

Original article:

Impact of socio-economic status, physical activity, and sedentary behavior on Bone Mineral Density in college-going boys and girls of District Gurdaspur

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Abstract:

Introduction: Low bone density is a prevalent health condition which manifests as osteoporosis in later part of life. Since it is being influenced by lifestyle factors like physical activity, sedentary behavior and food choices, the present study was proposed to find out their impact on bone health status of young population.

Material and Method: The present survey was designed to study Bone Mineral Density (BMD), using calcaneal ultrasound bone densitometer as a diagnostic instrument in 1000 young male and female subjects aged 16-23 years from local colleges.

Results and observations: Male individuals had a significantly better bone health with a larger number being normal for their BMD (Males: 57.1%; Females: 48.7%) whereas a higher number of females were osteopenic (Males: 37.8%; Females: 44.9%) and osteoporotic (Males: 5.1%; Females: 6.4%). Exposure to sunlight, intake of fast food and spongy bleeding gums significantly influenced BMD. Intake of milk products specifically cheese could be seen to significantly affect BMD in males. Bone fracture in father and paternal grand-mother made a significant difference to BMD in males and that of paternal grand-father in females. Socioeconomic status and physical activity had positive correlation while time spent engrossed on mobile phone was found to have significantly negative and adverse impact on T-score in females.

Conclusion: The study indicates that bone health status of young adults, which is significantly influenced by lifestyle choices, is at a precarious state and requires a timely intervention to prevent osteoporosis in later part of life.

Key words: Bone mineral density, Socio-economic status, Physical activity, Sedentary behavior, Pedigree studies.

Introduction:

Osteoporosis, "porous bone disease" is characterized by too little bone formation, bone fragility and high risk of fracture.¹ Osteoporosis is a major global public health problem associated with significant morbidity, mortality, and socioeconomic burden.^{2,3} Lifestyle factors are estimated to influence 20-40% of adult peak bone mass and due to unfavourable lifestyle factors there can be an increase in the risk of osteoporosis and associated fractures.⁴ Physical activity, optimal nutrition and adequate sun exposure are very crucial for attaining peak bone mass, and are major determinant of osteoporosis.⁵ A positive association exists between bone mineral status and daily participation in high-impact physical activity where engaging in appropriate levels of physical activity and exercise can have lifelong benefits on bone structure, strength, and potential fracture risk.^{6,7,8,9} With regular physical exercise young individuals intend to have normal bone mineral values.^{10,11} Physical activity is a promising non-drug modulator that

enhances bone density and prevents the occurrence of bone loss and osteoporosis among children and adults.¹² In modern times, sedentary lifestyle is the main reason for the increasing incidence of osteoporosis.¹³ The rise in sedentary behaviour is associated with deleterious health effects and it simply be defined as; “too much sitting and too little of exercise”.¹⁴ Along with regular physical activities adequate dairy consumption in young children positively influences bone mass accumulation¹⁵ and in adolescence period appropriate calcium intake of milk and milk products can increase the peak bone mass that results in minimized bone loss in later years.¹⁶ Adding calcium (dairy products) in diet can increase the bone mineral density.^{17,18,19} Insufficient calcium intake and insufficient sun exposure were reported to be the factors to cause low bone mineral density in young Saudi women.²⁰ and lower socioeconomic status also intends to affect BMD.²¹ Keeping all this in view, the present study was designed to see the impact of socio-economic status, physical activity, sedentary behavior and specific food preference of young adults so as to fathom their impact on bone health.

Methodology:

The study included 1000 students (394 boys and 606 girls) aged 16-23 years from different colleges of Batala. The information from each participant was collected through a self-administered questionnaire. Socioeconomic status was evaluated based on the education and occupation of father and mother and was categorized to be low, middle and high as specified.²² Physical activity of the study group was assessed by referring to WHO global physical activity questionnaire (GPHQ).²³ Activities were defined as either low, moderate and high. Sedentary behavior was analyzed through number of hours spent to watch television, usage of computer, and mobile phone. Symptoms like skin pallor, mottled enamel, spongy and bleeding gums and brittle nails were observed for nutritional deficiency signs.²⁴ The subjects were enquired about the intake of milk and milk products, fruit, cold drinks and fast food which was quantified as consumption per week. An intake of three or more than three times a week was considered to be to be positive. Bone mineral density was evaluated using calcaneal ultrasound bone densitometer (Furno's CM-200 light ultrasound bone densitometer; Furuno Electric Co.Ltd., Japan).²⁵ Heel Bone Mineral Density (HBMD) is equal to (patient's BMD – young normal mean BMD) / standard deviation of the young normal population) and is expressed as T-score. According to WHO definition T-score > -1 is normal bone mineral density, T-score between -1 and -2.5 is osteopenia and T-score < -2.5 is osteoporosis.²⁶

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.

Result:

Most of the subjects belonged to either low or middle socio-economic status where 60.9 percent of female belonged to low socio-economic status, and 56.6 percent male to middle strata. Poor physical activity status (Table 1) was indicated from the fact that 90.4 percent of female and 55.8 percent males showed low level of physical activity, and only 42.6% of males were at moderate level. Comparison of sedentary behavioral traits (Table1) revealed that more number of females (84.1) than males (78.4%) watched television for an average of at least 1-3 hours in a day. A higher number of females (Females: 93.2% ; Male:72.8%) responded to be busy on their mobile phones for about one to more than 3 hrs. per day whereas time spent on computer was less than one hours in most of the subject. Both male and female subjects reported exposure to sun for good two to three hours however females got exposed for

significantly longer duration. Average mean time (Table 4) being physically active (Male: 1.46 ± 0.528 ; Females: 1.10 ± 7.26 hr. /day) and in sedentary state (Male: 7.89 ± 1.6 ; Females: 6.84 ± 1.47 hr. /day) was significantly higher in males.

Examination of subjects for general health (Table 2) as indicated by healthy skin pallor (Males: 98.2%; Females: 93.9%), mottled enamel (Males: 17.8%; Females: 14.7%) and spoon shaped and brittle nails (Males: 2.0%; Females: 5.4%) had a significant difference in males and females revealing a better health for males, however frequency of dental caries (Males: 4.6%; Females: 4.0 %), and spongy and bleeding gums (Males: 24.4%; Females: 24.6%) was almost same among male and females. Specific food consumption as displayed in Table 2 showed, that fruit intake in most of the subjects was at least three times per week (Males: 85%; Male: 83%). Intake of milk and milk products like curd and cheese was significantly higher in male individuals in comparison to females. Most of the respondents were vegetarian in their diet pattern and only 33.2 percent of boys and 11.9 percent of girls reported consuming eggs. 61.7 percent of females and 50.3 percent of males gave affirmation to consumption of fast food. Pedigree studies (Table 3) showed that bone fracture was significantly more pronounced in fathers' and maternal grandfathers' of studied male individuals. Mean T-score (Males: 0.002 ± 0.882 ; Females: -0.360 ± 0.890) values (Table 4) were significantly higher in males in comparison to females. There was a significant difference in BMD with more of the males being normal compared to females whereas osteopenia (Females: 44.9%; Males: 37.8%) and osteoporosis (Females: 6.4%; Males: 5.1%) was more pronounced in females.

Discussion:

In the present study (Table 5) socio-economic status was positively ($r = 0.086$; $p = 0.007$) correlated with T-score. Similarly in a study on Lebanese children and adolescents in both genders, children of lower socio-economic status tended to have lower BMD than those from higher socio-economic background as environmental and lifestyle factors are largely determined by the socio economic status.^{21,27,28,29} Likewise in another study adult people of both the genders from higher socio economic status were reported to have higher spine BMD than those of low socioeconomic status.^{30,31} Although, the level of physical activity was low to moderate in the population studied, it had significant positive impact ($r = 0.086$; $p = 0.007$) on T-score in pooled data of male and female subjects, and in male subjects ($r = 0.121$; $p = 0.016$) specifically who had superior involvement in physical active. It is in conformity to the studies which also point out that regular and increasing level of physical activity and weight bearing exercises has positive effect on bone mineral density.^{10,32,33,34,35,36}

Independent of physical activity, sedentary living has also been shown to influence a variety of outcomes.³⁷ Evidences suggest that a reduction in sedentary time should accompany increase in moderate-to-vigorous intensity weight bearing activity to mitigate bone loss.³⁸ Sedentary activity, as indicated by the time spent engrossed on mobile phone, was found to have significant adverse impact on T-score ($r = -0.106$; $p = 0.009$) in females since they remained on mobile phone for longer hours and were physically less active. Similar to the present study low physical activity and sedentary lifestyle have been assessed as risk factors which are significantly associated with low mineral density resulting in osteopenia and osteoporosis.^{39,40,41} An exposure to sun was seen to have a significant effect on BMD in studied population ($\chi^2=16.140$; $p=0.013$ [OR]: 18.701 at CI: 95%). Likewise, in a study on college going students physical activity, optimal nutrition and adequate sun exposure were interpreted to be vital

for attaining peak bone mass,³⁹ on the contrary however another study by Verma explained that despite availability of plenty and adequate sunshine Indian population has the highest prevalence of low bone mass and bone mineral content.⁴²

Impact of selected food items on bone mineral density revealed that intake of cheese ($\chi^2 = 6.193$; $p=0.045$) had significant impact on bone mineral density in males and that of fast food ($\chi^2=11.075$; $p=0.004$) in total subjects including both males as well as females. Parallel to the present study physical activity and dairy consumption positively influenced whole bone body mass.^{15, 43} Examination of general health condition assessed through physical symptoms could indicate that spongy and bleeding gums, occurring due to vitamin C deficiency, affected BMD particularly in females ($\chi^2 = 7.817$; $p = 0.020$: [OR] $\chi^2 = 6.126$; $p = 0.047$) and overall data ($\chi^2 = 6.089$; $p=0.048$: [OR] $\chi^2 = 6.126$; $p = 0.047$). In accordance to the carried out study, Vitamin C was reported to be associated with BMD.⁴⁴ There was likelihood of dental caries caused by Calcium deficiency to effect BMD in overall data ($\chi^2 = 3.581$; $p = 0.167$: [OR] $\chi^2=6.017$; $p=0.049$ at 95% CI). A few studies point out that deficient calcium intake and vitamin D could cause low BMD.^{45,46} Pedigree studies (Table 5) depicted that state of bone fracture in father ($\chi^2=12.806$; $p < 0.012$) and paternal grand-mother ($\chi^2=13.140$; $p < 0.041$) has a significant impact on bone mineral density in male subjects. There was a strong likelihood of inheritance from father ($\chi^2=15.470$; $p < 0.04$; CI: 95%) and also from paternal grand-mother ($\chi^2=13.531$; $p < 0.035$; CI: 95%) in males. In female subjects bone fracture in paternal grand-father significantly affected BMD ($\chi^2=10.036$; $p < 0.040$), but on the other hand a study did indicate that predictor of bone status among adolescent boys were maternal T-score and for girls were paternal T-score and Z-score.⁴⁷

Conclusion:

Socioeconomic status and physical activity had positive correlation while time spent engrossed on mobile phone was found to have negative and adverse impact on T-score. Exposure to sunlight, intake of milk product specifically cheese, fast food and spongy bleeding gums significantly influenced BMD. Bone fracture in father and paternal grand-mother made a significant difference to BMD in males and that of paternal grand-father in females. Even though a significantly better bone health status could be assessed in male subjects, 42.9% suffered an impaired state and it was still worse in females with 51.3 percent. The study could conclude that promoting physical activity, decreasing sedentary behavior, and increasing intake of milk products can help young adults strengthen bones to prevent associated problems later in life.

37.8% osteopenia and 5.1% had osteoporosis while it was still higher in females with being 44.9% osteopenic and 6.4% osteoporotic.

The low physical activity, low diet consumption, socio-economic status and disturbed lifestyle play a role in poor bone mineral density which results into osteoporosis in young adults. It can be concluded that promoting physical activity, decreasing sedentary behavior, and increasing Ca intake in young adults, can help in the prevention of osteoporosis later in life.

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Table 1: Number and percentage distribution of college-going boys and girls w.r.t. their socio-economic status, sedentary behavior, physical activity and Exposure to sun.

Health symptoms and specific food preference.		Sex				χ^2	P	Likelihood ratio	P
		Male		Female					
		N	%	N	%				
<u>General Health symptoms:</u>									
Skin color	Normal	387	98.2	569	93.9	10.644*	0.005	12.026	0.002
	Pale	4	1.0	22	3.6				
	Odema	3	0.8	15	2.5				
Dental caries	Yes	18	4.6	24	4.0	0.219	0.639	5.183	0.159
	No	376	95.4	582	96.0				
Spongy and Bleeding gums	Yes	96	24.4	160	26.4	0.520	0.471	2.078	0.556
	No	298	75.6	446	73.6				
Mottled Enamel	Yes	70	17.8	89	14.7	1.694	0.193	8.437	0.038
	No	324	82.2	517	85.3				
Spoon Shaped / Brittle Nails	Yes	8	2.0	33	5.4	7.082	0.008	10.039	0.018
	No	386	98.0	573	94.6				
<u>Specific food preference:</u>									
Fruit	Yes	335	85.0	507	83.7	0.333	0.564	0.335	0.563
	No	59	15.0	99	16.3				
Milk	Yes	337	85.5	405	66.8	43.620*	0.000	46.127	0.000
	No	495	14.5	201	33.2				
Curd	Yes	303	76.9	397	65.5	14.755*	0.000	15.065	0.000
	No	91	23.1	209	34.5				
Cheese	Yes	261	66.2	303	50.0	25.620*	0.000	25.919	0.000
	No	133	33.8	303	50.0				

Egg intake	Yes	131	33.2	72	11.9	67.379*	0.000	66.121	0.000
	No	263	66.8	534	88.1				
Fast food	Yes	198	50.3	374	61.7	12.814*	0.000	12.787	0.000
	No	196	49.7	232	38.3				

Table 2: Number and percentage distribution of college-going boys and girls w.r.t. their Health symptoms and specific food preference.

Family members	Any Problem	Distribution of sex				χ^2	p-value	likelihood ratio	P-value
		Male		Female					
		N	%	N	%				
Father	Normal	321	81.5	506	83.5	8.717	0.117	11.539	0.042*
	B.F.	19	4.8	16	2.6				
	S.P.	54	13.7	80	13.2				
Mother	Normal	293	74.4	446	73.6	3.284	0.350	4.679	0.197
	B.F.	10	2.5	11	1.8				
	S.P.	91	23.1	145	23.9				
Paternal (Grand-father)	Normal	379	96.2	591	97.5	7.809	0.099	8.717	0.069
	B.F.	7	1.8	4	0.7				
	S.P.	5	1.3	11	1.8				
Paternal (Grand-mother)	Normal	377	95.7	590	97.4	6.599	0.159	7.548	0.110
	B.F.	5	1.3	2	0.3				
	S.P.	11	2.8	12	2				
Maternal (Grand-father)	Normal	373	94.7	598	98.7	19.947	0.001*	22.402	0.000*
	B.F.	6	1.5	0	0.0				
	S.P.	15	3.8	6	1				

Maternal (Grand-mother)	Normal	383	97.2	595	98.2	2.745	0.601	3.039	0.551
	B.F.	2	0.5	3	0.5				
	S.P.	7	1.8	6	1				
<ul style="list-style-type: none"> • B.F.- Bone fracture • S.P. – Skeleton problem 									

Table 3: Number and percentage distribution of college-going boys and girls w.r.t. their pedigree studies.

Parameter	Male				Female				Total			
	χ^2	P	Likelihood ratio	P	χ^2	P	Likelihood ratio	P	χ^2	P	Likelihood ratio	P
Exposure to sun	7.209	0.302	8.426	0.209	10.155	0.118	11.590	0.072	16.140	0.013*	18.701	0.005
Dental caries	1.360	0.507	2.262	0.323	2.144	0.342	3.662	0.160	3.581	0.167	6.017	0.049
Spongy and bleeding gums	0.312	0.855	0.314	0.855	7.817*	0.020	7.843	0.020	6.089*	0.048	6.126	0.047
Cheese	6.193*	0.045	7.300	0.026	1.423	0.491	1.429	0.489	4.529	0.104	4.678	0.096
Fast food	5.198	0.074	5.430	0.066	5.765	0.056	6.254	0.044	11.075*	0.004	11.912	0.003
<u>Pedigree analysis:</u>												
Bone fracture (father)	12.806	0.012*	15.470	0.004	8.401	0.210	7.747	0.257	10.829	0.094	10.829	0.094
Bone fracture (grand-mother)	13.140	0.041*	13.531	0.035	9.611	0.142	11.347	0.078	8.108	0.423	9.007	0.342

Table 4: Mean and Standard deviation of college-going boys and girls w.r.t. their time spent on physical activity, sedentary behavior and T-score value of bone mineral density.

Parameter	Male		Female		Total		F-value	P
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Age	19.17	2.282	19.53	2.254	19.39	2.270	5.936	0.015
Physical activity	1.46	0.528	1.10	0.302	1.24	0.443	186.611	0.000
Total of sedentary activities	7.89	1.60	6.84	1.47	7.26	1.60	113.291	0.000
Exposure to sun	2.60	0.75	2.69	0.68	2.65	0.71	9.254	0.002
T-score	0.002	0.882	-0.360	0.890	-0.217	0.904	40.071	0.002
Bone mineral density(BMD)								
	N	%	N	%	χ^2	P	Likelihood ratio	P
Normal	225	57.1	295	48.7	6.841*	0.033	6.859	0.032
Osteopenia	149	37.8	272	44.9				
Osteoporosis	20	5.1	39	6.4				

Table 5: Chi- square value 'r' of various affected parameters w.r.t. Bone Mineral Density (BMD) in college – going boys and girls.

Parameter	Male		Female		Total		F-value	P
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Age	19.17	2.282	19.53	2.254	19.39	2.270	5.936	0.015
Physical activity	1.46	0.528	1.10	0.302	1.24	0.443	186.611	0.000
Total of sedentary activities	7.89	1.60	6.84	1.47	7.26	1.60	113.291	0.000
Exposure to sun	2.60	0.75	2.69	0.68	2.65	0.71	9.254	0.002
T-score	0.002	0.882	-0.360	0.890	-0.217	0.904	40.071	0.002
Bone mineral density(BMD)								
	N	%	N	%	χ^2	P	Likelihood ratio	P
Normal	225	57.1	295	48.7	6.841*	0.033	6.859	0.032
Osteopenia	149	37.8	272	44.9				
Osteoporosis	20	5.1	39	6.4				

Table 6: Correlation value ‘r’ of various affected parameters w.r.t. Bone Mineral Density (BMD), T-score and Z-score in college – going boys and girls.

Parameter	Male		Female		Total	
	r	P-value	r	P-value	r	P-value
BMD (Bone mineral Density)						
Physical activity	-0.035	0.485	-0.036	0.370	-0.063*	0.047
Exposure to sun	0.067	0.185	-0.082*	0.043	0.080*	0.012
		T-Score				
Socio-economic status	0.130**	0.010	0.002	0.957	0.086**	0.007
Mobile phone	-0.011	0.833	-0.106**	0.009	0.013	0.679
Physical activity	121*	0.016	0.058	0.154	0.157**	0.000
Exposure to sun	-0.001	0.979	-0.100*	0.013	-0.069*	0.030

** . Correlation is significant at the 0.01 level .

* . Correlation is significant at the 0.05 level .