Bone mineral density comparison of total body, lumbar and thoracic: an exploratory study

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Abstract

Objective: To analyse the behaviour of bone mineral density (BMD) of total body, lumbar and thoracic spine, and compare it between different age-groups, ethnicity and gender as a secondary analysis of already published data of NHANES.

Methods: The study was done and compared data of the National Health and Nutrition Examination Survey which was done from 1999 to 2006. It comprised bone mineral density data of 26,215 subjects of age 8 years and over. The sample was divided into 10 age groups, 3 ethnicities and gender groups. All subjects had bodyweights not exceeding 300lb, and height not greater than 6'5''. Female subjects were non-pregnant. SPSS 16 was used for statistical analysis.

Result: Of the total subjects, 7712 (29.41%) were Mexican Americans, 11236 (42.86%) were non-Hispanic whites and 7267 (27.73%) were non-Hispanic blacks. There were 13291 (50.69%) males, and each ethnic group also had approximately 50% males. The bone mineral density of non-Hispanic blacks was higher than the other two groups, whereas males of all ethnic groups and races had higher density then females of the same group. Bone mineral density of total body, lumbar and thoracic was significantly different. After 50 years of age, total body, lumbar and thoracic bone mineral density decreased in females but lumbar slightly increased in males, whereas thoracic remained stable and total body decreased.

Conclusion: The bone mineral density of male and blacks was higher than female and non-black races in total body, lumbar and thoracic spine. The thoracic BMD was lower and might predict early fracture risk.

Keywords: Bone mineral density, DEXA, Lumbar spine, Osteoporosis, Thoracic spine. (JPMA 65: 388; 2015)

Introduction

Osteoporosis has become a widespread disease.[1] Weakening bones cause about 8.9 million fractures per year worldwide; around 200 million women are osteoporotic patients.[2] In Pakistan, this 'silent disease' affects 6.7 million people and it will increase to more than 7.1 million by 2020.[3] Majority of cases are not detected due to unavailability of dual-energy X-ray absorptiometry (DEXA) machines. Only 16 DEXA scanners are available in Pakistan,[4] rendering the cost of scans beyond the reach of most people in Karachi. According to the World Health Organisation (WHO), osteoporosis is referred to as faulty and weakened bone structure due to low bone mineral content per unit volume.[5]

Reduction of bone mass decreases strength and quality of bone, resulting in an increased fracture risk. The WHO declared DEXA scan as the gold standard to diagnose weakening bones.[5] The bone mineral density (BMD) values are presented as T-scores and Z-scores; these being

the number of standard deviations above or below an age-matched population (Z-scores) and above or below a young healthy adult population of the same ethnicity (T-scores).[6] WHO defined osteoporosis as T-score less than -2.5 of lumbar spine, hip or distal forearm,[7] but the diagnostic meaning of BMD values by DEXA scanner is different between different DEXA manufacturers.[8] Further, the subcontinent, especially Pakistan, still faces the same problem, as no Pakistani reference data exists for interpretation of osteoporosis. The American and the European regions resolve these problems to some extent by studying different population groups.

The study based on the secondary analysis of already published data of NHANES[9] that contains the BMD data of total body, lumbar spine and thoracic spine to establish the behaviour of BMD in different age group, sex and races. This present analysis is being done, in order to compare a future local study with similar variables.

Subjects and Methods

The BMD of total 26,215 subjects were measured by DEXA. The survey was conducted in America by National Health and Nutrition Examination Survey (NHANES) from 1999-2006.[9] The subjects were categorized into gender,

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three different ethnic and race groups; Mexican American, non-Hispanic white and non-Hispanic black, and 10 different age groups aged 8 years and over (Table-1). The ratio of males and females in each group were almost the same. Pregnant females, and subjects whose weight was over 300 lb and taller than 6 feet and 5 inches subjects were not included in examination.

The BMD was measured in g/cm² by Hologic QDR 4500A DEXA scanner. All scans were done by procedures defined by NHANES.[10] The total 10 sub regions were scanned by DEXA including head, thoracic and lumbar spines, pelvis, both sides ribs, both arms and legs. BMD of total body was measured by summing BMD values of all regions. NHANES also measured the bone area and bone mineral content those were excluded by our study.

The secondary analysis of BMD was performed using SPSS version 16.0. Levene's test for homogeneity of variances was used and this showed the stability of variances. After checking homoscedasticity ANOVA was used to determine the significance between BMD vales with respect to age, gender and race. 5% level of significance was taken and all graphs were generated using the same software.

Results

The NHBs had significantly (p <0.05) higher total body BMD compared to MAs and NHWs for both genders. Overall, males had higher BMD compared to females (Figure-1-a). Also, thoracic BMD was significantly lower than lumbar in both genders (p <0.05). The BMD of NHW and MA males was also significantly different, but in females BMD of both ethnic groups were the same (Figure-1-b). The total body BMD was significantly (p <0.05) higher than lumbar and thoracic spines in both genders.

Total body BMD was smooth in both genders, increased
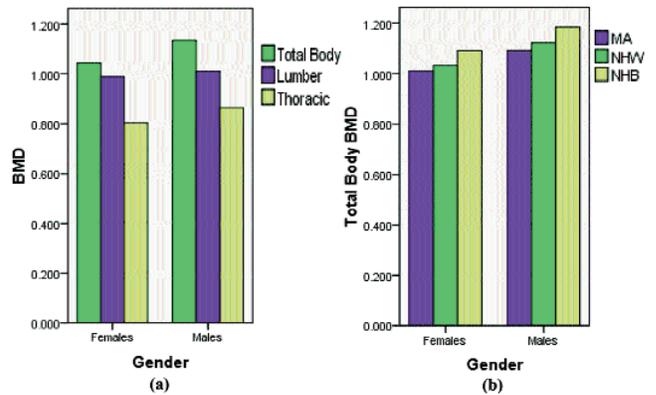
Figure-1: (a) Bone mineral density (BMD) of total body, lumbar and thoracic in males and females of all age and ethnic groups. (b) Total body BMD in males and females of all age with respect to ethnic groups and gender.
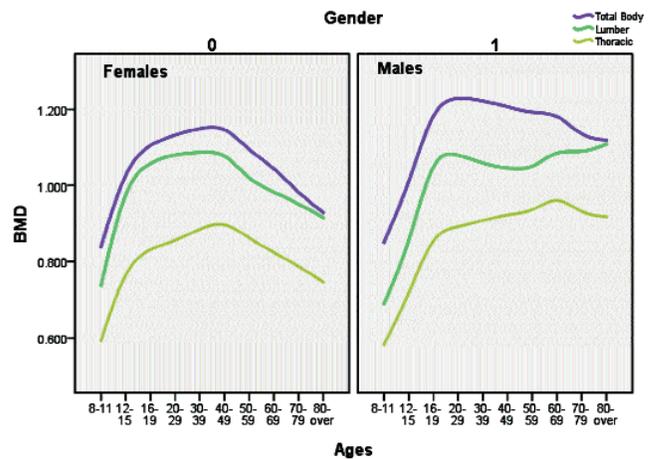
Figure-2: Bone mineral density (BMD) of total body, lumbar and thoracic.

during early adulthood, got relatively stable in both genders, and decreased after the 50 years of age. Same

Table: Distribution of sample by Age, Races/Ethnicity and Gender.

Age Group	Mexican American		Non-Hispanic White		Non-Hispanic Black	
	Males	Females	Males	Females	Males	Females
8-11	468	471	369	383	469	490
12-15	777	821	578	576	745	737
16-19	783	692	591	543	757	609
20-29	444	364	617	583	325	297
30-39	337	298	647	612	310	333
40-49	381	372	700	668	366	398
50-59	174	194	683	639	240	250
60-69	348	375	623	644	303	306
70-79	164	154	496	429	114	124
80-over	48	47	398	457	36	58
Total	3924	3788	5702	5534	3665	3602

behaviour was observed in lumbar and thoracic spines of females, but the BMD of lumbar remained stable and slightly increased in males (Figure-2).

Discussion

BMD is not the only factor used to predict fracture risk, measured using the DEXA scan. However, it has been declared the gold standard for diagnosing osteoporosis. It's also a fact that many osteoporosis-predicting tools have not used BMD values. These include OSIRIS,[11] SCORE,[12] ORAI,[13] and FRAX[14] which used BMD as optional input. There are many controversies about the reference population and optimal site to obtain BMD.[15-17] WHO has suggested three regions; hip, lumbar and one-third of distal side forearm for predicting osteoporosis,[7,18] whereas the femur neck is as a better predictor. The discussion is further complicated by the fact that although lumbar and thoracic spine have more trabeculae,[19] decrease of BMD was more significantly marked in spine compared to other skeletal sites.[20]

Ethnical or racial differences also highly affect BMD values as reported by many studies[21,22] which we also confirm as our results comprised 7712 MAs, 11236 NHWs and 7267 NHBs, and both NHB genders had significantly higher BMD. The BMD is not equally distributed in the whole skeletal structure; total body BMD does not correlate with lumbar and thoracic spine.[23]

Spine has more trabeculae than other skeletal sites,[19] so spine BMD can be used to predict early change in menopausal women, but BMD varies in different parts of spine;[24] lumbar has greater BMD than thoracic spine. The different segmental vertebrae studies have been done by different methods other than DEXA scan, showing significant correlations in different parts of spine.[25-27] One study[28] found no differences between lumbar and thoracic spine BMD, but the study contained only 6 subjects: 3 males and 3 females of mean age 81 years. The lumbar BMD uniformly increases and decreases in pre- and post-menopausal women, but the behaviour in men is entirely different (Figure-2). Our results also confirm the result of a study[29] that lumbar BMD does not decrease in males after 50 years of age. The thoracic region has low BMD compared to lumbar in all race/ethnic groups and gender, which might predict the early fracture risk.

The importance of the study is based on the need to accurately determine the onset of osteoporosis. The use of DEXA machines is widespread in determining BMD of the region of interest. The fact that Hispanics and Blacks have different BMDs and different for different parts of the body, opens up the question of what is osteoporotic in Pakistan? The WHO defines osteoporosis as when the

BMD score is 2.5 or more below the mean. If we were to use the NHB BMD as the reference value, then many Hispanics will be osteoporotic as due to their ethnicity, their BMD is lower. Yet there will be no significant fracture risk. Apply this to Pakistani population and the problem becomes acute for interpreting the result. The DEXA machine will give a BMD value, but how will this be interpreted to be osteoporotic? If compared to the NHBs, it may be osteoporotic, since the NHB BMD mean values are higher than those of NHWs. So a Pakistani individual could be osteoporotic when compared to a NHB, but not osteoporotic compared to a NHW. So the real issue is to compare the Pakistani individual BMD against a Pakistani population reference BMD distribution. Hence, the problem is the absence of a meaningful BMD distribution for Pakistan population, and its correlation with fracture risk. There is a need to measure comprehensively the BMD for different ethnicities of Pakistan and to determine fracture risk based on their clinical parameters as well.

Conclusion

Significant differences were observed in BMD of different skeletal sites in different age, ethnic and gender groups. DEXA is the gold standard to predict fracture risk, but optimal sites of bone and reference population are key to diagnosing osteoporosis, suggesting that DEXA scans may not be able to accurately predict fracture risk.

Acknowledgement

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