Effects of Physical Activity, Body Weight, Dairy Intake and Life Style Factors on Bone Mass Density in a Cohort of Young Women of a Public Sector University

Samina Rafique[a], Waseem Sarwar[b]
[a]Senior Women Medical Officer, Bahauddin Zakariya University, Multan, Pakistan. [b]Senior Medical Officer, Surgical Unit 2, Nishtar Medical College and Hospital, Multan, Pakistan.

Corresponding author:
Samina Rafique

Abstract

Back ground and objectives: Peak bone mass level in adolescence can predict postmenopausal osteopenia and osteoporosis. Maintenance the optimum level of bone mineralization in premenopausal years can prevent bone loss after menopause. This study was done to evaluate the importance of different factors in optimizing bone health in young women studying in Bahauddin Zakariya University Multan, Pakistan.

Methods: 266 healthy women, aged 20-25 years, were recruited for the study randomly. Bone mass density was measured by broad band ultrasound attenuation and speed of sound. The effects of level of physical activity, body weight, dairy intake and life style, on BMD were studied. Dietary information was obtained through questionnaire and 1 and 2 week dietary recalls.

Results: The results were interpreted in terms of T scores. 54.4% of young women had T score < -1.0.The percentage of osteopenia remained high in sedentary, low body weight and high cola consumption groups. Dairy intake appeared to have no effect on bone mineral status.

Conclusion: Young people should be motivated to participate in sports and athletics. Further study is needed to evaluate the effects of physical activity on bone health in aging people.

KEYWORDS: Physical activity, Body weight, cola consumption, BMD.

Introduction

Bones continuously undergo remodeling in all human beings. The rate of bone deposition exceeds bone absorption in growing children. However, it becomes equal in early and late adulthood (Ott,1990) then after a short period of stability, there begins an unremitting, age-related loss of bone. The involution of bone with advancing age has been reported in both men and women, but the rate of bone loss is much greater in females (Riggs et al. 2008). The consequent decrease in bone density may reach fracture

threshold resulting in increased susceptibility for fractures in the women. However, Chestnut (1989) revealed that the age related osteoporosis can be prevented by attaining an optimum level of bone density in young adulthood.

The peak bone mass in the adolescence is determined by genetics mainly, but role of nutrition and physical exercise cannot be overemphasized. It is generally believed that rate of new bone deposition depends upon the weight bearing activities and mechanical stress on the bones. (Vadenburgh et al. 1995, wang et al. 2003) Cross-sectional study by Duckham et al. 2013 revealed greater bone density in athletes .Many other studies also supported the positive effect of physical activity on bone density in middle-aged and older adults. For example Bailey et al. (2010) and Allison et al. (2013) reported a significant increase in the bone mineral content of the site exposed to high impact exercise. Though calcium is the most important mineral determining the bone density but the epidemiological evidence of the effect of higher intake of calcium on bone mineral content is conflicting. Korkor et al.,(2009) found a favorable outcome of intake of dairy while, Lanu et al.(2005) evaluated from 58 studies, that the evidence supporting the nutritional guidelines specifically focused on increasing the intake of milk or other dairy products for promoting child and adolescent bone mineralization, was not convincing. Nevertheless, it has been suggested that calcium supplementation may slow the age related bone loss in the elderly. (McCbee et al.2004)

Certain life style variables such as intake of carbonated beverages, alcohol, coffee and smoking etc. may also influence bone health in men and women. During the last decades, there has been an incredible increase in consumption of soft drinks in both developed and developing countries but the consequences on bone health in relation to this consumption have been investigated meagerly. However, Ma et al. (2004) and Libuda et al. (2008) revealed an inverse association between consumption of cola beverages and bone health. While, Whyshak (2000), McGartland et al. (2003) and Tucker (2009) reported the same relation only in females. Still other evidence suggested that only colas and not other carbonated beverages adversely affected bone mineral density in older women (Tucker et al. 2006).

Premenopausal women with osteopenia tend to have more rapid process of losing bone mineral density and they are diagnosed with osteoporosis more often than premenopausal women with normal BMD as revealed by Mortan and Morgan (1970). Chung et al. (2001) reported that If premenopausal women with osteopenia are identified and treated early enough, the process can be halted to reach osteoporosis. Moreover, it is imperative and practical to prevent osteoporosis than to treat it. Therefore, the foremost objective of the present study was to measure the bone mineral density of young healthy female students of a public sector university (Bahauddin Zakariya University, Multan, Pakistan) and to assess the possible effect of intake of dairy products, physical activity and life style on the bone density.

Subjects and Methods

Study Design

Cross sectional study.

The study was conducted in Bahauddin Zakariya University, Multan, Pakistan from 15th to 20th September 2012. The participants were young female students of the University who were recruited through advertisement and referral by medical center BZU. Measurement of areal bone mineral density through broadband ultrasound attenuation (BUA), and speed-of-sound (SOS) was done in the right os calcis by Sonost 3000 Ultra sonometer manufactured by Osteosys, South Korea. These methods are authentic ways to perform clinical assessment of bone quality and have been widely used in various studies in the past such as those conducted by He et al. (2000), Tyras et al.(2002) and Brook-Wavell et al. (2008)

A total of 310 female students got their BMD measured. Out of these 280 were included in the study. Exclusion criteria were history of previous fractures, intake of bone active drugs, any chronic illness and irregularity of menstrual cycle. Prior consent was taken from every volunteer. Dietary history was obtained by a questionnaire referring to frequency of intake of dairy products especially milk and yogurt. The questionnaire was developed taking guidelines from Monotmoli et al. (2002).The portion regarding intake of cheese was skipped since this food item is not commonly used in Pakistan. The questionnaire also assessed the current level of physical activity and life style factors such as frequency of intake of cola drinks. At the end, 266 women completed the survey forms that were considered for the final analysis.
The study subjects were asked to classify their level of physical activity as sedentary (spending most of the time in library or on computer desk), active (routine activity at work such as climbing up of stairs in departments or hall of residence) or very active (taking part in supports or having brisk walk for 30 minutes > 3 times a week). Similarly three levels of dairy and cola consumption were defined: a) daily, b) 2-3 times a week, c) infrequently.

Body weight of each participant was measured and the women were divided into five groups based on their body weight: 38-40, 41-50, 51-60, 61-70 and >70kg. Bone health was defined in terms of T scores by using WHO criteria for osteoporosis. T scores are standard deviations reflecting the difference from normal bone density from the reference population.

Statistical Analysis

Data was subjected to one way analysis of variance using Microsoft Excel 2007 to elucidate significant effect of independent variables.

Results

Mean age of the study subject was 21.3 years $\pm$ 1.5 and mean weight was 52.5 $\pm$ 9kg. Out of total 266 students 145 were found to be oseopenic (54.4%) with average T score of -1.75 and standard deviation of 0.46. Mean weight of normal women was 54.3$\pm$8 kg, for osteopenic women it was found to be 51.5 kg $\pm$8kg.The propitiate number of osteopenic and normal women according to different variables are illustrated in Figures1and 2.

Figure 1 shows the results by level of physical activity and body weight among the study subjects. It is evident from the figure that number of women with osteopenia was low

(38%) in" very active" group (n=55) as compared to active (n= 167) and "sedentary" (n=44) where it remained 53% and 77%, respectively.
The figure also manifests that the number of osteopenic women was greatest in 38-40 kg group (88%, n= 15). With increasing body weight, the percentage of osteopenia declined to 60%, 49% and 42% in 41-50 kg, 51-60 kg and 61-70 kg respectively. In 71-80 kg group no women was found to have osteopenia.

Number of osteopenic and normal women by self reported intake of dairy and cola drinks are described in Figure 2. It is clear from the figure that 178 (66%) women had a low (infrequent) intake of milk or other dairy products in their diet while 37 (13%) reported to have moderate (2-3times a week) and 51(19%) had milk and yogurt on daily basis (high intake). Percentage of osteopenia remained 55%, 40% and 56% in the three groups, in that order.

The figure also shows that 161 women took cola drinks infrequently, 44 had a moderate while 61 women had high consumption of these beverages. The percentage of osteopenia remained 50% (n=81**)** 38% (n=17) and 37% (n=23) among the three groups respectively. Average T scores of the study sample are described in Table 1. When assessed by physical activity, mean bone density was notably higher among very active with an average T score =-0.4 while "active" and "sedentary" women had average T scores of -0.9 and-1.05 respectively. The difference proved to be extremely significant statistically with a probability level at 0.001% (Table 2). Average T score of the girls falling in 38-40 kg group was -1.1 whereas > 70 kg group had an average value 0f -0.1. Women whose body weight ranged from 41-50 kg had average T score of -1.5 while those belonging to 51-60 kg and 61-70 kg fractions had T scores of -1.1 and -0.8 respectively, indicating that heavier women had higher T scores and a better bone quality. Statistical analysis showed the difference to be significant at 0.5% level of probability (Table 2).

Average T score of women with low intake of dairy was -0.99, while it was -1.6 and -0.90 in women with moderate and high intake of dairy respectively. The difference was found to be non significant statistically. Average T scores

in relation to intake of cola remained -1.2, -1.1 and -0.8 with low, moderate and high consumption of these drinks, in that order, indicating better bone health among non users of cola with the statistical difference significant at 0.01 % level of probability (Table2)

Discussion

We determined BMD of os calcis which is mainly a trabecular bone. Due to higher surface to volume ratio, high turnover and greater responsiveness to metabolic stimuli, trabecular bone is a better site than compact bone for the detection of osteoporosis and susceptibility to fracture as revealed by Han et al. (1992). Being the eventual weight bearing bone, os calcis is considered as perfect site for the assessment of osteoporosis and has been used earlier (Fordham et al. 2000) for estimation of bone mass and identification of women with fracture risk.
Our data showed alarmingly high prevalence of osteopenia in young women. Contrary to the studies which have claimed the beneficial effects of milk and other dairy products on the promotion of bone mass such as those by Soroko et al. (1994) and Roland et al.

(2000) we could not find a definitive relationship between intake of dairy products and bone mineral density. Nonetheless, the influence of calcium on bone density remains controversial. However, from a nutritional point of view, milk consumption in childhood and adolescence may be a necessity for growth and development as described above (McCabee et al. (2004) and in addition to calcium, dairy is also a good source of protein and vitamin D which are beneficial for bone health as revealed by Tucker (2009). Some studies have shown that without intake of dairy products, it is difficult to meet RDA of calcium (Gao et al. 2006).The same was also observed in our study. When calculated by self reported level of intake of dairy and one week dietary recall, currant dietary calcium ranged approximately from 150-900 mg/day from foods classified as good sources of calcium (> 75 mg calcium per serving). Mean intake of calcium was 302.5 mg/day. It remained 150-400 mg/d in low intake group, 400-800 to mg/d in women having moderate intake of dairy products and >800 mg/d in those study subject who reported to have dairy frequently. Further research is required on dietary factors in childhood, adolescence and young adulthood that may provide some protective effect on the development of osteoporosis in later life.

Klein Nuland et al. (2005) showed that bone tissue reorganizes when mechanical forces are applied. Bone contains a network of osteocytes that make up a bio-mechanostat that can sense load and strain on the skeleton. Bone stress generates signals that stimulate osteoblast mediated bone formation and decrease bone resorption by osteoclasts leading to increased bone mass. For this reason athletes have a better bone quality and exhibit higher bone mineral composition, bone mineral density (BMD), and enhanced bone geometry as proved by Torstveit and Sundgot (2005) and Tenford and Fredericson (2011). Our results support this hypothesis and identify the dynamic nature of bone and suggest that bone mineral density of os calcis in young women is influenced by the mechanical stress i.e. physical activity.

Cola drinks were found to be negatively associated with bone thickness. This is consistent with the previous studies (Hostmark et al. 2011) which state that high level of phosphorus in colas may increase the acid load in the body and have a negative effect on skeleton. Besides, Hallstorm et al.(2006) revealed earlier that caffeine (methyl xanthine) in colas may be a risk factor for osteoporotic fractures .Like previous studies conducted on other populations by Bedgony et al. (2002) and Aghaei Mobodi et al.(2011) body weight was found to be directly proportional to the bone mass. Hence lower weight should be considered as an important predisposing factor for bone loss and osteoporosis.

With the advent of new era of technology, young people indulge themselves in computers and mobile phones and as such physical activities and sports no longer remain popular among the students. Moreover, latest trends in Pakistani society have resulted in inclination towards private schools which in contrast to public schools are usually situated in small buildings so there are little sports or athletics at school level.

Furthermore, new life style has resulted in use of fast food and cola drinks more frequently. At the same time, under the influence of electronic media young females try to remain skinny and under weight. All these factors are deleterious for bone health. This situation should be addressed seriously and sports and athletics should be focused in the society generally, and in educational institutions specifically because modest increases in weight-bearing physical activity can result in considerable improvements in bone density and strength in growing children and adolescents as revealed by Hasselstorm et al.(2008)

.Furthermore Baxter et al. (2008) in a longitudinal study, proved that these benefits persist beyond adolescence and result in greater bone density in young adulthood .Therefore the women interested in weight reduction should be taught to reduce body weight through physical exercise. It helps in gaining the lean body mass which is a strong predictor of bone mass as suggested. (Lu et al. 2009)

Conclusion

Based on the findings of the present study, we strongly suggest a longitudinal study to substantiate the effects of physical activity on bone density observed in our cross-sectional study and if the differences in bone density persist into the aging population, the incidence of osteoporotic fractures may be reduced or the average age at the onset of osteoporotic fractures be increased by emphasizing upon sports and exercise programs.
The relation of intake of colas and bone strength also warrant further study. Furthermore, a healthy life style should be encouraged and masses educated about the effects of cola beverages and dietary factors on bone strength by using print and electronic media and by arranging lectures and seminars in educational institutions.

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Table1: Average T scores in 266 healthy women of BZU in relation to physical activity, body weight and currant intake of dairy and cola beverages.

Groups	Count	Average T score	
Sedentary	44	-1.05	
Active	167	-0.98	
Very active	55	-0.43	
38-40 kg	17	-1.13333	
41-50 kg	120	-1.05667	
51-60 kg	93	-1.12151	
61-70 kg	28	-0.85	
> 70 kg	8	-0.12222	
Low intake of dairy	181	-0.99	
Moderate intake of dairy	34	-1.06	
High intake of dairy	51	-0.90	
Low intake of cola	161	-0.83851	
Moderate intake of cola	44	-1.11364	
High intake of cola	61	-1.24098	

Table 2: Summary of Analysis of data by single factor ANOVA for all the independent variables.

Source Of Variance	Mean Square Value	F- Value	*DF*	P-value	Significance
Physical activity	6.962827	8.090312	2	0.000389	* * *
Intake of cola	4.080094	4.910588	2	0.008058	**
Intake of dairy	0.268949	0.311333	2	0.732739	N/S
Body weight	2.344876	3.03201	4	0.018099	*

*, **, ***: significant at 5%, 1% and 0.1% level of probability.
N/S: Non significant

Captions of Figures:

Figure 1: Number of osteopenic and normal women in relation to level of Physical activity and Body Weight amongst 266 young women of BZU

Figure 2: number of women with normal and low BMD with respect to intake of dairy products and cola beverages

Figure 1.

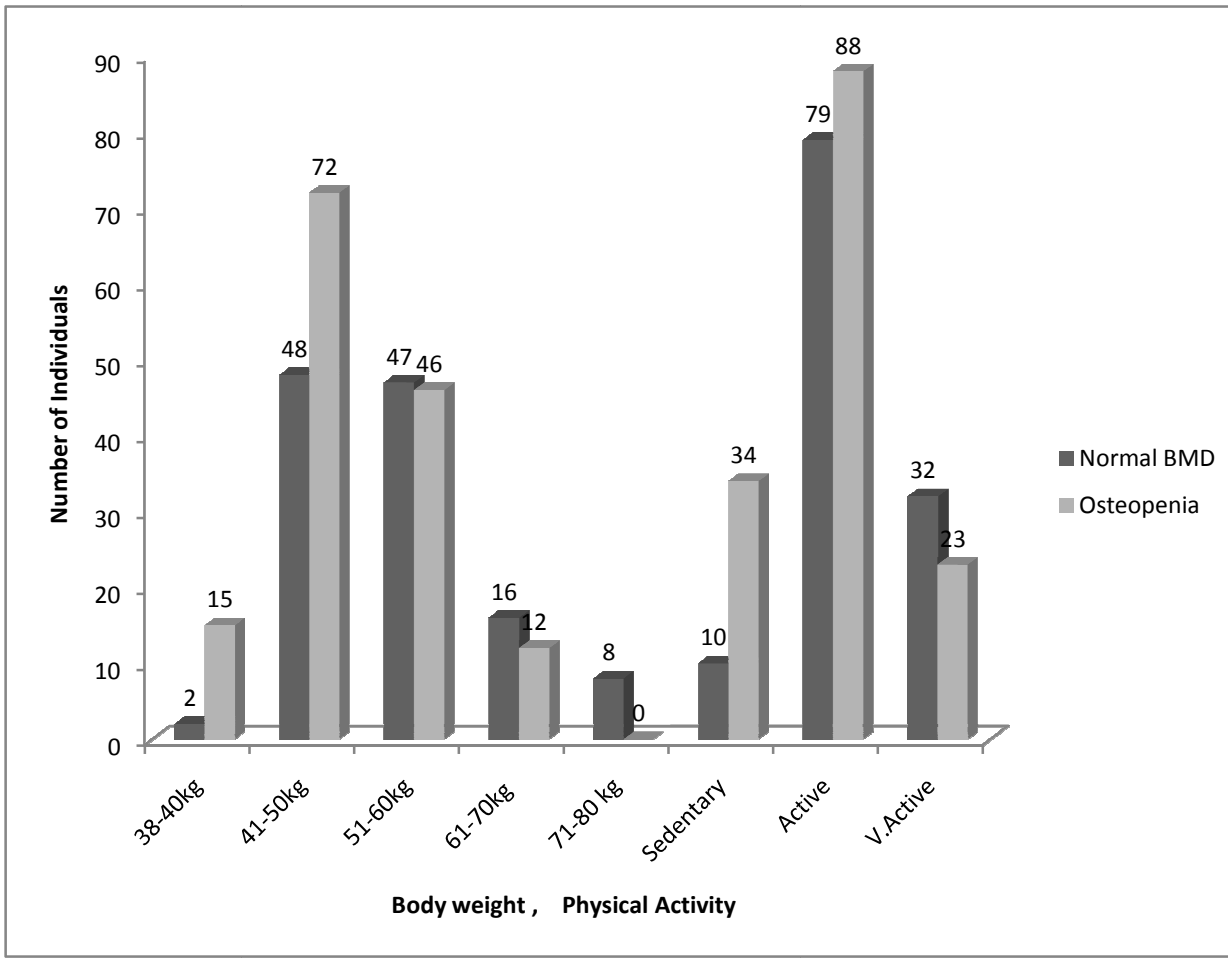
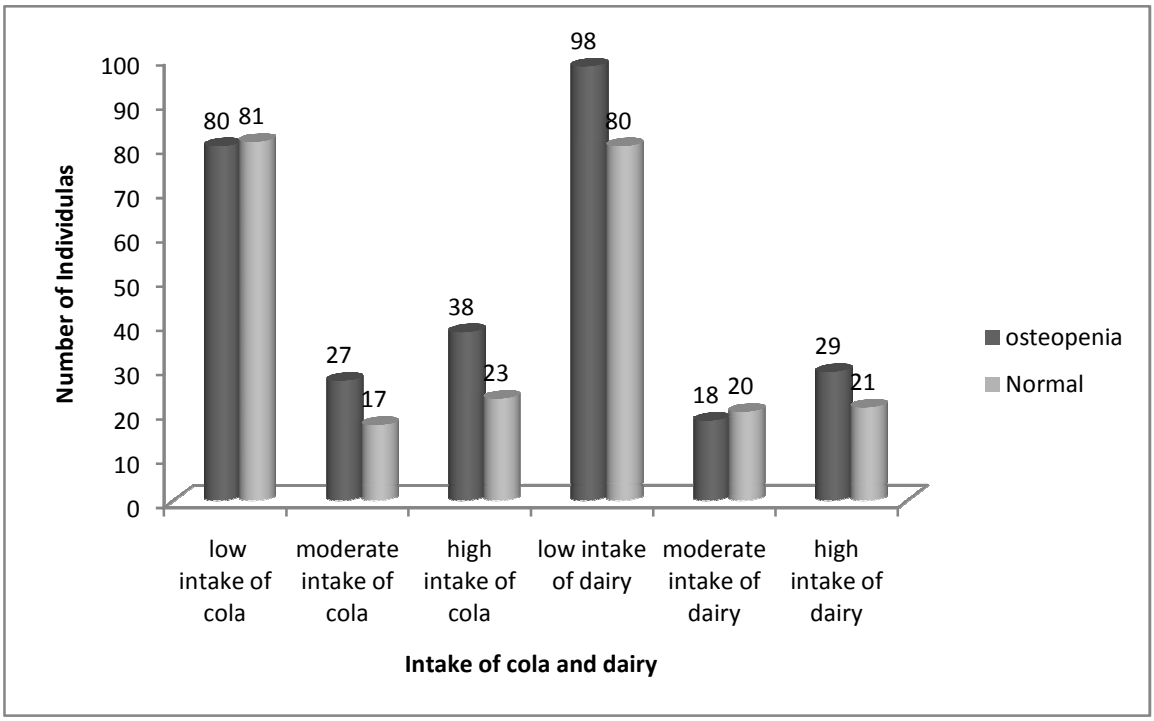


Figure 2:


Number of Individulas
100
90
80
70
60
50
40
30
20
10
0
80
81
27
17
38
23
98
80
18
20
29
21
low intake of cola
moderate intake of cola
high intake of cola
low intake of dairy
moderate intake of dairy
high intake of dairy
Intake of cola and dairy
osteopenia
Normal