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Lifestyle Pattern and Bone Mineral Density: A Preliminary Study

Renu Tyagi, PhD[1*]; Meenal Dhall, PhD[1]; Mary Grace Tungdim, PhD[1]; Peteneinuo Rülu, MSc[2]; Satwanti Kapoor, PhD[1]

[1]*Department of Anthropology, University of Delhi, Delhi 110007, India*
[2]*Department of Anthropology, University of Massachusetts, Amherst, Massachusetts 01002, USA*

[*]***Corresponding author***
Renu Tyagi, PhD
Department of Anthropology, University of Delhi, Delhi 110007, India; E-mail: renutyagiindia@gmail.com

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ABSTRACT

Objective
The aim of the study was to find an association of lifestyle pattern with bone mineral density among adults of Delhi.

Methodology
Cross-sectional data was collected among 153 participants both males and females with age ranging from 20-60 years. The bone mineral density was assessed using heel ultrasonic test. Each participant was studied for dietary pattern including vegetarian and non-vegetarian food, milk intake and physical activity. Stature and body weight were measured for each participant and body mass index (BMI) was computed. The respondents were classified in different nutritional status categories based on the BMI and different bone mineral density categories based on their bone quality index and T-score.

Results
The risk of osteoporosis and osteopenia was found to be significantly different among respondents belonging to different categories of nutritional status, fat percentage, dietary intake and physical activity.

Conclusion
Bone Quality Index (BQI) indicated an association with dietary trends, nutritional status, milk intake and physical activity (with only milk intake and physical activity being significant). There is need to sensitize the population towards taking an adequate care and to prevent themselves from loss of bone mineral and associated risks.

Keywords
Bone quality index; Nutritional status; Dietary trends; Physical activity; Fat percent; Body mass index (BMI); BQI.

INTRODUCTION

There is a worldwide increasing prevalence of osteoporosis which occurs in both men and women with advancing age, especially.[1,2] Various lifestyle aspects including dietary patterns, physical activity, and leisure time life activities influence on bone health among adults and elderly.[3] The change in bone contents and mass is controlled by several aspects involving genetic factors, peak bone mass (PBM), balanced nutrition, physical activity, and lifestyle risk factors such as beverage intakes, smoking, etc.[4] Osteoporotic fractures are a significant cause of morbidity and mortality, increased dependency in old age, both in developing and developed countries. Osteoporosis is one of the major public health concerns among adults including both males and females. Osteoporosis is responsible for two million broken bones and $19 billion in related costs every year.[5] Historically, calcium and vitamin D are the primary nutrients considered for osteoporosis prevention. It is very important to have the knowledge of bone health and its future impact as the amount of bone mass accrued from childhood to early adulthood and bone structure adaptation are the most important predictors of osteoporosis risk later in life.[6] Besides this, dietary components and physical activity are the two important modifiable factors that have a strong influence on bone accumulation, maintenance, and loss during the evolving life cycle of bone.[7] Since the dietary intake of a given nutrient is always related to the intake of other nutrients potentially affecting bone health, to disentangle the role of an individual nutritional item from that of the general dietary pattern is not easy. Accordingly, to

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better understand the effect of nutrition on bone mineral density (BMD), it seems more logical to focus on the relationship between the general dietary pattern and changes of BMD. Low body mass index (BMI) is a well-documented risk factor for low bone density and future fracture. The risk is most marked for lean individuals with a BMI of <20 kg/m^2. Above 20 kg/m^2 incremental increases in weight have little protective effect; leanness appears to be a risk factor rather than obesity protective. The association of fracture risk with leanness is largely dependent on BMD. For hip fracture, a modest risk persists after adjustment for BMD.[8] Several mechanisms have been proposed to explain the protective effect of obesity on bone mass. Physical activity prevents bone loss. Berard and co-workers found a significant protective effect of physical activity on BMD.[9] Diet has a significant effect on bone and muscle health. Bone health is affected by many factors such as genetic, nutrition especially dietary protein intake, environment and lifestyle. Nutrition is one of the vital modifiable factors in the maintenance and development of bone and prevention of osteoporosis. It is likely that other environmental and lifestyle factors, particularly exercise, may modulate this effect. Positive relationships of BMD with dairy product intake and with physical activity have been reported.[10-13] This study aimed to examine the relationship between dietary factors, physical activity, nutritional status and bone health.

METHODOLOGY

A cross-sectional study was conducted in Delhi population among 153 participants, both males and females, ranging in age from 20-60 years. The present study consist a part of on-going larger study therefore the sample size is small. Anthropometric data including stature and body weight was measured using standard techniques. The BMI was computed. The bone density was taken on each respondent using heel ultrasonic test. Quantitative ultrasound (QUS) of calcaneal bone was considered as a low-cost technique and a fast examination with absence of ionizing radiation for assessment of bone quality.[14] Bone densitometer (Sonost-3000) using ultrasonic waves was used to measure the speed of sound (SOS) in the heel. All subjects had QUS measurements of their right calcaneus using densitometer with transmission imaging. The instrument measures BUA and SOS in a circular area of lowest attenuation in the posterior tuberosity of the calcaneus. This method was used as a non-invasive technique and so the measurement is safe and is suitable for primary screening of healthy population especially for children and pregnant women. The measurement is also suitable due to its high correlativity with dual-energy x-ray absorptiometry (DEXA). Various standardized indices were used like BMI and Bone Quality index (BQI). The BMI was categorizedas per World Health Organization (WHO) standards.[15] The WHO has proposed a set of criteria to define osteoporosis in terms of a BMD measurement. The BMD value of an individual patient is expressed in terms of the number of standard deviations from the mean of healthy young adults i.e., T-score. Osteoporosis has been defined by a T-score ≤-2.5, as osteopenia -1> T-score >-2.5 and as normal T-score ≥-1.[16] A structured proforma was used for collecting demographic as well as information regarding lifestyle parameters. Informed consent was taken from each participant prior to the start of the study and ethical clearance was also obtained from the concerned Ethical clearance committee for conducting the study. A criterion of including apparently healthy individual has been followed to recruit the participants for the present study.

Statistical analysis

For analysis, the respondents were categorized in three groups based on their BQI values namely normal bone health, osteopenia and osteoporosis. Statistical analysis was performed using SPSS version 17.0. The data was checked for normal distribution. Fisher exact test (two sided) Chi square test were used.

RESULTS

Most of the male (56%) and female (63.1%) respondents belong to 20-40 years age group followed by 41-50 years and 51-60 years (Table 1).

Table 1. *Age and Gender Wise Distribution of Respondents*

Age Groups (years)	Males N (%)	Females N (%)	Total N (%)
20-40 years	28(56)	65(63.1)	93(60.8)
41-50 years	18(36)	26(25.2)	44(28.8)
51-60 years	4(8)	12(11.7)	16(10.5)
Total	50(100)	103(100)	153(100)

N–Number of respondents

Table 2 displays the distribution of respondents, males and females, as per BQI (T-score). Among males 24% were found to have osteoporosis and 4% were found to be suffering with osteopenia. However, among females more than half of the respondents (53.4%) were found to be suffering with osteoporosis and 3.9% were found to have osteopenia. Significant gender differences (χ^2=12.16, p<0.01) for BQI were reported.

Table 2. *Distribution of Respondents According to BQI (T-score)*

Respondents		Osteopenia	Osteoporosis	Normal	Total	Chi square Value
Males	N	2	12	36	50	χ^2=12.16** df=2
	%	4.0%	24.0%	72.0%	100%	
Females	N	4	55	44	103	
	%	3.9%	53.4%	42.7%	100%	
Total	N	6	67	80	153	
	%	3.9%	43.8%	52.3%	100%	

***p<0.01, BQI-Bone quality index, N-Number of respondents, df-Degrees of freedom*

Table 3 indicates that majority of respondents taking a vegetarian or non-vegetarian diet were comparable based on BQI. In the present study, our findings showed that those who consumed either vegetarians or non-vegetarian food are at equal risk of being osteopenic/osteoporotic. A higher percentage of respondents consuming vegetarian food (53.5%) were reported to be normal as compared to those consuming non-vegetarian diet

(51.2%). The chi square value (χ^2=0.45) was found to be non-significant.

Table 3. *Association of Dietary Components with BQI*

Respondents Category		Vegetarian	Non-vegetarian	Chi square Value
Osteopenia	N	2	4	χ^2=0.45 NS df=2
	%	2.8%	4.9%	
Osteoporosis	N	31	36	
	%	43.7%	43.9%	
Normal	N	38	42	
	%	53.5%	51.2%	

BQI–Bone quality index, NS-Non-significant, N–Number of respondents, df–degrees of freedom

Table 4 displays the association of milk intake with BQI. It was found that 5% of the participants taking milk were categorized as osteopenia according to BQI and 37.5% were osteoporotic and 57.5% were under the normal BQI category. Among the participants who were not taking milk, 66.7% of them were classified as osteoporotic and 33.3 % were under the normal BQI category. Significant milk intake differences (χ^2=9.57, p<0.01) were reported.

Table 4. *Association of Milk Intake with BQI*

Respondents Category		Yes	No	Chi square Value
Osteopenia	N	6	0	χ^2=9.57** df=2
	%	5.0%	0.0%	
Osteoporosis	N	45	22	
	%	37.5%	66.7%	
Normal	N	69	11	
	%	57.5%	33.3%	

*** p<0.01, BQI–Bone quality index, NS-Non-significant, N–Number of respondents, df–degrees of freedom*

Table 5 displays that most of the respondents who consumed milk on daily (58.8%) or weekly (56.2%) or occasionally (46.4%) basis had normal bone quality index. However, some of those taking milk were reported to be suffering with either osteopenia or osteoporosis. Fisher exact test reported significant association (F=2.881, p=0.019) among respondents with respect to frequency of milk intake and their BQI.

Table 5. *Association of Milk Intake Frequency with BQI*

Respondents Category		Daily	Weekly	Occasionally	Fisher's Exact Test
Osteopenia	N	1	0	4	2.881 p=0.019
	%	2	0	7.2	
Osteoporosis	N	20	7	26	
	%	39.2	43.8	46.4	
Normal	N	30	9	26	
	%	58.8	56.2	46.4	
Total	N	5	53	65	
	%	4.1	43.1	52.8	

BQI-Bone quality index, N-Number of respondents, df-Degrees of freedom

Table 6 displays an association of nutritional status with BQI. It was found that 2.6% of the respondents in the underweight BMI category were categorized as osteoporotic according to BQI and 2.0% were atthe normal BQI category. Atthe normal BMI category, 24.8% of the respondents were classified osteoporotic according to BQI, 1.3% respondents were osteopenia and 24.2% were under the normal BQI category. Among respondents who are overweight/obese according to BMI, it was found that 16.3 % were classified osteoporotic, 2.6% were osteopenia, and 26.1% were under BQI normal category. The association between BQI and nutritional status according to BMI was found to be non-significant (χ^2 =7.66).

Table 6. *Association of Nutritional Status with BQI*

Respondents Category		Under-weight	Normal Weight	Overweight/ Obese	Fisher's Exact Test
Osteopenia	N	0	2	4	χ^2=7.66 NS df=4
	%	0.0%	1.3 %	2.6 %	
Osteoporosis	N	4	38	25	
	%	2.6 %	24.8%	16.3%	
Normal	N	3	37	40	
	%	1.9%	24.2%	26.1%	

NS-non-significant, N–Number of respondents, df–degrees of freedom

Table 7 displays the association of bone health and physical activity. It was observed that among those respondents who performed any type of physical activity, 29.4% belonged to osteoporosis category and 70.6% to the normal category. Whereas, 47.9% respondents without any physical activity practices were found to belong to the osteoporosis category, 5.0% were osteopenic and 47.1% had no osteopenia and osteoporosis.. Significant differences (χ^2=6.58*, p<0.05) were obtained between respondents on the basis of physical activity.

Table 7. *Association of Physical Activity with BQI*

Respondents Category		With Physical Activityweight	Without Physical Activity	Chi square Value
Osteopenia	N	0	6	χ^2=6.58* df=2
	%	0.0%	5.0%	
Osteoporosis	N	10	57	
	%	29.4%	47.9%	
Normal	N	24	56	
	%	% 70.6	47.1%	

**p<0.05, BQI–bone quality index, N–number of respondents, df-degrees of freedom*

DISCUSSION

As compared to males, females were reported to be osteopenia/ osteoporosis. More than half of the female respondents under study were found to be suffering with osteoporosis/osteopenia.

Significant gender differences were reported. Earlier studies have reported that bone loss occurs with progression of age in both genders, but the rate of loss is much greater in women.[17]

Majority of respondent taking a vegetarian or non-vegetarian diet were comparable based on BQI. Dietary protein intake may be important in determining bone mass and fracture risk.[18] However, in the present study, it was reported that those who consumed either vegetarian or non vegetarian food are at equal risk of being osteopenia/osteoporotic. A higher percentage of respondent consuming vegetarian food were reported to be normal as compared to those consuming a non-vegetarian diet but this was not statistically different. It has been suggested that protein derived from vegetable sources may be more beneficial for the skeleton than animal protein.[8]

Milk is considered as one of the most complete foods enriched with needed amounts of minerals such as calcium and essential vitamins for formation of healthy bone. Most of the respondents who consumed milk on daily or weekly or occasional basis had normal BQI. Some of those taking milk were reported to have osteopenia or osteoporosis. This could be due to reasons that these participants were not consuming the adequate quantity of milk. Similar positive relationships between dairy product intake and BMD have been reported earlier.[10,11] It is uncertain which nutrient or combination of nutrients is responsible for changes in bone mass when dairy products are consumed because protein, calcium, phosphorus and vitamin D are known to be associated with bone health.[10] Also the role of exposure to sun cannot be ruled out. It was reported in previous studies that calcium has a positive effect on bone mass formation among people all ages.[19] This is due to the high levels of calcium in milk, as reported previously.[20] The respondents in our study in particular should increase their consumption of milk or calcium-rich foods to promote bone health and prevent osteoporosis during aging.

It is widely known that a high body weight or high BMI is related to a high bone mass but this is not the case in our data. An association of nutritional status (based on BMI) with BQI was reported in our present study but this was not statistically significant. Majority of those respondents who were overweight/obese were found to be suffering with osteoporosis or osteopenia. There are prior reports indicating that obesity significantly decreased the risk of osteoporosis but did not decrease the risk for osteopenia.[3] In addition, the supportive results of Guney et al,[21] showed that a lower BMI was associated with a low BMD and fractures.[21] Other studies also found associations between body weight and BMD.[22,23] Bone mineralization and resistance, result in stress that compresses the skeleton, and since body weight places the most constant mechanical stress on bones, the correlation between BMD and body weight is understandable.[24,25]

Physical activity plays an integral part in stimulating bone formation and helps in regulating bone size, shape, and strength.[26] In the present study, it was observed that among those respondents who performed any type of physical activity reported less occurrence of osteopenia/osteoporosis as compared to those who were not involved with any type of physical activity. Physical activity has been shown to contribute to bone mass in earlier studies.[12,13,27] Individuals with low physical activity were susceptible to bone loss or osteoporotic fracture and an increased physical activity results in an increase in BMD and a concomitant decrease in BMI.[28,29] Earlier studies showed significant continuing increase in bone mass in exercising premenopausal young women compared to non-exercising controls.[30,31]

Our data suggested that BMI and physical activity, along with other risk factors such as milk intake and dietary pattern are associated with bone health. The association of milk intake and physical activity were found to be significant, however the association of BMI and other dietary patterns are reported to be non significant which could be due to the small sample size. As the diet and lifestyle can be modified, demonstrating the effects of nutrition on bone health can provide an approach for osteoporosis prevention. Keeping in mind the incidence of osteopenia/osteoporosis in apparently healthy people as reported in the present study, it is important to sensitize the population towards taking an adequate care and to prevent themselves from bone mineral loss and associated risks. Proactive strategies need to be devised to reduce the risk and to lead a quality life.

CONCLUSION

An association of bone quality index and lifestyle trends including dietary pattern and physical activity were reported. Bone quality index or stiffness index indicated a significant association with milk intake and physical activity. Non-significant association are reported for dietary trends and nutritional status based on BMI. There is need to sensitize the population towards taking an adequate care and to prevent themselves from loss of bone mineral and associated risks.

STUDY STRENGTH

With globalisation and changing lifestyle, there is a paradigm shift in the dietary patterns of people across all cultures. In addition to this, people have sedentary lifestyle as many are migrating to the metropolitan cities for their livelihood. This sedentary lifestyle alongwith change in the dietary pattern makes it important to carry out such type of study. There are very few population based studies conducted on such a crucial aspect of health.

LIMITATIONS

The present study consist a part of on-going larger study therefore the sample size is small. As reflected in the sample distribution in Table 1, there was lesser number of male respondents due to their work schedule. Conversely, it is noteworthy that majority of the female respondents were homemakers/housewives which is better reflected in their larger representation.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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