

**Prevalence of Modifiable Risk Factors of Low Bone Density among Adults in an Urban Area of Tamil Nadu**

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**ABSTRACT**

**Introduction:** Low bone density (LBD) is a major public health problem that has enormous health-related, social and economic consequences. With increasing life expectancy, LBD is also expected to increase. LBD has both modifiable and non-modifiable risk factors and prevention of the modifiable risk factors will help in attaining optimal peak bone mass by younger populations and improving bone health in older populations. **Objective:** The study was done to assess the prevalence of modifiable risk factors of low bone density adults in an urban area of Tamil Nadu and its association with low bone density among the study population. **Methodology:** It was a community based cross-sectional study among 405 adults in Nanganallur, Chennai. The modifiable risk factors were assessed using a pre-tested semi structured questionnaire and LBD was measured by T-score using Quantitative Ultrasound (QUS). **Results:** Dietary risk factors like inadequate milk (<300ml), ragi (<once/week) and fish (<once/week) intake were seen in 54%, 55.3% and 56.7% of the population. Caffeine intake was seen among 46.6%. Physical activity was inadequate (aerobic exercises of 30 minutes < 5 times/week) in 93.3% of the population and 21.2% were not getting adequate sun exposure (<15 minutes/ day). Smoking and alcohol intake was seen among 21.2% and 32.8% of the males. Body mass index had significant positive correlation with T-score ( $r=0.152$ ,  $p=0.002$ ). **Conclusion:** There is a high prevalence of modifiable risk factors for low bone density among the population which is easily amenable to correction. Awareness must be promoted among the community on habits which will prevent bone loss and build bone density.

**Key Words:** Modifiable risk factors; Risk factors; Low bone density; Low bone mass; Osteoporosis

**INTRODUCTION**

Low bone density (LBD) which comprises of osteopenia and osteoporosis is the commonest bone disease. LBD is of major public health importance as osteoporosis alone affects an estimated 200 million people world over. (1) In India, it is estimated that 50 million people are affected by both osteoporosis and osteopenia up from earlier estimates of 36 million.(2,3) Low bone density is seen as a disease that mainly affects women and the elderly. However, recent studies show that among Indian populations in contrast to Caucasians, low bone density affects even younger populations and a large proportion of men as well.(4–8) The presence of low bone density can lead to increased fractures especially among the ageing population. The effects of fractures can be devastating to individuals, their care-givers and families physically, psychologically and socially. It also leads to high health system and economic burden.(9)

Peak bone mass in adults is attained at around 30 years after which there is a natural decline in bone mass. Presence of several risk factors can contribute to increased osteoclastic activity and thereby cause increased bone resorption. This can lead to non-

attainment of peak bone mass and also more rapid decline in the bone density. Some of these risk factors for low bone density are modifiable and others are non-modifiable. The modifiable risk factors include alcohol intake, smoking, low body mass index, poor nutrition, low dietary calcium intake, caffeine intake, Vitamin D deficiency, non-exposure to sunlight and low physical activity. Apart from the above risk factors which can be modified to prevent low bone density, there are other non-modifiable risk factors which include increasing age, sex, genetic factors, late menarche, early menopause or hysterectomy with oophorectomy, family history of osteoporosis and previous fractures. Low bone density may also occur consequent to secondary causes like endocrinological, rheumatological, malignant disorders or as a side effect of drugs like glucocorticoids and anticonvulsants.(10) Preventing the setting in of modifiable risk factors among the younger populations and risk modification among those in whom such factors are identified, can prevent development of low bone density and its consequent fractures. It is important to devise strategies to combat these risk factors in the

community and therefore this study was done to assess the prevalence of modifiable risk factors for low bone density and its association with low bone density among adults in an urban area of Tamil Nadu.

## METHODOLOGY

The study was a community based cross-sectional study conducted at Nanganallur, an urban area in Chennai, Tamil Nadu with a population of around 86,000. This study was conducted among 405 adults of age 18 years and above. The study was part of a larger study assessing prevalence of low bone density among the adult population of Nanganallur and employed cluster sampling. The detailed description of calculation of sample size, sampling, selection criteria of study subjects, method of data collection and use of Quantitative Ultrasound for measuring low bone density had been published elsewhere previously. (5)

Following approval of the Institutional Ethics Committee, a questionnaire in the local language was administered to the study subjects to collect details regarding socio-demographics and the risk factors for low bone density. The questionnaire to elicit risk factors has been adapted from the Osteoporosis risk test developed by the International Osteoporosis Foundation. Bone density was measured using a portable quantitative ultrasound machine. The T-scores from QUS were classified as normal, osteopenia, osteoporosis or severe osteoporosis according to the WHO criteria.(11) Any T score below -1 was considered as low bone density combining the categories of osteopenia, osteoporosis and severe osteoporosis. The modifiable factors studied were caffeine, fish, milk and ragi intake, sun exposure, physical activity, body mass index (BMI), alcohol intake, smoking status, etc. The operational definitions used to study each of the risk factors is given below:

**Milk intake:** The intake of 2 or more glasses of milk (300 ml) per day was classified as adequate milk intake.

**Fish intake:** The intake of fish on at least one day in a week

was classified as adequate fish intake. **Ragi intake:** Ragi consumption on at least one day in a week was classified as adequate ragi intake.

**Caffeine units:** The total number of caffeine units consumed by an individual was calculated as one cup of tea (150 ml) equaling 0.5 caffeine units and one cup of coffee (150 ml) equaling 1 caffeine unit.(12) **Sun exposure:** Exposure to direct sunlight for at least 15 minutes every day was classified as adequate sun exposure.

**Physical activity:** Taking up any sort of aerobic exercise like running, jogging, swimming, bicycling, etc. for at least 5 days a week for a minimum of 30 minutes on all those days was taken as adequate physical activity.(13) **Body Mass index:** BMI was calculated as weight in kilograms divided by height in m<sup>2</sup>.(14) **Calcium supplementation:** Consumption of supplementary calcium at least once daily for at least the last 1 month was taken as regular calcium supplementation.

## Statistical analysis:

The collected data were entered into a MS Office excel sheet and analysis was done with SPSS v18. The prevalence of risk factors for low bone density has been given as proportions. The association between the risk factors and low bone density were tested for statistical significance using chi-square test and the strength of association was expressed using Odd's ratio with 95% CI. Correlation coefficient was used to study the relationship between the T score and BMI. P-value of 0.05 was considered for statistical significance.

## RESULTS

The study was conducted among 405 individuals among whom 137 (33.8%) were males and 268 (66.2%) were females. The prevalence of low bone density was 53.3% (95% CI: 48.45 - 58.21%) of which osteopenia contributed 40% (35.21-44.79%) and osteoporosis contributed 13.3% (10.01 - 16.66%). The prevalence of LBD was 51.8% among males and 54.1% among females.

**Table 1: Prevalence of modifiable risk factors**

Variables		Prevalence n (%) (N = 405)
Milk intake	≤ 1 cup	350 (86.4)
	None	222 (54.8)
Calcium supplementation	No	368 (90.8)
	Irregularly	12 (2.9)
Total caffeine units	≥ 2units	189 (46.6)
	< once/ week	349 (86.2)
Ragi intake	Never	274 (67.7)
	< once/ week	215 (53)
Fish intake	Never	93 (23)
	Inadequate	86 (21.2)
Sun exposure	Inadequate	378 (93.3)
Physical activity	Inadequate	28 (6.9)
BMI	< 18.5	

### Prevalence of modifiable risk factors (Table 1)

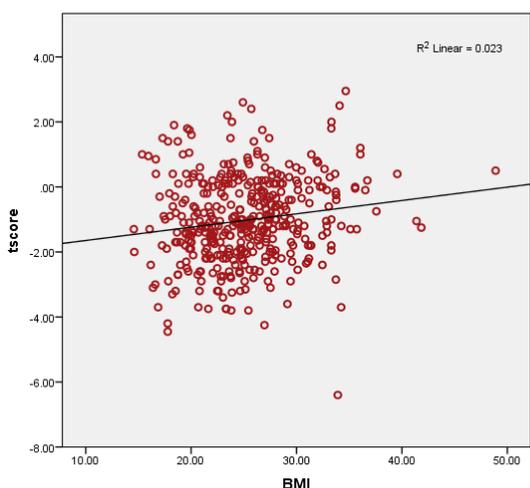
High prevalence of many of the risk factors for low bone density was seen in the study population. The dietary risk factors that were studied included milk, caffeine, ragi and fish intake. It was seen that 54.8% of the participants did not consume any milk and 31.6% consumed only a single glass of milk constituting 86.4% of total participants who consumed one glass of milk or none. Caffeine intake exceeded 2 units in 46.6% of the population. Rich sources of calcium like ragi and fish were not consumed at all by 67.7% and 23% of the population, respectively. At least once weekly consumption of ragi and fish was seen only among 13.8% and 53% of the participants and rest had less than once weekly consumption of these foods. It was seen that a very small proportion of the study population (6.6%) engaged in adequate physical activity that promotes bone health. Sun exposure was limited to less than 15 minutes a day in almost one-fifth (21.2%) of the

participants. Seven percent of the participants were underweight.

**Table 2: Prevalence of tobacco and alcohol use among males**

Factor	Prevalence (N=137)	
	n	(%)
Current Smoker	29	(21.2)
Ever Smoked	43	(31.4)
Other forms of tobacco	12	(8.8)
Alcohol intake	45	(32.8)

**Figure 1: Scatter Plot – BMI versus T score**



The prevalence of current smoking among the males was 21.2%; and 31.4% of the male subjects had ever smoked. Alternate forms of tobacco were used by 8.8% of the male subjects and alcohol was consumed by 32.8% of the males. Only 1 female participant answered as a current smoker and 3 of them had ever smoked. 4 of the females consumed other forms of tobacco and 3 of them consumed alcohol. Among the total population, 7.4%, 11.3% and 11.8% were currently smokers, had ever smoked and consumed alcohol, respectively.

**Association of modifiable risk factors with low bone density**

Greater prevalence of low bone density was noted among those with dietary risk factors such as lower intake of milk, ragi and fish, higher intake of caffeine and non-supplementation of calcium compared to those without these risk factors (54% vs 49.1%, 55.3% vs 41.1%, 56.7% vs 49.5%, 56.1% vs 50.9%, and 54.1% vs 45.9%. People with dietary risk factors had greater odds of developing low bone density than among those who did not have these risk factors but they were not statistically significant except for ragi consumption. Those not consuming ragi on at least one day of a week had 1.77 significantly greater odds of low bone density than those who consumed ragi on at least a single day of the week. (Table 3.

Higher prevalence of low bone density was seen among those who had inadequate sun exposure (58.1%) and inadequate physical activity (54.4%). No statistically significant difference was seen for low bone density in

**Table 4: Association of Low Bone Density and certain modifiable risk factors among males**

Variables		Low bone density		Odds Ratio (95% CI)	Chi-square value (df=1)	P value
		No N (%)	Yes N (%)			
Current smoker	No	53 (49.1)	55 (50.9)	1.18 (0.52 - 2.70)	0.165	0.684
	Yes	13 (44.8)	16 (55.2)			
Ever smoked	No	49 (52.1)	45 (47.9)	1.66 (0.80 - 3.46)	1.87	0.171
	Yes	17 (39.5)	26 (60.5)			
Alcohol intake	No	45 (48.9)	47 (51.1)	1.09 (0.53 - 2.23)	0.06	0.805
	Yes	21 (46.7)	24 (53.3)			
<b>Total (N = 137)</b>		<b>66 (48.2)</b>	<b>71 (51.8)</b>			

terms of sun exposure, physical activity and BMI. The association between low bone density and smoking and alcohol intake was studied only among the male population as very few women participants reported smoking and alcohol intake status. There was again higher prevalence of low bone density among males who consumed alcohol, were currently smoking or had ever smoked but there were no significant associations. (Table 4. Correlation between T-scores which indicate bone density and BMI showed that as BMI increases an increase in the T score is seen. The positive correlation seen between the two variables was statistically significant (r= 0.152, n=405, p=0.002). (Figure 1)

**DISCUSSION**

From this study, it can be seen that there is a high prevalence of modifiable risk factors for low bone density among adults. Recommended dietary allowance (RDA) of calcium in western countries & by WHO is 1000 mg but in India the RDA is only 600 mg but that is also not achieved, especially in lower socio-economic group men and women.(9,15) In this study, it is seen that poor dietary habits like avoidance of foods rich in calcium (milk, ragi and fish) are common among the participants. Consumption of caffeine in excessive amounts which promotes apoptosis of osteoblasts(16) is also common among the participants. Calcium supplementation which can compensate poor dietary intake is also absent among 90.8% of the participants and even among the small proportion on supplements, only few of them have regular intake. Ragi intake less than once a week had 1.77 odds of being significantly associated with low bone density than intake once or more in a week but no other dietary factors showed significant association. A study conducted in Chandigarh showed that among women with low calcium diet assessed by 24-hr recall method there was 2.3 significant odds of osteoporosis.(17) Another study conducted at rural and urban areas of Andhra Pradesh also showed a 62.3% prevalence of calcium poor diet and was significantly associated with LBD.(18)

The absorption of Calcium is augmented by Vitamin D which is naturally obtainable by exposure to sunlight.

Table 3: Association between Low Bone Density and modifiable risk factors

Variables	Low bone density		Odds Ratio (95% CI)	Chi-square value (df=1)	P value
	No N (%)	Yes N (%)			
Milk intake	≥2 cups	28 (50.9)	27 (49.1)	1.21	0.46
	≤ 1 cup	161 (46)	189 (54)	(0.68 – 2.15)	
Total caffeine units	< 2 units	106 (49.1)	110 (50.9)	1.23	1.07
	≥ 2units	83 (43.9)	106 (56.1)	(0.83 – 1.82)	
Ragi intake	≥ once/ week	33 (58.9)	23 (41.1)	1.77	3.92
	< once/ week	156 (44.7)	193 (55.3)	(1.001-3.14)	
Fish intake	≥ once/ week	96 (50.5)	94 (49.5)	1.34	2.14
	< once/ week	93 (43.3)	122 (56.7)	(0.90 -1.98)	
Calcium supplementation	Yes	20 (54.1)	17 (45.9)	1.38	0.89
	No	169 (45.9)	199 (54.1)	(0.70 – 2.73)	
Sun exposure	Adequate	153 (48)	166 (52)	1.28	1.01
	Inadequate	36 (41.9)	50 (58.1)	(0.79 – 2.07)	
Physical activity	Adequate	17 (63)	10 (37)	2.03	3.08
	Inadequate	172 (45.5)	206 (54.4)	(0.90 – 4.56)	
BMI	≥ 18.5	174 (46.2)	203 (53.8)	0.74	0.57
	< 18.5	15 (53.6)	13 (46.4)	(0.34 – 1.60)	
	<b>Total (N = 405)</b>	189 (46.7)	216 (53.3)		

Even in a tropical area like the study area, 21.2% of the population did not have enough sun exposure further impeding absorption of calcium however, there was no significant difference in those with or without adequate sun exposure. Other studies have also shown higher levels of inadequate sun exposure and significant difference in sun exposure among those with and without low bone density.(19,20)

Physical activity helps in building bone mass. It can help reduce fragility fractures even in those with LBD by helping develop posture and balance.(21) Similar to the current study which showed high proportion of physically inactive participants, other studies conducted at Andhra Pradesh and Loni also showed high prevalence of physical inactivity - 44.23% & 42%, respectively.(18,22) A meta-analysis of studies done in Asian countries has shown that women benefit from exercise in preventing low bone density.(10) Even if the current study has not shown any significant association of physical activity with low bone density, being physically active can still help those with who have already developed LBD from developing fractures by helping in muscle strengthening and preventing falls.(23)

Alcohol and smoking habits are also present in a relatively larger proportion of adult males. The current study shows 21.2% and 32.8% of the male study participants as smokers and alcohol consumers. A study conducted at Delhi which assessed risk factors for LBD showed that a smaller proportion of participants were smokers(9.66%) or alcohol consumers (6.06%).(24) However, this study has not mentioned the number of male and female smokers and alcohol consumers; and it is likely that in our society there are fewer women with these habits and expressing smoking and alcohol consumption among all participants may show a falsely low prevalence. The study done at Loni, shows that habits of alcohol intake and smoking is seen among 50% of healthcare personnel and 69.9% of them have low bone density.(22) Alcohol use can disrupt osteoblastic activity and decrease the bone mass.(25) Smoking and alcohol intake ≥ 2 glasses/ day also increase risk of osteoporotic fracture.(9,26) The males in our country are more predisposed to LBD than western counterparts(27), therefore, it is more important to address this risk factor among our population.

It has been documented that low BMI is a predictor of fracture risk.(28–30) As seen in other studies, T-scores

indicating LBD showed a positive correlation with BMI.(31–33) BMI is also an indicator of the overall health status and those with increasing BMI were also showing better bone mass.

### Conclusion:

The prevalence of low bone density and associated fractures is expected to increase with increase in life expectancy and presence of poor nutritional status. The over-burdened health system of our country will be further burdened by the increase in hospitalization due to osteoporotic fractures. Risk factors for LBD are also abundantly present in the population. Therefore, it is essential to focus on prevention of LBD and its risk factors. As indicated by many of the studies, increasing body weight and overall nutritional status, especially calcium intake along with adequate physical activity, improved Vitamin D status through adequate sun exposure and healthy lifestyle habits will help promote bone health. Strategies to prevent development of modifiable risk factors among the younger age groups must be developed to ensure optimal peak bone mass development and among older age groups to slow down age related bone density loss.(31) Even in the presence of low bone density, strategies to promote physical activity will ensure reduction of osteoporotic fractures.(34) Community based osteoporosis prevention programmes at the individual, interpersonal, institutional, community and policy level will help to reduce the burden of osteoporosis and its risk factors (35)

The limitations of the study is that it is a cross-sectional study and temporality of risk factors cannot be established. However, if the modifiable risk factors are removed even after onset of LBD, it still reduces age related bone loss. Though there are many more foods rich in calcium, only few items such as ragi, milk and fish were assessed considering they are the commonest foods available and consumed in the region. The strength of the study is that it was a community based study and reflects the truly rampant problem of risk factors in the population. Using operational definitions to assess the risk factors also ensured that any measurement bias was avoided.

It is recommended that awareness must be spread among the communities on how certain health habits predispose to bone loss and prevention of these modifiable risk factors can improve bone health and avoid osteoporotic fractures. Younger populations must be motivated to take up healthier diet, physical activity and other healthy lifestyle habits. Evidence of rampant risk factors must translate into policies that curb these risk factors and more research is needed into implementation of actionable policies.

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