RESEARCH
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PREVALENCE AND SEVERITY OF OSTEOPOROSIS IN INDIA: VITAMIN K2 OFFERS FOR BREAKING THE OSTEOPOROSIS CYCLE

Jana Arun*[1], Devi Velmurugan[2], Dhanushmathi Singaravel[3], Dharunkumar Sivalingam[4], Pragatheeshwaran Parthipan[5], Naveen Murugesan[6], Thenmozhi Velmurugan*[7]

[2,3,4,5,6]Department of Pharmaceutical Analysis, J.K.K. Nattraja College of Pharmacy, Kumarapalayam, Namakkal, Tamil Nadu, India
[*7]Thenmozhi Velmurugan, Assistant Professor, Department of Pharmacology, JKKN College of Pharmacy, Kumarapalayam, Namakkal, Tamil Nadu, India, thenmozhipharm@gmail.com.
[1]Research Scholar, JKKN College of Pharmacy, Tamil Nadu, India, janaarun1191@gmail.com.

Abstract
Objective: This study in Salem district, India, seeks to fill a knowledge gap by assessing osteoporosis prevalence, investigating the impact of vitamin K2-7 on bone health, and identifying socio- demographic factors associated with the condition.
Methods: A prospective cross-sectional study employed a 30-question questionnaire to gather data from 405 participants (74 males, 331 females) attending private and government hospitals. The survey covered demographics, medical history, dietary habits (including vitamin K2-7 intake), and social factors like literacy. Statistical analyses, including gender and vitamin K2-7 -based severity assessments, were performed. Statistical analysis is shown as number, percentages. To analyses the difference between the groups, chi- square tests is used to compare osteoporosis patients based on vitamin K2-7 supplement intake, with a general and specific analysis for comprehensive insights. P< 0.05 was considered to show significant associations. Graph Pad Prism version 10.1.2 facilitated robust data analysis
Results: An alarming 81.72% of participants, predominantly females, exhibited signs of osteoporosis. The higher prevalence in females was linked to factors like breastfeeding history, age at menopause, and oestrogen levels. Illiteracy rates of 60.9% highlighted significant awareness gaps about osteoporosis and bone health. Calcium intake trends varied, but interestingly, vitamin K2-7 intake demonstrated a potential correlation with reduced osteoporosis severity in both males and females. Concerns arose regarding the long- term impact of bisphosphonates, commonly prescribed medications for osteoporosis, on bone quality.
Conclusion: Vitamin K2-7's potential association with reduced osteoporosis severity, coupled with its influence on cardiovascular health, underscores the need for a nuanced approach to medication choices and increased awareness amongst both healthcare providers and patients. Further research is essential to fully elucidate the benefits of vitamin K2-7 and its potential integration into management strategies for osteoporosis and cardiovascular health in India.
Key words: Osteoporosis- Vitamin K2-7 (Menaquinone-7)-Calcium intake.

Introduction

Unraveling the secrets of osteoporosis, where its formidable impact emerges in whispers, yet resonates loudly in lives. Osteoporosis, a debilitating pathological condition characterized by the gradual erosion of bone density and structural integrity within the skeletal framework, results in bones becoming exceedingly fragile and alarmingly susceptible to fractures, even from minor incidents[1]. The aging global population, symbolizing extended lifespans, brings to light a growing public health concern: osteoporosis. Afflicting over 200 million individuals worldwide, this silent thief of bone density is poised to widen its grip further. In India, a study of over 31,000 adults revealed a stark reality: nearly half struggled with osteopenia, and one in five battled osteoporosis [3]. While globally, women after 50 face a one-in-three risk of osteoporotic fractures, compared to one in five for men[2] .Age also plays a crucial role, with elderly individuals (37.0%) facing a significantly higher risk compared to adults (12.5%)[3].

Unveiling The Two Faces of Osteoporosis: In both Postmenopausal Osteoporosis and Senile Osteoporosis (Type II), hormonal changes or the passage of time initiate a process where bone resorption surpasses formation, resulting in a gradual loss of bone density. Postmenopausal Osteoporosis highlights the imbalance in bone remodeling triggered by hormonal withdrawal, particularly affecting the intricate trabecular bone within the spongy core. Senile Osteoporosis, on the other hand, manifests as a thinning of the dense cortical bone, attributed to stem cell decline, which forms the outer shell of our bones as aging gracefully progresses across both genders [4].

In Medical conditions: Chronic diseases like rheumatoid arthritis, celiac disease, and hyperparathyroidism can impact bone health. Age-related bone loss is a universal truth, but childhood nutrition, exercise habits, and underlying medical conditions influence the peak bone mass achieved, influencing the odds of osteoporosis [5]. In India, osteoporosis poses a significant challenge, affecting approximately 46 later in life

million out of an anticipated 230 million Indians aged over 50 in 2015. Factors such as inadequate calcium intake, widespread vitamin D deficiency, extended life expectancy, and gender disparities contribute to escalating public health concern [6].

In India Bisphosphonates and Osteoporosis Management, Bisphosphonates-notably alendronate sodium, stand as a frontline defense against osteoporosis in India. Despite their efficacy, concerns arise regarding potential side effects, including osteonecrosis of the jaw (ONJ). However, they remain widely prescribed in India as a crucial [7]. While oral bisphosphonates are integral to treatment, component of osteoporosis treatment concerns surface about their prolonged use potentially inhibiting bone remodeling, contributing to [8]. Calcium intake emerges as pivotal for bone health, with studies highlighting atypical fracture sits role in slowing bone loss and reducing fracture risk. Calcium supplements are widely prescribed by doctors in India to improve bone health and reduce fracture risk [9].

Recent concerns highlight potential adverse effects of excessive calcium intake, especially from supplements, on arterial calcification and cardiovascular disease (CVD) risks in older adults. Studies suggest that high calcium intake may not significantly impact bone mineral density and fracture rates, prompting re-evaluation of current calcium recommendations. Excessive calcium intake, especially in bolus form, raises concerns about arterial calcification, particularly in older adults[10] .Globally, people widely use vitamin D and calcium supplements for overall health, but recent evidence suggests a more nuanced approach to vitamin D supplementation due to its potential role in arterial calcification, highlighting the importance of Vitamin K2 in calcium regulation[11].

The Scientific Landscape Osteoporosis, a stealthy undermine of bone density, looms over aging populations, leading to increased fracture risk, limited mobility, and compromised quality of life. While calcium and vitamin D have traditionally dominated osteoporosis management, vitamin K2, especially its MK7 form, emerges as a promising newcomer. However, the scientific understanding of vitamin K2's role in osteoporosis remains in flux, marked by intriguing discoveries and unresolved questions. Let's explore this evolving landscape and examine the current evidence. Vitamin K2 acts like a conductor, activating osteocalcin, a protein vital for calcium anchoring in bones. Studies indicate that MK-7 supplementation may increase active osteocalcin levels, potentially enhancing bone quality and reducing fracture risk. Understanding these factors is crucial for tailoring personalized approaches to maximize benefits and minimize risks. Research on vitamin K2's role in osteoporosis holds promise for improving millions of lives at risk of bone-related issues. While the definitive role of vitamin K2 in preventing and treating osteoporosis is still under investigation, existing evidence suggests its potential benefits[12]. Exploring the connections between osteoporosis, calcium, vitamin D, and Vitamin K2 leads to a deeper understanding and the potential for transformative changes in global health, promising a brighter future for skeletal health and overall well-being [13].

METHODS: RESEARCH STUDY

A prospective cross-sectional study was conducted at the Orthopedics Outpatient Department in Salem District, India, spanning from July 2023 to December 2023. The studyincluded 405 participants (74 males and 331 females) aged between 40 to 70 years. Participants were categorized based on the severity of osteoporosis, considering their prescribed medications and supplements. Inclusion criteria comprised individuals aged 40 to 70, both genders, with either newly diagnosed or pre-existing osteoporosis, or a willingness to actively participate. Exclusion criteria involved those who are Non- consenting, having other musculoskeletal disorders, cardiovascular disorders, cerebrovascular pathology, sarcopenia, diabetes, liver disorders, thyroid dysfunction, all lupus, chronic kidney disease, taking hormone therapy or any medication affecting blood pressure or lipoprotein metabolism, taking psychotropic, psychoactive, psychedelics or multivitamins/antioxidants were excluded., current pregnancy or lactation, and inability to provide informed consent. The study incorporated both government and private healthcare Facilities in Salem district over a 6-month period. A comprehensive questionnaire, administered in English and Tamil, collected data on demographic, medical, and social aspects. Participants provided informed consent, ensuring effective communication and yielding valuable insights into osteoporosis prevalence, guiding potential integration of vitamin K2 supplementation in prescriptions. The determined sample size exceeded 400, with a structured pro forma utilized to gather demographic data, including age groups (40-50, 51-60, 61-70) and BMI clinical and laboratory profile (body mass index [BMI] [kg/m2] categories (normal, overweight, obese). Maternal characteristics of females were analyzed, covering marital status, parity, breastfeeding history, age at menarche, and age at menopause(complete years of cessation of the menstrual cycle were enrolled for the study).Socio-family and clinical factors were explored, including education, occupation, and behavioral factors such as regular exercise(Active and sedentary lifestyle was based on whether the subject was doing a minimum of 30 min of brisk walking or aerobic exercise every day or not) to analyze their physical activity, immobilization time period. While family history was examined for fragility fractures and symptoms related to osteoporosis. The study also delved into the composition breakdown of osteoporosis supplements (Calcium intake, use of Vitamin D3 and Vitamin K2 level) and Bisphosphonates, NSAID’s and Osteoarthritis related medications, detailing calcium combinations (Calcium with Vitamin D3 or Vitamin K2 or Both) Salts (Calcium carbonate or citrate or maleate), and severity categorization (Mild, Moderate, Severe) based on the Vitamin K2 intake.

RESULTS

In our investigation, a significant proportion of participants (81.7%) were females **(Figure1).** The age distribution revealed that the majority (61.2%) fell within the 51-59 years range **(Figure 2).** Regarding BMI, 51.6% were classified as obese. Among the female participants (n=331), marital status predominantly indicated being married (96.6%). Parity demonstrated a higher count in the 1- 2 children category (80.9%). A significant proportion (94.2%) reported for breastfeeding. Interestingly, 85.1% of females experienced menopause before the age of 50. This summary provides a glimpse into the higher counts and prevalent characteristics within our study population [**Table 1**]

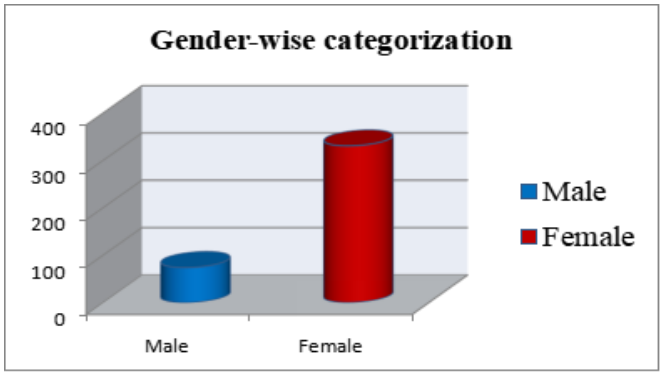

Figure 1: Gender wise categorization

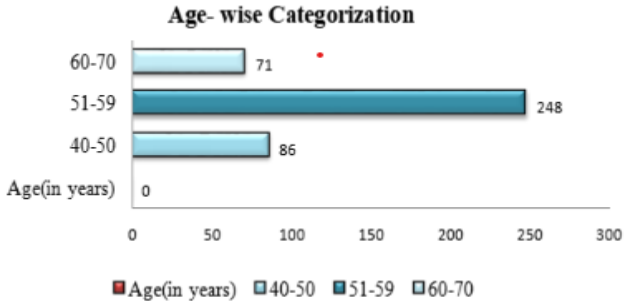

Figure 2: Age wise categorization

Table 1. Calcium Combinations and Medication Patterns

Variables	N (%)
Calcium combinations	
Calcium +Vitamin D3	198 (48.8)
Calcium+ Vitamin D3+Vitamin K2	108 (26.66)
Calcium +Essential minerals	99(24.4)
Calcium salt analysis	
Calcium Carbonate	290 (71.6)
Calcium Citrate	100 (24.69)
Calcium citrate maleate	15 (3.7)
Drugs	
Bisphosponates	106 (26.17)
Osteoarthritis related medications	148 (36.54)
NSAID (Non-Steroidal Anti-Inflammatory medications)	94 (23.20)
Multivitamins	57 (14)

Among 405 participants in our osteoporosis study, a significant 60.9% were illiterate, with weaving being the dominant occupation at 48.1%. Notably, 83.2% reported no specific habits or substances, and alcohol use was prevalent among 55.4% (Males n=74). Regarding family history, 71.8% had no self-history of fragility fractures, and 86.6% lacked a family history of such fractures. Symptoms related to osteoporosis were absent in the family history of 81.9% of participants. These findings offer a succinct glimpse into the social andfamilial dimensions of osteoporosis in our diverse study population [**Table 2**].

Table 2. Social History of Participants

Variables	N (%)
Education	
Illiterate	247 (60.9)
Primary/Middle school	38 (9.38)
High school or Above	120 (29.6)
Occupation	
Daily wages	83 (20.4)
Home maker	62 (15.3)
Weaver	195 (48.1)
Govt-Public sector workers	68 (16.7)
Behavioural factors	
Yes (n=48)	11.8%
No (n=357)	83.2%
Habits and Substances	
Current, Past, Regular user (Male=74,Female=Nil)	
Smoking (n=28)	37.8%
Alcohol (n=41)	55.4%
Tobacco (n=5)	6.7%

In our exploration of participants' medication patterns, calcium combinations were prevalent, with 48.8% using Calcium + Vitamin D3, 26.66% opting for Calcium Vitamin D3+Vitamin K2. Calcium salt analysis revealed a majority favoring Calcium Carbonate (71.6%). Noteworthy pharmaceutical choices included 26.17% on Bisphosphonates, 36.54% using medications for osteoarthritis, 23.20% on NSAIDs (Non-Steroidal Anti-Inflammatory medications), and 14% incorporating multivitamins. These insights illuminate prevalent medication preferences within our study cohort, providing a snapshot of the pharmaceutical landscape related to osteoporosis management [**Table 3**].

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In our analysis of osteoporosis severity among males (n=74), a striking association was observed between Vitamin K2 usage and the severity of osteoporosis. Among Vitamin K2 users (n=26), the majority exhibited mild osteoporosis (17 cases), while none showed severeosteoporosis. In contrast, among non-Vitamin K2 users (n=48), 34 cases were categorized as severe osteoporosis, and none fell into the mild category. This significant association was confirmed by a Chi-Square test (p value < 0.0001), emphasizing the potential impact of Vitamin K2 supplementation on osteoporosis severity in males within our study cohort.

In our examination of osteoporosis severity among females (n=331), a compelling relationship was identified between Vitamin K2 usage and the severity of osteoporosis. Among Vitamin K2 users (n=86), the majority experienced mild

osteoporosis (84 cases), while none were categorized as severe. Conversely, among non-Vitamin K2 users (n=245), 155 cases were classified as severe osteoporosis, with only 10 falling into the mild category.This substantial association was confirmed by a Chi-Square test (p value < 0.0001), underscoring the potential impact of Vitamin K2 supplementation on osteoporosis severity in females within our study cohort.

Note: A Chi-Square test was used to compare the Vitamin K2 user and NonVitamin K2 user and found to be statistically significant (p value<0.05) [**Table 4].**

Table 4. Severity of Osteoporosis in Male and Female

Total number of participants (405)				**Chi-Square/ p-value**
Severity of Osteoporosis	Mild	Moderate	Severe	
Male (74)				
Vitamin K2 User (26)	17	9	0	<0.0001
Non-Vitamin K2 (48)	0	14	34	
Female (331)				
Vitamin K2 User (86)	34	2	0	<0.0001
Non-Vitamin K2 (245)	10	80	155	

DISCUSSION

The study of 405 participants revealed notable demographic patterns and gender disparities in osteoporosis prevalence. This underscores the vulnerability of women to osteoporosis andthe need for tailored interventions. Unlike males, our study, in agreement with Marwaha et al. (2011), notes no clear age-related trend in male osteoporosis prevalence [14].The prevalence of obesity in our study population (51.6%) aligns with broader trends in India, echoing concerns about potential implications for bone health. This aligns with existing research highlighting the potential impact of obesity on bone-related issues, offering valuable insights for addressing conditions like osteoporosis and fractures[15]The high breastfeeding rates observed in our study (94.2%) align with the impact of lactation on calcium demand during pregnancy[16 ,17].The study revealed diverse characteristics, including lower literacy levels in 60.9% of participants, highlighting the potential need for tailored educational interventions focusing on osteoporosis awareness[18] Numerous studies indicate that oral intake of calcium is associated with a reduction in the pace of bone breakdown and mineral loss[19], The sole addition of calcium supplementation decreased the likelihood of all fractures and minimal trauma fractures in individuals without pre-existing health conditions [20].

In our research, participants primarily consumed calcium combinations like calcium citrate maleate at a dosage of 1000 mg. However, recent studies propose a between dietary calcium intake and cardiovascular mortality based on a meta-analysis of prospective cohort studies. The findings indicate that elevated dietary calcium intake (>900 mg/day) does not correlate with a reduced risk of all-cause mortality [21].Vitamin D facilitates the active absorption of calcium in the small intestine. The combination of calcium and phosphorus leads to the formation of hydroxyapatite crystals, contributing to the mineralization and fortification of bones[22].Existing evidence suggests that the concurrent intake of vitamins D and K could potentially yield greater benefits for both bone and cardiovascular health compared to consuming either vitamin in isolation. As our understanding of the synergistic effects of vitamins D and K expands, it reinforces the importance of maintaining a nutritious diet richin diverse foods, including vegetables and fermented dairy, to support overall bone and cardiovascular well-being[23].Vitamin D helps the body absorb the bone-strengthening trace elements zinc and manganese as well[24].Zinc, Manganese, Silicon, and Boron. Low intake of each of these minerals is associated with bone loss, and increased intake improves bone health in animals and in humans. Supported by these nutrients, vitamin K2 can provide powerful protection against fractures and bone loss [25].Our study underscores the significant impact of Vitamin K2 supplementation on reducing osteoporosis severity, promoting skeletal health in both genders. Aligning with existing research, the evidence supports Vitamin K2's positive effects, including preventing fractures and enhancing bone health.

Notably, a two-year study combining 150 mg/day calcium with 45 mg of Vitamin K2 (as MK-4) showed substantial benefits, with those receiving only calcium experiencing a 3% decline in bone density, while Vitamin K2 recipients largely maintained theirs. These findings emphasize the potential of Vitamin K2, particularly in conjunction with calcium, toprevent bone loss and maintain or increase bone mineral density, crucial for mitigating osteoporosis-related complications [26].

CONCLUSION

Our study indicates a substantial association between Vitamin K2 usage and reduced osteoporosis severity, particularly noteworthy in females. Among Vitamin K2 users, a majority exhibited mild osteoporosis, contrasting with non-users where severe cases predominated. This significant association was confirmed by a Chi-Square test ($p < 0.0001$).A similar pattern emerged in males, reinforcing the potential impact of Vitamin K2 supplementation on mitigating osteoporosis severity. These findings suggest that Vitamin K2 may play a crucial role in promoting bone health, with implications for cardiovascular well-being. Further research is warranted to elucidate the mechanisms and broader implications of Vitamin K2 supplementation.

CONFLICT OF INTEREST

The authors of this research declare no potential conflicts of interest.

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