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A Cross-Sectional Study on Bone Density in Adults from an Urban Area of South India

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Abstract

Introduction: Osteopenia and osteoporosis which refers to mild and severe bone density loss, together comprise Low Bone Density (LBD). Low bone density affects an estimated 200 million women globally but there are no estimates on the male population suffering from low bone density.In India, an estimated 36 million suffered from osteoporosis in 2013. The fractures that occur as a consequence burdens the individual and the public health system. **Objective**: The study aimed to estimate the prevalence of low bone density among individuals 18 years and above in an urban area of Chennai City in 2013.**Methodology**: Acommunity basedcross-sectional study was conducted among 405 individuals, 18years and above in Nanganallur area of Chennai city. Bone density was measured using a portable quantitative ultrasound machine.**Results**:The study subjects comprised of 33.8% males and the rest were females. Osteopenia was seen among 40%(95% CI: 35.21% - 44.79%) of the population and 13.3%(95% CI: 10.01% - 16.66%) had osteoporosis.An increasing trend of low bone density was seen as age increased. Both males and females showed low bone density prevalence of 51.8% & 54.1%, respectively. **Conclusion**: The presence of LBD was high even among the younger population and was not an exclusive problem of the elderly. Measures to promote bone health and prevent loss of bone density must be instituted early among both males and females.

Key-words: Low bone density, osteopenia, osteoporosis

INTRODUCTION

Bone density refers to the amount of minerals in bone tissue. These minerals are continuously resorbed and deposited in a process of bone remodeling.When the balance is disturbed, it results in low bone density. Low bone density (LBD) comprises of a spectrum in which osteopenia refers to mild bone loss and osteoporosis refers to severe bone loss based on T-score measurements. The result of low bone density is increased bone fragility and increased risk of fracture(1).Osteoporosis is considered a “silent disease” and a “silent global epidemic”. It is called a silent disease as bone density is gradually lost over time without manifesting any signs or symptoms, until a bone densitometry test reveals bone loss, or a fracture occurs with minor trauma. It is a silent epidemic as the disease has been rising in proportions without being recognized as a national and public health priorityby the medical fraternity, and without awareness among the general population(2).

International Osteoporosis Foundation (IOF) estimates that worldwide, 200 million people are affected by osteoporosis. An IOF audit in Indiaestimated that osteoporosis affected36 millionin the country in 2013(3). Though, low bone density is established as a disease of older age groups and women, in India,younger people and more men are affected compared to the West(4).The burden of disease is shown to be 51.6% among adults of all ages to 88.8% among postmenopausal women(5,6).

The main complication of low bone density is the occurrence of fractures that affect various bones of the body especially in the elderly. The incidence of fractures is alarmingly high and is predicted to rise with increase in the elderly population. Globally, osteoporotic fractures occur one in every three seconds. Over 50 years of age, one in two women and one in five men suffer a fracture in their lifetime(7). For the people treated at a public hospital in India for a hip fracture, the direct cost borne by the patient for hospital treatment is approximately 10,000 rupees and for those treated at a private hospital, the costs maybe up to rupees 2 lakhs. The public health system pays for the remaining costs incurred by the individual towards treatment in a government setting. This is in addition to the burden of lost wages and diminished quality of life of the affected individual and also an extra burden to care for the patient by the other family members(3).

Low bone density has both modifiable and non-modifiable risk factors. Age, gender, race and family history are some of the non-modifiable risk factors and calcium deficient diet, insufficient exercise, caffeine intake, smoking, alcohol

consumption and Vitamin D deficiency are some of the modifiable risk factors (8–10). Instituting simple measures against the known modifiable risk factors canhelp address the burden of low bone density and its consequent fractures. This in turn will help tacklethe huge socio-economic burden on the public health system and on the affected individuals even in developed countries and more so in a country like India. The high prevalence of insidious low bone density, vulnerability of the Indian population that is younger, presence of modifiable risk factors and lack of community level studies are essential reasons to study low bone density. The current study has therefore been carried out to estimate the prevalence of low bone density among adults in an urban area of Chennai, Tamil Nadu.

METHODOLOGY

This study was a community based cross–sectional study conducted in Nanganallur, an urban area in Chennai, Tamil Nadu.The number of residents above the age of 18 years was around 42,100.The study was carried out between July 2012 and March 2013.The study population comprised of all adults, i.e., males and females aged 18 years and above in the study area.All adults, males and females of age 18 years and above at Nanganallur who were permanent residents of the area and willing to participate were included as part of the study.Those who were bed-ridden were excluded as they needed to be mobilized for having their heel bone density measured by the quantitative ultrasound machine.

Due to the lack of published literature on previous community based studies done among individuals of this age group, the sample size was calculated by doing a pilot study. Based on results from the pilot study, prevalence of low bone density was 50% in the community.Minimum sample size calculated for cluster sampling at 95% of C.I., d =7(allowable error, 14% of 50%) and design effect = 2, worked out to be 392.

Study subjects were picked by a two stage sampling method.The first stage employed a cluster sampling technique followed by the simple random sampling within each cluster. The sampling frame was derived from the electoral list. There were 278 clusters/streets in the area. Fifteen individuals were selectedrandomly from each cluster, making 27 clusters necessary to be randomly selected and the final sample size was 405 individuals.In the absence of the individual selected by simple random sampling even after 2 visits, the next person on the list was included to be part of the study.

Approval of the Institutional Ethics Committee was obtained to conduct the study. After obtaining written informed consent, a predesigned and pretested questionnaire was administered to collect socio-demographic particulars of the individuals and their family and their risk factors for low bone density. The questionnaire was translated into the local language and again back translated to English and was administered in the local language at the homes of the participants. Anthropometry and bone density were measured by asking the participants to come to a house in the same street where the machine was placed. Height was measured using a portable stadiometer to the nearest 0.5cm and weight was measured using a portable weighing scale (Belita®) to the nearest 0.5kgvalidated with known weights.The heel bone densities of individuals were measured using a calibrated Quantitative Ultrasound machine (QUS) (Achilles®). The investigator was trained in the use and calibration of QUS and interpretation of the T –score. The foot of the participants was positioned such that the heel was placed exactly between the membranesand the T-score obtained fromthe machine was used for diagnosis of osteoporosis and osteopenia using WHO criteria (Table 1).The T score value gives the amount of bone a person has compared to a 30 year old adult of the same gender with peak bone mass.

Table 1. WHO Definitions of bone density Based on T-score (12)

Definition	T-Score
Normal	T-score ≥ –1
Osteopenia	T-score between –1 and –2.5
Osteoporosis	T-score ≤ –2.5
Severe Osteoporosis	T-score ≤ –2.5 with fragility fracture(s)

Statistical analysis

The data was entered into a MS excel sheet and analysis was done using SPSS v18. The quantitative parameters such as age was expressed as mean and standard deviation. Bone mineral density was expressed with T-score & classification was done as per WHO guidelines. All categorical variables were expressed as percentages.Prevalence of low bone density was estimated alongwith 95% CI. Association between low bone density and other categorical variables were tested for statistical significance by Chi-square/ Fisher's exact tests. To evaluate the quantitative relationship & prediction, Pearson's correlation and regression coefficients were computed. P-value of 0.05 was considered for statistical significance.

RESULTS

The study was conducted among 405 individuals consisting of 137 males (33.8%) and 268 females (66.2%)of Nanganallur.

The mean age of the male participants was 45.2 (14.1) years and of female participants was 40.23 (12.7) years, respectively. The age varied from 18 years to 83 years.Females and males constituted 66.2% and 33.8% of the participants, respectively.The prevalence of low bone density i.e. osteopenia and osteoporosis combined was 53.3% (95% Confidence interval – 48.45% - 58.21%). Osteopenia and osteoporosis contributed 40% (95% CI 35.21% - 44.79%) and 13.3% (95% CI 10.01% - 16.66%) of this, respectively (Figure 1).

With increasing age, an increase of osteoporosis and a reduction of normal bone density was seen (Table 3). There

Table 2: Age & sex- wise distribution of subjects based on Bone Density

Variable		Normal Bone Density n (%)	Osteopenia n (%)	Osteoporosis n (%)	Total	P value
Age Groups (in years)	18-29	52 (56.5)	33 (35.9)	7 (7.6)	92	<0.001
	30-44	72 (47.7)	68 (45)	11 (7.3)	151	
	45-59	54 (41.2)	53 (40.5)	24 (18.3)	131	
	≥ 60	11 (35.5)	8 (25.8)	12 (38.7)	31	
Sex	Males	66 (48.2)	51 (37.2)	20 (14.6)	137	0.688
	Females	123 (45.9)	111 (41.4)	34 (12.7)	268	
Total		189 (46.7)	162 (40)	54 (13.3)	405	

Table 3. Combined age and sex-wise distribution of subjects based on bone density

Variable		Males			Females		
		Normal Bone Density n (%)	Low Bone Density n (%)	Total	Normal Bone Density n (%)	Low Bone Density n (%)	Total
Age Groups (in years)	18-29	17 (80.9)	4 (19.1)	21	35 (49.3)	36 (50.7)	71
	30-44	21 (39.6)	32 (60.4)	53	51 (52.0)	47 (48)	98
	45-59	20 (43.5)	26 (56.5)	46	34 (40)	51 (60)	85
	≥ 60	8 (47)	9 (53)	17	3 (21.4)	11 (78.6)	14
Total		66	71	137	123	145	268
		Pearson chi square, P value - 0.012			**Pearson chi square, P value** -0.094		
		Trend chi square , P value - 0.073			**Trend chi square, P value -** 0.046		

was a negative correlation between age and the T score and this was seen to be statistically significant (r= -0.250, p < 0.001) (Figure 2).Females (54.1%) had higher prevalence of low bone density than males (51.8%).The association between sex of the individual and presence of low bone density was not statistically significant (p = 0.688) (Table 2).

Figure 1: Prevalence of Osteopenia and Osteoporosis among all participants

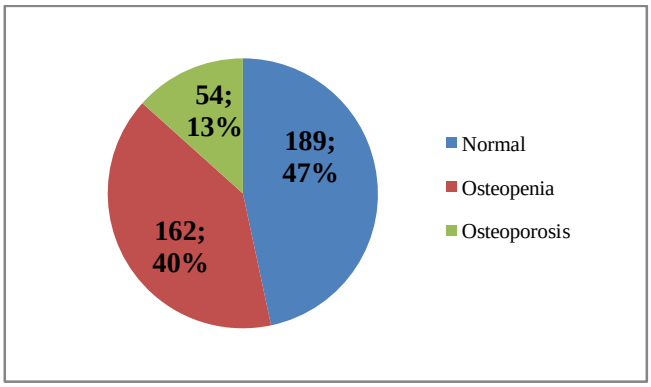
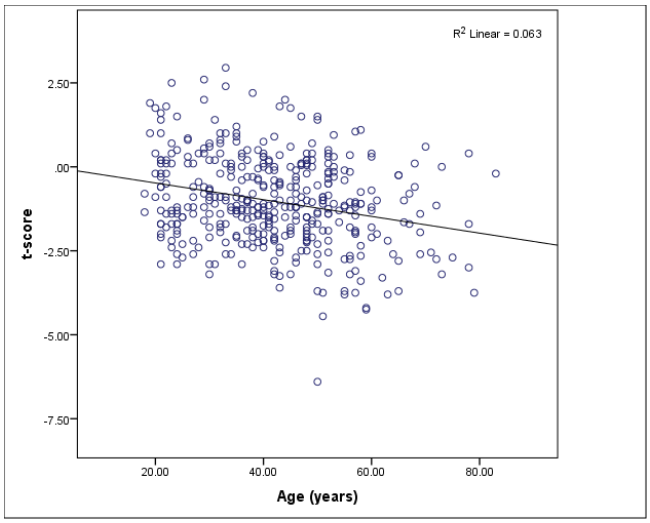


Figure 2: Scatter Plot – Age versus T score



When age wise prevalence of low bone density was seen among males and females separately, it was noted that there was significant difference between the groups of males (p = 0.012) but not among the females (p = 0.094). The linear association as seen by trend chi-square showed a significant trend of low bone density among the females (p = 0.046) but not among the males (p = 0.073) (Table 4).

DISCUSSION

The current study was a community based study conducted to estimate the prevalence of low bone density, i.e.

osteopenia and osteoporosis among the individuals aged 18 years and above in an urban area of Chennai, Tamil Nadu.

Prevalence of Low Bone Density

The prevalence of low bone density in the study population was 53.3% with 40% of osteopenia and 13.3% of osteoporosis. A study by Babu et al in north Kerala showed the prevalence of low bone density to be 82.7% with 40.5% of osteopenia and 42.2% of osteoporosis(13). The high prevalence noted in the latter study could be due to the camp based approach that was used and the higher mean age (52 ±12.8 years) of the participants compared to the current study (41.9 ±13.4 years). A study conducted at Loni among the health care professionals between the ages of 21 – 61 years noted a prevalence of 31.06% of osteopenia and 28.03% of osteoporosis(14). The higher proportion of low bone density in the study by Loni could be due to the selective study of health care professionals in a hospital.

Age and low bone density

The current study showeda decline in the bone density as age increased.There was an increase in the proportion of people with osteoporosis with increasing age and a significant association between age and low bone density was noted($p<0.001$). The T scores also showed a significant negative correlation ($r= -0.250$, $n = 405$, $p =0.000$) with age (Figure 2) as seen in other studies(15,16).

Though we see an increasing gradient of low bone density with age, the risk factors that lead to low bone density are laid down at a much earlier age. There are both modifiable and non-modifiable risk factors which lead to this. Preventive measures against the modifiable risk factors must begin in early adulthood so as to enable each individual to attain optimal bone density and prevent decline in bone density at an earlier age.

Sex and low bone density

The current study showed an increased prevalence of low bone density among the females (54.1%) compared to the males (51.8%) but the proportion of osteoporosiswasmore among the males (14.6%) compared to the females (12.7%) (Table 3). This could have been due to the higher mean age of the male participants than the females. No significant association was seen in the prevalence of low bone density between both the sexes ($p=0.688$). In a hospital study conducted among males with no other co-morbidities, osteoporosis and osteopenia was seen to affect 8.5% and 42%, respectively(17). In a study by Prasad, it was reported that 49% of the males 71% of the females had low bone density (14). In Pande's study 24.3% of the men and 29.9% of the women had low bone mass (18). The current study had employed QUS as a screening tool for low bone density whereas the latter had employed radiogammametry which maybe the reason for the difference seen from the current study.

The current study found consistent association between low bone density and age, however not with the sexes as reported by other studies (15,16,18,19). This showed how men were also demonstrating a high prevalence of low bone density nearly as much as women. The age group wise analysis of low bone density among males demonstrates that a high proportion of men have lower bone density established even at an earlier age and this continues equally into older age. For women, however, there is a high proportion who never reach optimal bone density and increasing number of women in older age groups keep losing bone density. This emphasizes that prevention of risk factors for low bone density has to start at an early age even among males and equal focus should be present on both men and women without assuming that low bone density is a problem solely of females.

Following the T-score measurement in this study, if osteopenia was detected the participants were counselled about life style modifications on calcium rich diet and an active lifestyle. If osteoporosis was identified, in addition to advice on life style modifications, the participants were advised further DEXA testing which would confirm diagnosis and help start pharmacologic treatment. This would help mitigating further risk of fractures.

CONCLUSION

The study carries huge significance, for the public health threat and huge socio economic problem that osteoporosis and its consequent fractures carry.The magnitude of low bone density seen in the population is alarming. Simple preventive measures in diet and other lifestyle may be instituted at a young age among both men and women for healthy bones at a later age and a sound backbone for the country's economy in the future.

The limitation in this studyis that the QUS technique had been used, though, DEXA is the gold standard technique. However, correlation betweenmeasurements by both is as much as 80-90% (20,21).QUS has a high sensitivity of 96%, though the specificity of QUS is only 55%. The negative predictive value of QUS is as high as 90% (22). Additionally, QUS offered the advantages of cost-effectiveness in a community setting, portability, absence of radiation and served as an effective screening tool, though, it may have led to some misclassifications due to low specificity (23).

However, the use of comprehensive electoral list of the study population for selection of subjects, use of standardized instruments and methodology, training of the investigator in the use of the device and interpretation of results, and very low non-response rates contributed to control selection and measurement biases that may occur in the study.The results of this study has limited generalizability confined to the adults of the population studied but similar studies among communities could help bring out the magnitude of the disease and help institute simple measures needed to prevent onset of risk factors.

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