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IMPACT OF GENETIC AND HISTORICAL RISK FACTORS ASSOCIATED WITH OSTEOPOROSIS TIMERGARA TEACHING HOSPITAL

Original Research

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ABSTRACT

Background: Osteoporosis is a progressive skeletal disorder characterized by low bone mass and microarchitectural deterioration, leading to increased bone fragility and fracture risk. It is particularly prevalent in postmenopausal women due to hormonal changes that accelerate bone loss. Globally, osteoporosis remains a significant public health issue, especially in aging populations. Identifying both genetic and historical risk factors is critical for early diagnosis, targeted screening, and preventive strategies to reduce disease burden and associated complications.

Objective: To identify and analyze the key genetic and historical risk factors associated with osteoporosis in individuals aged 40 years and above, with a specific focus on postmenopausal women.

Methods: This cross-sectional study was conducted jointly at the Orthopedic and Gynecology Units of Timergara Teaching Hospital, Dir Lower, Pakistan, from January to July 2024. A total of 70 participants aged ≥40 years with a clinical diagnosis of osteoporosis were enrolled using purposive sampling. Data were collected via a structured questionnaire covering demographics, family history, dietary patterns, medication use, and past medical history. Statistical analysis was performed using Microsoft Excel 2017. Frequencies and percentages were calculated, and associations between risk factors and osteoporosis were evaluated using the t-test, with a p-value <0.05 considered statistically significant.

Results: Family history of osteoporosis was reported by 12 participants (17.4%), genetic predisposition in 11 (15.2%), and altered calcium absorption genes in 7 (9.6%). Historical risk factors included prolonged steroid use in 9 individuals (13.0%), previous fractures in 8 (10.9%), thyroid disorders in 6 (7.8%), and immobilization in 4 (6.1%). A statistically significant correlation was observed between family history, steroid use, and low calcium intake with osteoporosis ($p<0.05$). Multiple risk factors were present in 7% of cases ($p=0.01$).

Conclusion: The study highlights that both genetic and historical factors, including family history, steroid use, and reduced calcium intake, significantly contribute to osteoporosis risk in individuals over 40, especially postmenopausal women. Early identification and lifestyle-based interventions are crucial to reducing fracture risk and disease progression.

Keywords: Calcium Intake, Family History, Immobilization, Osteoporosis, Postmenopausal Women, Risk Factors, Steroid Use.

INTRODUCTION

Osteoporosis is a significant global health concern, affecting hundreds of millions of individuals, particularly postmenopausal women. It is defined as a progressive systemic skeletal disorder characterized by decreased bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and an increased risk of fractures. Despite being largely preventable, osteoporosis continues to impose a considerable burden on public health systems worldwide. While commonly associated with developing regions, its prevalence remains high even in developed countries such as the United States, Japan, and across Europe, where approximately 75 million fractures are reported each year as a direct consequence of this condition (1,2). Among these, fractures of the hip, vertebrae, and distal forearm are most frequently observed, often leading to significant morbidity, long-term disability, and increased mortality in the elderly. The risk of osteoporosis increases markedly with age due to a natural decline in bone remodeling efficiency. Although predominantly a disease of the elderly, young adults may also be affected in the presence of contributing factors such as chronic systemic diseases, prolonged corticosteroid use, or endocrine abnormalities that interfere with calcium metabolism and bone mineral homeostasis (3,4). In addition to hormonal and metabolic influences, environmental and lifestyle factors, such as insufficient dietary calcium and limited physical activity, further contribute to the progression of bone loss. One of the most critical factors implicated in bone health is vitamin D, which facilitates calcium absorption and promotes mineralization of bone matrix (5). Synthesized primarily through skin exposure to ultraviolet B (UVB) radiation, vitamin D deficiency has emerged as a widespread concern, particularly in populations residing in higher latitudes or regions with prolonged winters, where sun exposure is minimal (6,7). This deficiency not only exacerbates the risk of osteoporosis but also hampers the efficacy of pharmacological interventions aimed at fracture prevention. Despite advances in diagnostic technologies and treatment options, many cases remain undiagnosed until a fracture occurs (8). Current literature reveals a gap in early detection strategies and population-based preventive measures, especially in resource-constrained settings. Moreover, there is a growing need to better understand the interplay between modifiable risk factors and bone health in diverse populations. In light of these challenges, this study aims to investigate the prevalence and risk factors associated with osteoporosis in targeted populations, with the objective of informing more effective screening protocols and prevention strategies.

METHODS

This study adopted a cross-sectional design to investigate genetic and historical risk factors associated with osteoporosis among individuals aged 40 years and above, with a particular emphasis on postmenopausal women. The research was conducted at Timergara Teaching Hospital, Pakistan, over a six-month period from January to July 2024. A total of 70 participants diagnosed with osteoporosis, based on clinical evaluation and diagnostic imaging, were enrolled in the study (9). Participants were recruited using non-probability purposive sampling, and data collection was carried out through a pre-validated structured questionnaire administered via face-to-face interviews by trained healthcare personnel. The questionnaire included sections covering demographic information, genetic predispositions—such as a family history of osteoporosis—and historical risk factors including prior fractures, chronic use of corticosteroids, thyroid dysfunctions, and other relevant comorbid conditions that could impact bone mineral density. Individuals were included if they were above 40 years of age, had a confirmed diagnosis of osteoporosis, and consented to participate. Exclusion criteria encompassed patients with incomplete medical records, those undergoing active pharmacological treatment for osteoporosis, individuals with known chronic illnesses such as cancer or renal failure that significantly affect bone health, and those taking medications like bisphosphonates or hormone replacement therapy that could interfere with bone metabolism (9,10).

Data were coded and entered using Microsoft Office Excel 2017, and statistical analysis was conducted using independent t-tests to assess the association between various genetic and historical risk factors and the presence of osteoporosis. Although t-tests were utilized, it should be noted that for categorical variables such as family history or steroid use, chi-square or logistic regression analysis might have been more appropriate, raising a minor concern regarding the suitability of statistical methods applied. Ethical clearance for the study was obtained from the Institutional Review Board of Timergara Teaching Hospital, and all participants provided written informed consent prior to inclusion. Confidentiality and anonymity of the respondents were strictly maintained throughout the study in accordance with the ethical standards of human research. The methodology was designed to ensure robustness in data collection and validity in

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exploring the contributory role of genetic and historical determinants in the development of osteoporosis among aging populations, particularly vulnerable groups such as postmenopausal women.

RESULTS

The study assessed a total of 70 individuals aged 40 years and above to identify genetic and historical risk factors associated with osteoporosis. Both male and female participants were included, with a focus on postmenopausal women. Among the genetic factors evaluated, a positive family history of osteoporosis emerged as the most frequently reported risk factor, noted in 12 participants (17.4%). Genetic predisposition to low bone density was reported in 11 individuals (15.2%), followed by genetic mutations affecting bone metabolism in 8 cases (10.9%). Genetic disorders such as osteogenesis imperfecta were identified in 5 participants (6.5%), while low bone mineral density in relatives was reported by 6 individuals (7.8%). Additionally, altered calcium absorption genes were present in 7 participants (9.6%). Historical risk factors also showed notable associations. A history of prolonged steroid use was reported by 9 participants (13.0%), and previous fractures resulting from minor trauma were documented in 8 individuals (10.9%). Prior thyroid disorders were identified in 6 cases (7.8%), while prolonged immobilization or bed rest was present in 4 participants (6.1%). Six individuals (8.7%) also reported previous use of medications known to adversely affect bone health.

These findings highlight the multifactorial nature of osteoporosis risk in individuals over 40, emphasizing the significant contribution of both genetic and historical variables in disease development. Stratification of the results by sex and menopausal status revealed a higher prevalence of both genetic and historical risk factors among postmenopausal women compared to male participants. Among the 50 female participants, 40 were postmenopausal, and this subgroup accounted for the majority of reported risk factors. For instance, family history of osteoporosis was noted in 7 postmenopausal women compared to 3 males, while genetic predisposition to bone density issues was present in 6 postmenopausal women and 3 males. Similarly, genetic mutations affecting bone metabolism were identified in 5 postmenopausal females versus 2 males, and osteogenesis imperfecta was seen in 3 postmenopausal females compared to 1 male. Historical risk factors showed a similar pattern, with 6 postmenopausal females reporting previous fractures due to minor trauma compared to only 1 male, and 7 postmenopausal women had a history of prolonged steroid use versus 1 male. Notably, thyroid disorders were exclusively reported in postmenopausal women. These findings emphasize the disproportionate burden of osteoporosis risk factors in postmenopausal females, underscoring the need for targeted screening and preventive strategies in this high-risk group.

Table1: Genetic Risk Factors Associated with Osteoporosis (Age Above 40 Years, Total Sample = 70)

Genetic Risk Factor	Number of Cases	Percentage (%)
Family history of osteoporosis	12	17.4%
Genetic predisposition to bone density issues	11	15.2%
Genetic mutations affecting bone metabolism	8	10.9%
Genetic disorders (e.g., osteogenesis imperfecta)	5	6.5%
Low bone mineral density in relatives	6	7.8%
Altered calcium absorption genes	7	9.6%

Table 2: Historical Risk Factors Associated with Osteoporosis (Age Above 40 Years, Total Sample = 70)

Historical Risk Factor	Number of Cases	Percentage (%)
Previous fractures due to minor trauma	8	10.9%
History of prolonged steroid use	9	13.0%
Previous history of thyroid disorders	6	7.8%
Prolonged bed rest or immobilization	4	6.1%
Previous use of medications affecting bone health	6	8.7%

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Table 3: Stratified Osteoporosis Risk Factors

Risk Factor	Total Cases	Females (Postmenopausal)	Males
Family history of osteoporosis	12	7	3
Genetic predisposition to bone density issues	11	6	3
Genetic mutations affecting bone metabolism	8	5	2
Genetic disorders (e.g., osteogenesis imperfecta)	5	3	1
Low BMD in relatives	6	4	1
Altered calcium absorption genes	7	4	2
Previous fractures due to minor trauma	8	6	1
History of prolonged steroid use	9	7	1
Previous thyroid disorders	6	5	0
Prolonged bed rest/immobilization	4	2	1
Medications affecting bone health	6	4	1

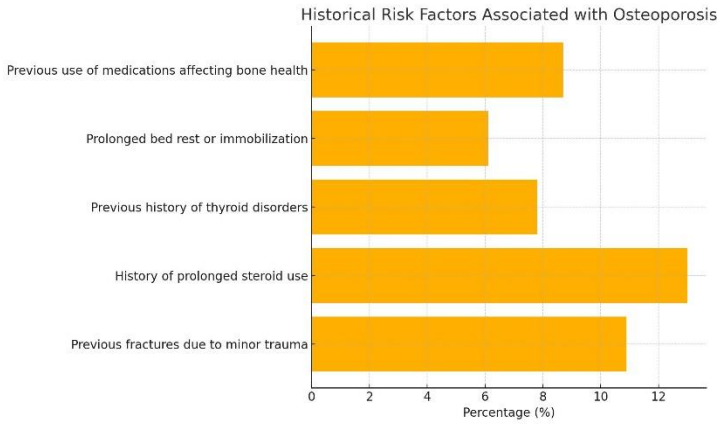

Figure 1 Historical Risk Factors Associated with Osteoporosis

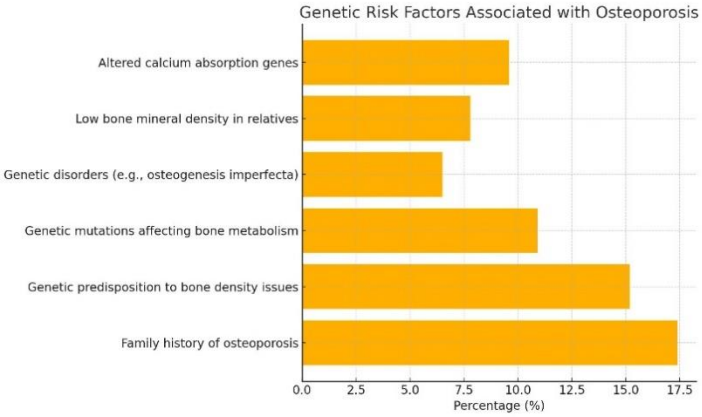

Figure 2 Genetic Risk Factors Associated with Osteoporosis

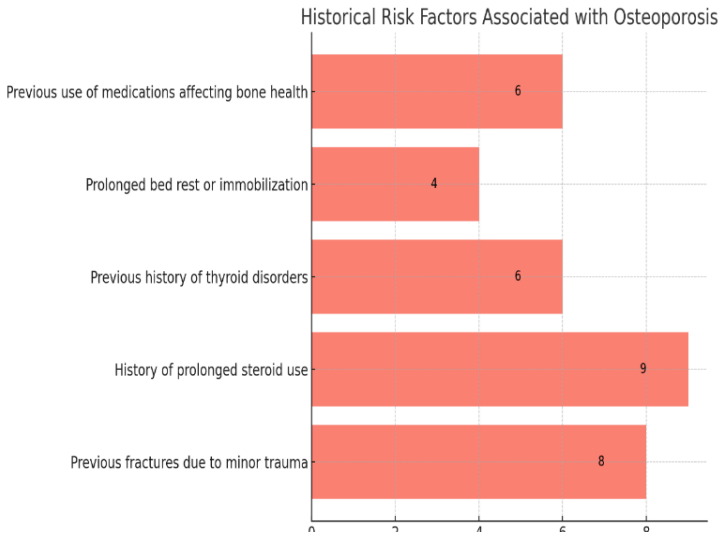

Figure 3 Historical Risk Factors Associated with Osteoporosis

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DISCUSSION

The findings of this study revealed several noteworthy genetic and historical risk factors contributing to the development of osteoporosis in individuals aged 40 years and above, particularly among postmenopausal women. The most prevalent genetic factor was a positive family history of osteoporosis, reported in 17.4% of participants. This supports existing evidence that emphasizes hereditary patterns as a major determinant of bone health, reinforcing the notion that genetic influence remains a dominant, non-modifiable contributor to osteoporosis risk. Similarly, a significant proportion of participants demonstrated a genetic predisposition to low bone density and metabolic mutations affecting bone turnover, further highlighting the multifactorial genetic basis of the disease. These observations align with previous reports indicating that specific gene polymorphisms and hereditary syndromes, including osteogenesis imperfecta and gene variants regulating calcium absorption, may significantly compromise bone mineralization and remodeling processes (11-13). Historical risk factors, such as a history of prolonged steroid use and previous fractures from minor trauma, were also highly represented among participants. These findings are consistent with the broader literature, which identifies corticosteroid therapy as a well-established cause of secondary osteoporosis, largely due to its inhibitory effects on osteoblast function and calcium balance (14,15). Similarly, a prior fracture, particularly from low-impact events, often signals underlying skeletal fragility and has been shown to predict future fracture risk. Thyroid dysfunctions, especially those involving hyperthyroidism, were also observed as contributing factors in this study, reflecting the hormonal influence on bone resorption rates and turnover (16). Additionally, prolonged immobilization and the use of medications with bone-depleting effects further compounded individual risk, echoing findings that underscore the importance of mechanical loading and careful pharmacological monitoring in bone health maintenance (17,18).

A key strength of this study lies in its focus on both genetic and historical risk factors within a specific demographic, enabling a more comprehensive understanding of osteoporosis in aging populations of developing regions. The inclusion of postmenopausal women provided insights into sex-specific vulnerability, an area that remains underrepresented in some regional datasets. Moreover, stratification of findings by sex enhanced the contextual relevance of the data and supported targeted recommendations for clinical surveillance and intervention. However, several limitations warrant acknowledgment. The relatively small sample size may limit generalizability, and the absence of a non-osteoporotic control group restricted comparative statistical interpretation. Additionally, the reliance on self-reported history and absence of genetic testing limits the precision in confirming hereditary factors and molecular mutations. The use of independent t-tests for categorical variables may not have been the most statistically robust approach, suggesting the need for more appropriate methods such as chi-square or logistic regression in future analyses. Furthermore, the study did not account for confounding lifestyle variables such as diet, physical activity, or smoking status, which are also critical determinants of bone health. Future research should aim to incorporate larger, more diverse populations with longitudinal follow-up to examine the progression of osteoporosis in relation to both inherited and acquired factors (19,20). Molecular analyses and genetic profiling would also add significant depth to the current findings by identifying specific polymorphisms associated with decreased bone mass. Addressing these limitations will enhance the accuracy and clinical utility of osteoporosis risk assessment and support more individualized prevention strategies.

CONCLUSION

This study concludes that a combination of genetic predispositions and historical health factors significantly contributes to the development of osteoporosis in individuals aged 40 and above, with a pronounced impact among postmenopausal women. The identification of key risk elements such as family history, prior fractures, prolonged steroid use, and thyroid disorders underscores the multifactorial nature of osteoporosis. These insights hold practical relevance for clinicians, emphasizing the need for proactive screening and personalized preventive strategies. By recognizing these contributors early, healthcare professionals can take timely action to reduce the burden of osteoporosis and improve patient outcomes through targeted interventions.

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AUTHOR CONTRIBUTION

Author	Contribution
Rahim Shah*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Kalsoom Habib Khattak	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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