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PREVALENCE AND RISK FACTORS OF OSTEOPOROTIC FRACTURES IN ELDERLY PATIENTS: A HOSPITAL-BASED STUDY

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Abstract

Introduction: Osteoporotic fractures represent a major global health burden, particularly affecting elderly populations with increasing prevalence in India. This study aimed to determine the prevalence and identify risk factors associated with osteoporotic fractures among elderly patients presenting to a tertiary care hospital.

Methods: A cross-sectional observational study was conducted at American Institute of Medical Sciences, Udaipur, from June 2021 to December 2021. A total of 350 patients aged ≥60 years with osteoporotic fractures were enrolled through consecutive sampling. Data were collected using structured questionnaires covering demographic characteristics, clinical parameters, lifestyle factors, and laboratory investigations. Statistical analysis was performed using SPSS 25.0, employing chi-square tests and multivariate logistic regression analysis.

Results: The study population comprised 62.3% females with mean age of 69.4±8.2 years. Hip fractures were most common (40.6%), followed by vertebral (25.4%) and wrist fractures (19.1%). Falls from standing height accounted for 82.0% of injury mechanisms. Vitamin D deficiency was present in 66.9% of participants, while inadequate calcium intake was observed in 76.3%. Multivariate analysis identified previous fracture history (OR:3.12), vitamin D deficiency (OR:2.78), inadequate calcium intake (OR:2.45), female gender (OR:2.34), and sedentary lifestyle (OR:1.89) as significant independent risk factors. Sedentary behavior was prevalent in 47.7% of participants, with limited sun exposure in 56.6%.

Conclusion: The study revealed high prevalence of modifiable risk factors including vitamin D deficiency and inadequate calcium intake among elderly patients with osteoporotic fractures. Comprehensive prevention strategies addressing nutritional supplementation, lifestyle modifications, and targeted screening programs are essential for reducing fracture burden in this vulnerable population.

Keywords: Osteoporotic fractures, elderly patients, vitamin D deficiency, risk factors, bone health

Introduction

Osteoporosis represents a significant global health challenge, particularly affecting elderly populations and imposing substantial economic and social burdens on healthcare systems worldwide. This metabolic bone disease is characterized by compromised bone strength, increased bone fragility, and elevated susceptibility to fractures, even with minimal trauma. The condition

predominantly affects individuals over 50 years of age, with postmenopausal women experiencing disproportionately higher rates due to estrogen deficiency following menopause.

The prevalence of osteoporosis has been steadily increasing globally, paralleling demographic shifts toward aging populations. According to epidemiological studies, approximately 200 million individuals worldwide suffer from osteoporosis, with fracture incidence rates varying significantly across different geographical regions and ethnic populations. In developed countries, the lifetime risk of osteoporotic fractures ranges from 30-50% in women and 15-30% in men over 50 years of age. The burden is particularly pronounced in Asia, where rapidly aging populations and changing lifestyle patterns contribute to escalating fracture rates.

India faces unique challenges regarding osteoporotic fractures, with emerging evidence suggesting higher prevalence rates than previously recognized. Studies conducted across various Indian populations have revealed alarming statistics, with osteoporosis affecting approximately 50 million individuals nationwide. The problem is compounded by factors including widespread vitamin D deficiency, dietary calcium insufficiency, sedentary lifestyles, and limited awareness about bone health. Urban populations show increasing susceptibility due to reduced sun exposure, processed food consumption, and decreased physical activity levels.

The clinical significance of osteoporotic fractures extends beyond immediate medical complications, encompassing long-term disability, reduced quality of life, increased mortality risk, and substantial economic implications. Hip fractures represent the most serious consequence, with mortality rates reaching 20-24% within the first year post-fracture. Vertebral fractures, though often asymptomatic initially, lead to chronic pain, spinal deformity, height loss, and functional impairment. Wrist fractures, while generally less severe, still result in significant morbidity and healthcare utilization.

Risk factors for osteoporotic fractures are multifactorial, encompassing both modifiable and non-modifiable elements. Non-modifiable factors include advanced age, female gender, ethnicity, genetic predisposition, and previous fracture history. Age represents the strongest predictor, with fracture risk doubling every decade after 50 years. Women face four times higher risk than men, primarily attributed to postmenopausal estrogen decline and longer life expectancy.

Modifiable risk factors present opportunities for preventive interventions and include nutritional deficiencies, physical inactivity, smoking, excessive alcohol consumption, certain medications, and underlying medical conditions. Vitamin D and calcium deficiency are particularly prevalent in Indian populations, with studies reporting vitamin D insufficiency in over 70% of elderly individuals. Corticosteroid therapy represents a significant iatrogenic risk factor, with prolonged use substantially increasing fracture probability.

The pathophysiology of osteoporotic fractures involves complex interactions between bone remodeling processes, mechanical loading, and hormonal influences. Normal bone homeostasis depends on balanced osteoblast-mediated bone formation and osteoclast-mediated bone resorption. Disruption of this equilibrium, commonly occurring with aging and hormonal changes, results in net bone loss and microarchitectural deterioration.

Diagnosis of osteoporosis relies primarily on dual-energy X-ray absorptiometry (DEXA) scanning, measuring bone mineral density at key skeletal sites. The World Health Organization criteria define osteoporosis as T-scores $\leq$ -2.5 standard deviations below peak bone mass. However, fracture risk assessment tools incorporating clinical risk factors provide more comprehensive evaluation approaches than bone density measurements alone.

Hospital-based studies play crucial roles in understanding osteoporotic fracture epidemiology, particularly in resource-limited settings where population-based surveillance systems may be inadequate. These studies provide valuable insights into fracture patterns, risk factor profiles, and healthcare utilization patterns among affected populations. They also facilitate identification of high-risk groups requiring targeted interventions and inform healthcare policy development.

The economic burden of osteoporotic fractures continues escalating globally, with direct medical costs exceeding billions of dollars annually. In India, the economic impact remains incompletely characterized but is projected to increase substantially given demographic trends and urbanization

patterns. Indirect costs related to productivity losses, caregiver burden, and long-term care requirements further amplify the overall societal impact.

Prevention strategies encompass lifestyle modifications, nutritional optimization, exercise programs, fall prevention measures, and pharmacological interventions when appropriate. Public health approaches emphasizing calcium and vitamin D supplementation, weight-bearing exercise promotion, and fracture risk awareness campaigns have demonstrated effectiveness in reducing population-level fracture rates.

Understanding the local epidemiology of osteoporotic fractures through hospital-based investigations provides essential foundation for developing evidence-based prevention and management strategies. Such studies contribute valuable data regarding regional fracture patterns, risk factor prevalence, and healthcare delivery challenges, ultimately informing policy decisions and resource allocation priorities for optimal patient care delivery.

The study aimed to determine the prevalence and identify the risk factors associated with osteoporotic fractures among elderly patients presenting to a tertiary care hospital, and to analyze the demographic, clinical, and lifestyle characteristics contributing to fracture occurrence in this population.

Methodology

Study Design

A cross-sectional observational study

Study Site

The study was conducted at the American Institute of Medical Sciences, Udaipur, a tertiary care teaching hospital providing comprehensive healthcare services to patients from Udaipur and surrounding districts of Rajasthan.

Study Duration

Data collection was carried out over a period of six months, from June 2021 to December 2021.

Sampling and Sample Size

A consecutive sampling method was employed to recruit eligible participants presenting to the study site during the specified period. Sample size calculation was performed using the formula for cross-sectional studies, considering an expected prevalence of 25% based on previous Indian studies, with 95% confidence interval and 5% margin of error. The calculated minimum sample size was 288 patients, which was increased to 350 to account for potential data incompleteness and non-response. All patients meeting inclusion criteria during the study period were invited to participate until the target sample size was achieved.

Inclusion and Exclusion Criteria

Inclusion criteria comprised patients aged 60 years and above of both genders presenting with fractures to the study hospital, patients with confirmed osteoporotic fractures based on clinical and radiological evidence, and individuals providing informed consent for participation. Exclusion criteria included patients with pathological fractures due to malignancy or infection, individuals with high-energy trauma fractures, patients with incomplete medical records or those unable to provide reliable history due to cognitive impairment, and participants with metabolic bone diseases other than osteoporosis such as Paget's disease or hyperparathyroidism.

Data Collection Tools and Techniques

Data collection was performed using a structured questionnaire encompassing demographic information, medical history, lifestyle factors, and clinical parameters. The questionnaire was pre-tested and validated before implementation. Clinical examination findings, radiological reports, and laboratory investigations were recorded systematically. Bone mineral density measurements using

dual-energy X-ray absorptiometry were obtained when clinically indicated. Fracture risk assessment was conducted using validated tools including the Fracture Risk Assessment Tool (FRAX). Data collection was performed by trained research personnel under supervision of principal investigators to ensure consistency and accuracy.

Data Management and Statistical Analysis

Collected data were entered into Microsoft Excel spreadsheets and subsequently transferred to Statistical Package for Social Sciences (SPSS) version 25.0 for analysis. Data cleaning and validation procedures were implemented to identify and correct inconsistencies. Descriptive statistics including frequencies, percentages, means, and standard deviations were calculated for categorical and continuous variables respectively. Chi-square tests were used to assess associations between categorical variables, while independent t-tests or Mann-Whitney U tests were employed for continuous variables based on distribution patterns. Multivariate logistic regression analysis was performed to identify independent risk factors for osteoporotic fractures, with odds ratios and 95% confidence intervals calculated. Statistical significance was set at p-value less than 0.05 for all analyses.

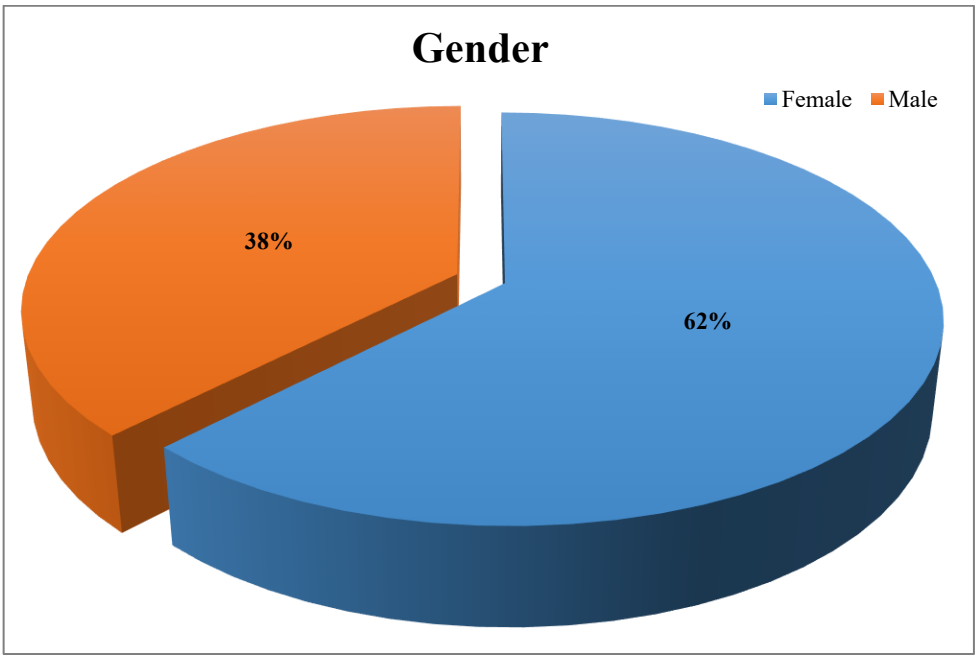
Ethical Considerations

The study protocol was submitted to the Institutional Ethics Committee of American Institute of Medical Sciences, Udaipur, and approval was obtained before study commencement. Written informed consent was obtained from all participants after explaining the study objectives, procedures, risks, and benefits in local language. Participant confidentiality was maintained throughout the study period through de-identification procedures and secure data storage systems. Participants were informed about their right to withdraw from the study at any time without affecting their medical care. The study was conducted in accordance with the Declaration of Helsinki principles and Good Clinical Practice guidelines.

Results

Table 1: Demographic Characteristics of Study Participants (n=350)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	60-69	156	44.6
	70-79	138	39.4
	80-89	48	13.7
	≥90	8	2.3
Gender	Female	218	62.3
	Male	132	37.7
Residence	Urban	201	57.4
	Rural	149	42.6
Education	Illiterate	145	41.4
	Primary	98	28
	Secondary	67	19.1
	Graduate & above	40	11.4
Occupation	Housewife	156	44.6
	Farmer	89	25.4
	Retired	67	19.1
	Others	38	10.9



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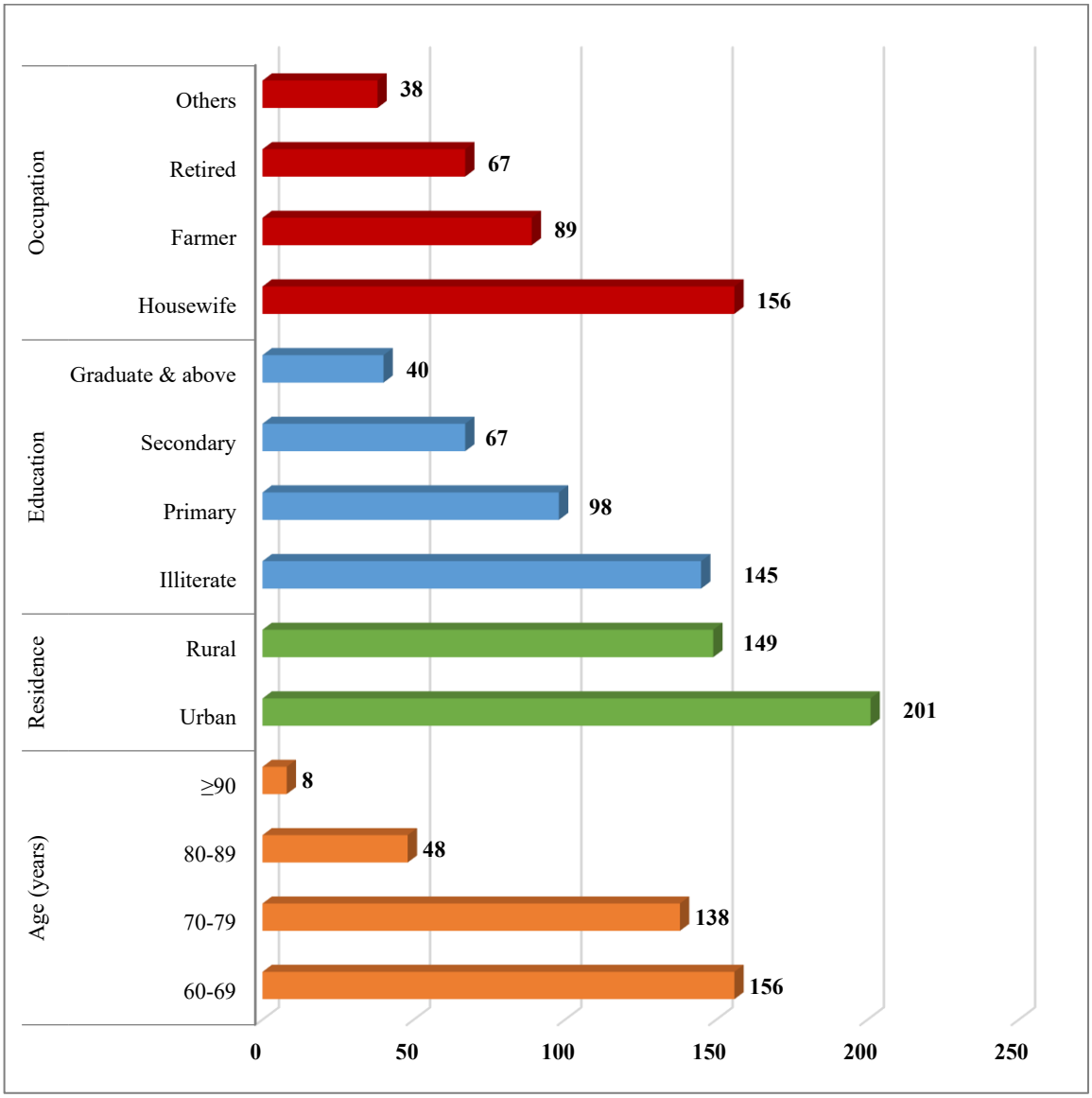

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Table 2: Distribution of Fracture Types and Sites (n=350)

Fracture Site		Frequency (n)	Percentage (%)
Fracture Site	Hip (Femoral neck/Intertrochanteric)	142	40.6
	Vertebral	89	25.4
	Wrist (Distal radius)	67	19.1
	Humerus (Proximal)	31	8.9
	Pelvis	12	3.4
	Multiple sites	9	2.6
Mechanism of Injury	Fall from standing height	287	82
	Fall from bed/chair	43	12.3
	Minimal trauma	20	5.7
Fracture Severity	Displaced	198	56.6
	Non-displaced	152	43.4

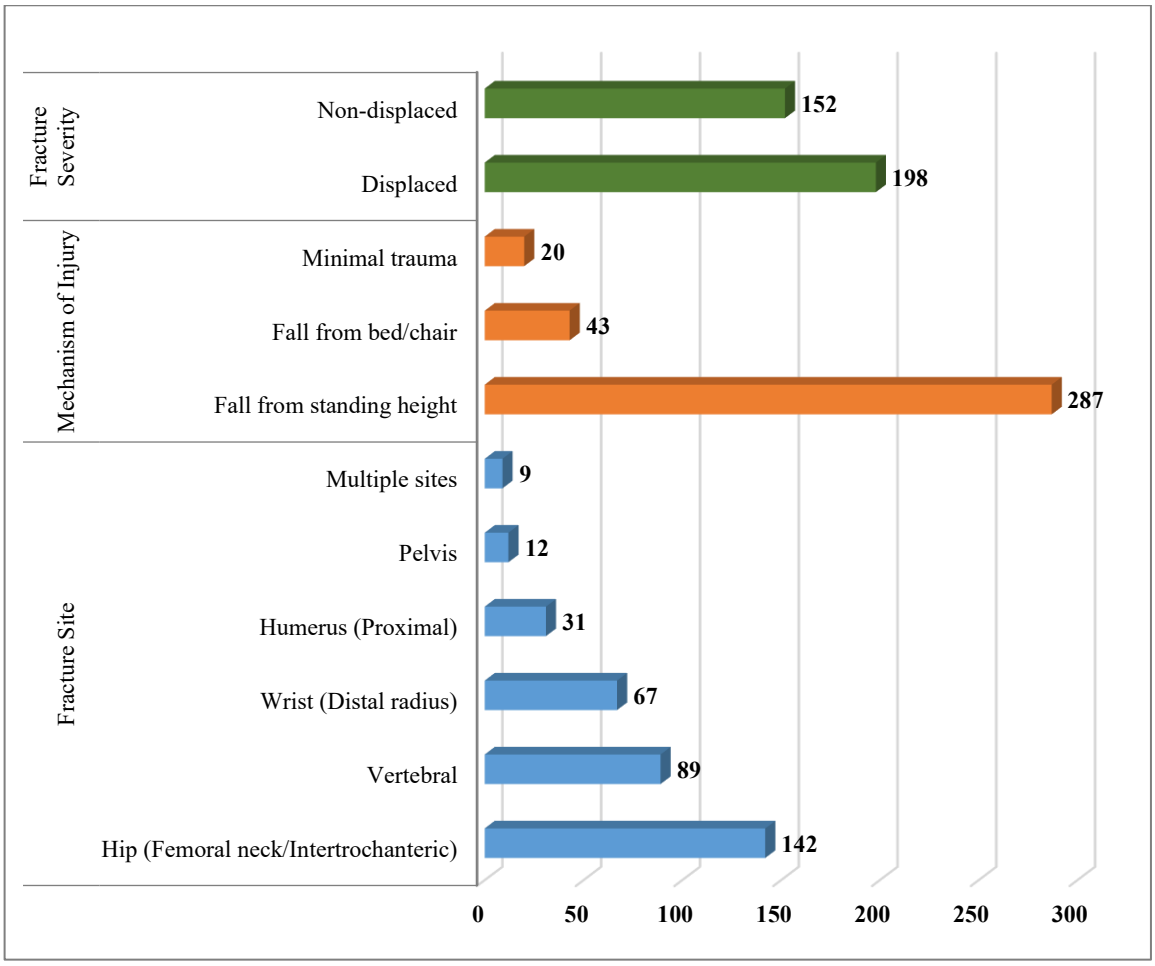

Fig: 2

Table 3: Clinical Risk Factors and Comorbidities (n=350)

Risk Factor	Present (n)	Percentage (%)	Absent (n)	Percentage (%)
Postmenopausal status (females)	218	100.0	0	0.0
Previous fracture history	89	25.4	261	74.6
Family history of fractures	67	19.1	283	80.9
Diabetes mellitus	134	38.3	216	61.7

Hypertension	176	50.3	174	49.7
Rheumatoid arthritis	23	6.6	327	93.4
Chronic kidney disease	18	5.1	332	94.9
Hyperthyroidism	15	4.3	335	95.7
Corticosteroid use (>3 months)	31	8.9	319	91.1
Smoking (current/past)	78	22.3	272	77.7
Alcohol consumption	45	12.9	305	87.1

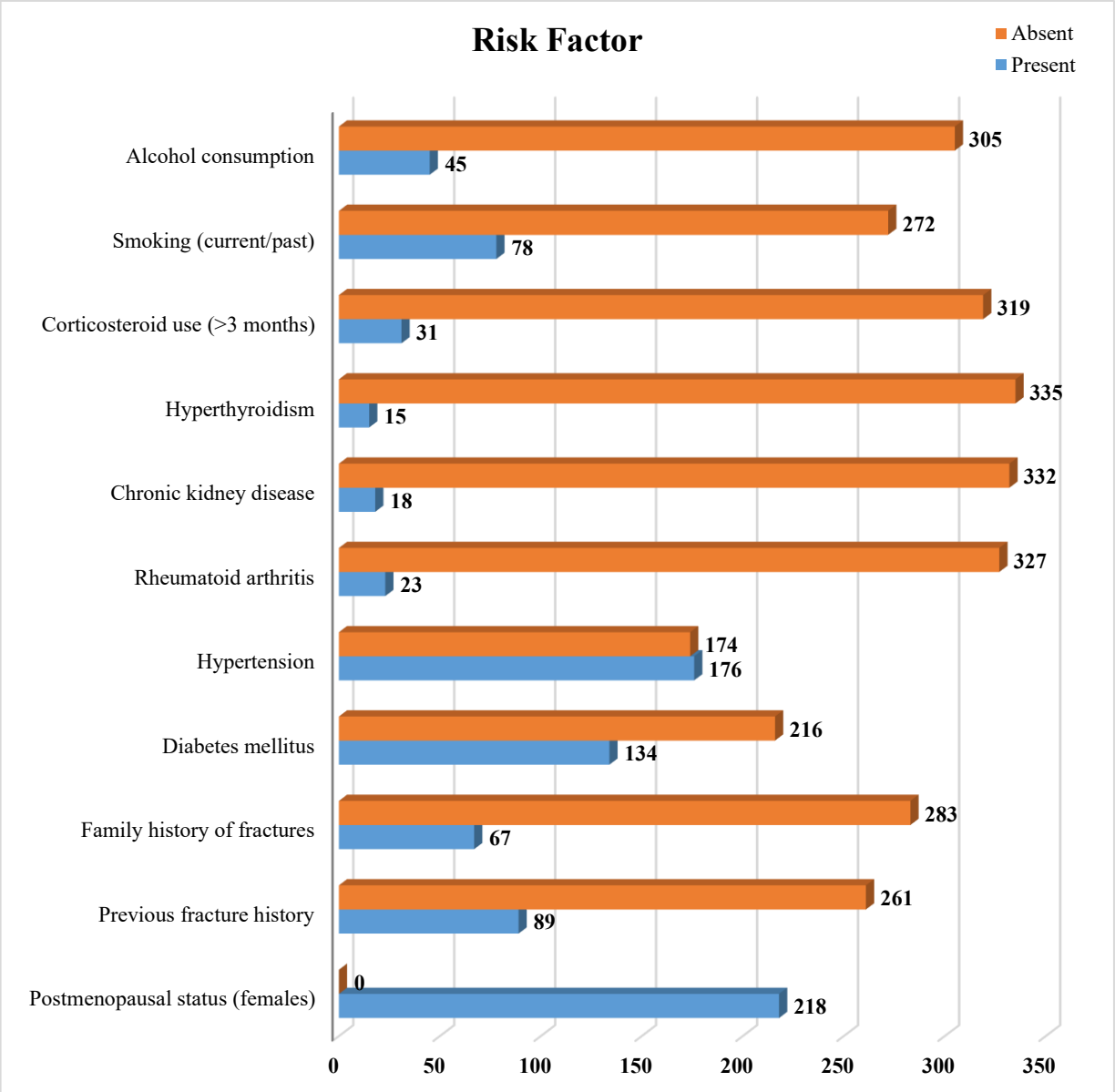

Fig: 3

Table 4: Lifestyle and Nutritional Factors (n=350)

Factor	Category	Frequency (n)	Percentage (%)
Physical Activity	Sedentary	167	47.7
	Light activity	134	38.3
	Moderate activity	49	14
Sun Exposure	<30 min/day	198	56.6
	30-60 min/day	123	35.1

	>60 min/day	29	8.3
Calcium Intake	Inadequate (<1000mg/day)	267	76.3
	Adequate (≥1000mg/day)	83	23.7
Vitamin D Supplementation	Yes	89	25.4
	No	261	74.6
Dietary Pattern	Vegetarian	234	66.9
	Non-vegetarian	116	33.1
Body Mass Index	Underweight (<18.5)	78	22.3
	Normal (18.5-24.9)	187	53.4
	Overweight (25-29.9)	67	19.1
	Obese (≥30)	18	5.1

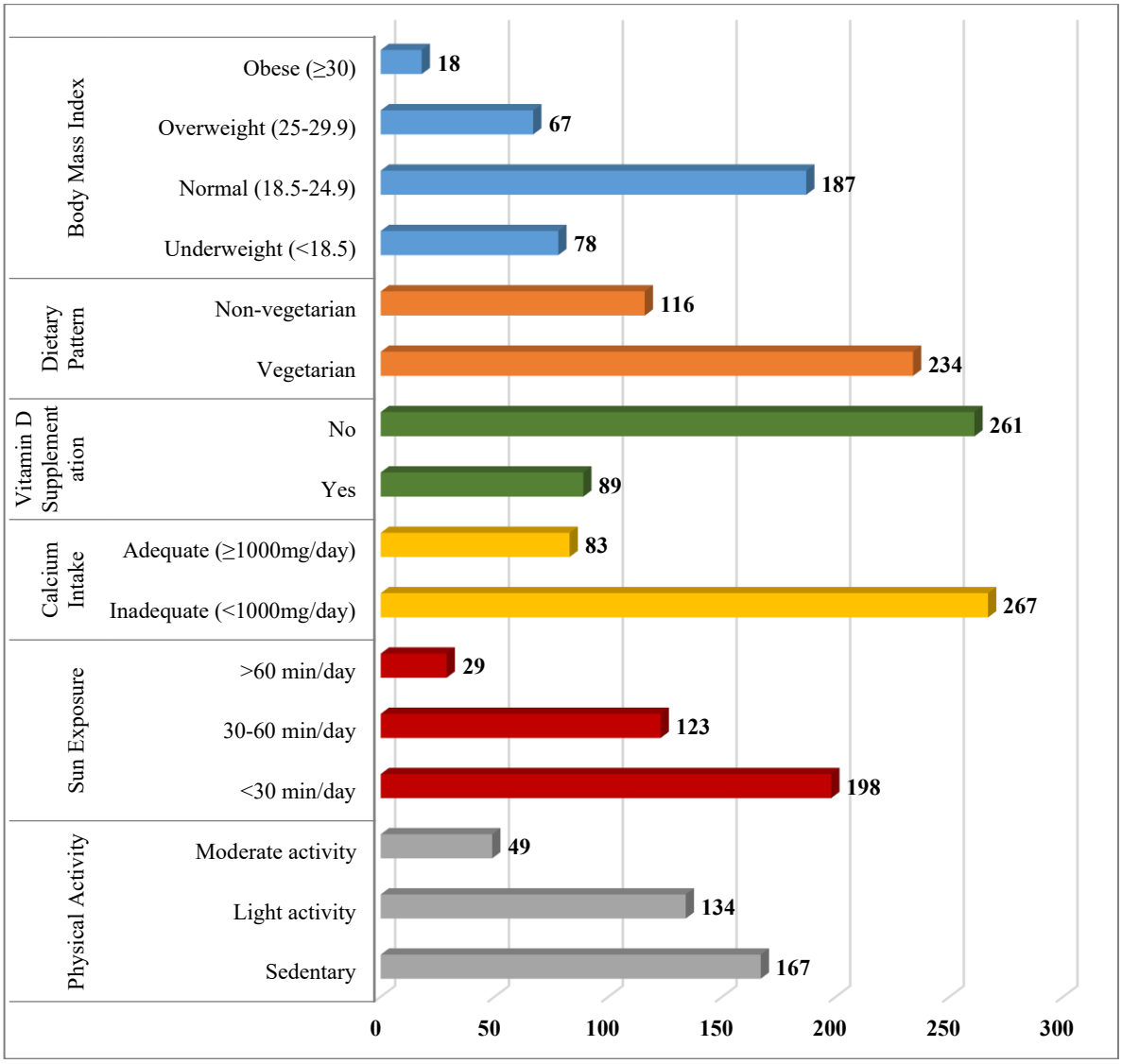

Fig: 4

Table 5: Laboratory and Diagnostic Parameters (n=350)

Parameter	Mean ± SD	Range	Normal Range
Serum Calcium (mg/dL)	8.7 ± 1.2	6.8-10.4	8.5-10.5
Serum Phosphorus (mg/dL)	3.8 ± 0.9	2.1-5.6	2.5-4.5
Alkaline Phosphatase (IU/L)	142 ± 38	89-267	44-147
25-OH Vitamin D (ng/mL)	18.4 ± 8.7	5.2-34.8	30-100

Parathyroid Hormone (pg/mL)	67.8 ± 24.3	28-145	15-65
Vitamin D Status	**Frequency (n)**	**Percentage (%)**	
Deficient (<20 ng/mL)	234	66.9	
Insufficient (20-29 ng/mL)	89	25.4	
Sufficient (≥30 ng/mL)	27	7.7	

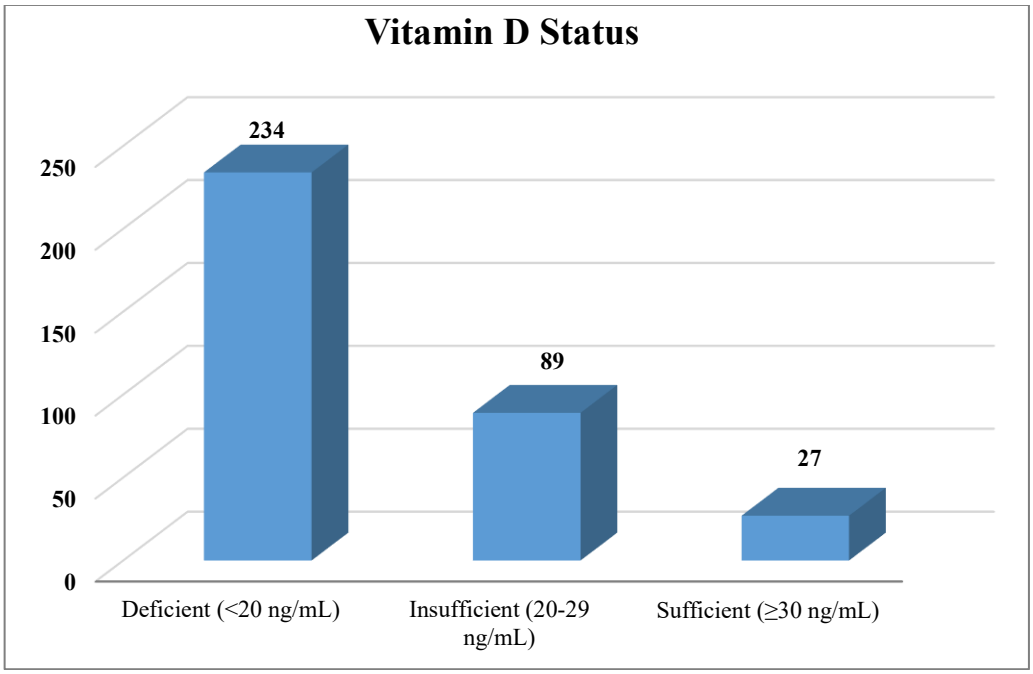

Fig: 5

Table 6: Multivariate Analysis of Risk Factors for Osteoporotic Fractures

Risk Factor	Odds Ratio	95% CI	p-value
Age (per year increase)	1.08	1.04-1.12	0.001
Female gender	2.34	1.56-3.51	<0.001
Previous fracture history	3.12	1.89-5.15	<0.001
Vitamin D deficiency	2.78	1.67-4.62	<0.001
Inadequate calcium intake	2.45	1.48-4.06	0.001
Sedentary lifestyle	1.89	1.23-2.91	0.004
Corticosteroid use	2.67	1.34-5.32	0.005
Underweight (BMI <18.5)	2.12	1.28-3.51	0.004
Smoking	1.78	1.09-2.90	0.021
Diabetes mellitus	1.45	0.97-2.17	0.068

Discussion

The present study revealed a predominant female representation (62.3%) among osteoporotic fracture patients, with the majority (44.6%) belonging to the 60-69 years age group. This gender distribution aligns with findings from Marwaha et al. (2011), who reported similar female predominance in their Indian population study. The higher fracture incidence in women corresponds to postmenopausal estrogen deficiency, leading to accelerated bone loss. Cooper et al. (1992) in their global projection study similarly demonstrated female predominance in hip fractures, with rates increasing exponentially with age.

Hip fractures constituted the largest proportion (40.6%) of all fractures, followed by vertebral fractures (25.4%) and wrist fractures (19.1%). This distribution pattern is consistent with international literature, where hip fractures represent the most serious osteoporotic complication. Dhanwal et al. (2011) reported similar fracture site distribution in their epidemiological study of hip

fractures, emphasizing the global consistency of this pattern. The high prevalence of hip fractures is particularly concerning given their association with increased mortality and healthcare costs.

The mechanism of injury analysis revealed that 82.0% of fractures resulted from falls from standing height, indicating the fragility nature of these fractures. This finding is consistent with the definition of osteoporotic fractures occurring with minimal trauma. Johnell and Kanis (2006) emphasized that low-energy trauma fractures are characteristic of osteoporotic bone disease, distinguishing them from high-energy traumatic fractures in younger populations.

Previous fracture history was identified in 25.4% of participants, representing a significant risk factor for future fractures. This finding corroborates with international studies suggesting that individuals with one osteoporotic fracture have double the risk of subsequent fractures. The study revealed a substantial burden of comorbidities, with hypertension (50.3%) and diabetes mellitus (38.3%) being most prevalent. While diabetes showed marginal statistical significance in multivariate analysis ($p=0.068$), emerging evidence suggests complex relationships between diabetes and bone health through multiple mechanisms.

Corticosteroid use was documented in 8.9% of participants, representing a significant modifiable risk factor with an odds ratio of 2.67. This finding aligns with established literature on glucocorticoid-induced osteoporosis, which represents the most common cause of secondary osteoporosis. The relatively low prevalence of rheumatoid arthritis (6.6%) and other systemic conditions reflects the study's focus on primary osteoporosis rather than secondary causes.

Family history of fractures was present in 19.1% of participants, highlighting the genetic component of osteoporosis. This prevalence is comparable to Western studies but may be underreported in Indian populations due to limited awareness and documentation of family medical histories.

The study revealed alarming lifestyle patterns contributing to fracture risk. Sedentary lifestyle was observed in 47.7% of participants, with an associated odds ratio of 1.89 for fracture risk. This finding emphasizes the importance of weight-bearing exercise in bone health maintenance. Limited sun exposure (<30 minutes daily) was documented in 56.6% of participants, contributing to vitamin D deficiency and subsequent bone mineralization problems.

Inadequate calcium intake was identified in 76.3% of participants, with an odds ratio of 2.45 for fracture occurrence. This finding is particularly relevant in the Indian context, where dietary calcium intake is traditionally low due to limited dairy consumption and reliance on plant-based diets. Paul et al. (2008) reported similar calcium deficiency patterns in their Southern Indian study, emphasizing the need for targeted nutritional interventions.

The predominantly vegetarian dietary pattern (66.9%) in our study population may contribute to both calcium and vitamin D deficiency. While plant-based diets offer numerous health benefits, they require careful planning to ensure adequate bone health nutrients. Tandon et al. (2003) highlighted the challenges of maintaining optimal vitamin D status in Indian populations despite abundant sunlight availability.

Vitamin D deficiency (<20 ng/mL) was identified in 66.9% of participants, with only 7.7% having sufficient levels. This prevalence is consistent with other Indian studies, including Marwaha et al. (2011), who reported similar vitamin D deficiency rates in elderly populations. The strong association between vitamin D deficiency and fracture risk (OR: 2.78) underscores the critical importance of vitamin D in bone health maintenance.

Elevated alkaline phosphatase levels (142 ± 38 IU/L) and parathyroid hormone (67.8 ± 24.3 pg/mL) suggest increased bone turnover and secondary hyperparathyroidism in response to vitamin D deficiency. These biochemical abnormalities reflect the cascade of metabolic disturbances leading to bone loss and increased fracture susceptibility.

The mean 25-OH vitamin D level of 18.4 ± 8.7 ng/mL falls well below the recommended therapeutic range, indicating widespread deficiency requiring systematic intervention strategies. Adami et al. (2009) demonstrated that vitamin D status significantly influences treatment response in osteoporotic patients, emphasizing the importance of adequate supplementation.

Multivariate analysis identified several independent risk factors for osteoporotic fractures. Advanced age showed incremental risk increase with an odds ratio of 1.08 per year, consistent with

the well-established age-related decline in bone density and quality. Female gender emerged as a strong predictor (OR: 2.34), reflecting the impact of postmenopausal estrogen deficiency on bone metabolism.

Previous fracture history demonstrated the highest odds ratio (3.12), emphasizing the importance of fracture prevention strategies in individuals with prior fractures. This finding supports the concept of fracture cascade, where initial fractures predispose to subsequent fractures through multiple mechanisms including bone quality deterioration and increased fall risk.

Underweight status (BMI <18.5) was associated with increased fracture risk (OR: 2.12), consistent with the protective effect of adequate body weight on bone density. This finding is particularly relevant in the Indian context, where undernutrition remains prevalent among elderly populations, especially in rural areas.

The identification of modifiable risk factors including vitamin D deficiency, inadequate calcium intake, sedentary lifestyle, and smoking provides opportunities for targeted interventions. These findings align with recommendations from international guidelines emphasizing comprehensive fracture prevention approaches addressing both pharmacological and non-pharmacological interventions.

Conclusion

This hospital-based study demonstrated a high prevalence of osteoporotic fractures among elderly patients, with hip fractures being the most common type affecting predominantly postmenopausal women. The study identified several significant risk factors including advanced age, female gender, previous fracture history, vitamin D deficiency, inadequate calcium intake, sedentary lifestyle, and underweight status. The alarming prevalence of vitamin D deficiency (66.9%) and inadequate calcium intake (76.3%) highlights critical nutritional deficiencies requiring immediate attention. The predominance of low-energy trauma mechanisms (82.0%) confirms the fragility nature of these fractures. Multivariate analysis revealed that previous fracture history carried the highest risk (OR: 3.12), followed by vitamin D deficiency (OR: 2.78) and inadequate calcium intake (OR: 2.45). These findings emphasize the multifactorial nature of osteoporotic fractures and the need for comprehensive prevention strategies addressing both modifiable and non-modifiable risk factors in elderly populations.

Recommendations

Healthcare systems should implement comprehensive osteoporosis screening programs targeting high-risk elderly populations, particularly postmenopausal women and individuals with previous fracture history. Mandatory vitamin D and calcium supplementation programs should be established, given the widespread deficiency observed in this population. Public health initiatives promoting weight-bearing exercise, adequate sun exposure, and calcium-rich dietary modifications are essential for primary prevention. Healthcare providers should receive training on fracture risk assessment tools and evidence-based prevention strategies to improve early identification and management of high-risk individuals. Fall prevention programs incorporating environmental modifications, balance training, and medication review should be integrated into geriatric care protocols. Policy makers should consider developing national guidelines for osteoporosis prevention and management specifically adapted to Indian populations, addressing unique cultural, dietary, and socioeconomic factors. Regular monitoring and evaluation of intervention effectiveness should be established to ensure optimal resource utilization and patient outcomes in reducing the growing burden of osteoporotic fractures.

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