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Prevalence and Risk Factors of Osteoporosis in Postmenopausal Females in Central India

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ABSTRACT

This observational cross-sectional study examined the prevalence and determinants of osteopenia and osteoporosis in postmenopausal females from Central India. A total of 407 women were screened using dual-energy X-ray absorptiometry (DEXA) to determine T-scores at the hip bone and lumbar spine. The study found that 32.10% of women had osteoporosis and 42.20% had osteopenia. Regression analysis revealed several independent factors impacting the likelihood of osteopenia and osteoporosis, including higher systolic blood pressure, triglyceride levels, poor sleep quality and elevated C-reactive protein levels. Notably, postmenopausal women with more than 10 years since menopause were at a higher risk of osteopenia. Conversely, a higher body mass index was found to be protective against both osteoporosis and osteopenia. The high prevalence of osteopenia and osteoporosis among postmenopausal females in Central India indicate the need for increased awareness and early testing for those approaching menopause. These findings highlight the importance of preventive measures and promoting the well-being of this population.

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Key Words
Osteoporosis, post menopause, triglycerides, female, C-reactive protein

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INTRODUCTION

Osteoporosis represents a systemic condition characterized by intricate and multifaceted molecular pathways that interact to diminish both the quantity and strength of bone tissue, leading to the deterioration of its microarchitecture[1]. A primary consequence of this pathological process is the reduction in bone mineral density (BMD), which correlates with the increased susceptibility to fractures and the development of weakened and fragile bones[2]. Although, osteoporosis and associated complications, such as chronic pain and fractures, can occur in both gender, females face a higher vulnerability, accounting for approximately 70-80% of all incidents involving fractures in areas such as the hip, vertebral column and wrist[3]. This higher prevalence is furthermore accentuated in postmenopausal females due to the decline in estrogen levels, which accelerates the reduction in bone density[4].

Numerous studies have extensively documented a range of factors that are closely linked to osteoporosis and contribute to its heightened threat[1-4]. These factors encompass female gender, increasing age following menopause, lower body mass index (BMI), familial predisposition, inadequate dietary habits, inactive lifestyle, smoking, alcohol drinking and associated comorbidities[1-4]. It is important to note that the amount and influence of such factors, either in isolation or in combination, exhibit variations across different geographical locations[5]. For example, the prevalence of osteoporosis and related fracture is more pronounced among Scandinavian people compared to individuals in Africa and South America. This discrepancy can be attributed to the relatively lower vitamin D exposure in Scandinavia compared to regions with a higher annual incidence of sunlight and sunshine[6]. Furthermore, the attainment of peak bone mass is also subject to disparity due to divergent nutritional intake patterns observed between developing versus developed countries[2].

As per the data provided by the World Health Organization (WHO), approximately 30% of postmenopausal females experience osteoporosis[4]. In India, it is stated that 61 million individuals are affected by osteoporosis, with women constituting 80% of this population[7]. Notably, the incidence of osteoporosis occurs about one to two decades earlier in India compared to Western countries, resulting in significant repercussions on both health and financial resources[8,9]. However, there is a dearth of prevalence statistics and knowledge regarding independent predictors of postmenopausal osteoporosis, particularly in India, where one in every three women and one in every eight men are affected by this condition[7]. Investigating common risk factors to identify independent factors associated with the development of osteoporosis is a crucial strategy that can aid in the development of effective management approaches for osteoporosis and its associated consequences. Remarkably, there is a lack of comprehensive studies on the occurrence rates and determinants of osteoporosis or osteopenia specifically among the population of Central India, which is the focus of the present study.

MATERIALS AND METHODS

This prospective cross-sectional study was done at a tertiary care medical college in Central India, specifically focusing on postmenopausal women. The inclusion criteria involved women aged between 50-80 years who had experienced established menopause, defined as the absence of menstruation for one or more complete years. Exclusion criteria encompassed non-consenting individuals, those with musculoskeletal diseases, cardiovascular diseases, cerebrovascular pathology, diabetes, liver diseases, sarcopenia, family history of osteoporotic fracture, thyroid disorders, systemic lupus erythematosus, chronic renal disorders, individuals taking medications that can alter blood pressure or lipoprotein levels, individuals taking psychotropic medications or psychoactive substances and those taking multivitamins and/or antioxidants.

Ultimately, a total of 407 postmenopausal females were selected for bone mineral density (BMD) testing. Dual-energy X-ray absorptiometry (DXA) was utilized to measure BMD at the neck of femur (hip) and the lumbar vertebral region (L1-L4). Based on T-scores calculated as per the guidelines provided by the World Health Organization (WHO)[10], the patients were divided into three groups i.e., females with osteoporosis (n = 123), with osteopenia (n = 179) and with normal bone mass (n = 105). Prior to participation in the study, all postmenopausal women provided written consent. The study protocol obtained ethical approval from the Institutional Ethics Committee and adherence to ethical principles was ensured throughout the study[11,12].

The medical records of the patients were reviewed and personal interviews were conducted to gather information on Age and years since menopause (YSM). BMI was derived by dividing the weight in kilograms by square of height in meters. The classification lifestyle as active or sedentary was established by assessing whether the subjects participated in a minimum of thirty minutes of brisk walking/aerobic exercises on a daily basis. Blood pressure (Systolic and Diastolic) was measured by obtaining three readings using a mercury sphygmomanometer at 3 min intervals while

the subject was in a resting position. The average of these readings was used. High-density lipoprotein (HDL), low-density lipoprotein (LDL), Total cholesterol (TC) and triglycerides (TG) were assessed using assay kits. The sleep quality of all postmenopausal women was evaluated using the Pittsburgh Sleep Quality Index (PSQI) questionnaire, which comprises 19 questions across 7 domains related to sleep[13]. Plasma levels of nitric oxide (NO) and C-reactive protein (CRP) and were measured using enzyme-linked immunosorbent assay (ELISA) techniques and analyzed with a microplate reader.

The data were presented using numbers, percentages, or Mean±standard deviation, depending on the nature of the variable. To compare differences between groups, categorical variables were analyzed using the Chi-square test, while continuous variables were assessed using Student's t-test. Univariable linear regression analysis was employed to investigate the influence of risk variables. Variables that exhibited significant relationships ($p<0.1$) in the univariable analysis were further examined using backward stepwise multivariable logistic regression analysis. A significance level of $p<0.05$ was considered statistically significant and Bonferroni's correction was applied for multiple comparisons when necessary.

RESULTS

The present study comprised a sample of 407 postmenopausal females, among whom 123 individuals (30.22%) were classified as osteoporotic, 179 individuals (43.98%) as osteopenic and 105 individuals (25.80%) exhibited normal bone mass. The baseline characteristics of the study participants are detailed in Table 1. Notably, the lipid profile measurements, with the exception of HDL (high-density lipoprotein), were found to exhibit the highest values in osteoporotic subjects, followed by osteopenic subjects and then control subjects.

Univariable regression analysis by employing all the probable risk factors for osteoporosis and osteopenia (Table 2) revealed that BMI>30 kg m^{-2} is a protective factor against the risk of osteopenia and osteoporosis.

Women having YSM >10 years had a higher risk of osteopenia and osteoporosis. Similarly, SBP >120 mmHg and TG levels >150 mg dL^{-1} were observed to impact the risk of osteopenia and osteoporosis. It is well known that lower BMD is a hallmark for osteoporosis and osteopenia, which has been endorsed by this study, as well as the fact that lesser values of BMD at the femoral neck and lumbar spine influence the risk of both osteopenia and osteoporosis. CRP levels >3 mg L^{-1} emerged to be the most significant univariable marker, which tripled the risk of osteoporosis osteopenia and osteoporosis. Multiple backward stepwise regression analysis revealed that YSM >10 years was an independent predictor for osteopenia but not for osteoporosis. All risk variables which were significantly associated in the univariable analysis (except YSM) retained their significance in the multivariable model, influencing the risk of osteopenia and osteoporosis.

Table 1: Anthropometric and otherdetails of study population

Variables	Normal bone mass (n = 105)	Osteoporosis (n = 123)	Osteopenia (n = 179)	p-value (normal bone mass vs. osteoporosis)	p-value (normal bone mass vs. osteopenia)
Age (in years)	69.3±8.0	67.6±7.9	69.5±8.3	0.169	0.486
YSM (years)	13.5±6.1	13.2±4.3	13.5±5.7	0.749	0.913
BMI (kg m^{-2})	24.7±1.8	23.4±1.6	23.8±1.8	<0.050	<0.050
SBP (mmHg)	124.20±12.60	128.95±13.90	127.20±12.30	0.011	0.033
DBP (mmHg)	96.6±11.50	100.20±14.30	98.30±13.10	0.014	0.123
TC (mg dL^{-1})	224.75±20.95	226.05±21.20	225.35±20.66	0.696	0.852
LDL (mg dL^{-1})	195.25±19.55	198.25±14.45	196.55±9.50	0.244	0.502
HDL (mg dL^{-1})	49.32±4.92	48.65±3.72	49.05±3.90	0.503	0.782
TG (mg dL^{-1})	133.65±47.00	169.45±56.89	162.81±54.97	<0.050	<0.050
Non-smokers	86 (81.90)	101 (82.11)	145 (81.01)	0.660	0.510
Smokers	13 (12.38)	12 (10.04)	20 (11.17)		
Ex-smokers	6 (5.71)	10 (8.03)	14 (7.59)		
Non-drinkers	88 (83.81)	97 (78.86)	151 (84.36)	0.190	1.010
Drinkers	9 (8.99)	19 (15.45)	19 (10.61)		
Ex-drinkers	8 (7.19)	7 (5.69)	9 (5.03)		
Family history (yes)	43 (40.49)	75 (60.98)	98 (54.75)	<0.050	<0.050
Family history (no)	62 (59.31)	48 (39.02)	81 (45.25)		
Active lifestyle	65 (62.46)	53 (43.09)	84 (46.93)	<0.050	<0.050
Sedentary	40 (37.55)	70 (56.91)	95 (53.07)		
Good sleep	66 (62.86)	52 (42.28)	85 (47.49)	<0.050	<0.050
Poor sleep	39 (37.14)	71 (57.72)	94 (52.51)		
BMD_FN (g cm^{-2})	0.92±0.11	0.86±0.18	0.89±0.14	<0.050	<0.050
BMD_LS (g cm^{-2})	0.89±0.06	0.74±0.16	0.81±0.21	<0.050	<0.050
CRP (mg L^{-1})	6.02±7.2	13.98±7.0	12.05±6.9	<0.050	<0.050
NO (µmol L^{-1})	8.9±5.7	8.4±5.15	9.2±5.3	0.430	0.320

Table 2: Independent risk determinants for osteopenia and osteoporosis

Variables	Input variables	p-value (univariate analysis)	p-value (multivariate analysis)
Age (years)	≤60 vs. >60	Osteoporosis: 0.19 Osteopenia: 0.25	--
BMI (kg·m−2)	≤30 vs. >30	Osteoporosis:<0.05 Osteopenia:<0.05	Osteoporosis: <0.05 Osteopenia: <0.05
YSM (years)	≤10 vs. >10	Osteoporosis:<0.05 Osteopenia:<0.05	Osteoporosis: 0.06 Osteopenia:<0.05
DBP (mmHg)	≤80 vs. >80	Osteoporosis: 0.19 Osteopenia: 0.23	--
SBP (mmHg)	≤120 vs. >120	Osteoporosis: <0.05 Osteopenia: <0.05	Osteoporosis: <0.05 Osteopenia: <0.05
TC (mg dL^{-1})	≤200 vs. >200	Osteoporosis: 0.18 Osteopenia: 0.28	--
LDL (mg dL^{-1})	≤100 vs. >100	Osteoporosis: 0.21 Osteopenia: 0.20	--
HDL (mg dL^{-1})	≤40 vs. >40	Osteoporosis: 0.16 Osteopenia: 0.21	--
TG (mg dL^{-1})	≤150 vs. >150	Osteoporosis: <0.05 Osteopenia: <0.05	Osteoporosis: <0.05 Osteopenia: <0.05
Sleep (scores)	≤5 vs. >5	Osteoporosis: <0.05 Osteopenia: <0.05	Osteoporosis: <0.05 Osteopenia: <0.05
CRP (mg L^{-1})	≤3 vs. >3	Osteoporosis: <0.05 Osteopenia: <0.05	Osteoporosis: <0.05 Osteopenia: <0.05
NO (µmol L^{-1})	≤11 vs. >11	Osteoporosis: 0.34 Osteopenia: 0.38	--
BMD_FN (g cm^{-2})	≤0.7 vs. >0.7	Osteoporosis: <0.05 Osteopenia: <0.05	Osteoporosis: <0.05 Osteopenia: <0.05
BMD_LS (g cm^{-2})	≤0.8 vs. >0.8	Osteoporosis: <0.05 Osteopenia: <0.05	Osteoporosis: <0.05 Osteopenia: <0.05

DISCUSSIONS

This study aimed to examine the prevalence and prognosticators of osteopenia and osteoporosis within a sample of 407 postmenopausal women residing in Central India. The research findings indicate that osteoporosis is prevalent in approximately 32.10% of the participants, whereas osteopenia affects a higher proportion, accounting for approximately 42.20% of the sample. Notably, an elevated body BMI exceeding 30 kg m^{-2} emerged as an independent defending factor against the development of both osteopenia and osteoporosis. These findings are consistent with a systematic review Turcotte *et al*.[14] that also provide supporting evidence for the inverse relationship between higher BMI and the risk of these conditions. However, it is essential to acknowledge that contradictory results have been reported in other studies, suggesting a positive association between higher BMI and increased susceptibility to osteoporosis and fragility fractures[13,15]. Intriguingly, it has been demonstrated that risk of fractures in postmenopausal females is influenced more significantly by higher BMI rather than low bone mineral density (BMD)[16].

The comprehensive scrutiny of these inconsistent and inconclusive findings about the relationship between BMI and osteoporosis risk leads to two key observations. Firstly, the association between BMI and the occurrence of osteoporosis appears to be a sequel rather than a direct cause, influenced by other factors such as a sedentary lifestyle. Secondly, preserving a normal weight following menopause is favorable approach. Therefore, interventions aimed at modifying BMI through exercise may play a crucial role in alleviating the threat of post-menopausal osteoporosis.

Several studies have demonstrated a significant association between elevated lipid profiles, particularly triglycerides (TG) and compromised bone mineral mass, impaired bone metabolism and greater susceptibility to brittleness fractures[17,18]. Triglycerides are synthesized by the liver and are transported by the very low-density lipoproteins (VLDLs). In cases where LDL-mediated transport is impaired, these uncleared triglycerides contribute to the generation of oxygen free radicals, leading to lipid oxidation. The resulting oxidized lipids hinder osteoblast development both in bones and arterial walls, thereby impeding bone mineral development[19].

In or study, it was observed that females with TG levels greater than 150 mg dL^{-1} exhibited a twofold increased threat of osteoporosis and 1.67 times greater chances of osteopenia. Notably, lipid-lowering medications, particularly statins (HMG-CoA reductase inhibitors), have shown the ability to enhance bone mineralization and considerably reduce risk of fractures[20,21]. Since lipid levels can be altered either through dietary regulation or pharmacological mediations, it is possible to mitigate the risk of osteoporosis associated with elevated lipids to some extent.

A meta-analysis has established a clear association between hypertension and bone loss, as well as an increased risk of fractures[22]. These findings are consistent with the present study, which demonstrates that higher systolic blood pressure (SBP) (>120 mmHg) is independently linked to the risk of osteopenia and

osteoporosis. Hypertension has been associated in significant loss of bone minerals and disturbances in calcium metabolism, leading to enhanced bone resorption[23].

It is nowadays recognized that certain antihypertensive medications, such as thiazide, can decrease the risk of fracture by promoting the deposition of bone minerals. Additionally, the activation of osteoclasts can be inhibited by Ang II inhibitors, resulting in a substantial decrease in the risk of osteoporotic fracture[24]. Consequently, it is suggested to manage the detrimental effects that hypertension can have on bone health through the implementation of an appropriate antihypertensive drug regimen.

Adequate and restful sleep plays a crucial role in maintaining bone health, whereas poor sleep quality can negatively impact skeletal health by contributing to deformities and impairing the bone's healing ability following fragility fractures[25]. In line with this, our study has discovered that postmenopausal females experiencing poor sleep (scoring $\geq$5 on the PSQI scale) are at approximately twice the risk of developing osteopenia and osteoporosis. Furthermore, the study's findings indicate that persons who consistently achieve 8 hrs of quality sleep have a lesser likelihood of developing osteoporosis as compared to those who sleep only 6 hrs[26].

In the clinical literature, it has been proposed that chronic inflammation negatively affects bone mineral density (BMD) and elevated values of the pro-inflammatory indicator C-reactive protein (CRP) are inversely related with BMD, thereby increasing the threat of osteoporosis and fracture[27]. This association is further supported by the findings of our study, where higher CRP values were identified as the most significant threat factor for osteopenia and osteoporosis. Plasma CRP is strongly influenced by changeable factors like exercise. A systematic review has demonstrated that exercise has a significant impact on reducing CRP levels[28]. Additionally, another study has established a significant correlation between higher CRP levels and lower BMD both in healthy pre as well as postmenopausal women[29]. Collectively, these studies propose that interventions aimed at reducing CRP levels through exercise or anti-inflammatory medications may hold promise in mitigating the risk of demineralization of bone and the occurrence of fractures.

CONCLUSION

The prevalence of osteopenia and osteoporosis among postmenopausal females in Central India, is a cause for significant concern. These findings underscore the necessity for comprehensive osteoporosis testing and preliminary awareness programs targeting women entering menopause. By implementing these measures, the aim is to ensure enhanced healthcare provisions for postmenopausal women in order to mitigate the impact of these conditions. Postmenopausal women in Central India, demonstrate a noteworthy association between BMI and the possibility of decreased bone mineral density. A higher BMI appears to confer a protective effect against these conditions. Conversely, elevated SBP, increased values of plasma C-reactive protein (CRP) and triglycerides (TG), as well as poor sleep patterns, independently contribute to an elevated risk of decreased bone mineral density among this population.

REFERENCES

1. Hendrickx, G., E. Boudin and W.V. Hul, 2015. A look behind the scenes: The risk and pathogenesis of primary osteoporosis. Nat. Rev. Rheumatol., 11: 462-474.
2. Weaver, C.M., C.M. Gordon, K.F. Janz, H.J. Kalkwarf and J.M. Lappe *et al*., 2016. The national osteoporosis foundation's position statement on peak bone mass development and lifestyle factors: A systematic review and implementation recommendations. Osteoporosis Int., 27: 1281-1386.
3. Johnell, O. and J.A. Kanis, 2006. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporosis Int., 17: 1726-1733.
4. Kanis, J.A. and J.A. Kanis, 1994. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: Synopsis of a who report. Osteoporosis Int., 4: 368-381.
5. Litwic, A., M. Edwards, C. Cooper and E. Dennison, 2012. Geographic differences in fractures among women. Women's Health, 8: 673-684.
6. Holick, M.F., 2004. Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers and cardiovascular disease. Am. J. Clin. Nutr., 80: 1678-1688.
7. Joshi, V.R., G. Mangat, C. Balakrishnan and G. Mittal, 1998. Osteoporosis: Approach in Indian scenario. J. Assoc. Physicians India, 46: 965-967.
8. Krishna, U. and R.U. Mehta, 2000. Osteoporosis: Incidence and implications. J. Obstet. Gynecol. India, 50: 150-156.
9. Khajuria, D.K., R. Razdan and D.R. Mahapatra, 2011. Drugs for the management of osteoporosis: A review. Rev. Bras. Reumatol., 51: 365-371.
10. Consensus development Conference, 1993. Diagnosis, prophylaxis and treatment of osteoporosis. Am. J. Med., 94: 646-650.
11. World Medical Association, 2008. Ethical principles for medical research involving human subjects. https://www.wma.net/wp-content/uploads/2016/11/DoH-Oct2008.pdf

12. Mathur, R., 2017. National Ethical Guidelines for Biomedical and Health Research Involving Human Participants. Indian Council of Medical Research, New Delhi, ISBN-16: 978-81-910091-94, Pages: 187.
13. Premaor, M.O., K. Ensrud, L. Lui, R.A. Parker and J. Cauley, 2011. Risk factors for nonvertebral fracture in obese older women. J. Clin. Endocrinol. Metab., 96: 2414-2421.
14. Turcotte, A.F., S. O'Connor, S.N. Morin, J.C. Gibbs, B.M. Willie, S. Jean and C. Gagnon, 2021. Association between obesity and risk of fracture, bone mineral density and bone quality in adults: A systematic review and meta-analysis. PLOS ONE, Vol. 16 .10.1371/journal.pone.0252487.
15. Kim, J., S. Lee, S.S. Kim, J.P. Lee and J.S. Kim *et al*., 2021. Association between body mass index and fragility fracture in postmenopausal women: A cross-sectional study using Korean national health and nutrition examination survey 2008-2009 (KNHANES IV). BMC Women's Health, Vol. 21. 10.1186/s12905-021-01209-4.
16. Barbour, K.E., J.M. Zmuda, R. Boudreau, E.S. Strotmeyer, M.J. Horwitz, 2012. The effects of adiponectin and leptin on changes in bone mineral density. Osteoporos Int., 23: 1699-1710.
17. Sivas, F., E. Alemdaroğlu, E. Elverici, T. Kuluğ and K. Özoran, 2008. Serum lipid profile: Its relationship with osteoporotic vertebrae fractures and bone mineral density in Turkish postmenopausal women. Rheumatol. Int., 29: 885-890.
18. Singh, M., P. Singh, P.K. Juneja, S. Singh and T. Kaur, 2010. SNP-SNP interactions within apoe gene influence plasma lipids in postmenopausal osteoporosis. Rheumatol. Int., 31: 421-423.
19. Parhami, F., A.D. Morrow, J. Balucan, N. Leitinger and A.D. Watson *et al*., 1997. Lipid oxidation products have opposite effects on calcifying vascular cell and bone cell differentiation: A possible explanation for the paradox of arterial calcification in osteoporotic patients. Arteriosclerosis, Thrombosis, Vasc. Biol., 17: 680-687.
20. Edwards, C., D. Hart and T. Spector, 2000. Oral statins and increased bone-mineral density in postmenopausal women. Lancet, 355: 2218-2219
21. Meier, C.R., R.G. Schlienger, M.E. Kraenzlin, B. Schlegel and H. Jick, 2000. HMG-CoA reductase inhibitors and the risk of fractures. JAMA, 283: 3205-3210.
22. Li, C., Y. Zeng, L. Tao, S. Liu, Z. Ni, Q. Huang and Q. Wang, 2017. Meta-analysis of hypertension and osteoporotic fracture risk in women and men. Osteoporosis Int., 28: 2309-2318.
23. Strazzullo, P., V. Nunziata, M. Cirillo, R. Giannattasio, L.A. Ferrara, P.L. Mattioli and M. Mancini, 1983. Abnormalities of calcium metabolism in essential hypertension. Clin. Sci., 65: 137-141.
24. Nakagami, H. and R. Morishita, 2013. Hypertension and osteoporosis. Clin. Calcium., 23: 497-503.
25. Luyster, F.S., P.J. Strollo, P.C. Zee and J.K. Walsh, 2012. Sleep: A health imperative. Sleep, 35: 727-734.
26. Fu, X., X. Zhao, H. Lu, F. Jiang, X. Ma and S. Zhu, 2011. Association between sleep duration and bone mineral density in Chinese women. Bone, 49: 1062-1066.
27. de Pablo, P., M.S. Cooper and C.D. Buckley, 2012. Association between bone mineral density and c-reactive protein in a large population-based sample. Arthritis Rheumatism, 64: 2624-2631.
28. Kasapis, C. and P.D. Thompson, 2005. The effects of physical activity on serum c-reactive protein and inflammatory markers. J. Am. Coll. Cardiol., 45: 1563-1569.
29. Koh, J.M., Y.H. Khang, C.H. Jung, S. Bae, D.J. Kim, Y.E. Chung and G.S. Kim, 2005. Higher circulating hsCRP levels are associated with lower bone mineral density in healthy pre- and postmenopausal women: Evidence for a link between systemic inflammation and osteoporosis. Osteoporosis Int., 16: 1263-1271.