Attention to the Bone Health of a Neglected Rural-Tribal Population in India: A Pilot Study

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Abstract

Objective: The aim of this pilot study was to analyze the need and feasibility of conducting prospective research on the epidemiological factors of bone mineral density (BMD) in the at-risk population in a rural and tribal-dominated area based on a screening test. **Methods:** This community-based retrospective cross-sectional study was based on data from the medical records from July 2021 to September 2021 at community camps organized in a rural area of Deoghar district of Jharkhand, India, and the at-risk patients who had undergone ultrasound-based BMD measurement were included in this study. **Results:** The mean age of the patients (N = 216) was 68.2 ± 10.2 years (range 35–73 years) with a mean T-score of -0.83 ± 0.09 (range -2.78–0.3, 95% CI 0.19). 70.3% (n = 152) of the patients were diagnosed as either osteopenic or osteoporotic based on the T-score. 14.8% (n = 32) of the patients had a comorbidity making them susceptible for low BMD. BMD was significantly low in patients above 60 years of age (t - 3.36, P – 0.0005), presence of comorbidity (t – 3.12, P – 0.001), and urban population (t - -1.93, P – 0.02). **Conclusion:** Although DEXA remains the study of choice, QUS can be used in primary healthcare systems in the developing world for the purposes of screening. Females, elderly, and urban residence have an increased chance of low BMD. This pilot study shows that a large-scale prospective study analyzing various aspects of bone health including dietary and lifestyle practices is the need of the hour.

Keywords: Bone mineral density, developing nation, epidemiology, rural, tribal

Introduction

Low bone mineral density (BMD) in the elderly and susceptible population leads to multiple musculoskeletal complaints like pain, deformity, and fractures. This causes a major burden on the patients, family, and the healthcare systems.[1] Fracture and deformity lead to possible loss of function and entail surgical intervention for its treatment, while pain in bones and joints is present in up to 84% of the elderly population which affects their activities of daily living.[2] These factors all the more become important in the rural areas of a developing country where the acute healthcare needs of the population are barely met, let alone the needs for improvement in quality of health care. The number of fractures in Asian countries, more specifically in southeast Asia, due to osteoporosis is higher than all the European countries combined.[3]

Although dual energy x-ray absorptiometry (DEXA) is the gold standard for measuring BMD, it is not widely available in developing countries, in the setting of which quantitative ultrasound (QUS) has been proved to be clinically useful.[4] QUS has been used to assess bone status for almost two decades and has proven to be widely and clinically useful.[5]

The current literature lacks any community-based epidemiological study on BMD among the at-risk population in a rural and tribal-dominated area of any developing nation. The aim of this pilot study was to analyze the need and feasibility of conducting prospective research on the epidemiological factors of BMD in the at-risk population based on a low-cost screening test.

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MATERIAL AND METHODS

Study details

This study was a retrospective study based on data from the medical records from July 2021 to September 2021 at community camps organized in a rural area of Deoghar district of Jharkhand, India, performed after obtaining institutional ethical clearance (2021-19-IND-02, 24/11/21). Consent was obtained from the patients participating in the study after explaining to them the benefits of taking part in this study. The at-risk patients who had undergone BMD measurement were included in this study. Suspected low BMD due to undiagnosed secondary causes was excluded.

Area of study

The study was conducted in the Deoghar district of Jharkhand state which is located in the eastern part of India. Tribals like Santhals, Paharias, and Lohras make a sizeable chunk of the population (27.1%).[6] 82.6% (12,33,712/14,92,073) of the population residing in the district belong to rural area, and of these, females constitute 48.2% (5,95,376/12,22,712) of the rural population.[6] Exposure to healthcare facilities is quite low in the district, present in only 15.3% of all villages.

Inclusion criteria

The method of purposive sampling was used to include subjects in the study based on the inclusion criteria. Any subject fulfilling any one of the criteria mentioned was included in the study. The at-risk population were defined as a) all women 65 years and older and men 70 years and older, b) women younger than 65 years old who have the following history: menopause, history of maternal hip fracture before the age of 50, low body mass (less than 60 kg), and history of amenorrhea more than 1 year before the age of 42, c) history of cigarette smoking, loss of height, thoracic kyphosis, d) individuals at any age with fragility or insufficiency fracture, e) individuals receiving (or expected to receive) steroid therapy, f) individuals with an endocrine disorder known to affect BMD adversely like hyperparathyroidism, hyperthyroidism, and Cushing's syndrome, and g) individuals with medical conditions that could alter BMD like chronic renal failure, rheumatoid arthritis and other inflammatory arthritis, eating disorders including anorexia nervosa and bulimia, organ transplantation, prolonged immobilization, and conditions associated with secondary osteoporosis, such as gastrointestinal malabsorption or malnutrition, sprue, osteomalacia, vitamin D deficiency, endometriosis, acromegaly, chronic alcoholism or established cirrhosis, and multiple myeloma.

BMD calculation

The BMD was measured by calcaneal quantitative ultrasound (QUS) using a Pegasus device (Beam Med Ltd., Tel Aviv, Israel), which is designed to measure the SOS (m/s) of ultrasonic waves that travel longitudinally along the bones at a center frequency of 1.25 MHz. The machine uses gel as a coupling agent between the probe and skin. QUS can be measured at either the left or right calcaneus. The device was calibrated each day before data collection using a verification phantom provided by the manufacturer. The QUS T-score was calculated according to the normative data derived from a sex- and age-matched Asian population, provided by the manufacturer. The precision of BMD measurement was denoted by co-efficient of variation which was noted from five consecutive scans in five volunteers at the beginning of each week and was calculated to be 4.7%.

Data collection

The data collected in this cross-sectional study were age, sex, weight, height, place of residence, musculoskeletal complaints and its duration, and other relevant history like diet, menstrual, drug, and prior treatment history during the camps. The bone density and T-score derived from the QUS were be taken as a measure of BMD. T-score is the number of standard variations of BMD with relation to younger age group. According to WHO definition, normal bone mass—T-score >-1, osteopenia—T-score between -1 and -2.5, and osteoporosis—T-score <-2.5.[4]

Statistical analysis

Descriptive statistical analysis of the collected data was done. Continuous variables were presented as mean ± SD and categorical variables were presented as absolute numbers and percentages. The Kolmogorov–Smirnov test was applied to check for normality of data. Relevant statistical tests like Student's t-test, Spearman correlation, and Mantel–Haenszel Chi-square test were used for the appropriate data using SPSS v 26 for Windows v11 (Chicago, USA). Subgroup analysis was done based on age (above or below 60), sex, rural or urban location, and comorbidities (presence or absence). Stratified analysis was done in the rural and urban population group based on age and sex. A *P* value of less than 0.05 was considered significant.

RESULTS

A total of 216 patients were analyzed for the study who underwent BMD measurement. The majority of the patients were females (127, 58.7%) and above 60 years of age (184, 85.2%). The mean age of the patients was 68.2 ± 10.2 years (range 35–73 years) with a mean T-score of -0.83 ± 0.09 (range -2.78–0.3, 95% CI 0.19). 70.3% (n = 152) of the patients were diagnosed as either osteopenic or osteoporotic based on the T-score. The most common complaints with which the patients presented were generalized body ache (189/216, 87.5%) and back pain (146/216, 67.5%). 14.8% (n = 32) of the patients had a comorbidity making them susceptible for low BMD (patients receiving steroid therapy = 15, history of amenorrhea before 42 years = 9, previous low velocity fracture = 4, Cushing disease = 2, hyperthyroidism = 2, hyperparathyroidism = 1, chronic renal failure = 1). Of the 15 patients receiving steroid therapy, inflammatory arthritis was the leading cause (n = 12). The most common cause of BMD calculation was the age criteria (females >65 years (107/127, 84.2%) and males >70 years (77/89, 86.5%)).

The majority of the screened population was rural (145/216, 67.3%).

BMD was significantly low in patients above 60 years of age (t = 3.36, *P* = 0.0005), presence of comorbidity (t = 3.12, *P* = 0.001), and urban population (t = -1.93, *P* = 0.02) [Table 1]. There was no significant difference in BMD between males and females (t = 0.69, *P* = 0.244). Among the rural population, BMD was significantly lower in patients above 60 years (mean T-score = -2.41 vs -1.34, *P* = 0.001), while both males and females did not differ significantly in BMD (mean T-score = -1.93 vs -2.12). In analysis of the urban population, females (mean T-score = -2.45 vs -1.24, *P* = 0.02) and patients above 60 years (mean T-score = -2.41 vs -1.37, *P* = 0.01) had significantly low BMD.

DISCUSSION

Osteoporosis is a major health problem, with around 250000 hip fractures occurring annually, and of these, 10 to 15% end in a mortality within a year of fracture occurrence.[7] They are also associated with significant morbidity with loss of function and pain being common problems encountered.[8] Early diagnosis and treatment can prevent these problems, and it has been postulated that lack of early and regular screening in the at-risk population is one of the important causes for its problem severity.[9]

The study population in the current study belongs to a province which is primarily rural and tribal dominated of a developing country which have a lacuna in the current literature regarding the epidemiology of BMD in the at-risk population. The aim of this pilot study was to analyze the need and feasibility of conducting prospective research on the epidemiological factors of BMD in the at-risk population based on a screening test. 70.3% (n = 152) of the patients with any clinical risk factor were diagnosed as either osteopenic or osteoporotic based on the T-score. Even with such a high percentage, there exists no data regarding the epidemiology of BMD in this geographical area. This pilot study shows that a large-scale prospective study analyzing various aspects of bone health including dietary and lifestyle practices is the need of the hour. Low BMD is a major concern among the elderly and at-risk population, and its screening leads the population to early diagnosis, treatment,

and greater awareness about fracture reduction strategies.[10,11] The cheap and effective method used in this pilot study in the form QUS can be used on a wide scale in various healthcare programs, specifically targeting geriatric population which would lead to early detection of osteoporosis and reduction of fracture burden among the population.

The majority of the sample population in this study were rural and elderly. Although studies report, a prevalence of secondary osteoporosis in about 30% of perimenopausal women, this study could find secondary causes in only 14.8% of the patients which could be attributed to the recall bias and small sample size.[12] Prior studies from India have noted low BMD (osteopenia or osteoporosis) in upward of 50% in the female population above 40 years of age.[13] The BMD was significantly low in urban population as compared to the rural population although it has been found to be similar in another study.[14] Increased physical activity right since childhood and adolescence due to their involvement in primary farming and livestock rearing activities and increased sunlight exposure in the rural population can be one of the causes of improved BMD. Among the rural population, the BMD of males and females did not differ significantly, whereas in the urban population, the BMD of females was significantly lower as compared to males. The same reasons of increased physical activity and sunlight exposure among the rural females may be one of the causes for the same.

QUS of calcaneum, which has been used in this study to calculate BMD, has been shown to correlate well with BMD values of hip and spine by DEXA in various studies.[4,15] Although the diagnosis of osteoporosis by QUS remains controversial, it is more due to the present state of T-scores rather than the technique.[5] Previous studies in the Asian population have shown that T-scores are reliable when the reference population is same as the study population and the current study has derived T-scores based on the data of the Asian population as provided by the manufacturer.[16] Currently, around 20 QUS devices are approved for usage around the globe and Pegasus is one of them which has been used in this study.[5] It has a great potential for widespread usage due to its low-cost, portability, and non-ionizing radiation. Cost-effectiveness studies of QUS have shown that it can be used widely in the primary healthcare population to detect low bone mass in the at-risk population.[17]

The retrospective cross-sectional nature of this study is the major limitation of this study along with the small sample size. The natural course of BMD and its rate of change as age progresses needs to be studied in future prospective studies. Also, a large sample size in a prospective study would increase the power as well as internal validity of the study. The normative data for calculation of T-score in the study population are not available, and it was derived from data from other population which are ethnically different, although from the same continent. Further, the interpretation of T-scores in QUS is not available, and the inference is derived from its

Table 1: Comparison on bone mineral density of the calcaneum between various subgroups based on age, gender, presence of comorbidity, and area of residence

	Bone mineral density (g/cm²)	*P*
>60 years	0.47±0.01	0.0005
<60 years	0.5±0.01	
Males	0.51±0.02	0.24
Females	0.49±0.04	
With comorbidity	0.5±0.09	0.001
Without comorbidity	0.53±0.09	
Urban	0.49±0.03	0.02
Rural	0.53±0.07	

close correlation with DEXA T-score. Although DEXA is the gold standard for diagnosing low bone mass, its availability and cost of the investigation limited its use in the current study. A correlation study of BMD with physical activity and dietary intake should be conducted to better understand the preventive measures to be implemented. Despite these limitations, this study is one of the few studies dealing with epidemiology of BMD in the at-risk population in a predominant rural and tribal region of a developing country.

Conclusion

This study does an epidemiologic analysis of BMD in at-risk population in a predominant rural and tribal region of a developing country using QUS. Although diagnosis of osteoporosis cannot be done on the basis of T-scores from QUS, they give an indication toward adequacy or inadequacy of BMD. Although DEXA remains the study of choice, QUS can be used in primary healthcare systems in the developing world for the purposes of screening. Such screening would lead to increased awareness about awareness and fracture reduction strategies among the lesser literate population. Females, elderly, and urban residence have an increased chance of low BMD and should be counseled accordingly for the improvement of bone and general health. This pilot study shows that a large-scale prospective study analyzing various aspects of bone health including dietary and lifestyle practices is the need of the hour.

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Conflicts of interest
There are no conflicts of interest.

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