				χ^2	P-value
	Male (n=394)		Female (n=606)			
	N	%	N	%		
Obesity indicators :						
BMI:						
Underweight	75	19.0	173	28.5		
Normal	236	59.9	355	58.6		
Overweight	78	19.8	68	11.2	21.539	0.000*
Obese-I	5	1.3	9	1.5		
Obese – II	0	0.0	1	0.2		
WC (Waist-circumfrence)						
Normal	351	89.1	576	95.0		
Obese	43	10.9	30	5.0	12.547	0.000*
WHR (Waist-to-hip ratio)						
Normal	342	86.8	478	78.9		
Obese	52	13.2	128	21.1	10.158	0.001*
WHtR (Waist-to-height ratio)						
Normal	354	89.8	564	93.1		
Obese	40	10.2	42	6.9	3.292	0.070
BMD (Bone mineral density)						
Normal	225	57.1	295	48.7		
Osteopenia	149	37.8	272	44.9	6.841	0.033*
Osteoporosis	20	5.1	39	6.4		

**. Correlation is significant at the 0.01 level.
*. Correlation is significant at the 0.05 level.

Anthropometric parameters: There was a significant difference in mean height, weight, waist circumference and hip circumference between male and female participants (Table 1). Chi-Square implied on anthropometric obesity indicators viz. BMI, WC, WHR and W-Ht. ratio did reveal a significant difference in male and female counterparts (Table 2). BMI could identify78 (19.8%) males and 68 (11.2%) females as overweight and only 5 (1.3%) males and 10 (1.7%) female respondents were obese while 75 (19%) males and 173 (28.3%) females were underweight. Taking WC as obesity indicator, 43 (10.9%) males and 30 (5%) females were classified to be obese. WHR criterion could point out the enormity of being obese with an involvement of a higher number of females (21.1%) rather than males (13.2%).

Bone mineral density (BMD) parameters: Bone mineral density taken at calcaneus heel as mean T-score and Z-score was significantly higher in males in comparison to females (Table 1). A significant difference (χ^2 = 6.841; *P*< 0.033) was indicated in BMD between male and females with a higher number of females to be either osteopenic or osteoporotic (Table 2).

DISCUSSION

The study was carried out to assess the level of bone health in young adults from same social background consuming supposedly healthy diet and with normal anthropometric disposition. The observations can be reflected to find the impact of nutrition and anthropometric parameter on bone mineral density and bone health. Peak bone mass achieved during younger age is a determinant of skeletal age all through the life of an individual. [23]

Though the intake of energy in the studied group was lower than the recommended ICMR limits but it depicted a positive correlation with T-score (*r* = 0.089; *P*<0.005) and Z-score w (*r* = 0.169; *P*<0.000). Likewise in a study on Greek population positive correlation was observed between fat intake and T-score (*r* =0.069;*P*<0.029).

Table 3: Correlation values of nutritional component and anthropometric variables w.r.t. T-score and Z-score.

Parameter	***Male***		***Female***		***Total***	
	Correlation value 'r'	***P-value***	***Correlation value 'r'***	***P-value***	***Correlation value 'r'***	***P-value***
			T-score			
Energy	0.049	0.331	0.035	0.393	0.089**	0.005
Fats	0.034	0.505	0.037	0.369	0.069*	0.029
Calcium	0.067	0.182	-0.096*	0.018	0.027	0.385
Phosphorus	0.030	0.548	-0.006	0.889	0.080*	0.011
Ca:P	0.029	0.569	-0.109**	0.007	-0.027	0.394
Height (cm)	-0.079	0.116	-0.125**	0.002	0.059	0.060
Weight (kg.)	-0.121*	0.017	-0.014	0.729	0.044	0.166
H.C.	-0.092	0.067	0.120**	0.003	0.085**	0.007
W.C.	-0.081	0.109	0.060	0.143	0.077*	0.016
WHtR (Waist-to-height ratio)	-0.059	0.246	0.095*	0.019	0.113*	0.016
			Z-score			
Energy	0.123	0.118	0.088	0.133	0.169**	0.000
Carbohydrates	0.134	0.089	0.097	0.096	0.156**	0.001
Phosphorus	0.057	0.475	0.016	0.789	0.122**	0.009
Ca:P	0.080	0.313	-0.122*	0.037	-0.049	0.296
Height	-0.113	0.151	-0.188**	0.001	0.044	0.353
HC	-0.042	0.597	0.095	0.103	0.104*	0.027
WC	-0.073	0.359	0.093	0.110	0.122**	0.009
WHtR (Waist-to-height ratio)	-0.047	0.554	0.144*	0.014	0.113*	0.016

**. Correlation is significant at the 0.01 level.
*. Correlation is significant at the 0.05 level.

Total energy and monounsaturated fats intake was positively associated with BMD among both men and women aged 25-69 years. [24] In the carried out study, a negative correlation was established in females for their calcium intake and T-score. Calcium is considered to be one of the main mineral required for bone

formation at every age and stage of life and in studied population the mean consumption was more than the recommended level. In populations with moderate to high risk of osteoporosis, cohort studies in countries with an average calcium intake close to recommended levels had shown no relationship between calcium intake and risk of hip fracture. [25-29] The evidence to date suggest that there is threshold of increasing fracture risk for older men and women at calcium intake below around 400-500 mg/d but there is no additional benefit in terms of prevention of osteoporosis of a customary dietary calcium intake above those currently recommended. Because the disease outcome i.e. fracture is not clearly related to BMC or density, dietary recommendations that address BMD or calcium stores will not necessarily impact upon fractures. Therefore, increases in BMD or calcium stores in childhood or at peek bone mass, may not have an impact on later fractures [30] and calcium intake was found to be unrelated to stress fractures after controlling age among preadolescents and adolescents. [31] However, recommendation of calcium intake lies in the range of 600-1300mg/d (WHO), [32] 500-1300 mg/d (US) [33] and 1000-1200 mg/d (NIH) [34] and it is further recommended that proper daily intake of calcium [35] could contribute to optimize young adults' bone health. The role of dairy products in bone mineral density has been sufficiently established in Chinese and Caucasian girls and women and in latter it is also reported to reduce fracture risk. [36] In the studied population phosphorous intake was positively correlated with T-score (r=0.80; P<0.011) as well as Z-score (r=0.122; P<0.009) whereas calcium-phosphorous ratio had a significant negative correlation with both T and Z-score in girls and was lower than the ICMR [22] recommended 1:1 ratio. In a survey in Multan on young healthy resident doctors mean daily calcium intake was adequate in females and even though dietary calcium had no significant correlation with BMD, there was a positive correlation of calcium to phosphorous ratio with BMD. [37] A study of cross sectional nature in healthy Caucasian postmenopausal women did show a significant relationship between BMD and several critical nutrients: energy, protein, calcium, magnesium, zinc and vitamin C. The exact involvement of these nutrients and their clinical significance in bone health need to be elucidated and conclusions about the effects of a single nutrient on bone mass must be given taking into account its co-linearity with others. Understanding relationships among nutrients, not just limited to calcium and vitamin D, but others that have not been investigated to such extent, is an important step towards identifying preventive measures for bone loss and prevention of osteoporosis. [38]

Body size influence bone mineral content and density and populations of shorter stature have lower bone mineral status but do not have higher rate of osteoporotic fracture. [39,40,41] In the studied population weight was negatively correlated (r=0.121; P<0.017) with T-score in males and height in females (r=0.125; P<0.002) while WC (r=0.77; P<0.016) and HC (r=0.085;P<0.007) significantly influenced T-score values whereas WHtR (r=0.144; P<0.014) significantly affected Z-score. It was noticeable that BMI which could identify a large number of young subjects to be underweight had no impact on bone health whereas other established criteria like WC, WHR and WHtR, which could specifically point out the state of obesity, were significantly correlated with bone health. Contrary to present study weight and BMI were significant predictor of BMD in young adults [42] where weight and height positively correlated with BMD.A positive association of high body weight (BMI) but a negative association of high body fat with BMD [42] was reported and it was further recommended that some of the determinants of bone mass should include modalities like increase in lean and decrease in fat mass. Besides genetic factors, lower body weight, lower height, lower BMI, decreased bioavailability of calcium from diet and

inadequate physical activity contribute to lower BMD. [37] These observations reconfirmed earlier studies which indicate that body weight is powerful predictor of BMD. [44,45]

CONCLUSION

BMD is influenced by nutritional components, anthropometric variables and obesity indicators. Energy, fat, phosphorus, waist circumference, hip circumference had significant positive correlation with T-score. Energy, carbohydrate, phosphorous and waist- height ratio was positively correlated with Z-score and height was negatively correlated with a significant difference. Calcium, Ca:P and height had a significantly negative and waist circumference and waist hip ratio had positive correlation with T score in females while only Ca:P with Z-score. Weight was negatively correlated with T-score and waist circumference, hip circumference and waist hip ratio was positively correlated with Z-score in males with a significant difference. Though the male subjects were found be better compared to females as far as their bone health was concerned but out of 394 male subjects 169 (42.9%) and out of 606 young females 311 (51.3%) were analyzed to be affected with poor bone health which is quite an alarming and precarious situation and may prove to be counter productive for the demographic dividend of the country.

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