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Article

Screening of osteoporosis and risk of osteoporotic fracture among the population in old Dhaka city using Quantitative Ultrasound (QUS) and Fracture Risk Assessment Tool (FRAX)

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Abstract: Osteoporosis is a silent, progressive skeletal disorder characterized by decreased bone strength, leading to an increased risk of fractures, particularly among aging populations. This cross-sectional study was conducted over six months from June to December 2018 in the Tatibazar area of Old Dhaka, Bangladesh, to assess bone health using quantitative ultrasound (QUS) and estimate fracture risk through the Fracture Risk Assessment Tool (FRAX). A total of 188 conveniently selected participants aged 40 years and older underwent BMD screening with QUS. The FRAX tool, a validated clinical prediction model, was used to calculate the 10-year probability of major osteoporotic fractures (MOF) and hip fractures (HF) based on clinical risk factors, with and without BMD input. The prevalence of osteopenia and osteoporosis was 31.4% and 11.2%, respectively. Age group ($P < 0.001$), BMI ($P = 0.013$), and smoking ($P = 0.019$) were significantly associated with lower T-scores. According to FRAX with BMD, 5.3% of participants had a moderate to high risk of MOF, and 12.2% had a high risk of HF. Age, prior fracture, glucocorticoid use, and rheumatoid arthritis were significantly linked to MOF risk; age, BMI, smoking, glucocorticoid use, and rheumatoid arthritis were linked to HF risk. The findings highlight a high burden of reduced bone mass and fracture risk in the urban aging population of Dhaka. These results emphasize the need for early diagnosis and preventive strategies, especially in resource-limited settings. Further studies are required to validate the effectiveness of QUS and FRAX as population-level screening tools in Bangladesh.

Keywords: bone health; postmenopausal women; community screening; public health intervention; non-invasive diagnostics

1. Introduction

Osteoporosis, a significant public health concern, is often diagnosed only after a related complication occurs, as its symptoms remain silent for an extended period (Sözen *et al*., 2017). In low- to middle-income countries in

Southeast Asia, the prevalence and risk of osteoporosis (RO) have also increased (Khan *et al*., 2018). In Bangladesh, osteoporosis rates are rising, particularly among post-menopausal women (Begum *et al*., 2015; Ali *et al*., 2021). Many individuals suffer from osteoporosis-related fractures (ORF) each year (Wright *et al*., 2014). Pain and disability are the primary outcomes of osteoporosis, significantly affecting quality of life and increasing dependence on others (Siris *et al*., 2014). However, timely diagnosis of osteoporosis and ORF, along with appropriate preventative measures and treatment, can significantly reduce their occurrence (Vondracek and Linnebur, 2009).

Osteoporotic fractures are linked to low bone mineral density (BMD) and primarily occur in the spine, hip, forearm, and shoulder (Vaishya *et al*., 2017). It is crucial to screen the population for potential osteoporosis risks and other bone health issues to mitigate the risk of fractures and the associated socio-economic burden. The lack of cost-effective screening tools is a primary barrier to identifying osteoporosis risks in low- to middle-income countries (Rajendran *et al*., 2015; Vaishya *et al*., 2017). Dual-energy X-ray absorptiometry (DXA), the commonly accepted method for diagnosing osteoporosis by measuring BMD, is widely used but incurs significant costs (Steiner *et al*., 2019). Additionally, there is a scarcity of DXA machines in many developing Asian countries, making this modality less accessible and more expensive (Mithal *et al*., 2014).

In recent years, there has been a growing adoption of calcaneal quantitative ultrasound (QUS) as an alternative to DXA for osteoporosis screening globally (Steiner *et al*., 2019). QUS offers advantages such as ease of access, being radiation-free, and suitability for bone testing. Its portability, widespread availability, and affordability have made it particularly popular in low-income countries as a practical tool for osteoporosis screening (Chin and Ima-Nirwana, 2013). It is also recommended by the International Society of clinical densitometry as an alternative to DXA for osteoporosis screening (Burke *et al*., 2019). Studies indicate that both QUS findings and BMD exhibit a strong predictive association with osteoporosis risk factors (Steiner *et al*., 2019; Burke *et al*., 2019).

Fracture risk is influenced by multiple factors, with independent elements related to fall risk contributing to the overall risk beyond what is indicated by BMD alone. Therefore, it is crucial to consider additional factors, including those linked to fall risk, for a comprehensive fracture risk assessment (Hans *et al*., 2008). A scientific group convened by the World Health Organization (WHO) recommended utilizing the 10-year probability of fracture, which incorporates clinical risk factors (CRFs) with or without BMD data, in clinical settings. This approach is suggested for determining intervention thresholds and providing a thorough evaluation of fracture risk (Kanis *et al*., 2005).

Despite the increasing prevalence of osteoporosis and associated fractures, access to standard diagnostic tools like DXA remains limited due to high costs and insufficient availability in low-resource settings. As a result, many individuals at risk go undetected until complications arise, leading to reduced quality of life and increased healthcare burdens. There is a critical need for cost-effective, accessible, and reliable screening methods to identify individuals at RO and osteoporotic fractures. Previous studies in Bangladesh have assessed the prevalence and RO but were limited to specific groups or utilized particular tools (Begum *et al*., 2015; Ali *et al*., 2021).

This study aimed to identify the prevalence of osteoporosis, the risk of osteoporotic fractures, and the association between socio-demographic factors and osteoporosis risk, as well as the 10-year risk of major osteoporotic fractures (MOF) with or without BMD and the 10-year risk of osteoporotic hip fractures (HF) with or without BMD among the population in Old Dhaka, which has distinct living conditions and dietary habits. The study utilized the QUS and fracture risk assessment tool (FRAX). The findings will provide valuable insights into the use of QUS and FRAX as potential alternatives to DXA in low-resource settings, guiding public health initiatives and informing national screening policies to mitigate the growing impact of osteoporosis-related disability and healthcare costs.

2. Materials and Methods

2.1. Ethical approval

This study adhered to the ethical standards set by the Declaration of Helsinki and was approved by the ethical review committee of Gono Bishwabidyalay, Savar, Dhaka. All participants were informed of their right to withdraw from the study at any stage of data collection or testing. Additionally, we obtained permission from the local health authority before conducting the awareness program and collecting data.

2.2. Study area, periods, design and participants

We carried out a cross-sectional study over a six-month period, from June to December 2018, in the Tatibazar area of Old Dhaka, Bangladesh (Figure 1). The study was conducted as part of a community-based bone health

awareness and screening program, organized by a specialized physiotherapy center in Tatibazar. The study enrolled 188 participants who voluntarily participated in the screening. The QUS was used to assess participants' bone health during the program. The program details—including dates, location, topics for the awareness sessions, testing methods, and eligibility criteria—were announced to the residents of Old Dhaka. Males and females from the neighborhood attended the awareness sessions and participated in the subsequent testing based on their interests. During the bone health awareness program, we asked participants if they were interested in testing their bone health and whether we could use their data anonymously for research purposes.

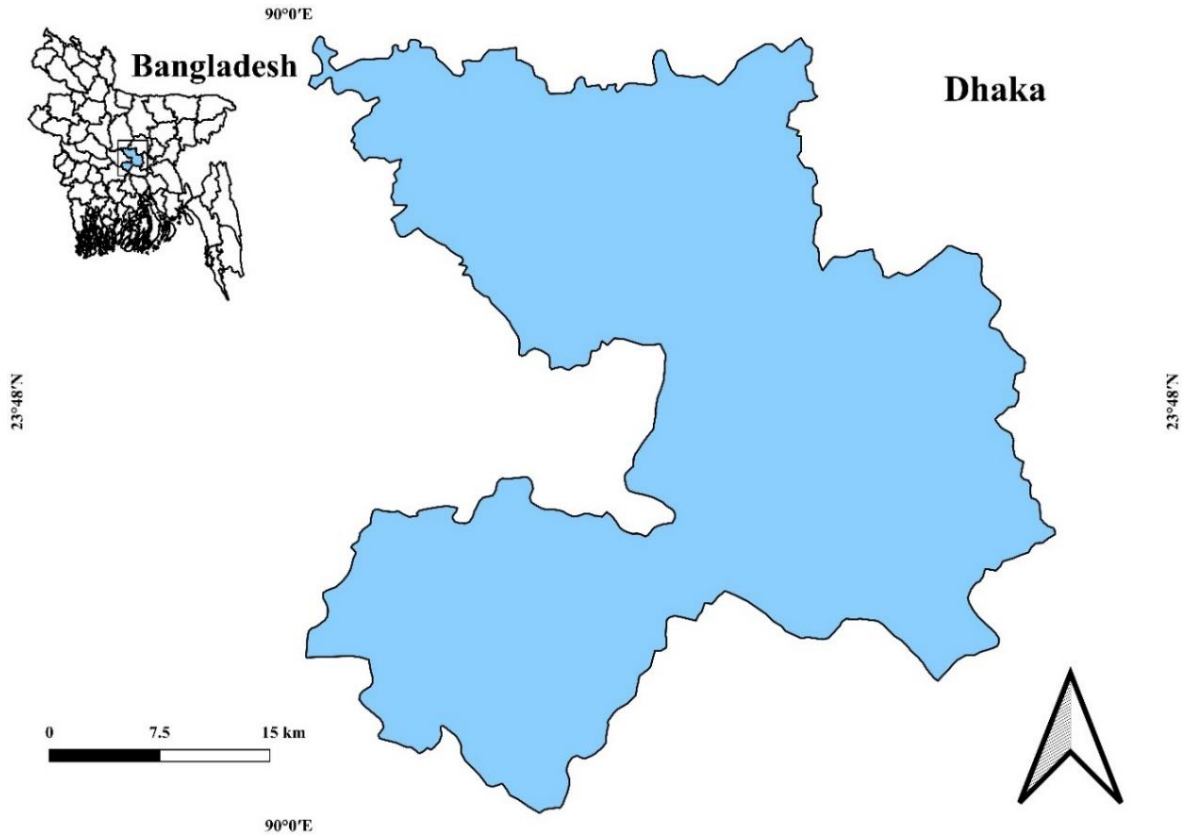

Figure 1. Map of the study area.

2.3. Inclusion criteria

We included participants aged between 40 and 90 years, consisting of healthy men and women, using a convenient sampling technique. The exclusion criteria were, firstly individuals younger than 40 years or older than 90 years; secondly, those diagnosed with osteoporosis and currently on medication, and lastly individuals who have been bedridden in the past year. We explained the study's objectives and procedures to the participants and obtained written consent prior to data collection and testing.

2.4. Instruments of the study

We collected anthropometric data from the participants, measuring height and weight before the QUS test. Weight was recorded in the morning, with participants dressed in light clothing and without shoes. The BMI was calculated using height (in meters) and weight (in kilograms) measurements, and categorized as follows: i) underweight (<18.5 kg/m²), ii) normal (18.5 to 22.9 kg/m²), iii) overweight (23.0 to 24.9 kg/m²), and iv) obese (>25 kg/m²), based on the BMI cut-offs for the Asian subcontinent (Misra, 2015). We also inquired about participants' history of cigarette smoking and alcohol consumption. Additionally, we recorded each participant's age (in years), gender, history of previous fractures (including location if applicable), parental history of hip fractures, history of rheumatoid arthritis and secondary osteoporosis, and history of glucocorticoid use.

2.5. Measurements

Using a standard procedure, we measured the BMD of study participants with an OSTEO KJ3000 Series Ultrasound Bone Densitometer. To maintain the reliability of the testing process, a single investigator conducted

all measurements, each of which took approximately 20-25 seconds. We calculated and recorded the T-score of each participant after testing at the calcaneum. Participants were then divided into three categories based on their T-scores from QUS: i) normal (≤ −1.0), ii) osteopenia (−1.0 - −2.5), and iii) osteoporosis (≥ −2.5) (NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy, 2001). The WHO recommends using the same criteria as DXA scans to classify the population into subgroups based on QUS, a recommendation supported by a population-based study in China (Jin *et al.*, 2010). To ensure the quality of the measurements, we carefully standardized our methods according to the manufacturer's instructions.

The 10-year risk of MOF, which includes spine, forearm, hip, or shoulder fractures, as well as osteoporotic HF, was calculated using the FRAX tool (University of Sheffield, UK). We entered the T-scores calculated from the QUS instead of BMD scores into the FRAX online tool to assess the 10-year risk of MOF and HF. We also measured these parameters without inputting the T-scores into the FRAX tool. Developed by the WHO and launched by the University of Sheffield in 2008, the FRAX tool is used to assess clinical fracture risk with or without BMD (Kanis *et al.*, 2008). This model calculates fracture risk for both men and women based on several factors, including age, BMI, calculated from height and weight, along with individual risk factors—including prior fragility fractures, family history of hip fractures, current tobacco use, prolonged oral glucocorticoid therapy, rheumatoid arthritis (RA), secondary causes of osteoporosis, and regular alcohol intake of three or more units per day—contribute to overall fracture risk. Additionally, ethnic background significantly influences fracture susceptibility, emphasizing the importance of evaluating population- and ethnicity-specific risk factors (Barrett-Connor *et al*., 2005; Kung *et al.*, 2007). Since the FRAX calculation tool is not designed for the Bangladeshi population, we utilized the calculation tool intended for India, as we share the same ethnicity.

2.6. Data management and statistical analysis

After data collection, all entries were organized and stored in an Excel spreadsheet. The dataset was reviewed for consistency, and any outliers or missing values were identified. Statistical analysis was performed using IBM SPSS Statistics version 28.0 (IBM Corp., 2021). Categorical variables were summarized using frequencies and percentages, while descriptive statistics were used to assess the prevalence and risk of osteoporosis (RO). Fisher's exact test was applied to compare categorical variables across groups, with adjustments for multiple comparisons made using the Bonferroni correction. A *P*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Socio-demographic characteristics of the study participants

Their mean age was 53.23± 9.77 years, with ages ranging from 40 to 90 years. The majority of participants were between 40 and 49 years old (36.2%), followed closely by those aged 50 to 59 years (35.6%). Of the participants, most were female (n=101, 53.7%). The mean height of the participants was 1.57±0.08 meters, and their mean weight was 63.35±12.32 kilograms. A significant portion of the participants had normal BMI levels (n=85, 45.2%), while 34% (n=64) were classified as overweight (Table 1).

Table 1. Characteristics of participants (n=188).

Characteristics	Frequency (N)	Percentage
Age (years)		
40-49	68	36.20
50-59	67	35.60
60-69	41	21.80
70-79	9	4.80
80 or above	3	1.60
Gender		
Male	87	46.30
Female	101	53.70
BMI		
Underweight (<18.5 kg/m^2)	8	4.30
Normal (18.5 – 24.9 kg/m^2)	85	45.20
Overweight (25-29.9 kg/m^2)	64	34.0
Obese (>30 kg/m^2)	31	16.50

Approximately 19.1% (n=36) of participants had a previous history of fractures, and only 11 participants (5.9%) reported that their parents had also experienced fractures in their lifetime. We found that nearly 15.4% (n=29) of participants were smokers, and about 14.4% (n=27) used other forms of tobacco. Almost none of the participants consumed alcohol (n=1, 0.5%). Approximately 17.6% (n=33) were taking glucocorticoid medications. The prevalence of rheumatoid arthritis and type 2 diabetes in this population was 51.1% and 13.8%, respectively. The mean T-score was -0.73 (±1.34). Nearly 60% (n=108, 57.4%) had normal bone density based on the T-score, while 31% (n=59, 31.4%) were at RO (osteopenia), and 11.2% (n=21) were diagnosed with osteoporosis (Table 2).

The Chi-square test assessed the association between clinical risk factors, demographic factors, and osteopenia/osteoporosis. The results indicated a significant association between age and T-score (*P*=0.001). A significant association was also found between BMI and T-score (*P*=0.013). However, gender did not show a significant association with T-score (*P*=0.334) (Table 2).

Table 2. Bivariate analysis of demographic factors with the classification of patients based on T-score (n=188).

Demographic factors	Classification of patients			*P* value
	Normal (n=108)	**Osteopenia (n=59)**	**Osteoporosis (n=21)**	
Age-group				
40-49	48 (70.60)	15 (22.10)	5 (7.40)	**0.002**
50-59	40 (59.70)	15 (22.40)	12 (17.90)	
60-69	18 (43.90)	21 (51.20)	2 (4.90)	
70-79	2 (22.20)	6 (66.70)	1 (11.10)	
80 or above	0 (0.0)	2 (66.70)	1 (33.30)	
Gender				
Male	46 (52.90)	32 (36.80)	9 (10.30)	0.351
Female	62 (61.40)	27 (26.70)	12 (11.90)	
BMI				
Underweight	4 (50)	3 (37.50)	1 (12.50)	**0.013**
Normal	52 (61.20)	30 (35.30)	3 (3.50)	
Overweight	39 (41.90)	17 (26.60)	8 (12.50)	
Obese	13 (41.90)	9 (29.0)	9 (29.0)	

Values in parentheses denote percentage

Among the clinical risk factors, only a history of smoking was significantly associated with osteopenia/osteoporosis (*P*=0.019). Other factors, including previous fractures, alcohol intake, secondary osteoporosis, rheumatoid arthritis, and glucocorticoid intake, were not significantly associated with T-score (Table 3).

Table 3. Bivariate analysis of clinical risk factors (CRFs) with the classification of patients based on T-score (n=188).

Clinical risk factors	Number of patients with each CRF	Classification of patients			*P* value
		Normal (n=108)	**Osteopenia (n=59)**	**Osteoporosis (n=21)**	
Previous history of fracture					
Yes	36 (19.10)	20 (55.60)	9 (25.0)	7 (19.40)	0.188
No	152 (80.90)	88 (57.90)	50 (32.90)	14 (9.20)	
Parent fractured hip					
Yes	11 (5.90)	5 (45.50)	4 (36.40)	2 (9.50)	0.739
No	177 (94.10)	103 (58.20)	55 (31.10)	19 (10.70)	
Smoking					
Yes	29 (15.40)	10 (34.50)	13 (44.80)	6 (20.70)	**0.017**
No	159 (84.60)	98 (61.60)	46 (28.90)	15 (9.40)	
Glucocorticoids					
Yes	33 (17.60)	21 (63.60)	7 (21.20)	5 (15.20)	0.361
No	155 (82.40)	87 (56.10)	52 (33.50)	16 (10.30)	

Table 3. Contd.

Clinical risk factors	Number of patients with each CRF	Classification of patients			*P* value
		Normal (n=108)	Osteopenia (n=59)	Osteoporosis (n=21)	
Rheumatoid arthritis					
Yes	96 (51.10)	50 (52.10)	31 (32.30)	15 (15.60)	0.107
No	92 (48.90)	58 (63.0)	28 (30.40)	6 (6.50)	
Alcohol intake					
Yes	1 (0.50)	0 (0.0)	1 (100)	0 (0.0)	0.426
No	187 (99.50)	108 (57.80)	58 (31.0)	21 (11.20)	
Secondary Osteoporosis					
Yes	34 (18.10)	18 (52.90)	14 (41.20)	2 (5.90)	0.291
No	154 (81.90)	90 (58.40)	45 (29.20)	19 (12.30)	

Values in parentheses denote percentage

From the FRAX tool, the 10-year probabilities of major morphometric osteoporotic fractures (MOF) and osteoporotic HF were identified among survey participants, both with and without BMD T-scores entered into the tool. The MOF risk ranged from 0.70% to 25%, while the HF risk ranged from 0% to 21%. According to the tool, approximately 94% (n=178) of participants had a low risk of MOF (<10%) with BMD. Among the 188 participants, 4 (2.10%) were classified as having a high risk of MOF (≥20%), and 6 (3.20%) had a moderate risk of MOF (10-19%) with BMD T-scores. Without BMD T-scores, 177 participants (94.10%) were at low risk of MOF, while 11 (5.90%) had a moderate risk. None had a high risk of MOF without BMD (T-score) (Figure 2).

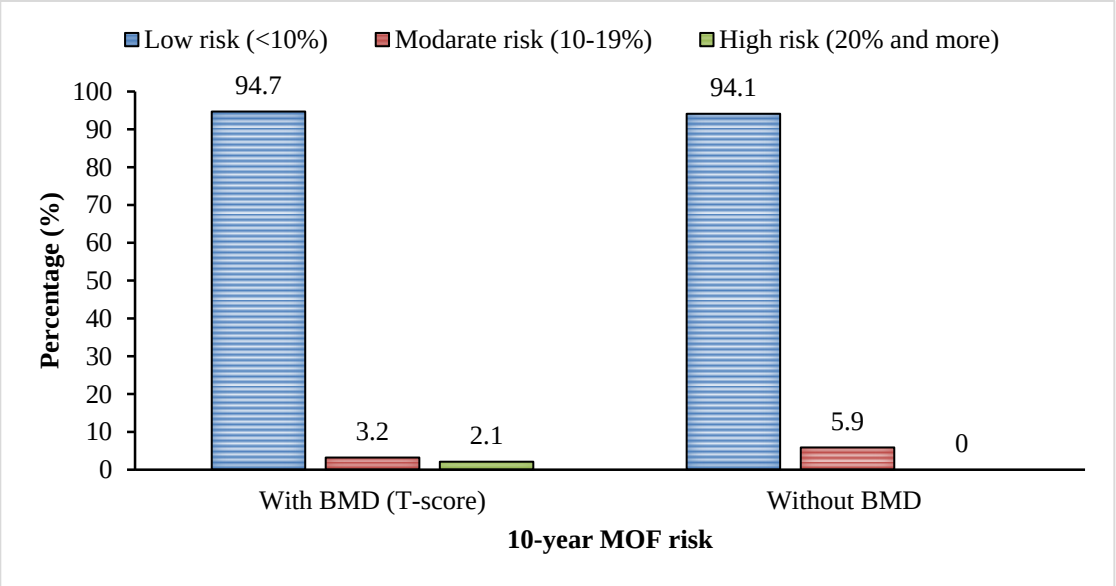

Figure 2. Probability of 10-year MOF risk with or without BMD.

The number of participants with an HF risk greater than 3% was 23 (12.20%) with BMD, compared to 20 (10.60%) without BMD T-scores in the FRAX tool. Nearly 90% (n=165, 87.80%) of participants were at below high risk for 10-year HF with BMD T-scores, a figure that was similar (89.40%) among participants without BMD T-scores (Figure 3).

The chi-square test indicated that age group (P<0.001), previous history of fractures (P=0.010), glucocorticoid intake (P=0.021), and presence of rheumatoid arthritis (P=0.036) were associated with the 10-year probability of MOF with BMD T-scores in the FRAX tool. Without the BMD score, age group (P<0.001), BMI (P=0.023), and presence of rheumatoid arthritis (P=0.035) were the only associated factors for the 10-year probability of MOF. The chi-square results also showed that age group (P=0.022), BMI (P<0.001), glucocorticoid intake (P=0.020), smoking (P=0.033), and presence of rheumatoid arthritis (P<0.001) were associated with the 10-year probability of HF when BMD T-scores were included in the FRAX tool. In contrast, age group (P<0.001), BMI

(*P*<0.001), previous history of fractures (*P*=0.002), and secondary osteoporosis (*P*=0.038) were the associated factors for the 10-year probability of HF without BMD (Table 4).

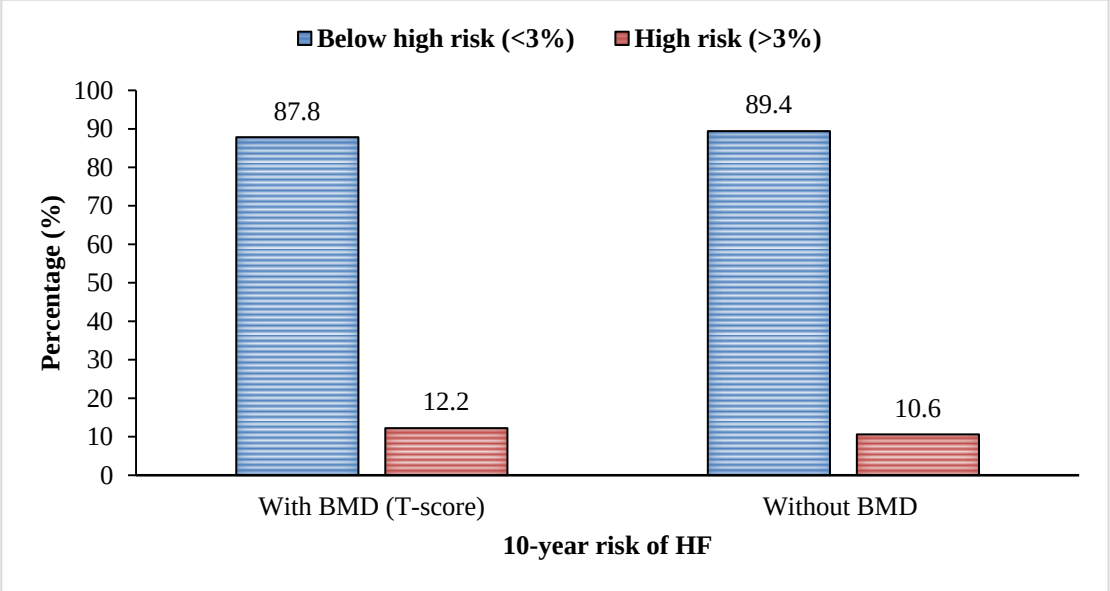

Figure 3. Probability of 10-year HF risk with or without BMD.

Table 4. Demographic and clinical risk factors (CRFs) with 10-year major osteoporotic fracture (MOF) and hip fracture (HF) (n=188).

Factors	10-year MOF (With BMD)		10-year MOF (Without BMD)		10-year HF (With BMD)		10-year HF (Without BMD)	
	χ^2(df)	*P* value	χ^2(df)	*P* value	χ^2(df)	*P* value	χ^2(df)	*P* value
Age-group	30.62 (8)	**<0.001**	55.86 (4)	**<0.001**	11.45 (4)	**0.022**	55.92 (4)	**<0.001**
Gender	3.00 (2)	0.223	0.46 (1)	0.497	0.08 (1)	0.774	0.02 (1)	0.904
BMI	6.47 (6)	0.373	9.53 (3)	**0.023**	18.79 (3)	**<0.001**	16.74	**<0.001**
Previous history of fracture	9.18 (2)	**0.010**	2.24 (1)	0.135	2.16 (1)	0.142	9.66(1)	**0.002**
Parent fractured hip	1.54 (2)	0.463	0.73 (1)	0.394	0.11 (1)	0.743	1.39 (1)	0.238
Smoking	3.76 (2)	0.152	1.26 (1)	0.262	4.52 (1)	**0.033**	1.57 (1)	0.210
Glucocorticoids	7.68 (2)	**0.021**	0.76 (1)	0.382	5.38 (1)	**0.020**	0.09 (1)	0.761
Rheumatoid Arthritis	6.67 (2)	**0.036**	4.42 (1)	**0.035**	16.98 (1)	**<0.001**	3.21 (1)	0.073
Alcohol intake	0.05 (2)	0.972	0.06 (1)	0.803	0.14 (1)	0.708	0.12 (1)	0.729
Secondary Osteoporosis	2.33 (2)	0.312	0.00 (1)	0.993	3.34 (1)	0.068	4.32 (1)	**0.038**

4. Discussion

In the last decade, osteoporotic fractures have emerged as a significant public health concern. Identifying individuals at risk of developing osteoporosis and providing appropriate treatment can help prevent the long-term health issues associated with these fractures. Unfortunately, a large portion of the population remains unaware of the severe consequences linked to osteoporosis. In this study, the prevalence of osteopenia and osteoporosis among adults over 40 years old in the old town of Dhaka city was found to be 31.4% and 11.2%, respectively, indicating that approximately 42.6% of the overall population is at risk. A study in Dhaka city reported a RO of 37.3%, which aligns with our findings (Ali *et al*., 2021). Another study conducted in India reported the prevalence of osteoporosis and osteopenia at 8.99% and 59.55%, respectively, using similar assessment tools (Vaishya *et al*., 2017).

In the current study, age was significantly associated with T-scores, with osteopenia and osteoporosis being more prevalent among older age groups. An Asian study similarly found that the occurrence of osteoporosis increased with age in both Asian males and females (Pasco *et al*., 2014). Age is a crucial predictor of osteoporosis, with the incidence significantly rising as individuals get older (Black and Rosen 2016; Thulkar *et al*., 2016; Ali *et al*., 2021). This increase can be linked to declining estrogen levels in older age, which adversely

affects bone health, particularly among women (Mahboub *et al*., 2014). In our study, the gender of participants was not associated with T-scores. In contrast, a study conducted in China reported that half the population had moderate to severe osteoporosis, with a higher prevalence among women (Qiao *et al*., 2020). This finding is supported by a meta-analysis that identified an association between female gender and osteoporosis (Chen *et al*., 2016). Furthermore, in a recent study a higher prevalence of osteoporosis risk in females compared to males in Bangladesh (Ali *et al*., 2021). Conversely, other research indicates that the incidence of osteoporosis in males, or the number of affected males, is either greater than or comparable to that in females (Kadam *et al*., 2018). Further investigation is needed for a comprehensive understanding of these disparities. Additionally, our study found a significant association between BMI and T-score categories. This finding is consistent with a study in Bangladesh, which reported that the RO was higher among underweight participants (Ali *et al*., 2021).

In this study, the presence of multi-morbidity (secondary osteoporosis) was not associated with the T-score categories. A high prevalence of multi-morbidity among osteoporotic patients was reported in a previous study (Puth *et al*., 2018). Diabetes and cardiovascular diseases were also found to be associated with the RO (Puth *et al*., 2018). A study conducted among adults in Dhaka city also reported multi-morbidity as a primary factor in the RO (Ali *et al*., 2021). Multi-morbidity, involving the simultaneous occurrence of two or more chronic conditions, is associated with a heightened risk of functional decline, mortality, and diminished quality of life (Zhang *et al.*, 2021). Smoking was significantly associated with the T-score in our surveyed population. Other studies have reported that the relationship between smoking and osteoporosis is either unclear or non-significant, contrasting with our findings (Strozyk *et al.*, 2018; Ali *et al*., 2021).

In this study, the 10-year fracture risk for MOF, calculated using BMD (T-score), showed significant associations with age, prior fracture history, glucocorticoid use, and rheumatoid arthritis. Likewise, the estimated risk of HF over 10 years was linked to age, BMI, glucocorticoid use, and rheumatoid arthritis. Comparable findings were reported in an Indian study, where both age and gender were significantly associated with MOF and HF risk. Other research has also identified parental history of fractures, secondary osteoporosis, and rheumatoid arthritis as important predictors of increased 10-year fracture risk (Vaisya *et al.*, 2017).

In this study, 10 participants (5.3%) were found to be at moderate to high risk for MOF, while 23 individuals (12.2%) were identified as having a high risk of HF, indicating the need for clinical intervention. In comparison, a related study from India utilizing the FRAX assessment tool reported that nearly one-quarter of its participants required treatment based on their fracture risk levels (Shetty *et al*., 2014). This figure was consistent (25.39%) in another study in India, which found that the majority were at risk of developing HF, aligning with our findings (Vaisya *et al.*, 2017). Given the number of individuals at risk of fractures, management should focus on minimizing the risk of disease by modifying lifestyle factors, addressing disease-specific risk factors, and identifying patients at risk to reduce future fractures. Therefore, there is a need for a screening instrument that can be used in community settings to identify individuals at higher risk for osteoporosis. Multiple studies have indicated that QUS performed at peripheral sites can serve as an effective screening tool to evaluate bone health (Lin *et al*., 2001). QUS is comparatively affordable and portable, making it suitable for screening bone health at the community level. Furthermore, QUS has demonstrated comparable efficacy to DXA in predicting fracture risk (Nicholson *et al.*, 1998). Among elderly individuals, QUS has been found to yield results similar to central DXA. Additionally, QUS has shown its capability to predict both HF and non-spine fractures in men (Bauer *et al.*, 2007).

In this study, we had a very limited sample size due to time and budget constraints, including participants from a small geographical area in an urban context. Consequently, the results may not be as robust or representative of the broader population, making it challenging to draw accurate and generalizable conclusions. The study was conducted in a community setting and included participants aged 40 years or older, most of whom had musculoskeletal complaints and sought medical attention. Information related to age, smoking, and the presence of multi-morbidity was self-reported, so it may vary slightly. However, measurements for height and weight were strictly monitored. Additionally, we did not consider the menstrual status of the participants at the time of data collection, nor did we account for other background variables such as education, physical activity status, intake of vitamins, and food habits.

5. Conclusions

In our study, osteopenia and osteoporosis were prevalent. We found a significant association between age group, BMI, and smoking with low T-scores. Many participants were at risk of MOF and HF, regardless of their BMD, and required immediate medical attention. Our study suggests that different targeted approaches are necessary for at-risk groups to prevent or manage osteoporosis, taking into account factors such as age, BMI, smoking, and multi-morbidity. Tools like QUS and the FRAX can be valuable for assessing fracture risk at a low cost.

However, further research is needed to determine the accuracy and feasibility of these tools within the Bangladeshi population. Additionally, we recommend further research, including longitudinal studies with more variables of interest.

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Data availability
Data can be available upon request.

Conflict of interest
None to declare.

Authors' contribution
Md. Mozammal and Kh Shafiur Rahaman: provided substantial contributions to the conception and design, acquisition of data, or analysis and interpretation of data; Kh Shafiur Rahaman: drafted the article or revised it critically for important intellectual content. All authors have read and approved the final manuscript.

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