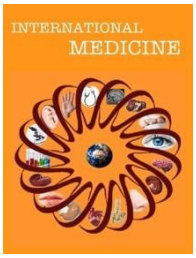

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Original Research Article

Awareness of Bone Health and Calcium/Vitamin D Intake Among Women in Himachal Pradesh: An Orthopaedic Perspective

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Abstract

Background: Women are at increased risk for bone-related disorders such as osteoporosis and osteopenia, especially in regions like Himachal Pradesh where limited sun exposure, traditional diets, and low health literacy prevail. This study aimed to assess awareness of bone health and knowledge of calcium/vitamin D intake among women in Himachal Pradesh, highlighting socio-demographic influences from an orthopaedic perspective.

Materials and Methods: A descriptive, cross-sectional study was conducted among 400 women aged ≥18 years across urban and rural districts of Himachal Pradesh. Participants were selected via purposive and convenience sampling. Data were collected through a bilingual (Hindi/English), self-administered Google Form assessing socio-demographics, bone health knowledge (20 MCQs), and related lifestyle practices. Knowledge scores were categorized as Very Good (17-20), Good (13-16), Fair (9-12), and Poor (0-8). Statistical analysis was performed using Epi Info Version 7; associations were tested using chi-square, with significance at $p < 0.05$.

Results: Most participants demonstrated either Very Good (31.0%) or Good (35.5%) awareness. High knowledge was observed for calcium's role in bone health (77.8%), vitamin D for absorption (73.8%), and sun exposure (75.8%). However, awareness was lower for osteopenia (60.8%), safe supplementation (62.8%), and optimal calcium requirements (61.8%). Education ($p < 0.001$), residence ($p = 0.031$), age ($p = 0.026$), occupation ($p = 0.042$), and marital status ($p = 0.044$) were significantly associated with knowledge levels. Rural, older, and less-educated women were more likely to have Fair or Poor awareness.

Conclusion: While general awareness of bone health and calcium/vitamin D intake is encouraging, critical knowledge gaps persist–particularly among rural and undereducated women. Orthopaedic and public health efforts must prioritize community-based, culturally tailored education to promote early prevention and reduce the burden of bone-related disorders in this high-risk population.

Keywords: Bone Health, Calcium, Vitamin D, Women's Health, Himachal Pradesh, Osteoporosis, Rural Awareness, Orthopaedic Prevention, Musculoskeletal Health.

Introduction

Bone health is a cornerstone of overall musculoskeletal well-being, particularly among women, who are disproportionately affected by conditions such as osteoporosis, osteopenia, and related fractures. Adequate intake of calcium and vitamin D—both critical for bone mineralization and skeletal strength—remains a foundational public health recommendation. Globally, millions of women suffer silently from micronutrient deficiencies and undiagnosed bone loss, leading to increased morbidity, functional dependence, and healthcare costs. In India, despite the availability of preventive strategies, a significant proportion of women remain unaware of the importance of bone health, often due to sociocultural norms, inadequate dietary habits, limited sun exposure, and poor access to health education and screening.[1-5]

Himachal Pradesh presents a unique demographic and geographical setting in this context. The state's mountainous terrain, limited dietary diversity, harsh winters, and cultural dress patterns limit sun exposure and may exacerbate vitamin D deficiency, even among active rural women. Simultaneously, traditional diets often lack sufficient calcium-rich foods, and dairy consumption varies based on socioeconomic and regional factors. Furthermore, gender-related disparities in healthcare access, health literacy, and prioritization of women's health amplify the risk of undetected bone degeneration in this population. Despite the high physical demands placed on women in both rural and urban households—especially in labor-intensive roles—there remains a notable gap in awareness regarding bone-strengthening practices, nutritional supplementation, and preventive orthopedic care.[6-9]

From an orthopedic perspective, early awareness and intervention are key to reducing the long-term burden of fragility fractures, spinal deformities, and degenerative conditions. Identifying population-level gaps in knowledge about bone health and the role of calcium and vitamin D is thus essential for implementing timely public health strategies.[10-12] While national programs such as RBSK and NPHCE include elements of musculoskeletal care, localized data are needed to tailor interventions

for region-specific challenges. This study aims to assess the level of awareness regarding bone health and calcium/vitamin D intake among women in Himachal Pradesh, with a focus on socio-demographic variations. The findings are expected to guide orthopaedic and community health stakeholders in designing targeted education campaigns and nutrition-based interventions to enhance skeletal health outcomes among women in this region.

Materials and Methods

Study Design and Objective

This study adopted a descriptive, cross-sectional design to assess the awareness of bone health and knowledge regarding calcium and vitamin D intake among women in Himachal Pradesh. The objective was to evaluate levels of understanding, identify demographic gaps in awareness, and provide an orthopaedic perspective for preventive strategies related to bone health.

Study Area and Population

The study was conducted across selected districts of Himachal Pradesh to represent both urban and rural populations. The target population included women aged 18 years and above from diverse educational, occupational, and socioeconomic backgrounds. Women who had received professional healthcare or nutrition-related training were excluded to maintain the focus on the general population's awareness.

Sample Size and Sampling Technique

A total of 400 women participated in the study. The sample size was determined using a confidence level of 95% and a 5% margin of error, assuming a 50% expected awareness rate. Participants were recruited through purposive and convenience sampling. Community groups, self-help networks, local influencers, and digital platforms (WhatsApp, Facebook, email) were used to distribute the questionnaire link and encourage participation.

Data Collection Tool

Data were collected via a structured, bilingual (English and Hindi) self-administered Google Form questionnaire designed in consultation with orthopedic experts, community health workers, and dietitians. The questionnaire was divided into three sections:

1. **Socio-Demographic Information** – including age, education level, occupation, residence (urban/rural), marital status, and dietary habits.
2. **Knowledge Assessment** – consisting of 20 multiple-choice questions related to bone health, dietary calcium sources, vitamin D, sun exposure, supplementation, and prevention of bone diseases.
3. **Awareness and Practices** – focused on participants' lifestyle behaviors such as physical activity, dietary intake, and awareness of screening for osteoporosis or bone density.

Pilot Testing

A pilot test was conducted on 30 women from different districts to ensure clarity, cultural appropriateness, and digital accessibility. Feedback led to minor modifications in question phrasing for simplicity and better comprehension.

Scoring and Classification

Each correct response in the knowledge section was awarded one point. Total scores ranged from 0 to 20 and were categorized into four levels:

- **Very Good Awareness**: 17–20
- **Good Awareness**: 13–16
- **Fair Awareness**: 9–12
- **Poor Awareness**: 0–8

This categorization allowed for comparative analysis across demographic variables.

Ethical Considerations

Participation was voluntary, and informed electronic consent was obtained from all respondents. The consent form described the study's aims, confidentiality measures, anonymity, and the right to withdraw. Ethical guidelines were adhered to in accordance with the Declaration of Helsinki.

Data Analysis

Data were exported from Google Forms to Microsoft Excel and analyzed using Epi Info Version 7. Descriptive statistics (frequencies, percentages) summarized demographic and knowledge variables. Chi-square tests were applied to assess associations between awareness scores and socio-demographic factors, with a p-value < 0.05 considered statistically significant.

Results

The study encompassed 400 women across a diverse socio-demographic spectrum. The largest age group was 26–35 years (30.5%), followed by women aged 46 and above (28.5%), indicating good participation from both reproductive-age and postmenopausal women—crucial cohorts for assessing bone health. Educational levels varied, with 34.5% having secondary school education and 27.5% holding undergraduate degrees. However, 8.8% of participants had no formal education, which highlights potential barriers to health literacy. Homemakers constituted the largest occupational category (45.5%), followed by students (14.5%) and private sector employees (14.0%). Over half of the participants (57.2%) were from rural areas, ensuring strong representation of under-researched populations. Most respondents were married (66.0%), while unmarried and widowed/separated women represented 25.3% and 8.8% respectively. This demographic spread enabled meaningful insight

into how lifestyle, education, and rural–urban differences influence bone health awareness.

Table 1: Socio-Demographic Characteristics of Women Participants (n = 400)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (Years)	18–25	61	15.3%
	26–35	122	30.5%
	36–45	103	25.8%
	46 and above	114	28.5%
Education Level	No formal education	35	8.8%
	Primary school	69	17.3%
	Secondary school	138	34.5%
	Undergraduate	110	27.5%
	Postgraduate	48	12.0%
Occupation	Homemaker	182	45.5%
	Student	58	14.5%
	Government Employee	42	10.5%
	Private Sector	56	14.0%
	Self-Employed	39	9.8%
	Retired/Other	23	5.8%
Residence	Urban	171	42.8%
	Rural	229	57.2%
Marital Status	Married	264	66.0%
	Unmarried	101	25.3%
	Widowed/Separated	35	8.8%

Participants demonstrated a moderate to high level of awareness on several key aspects of bone health. A significant proportion correctly identified calcium (77.8%) and vitamin D (73.8%) as essential for bone strength and absorption, and 75.8% acknowledged sunlight as a natural source of vitamin D. Common bone health concerns such as the impact of menopause (64.8%), pregnancy (74.5%), and the role of exercise (69.3%) were understood by many, though knowledge was lower for technical terms like "osteopenia" (60.8%) and safe supplementation practices (62.8%). While most participants recognized that poor childhood nutrition can impair adult bone strength (72.3%) and that smoking/alcohol harm bone health (68.8%), only 66.5% correctly identified indoor lifestyles as risk factors for vitamin D deficiency. The responses highlight a promising baseline of awareness but also point to gaps in nuanced and clinical knowledge areas that could hinder effective prevention and early intervention.

Table 2: Awareness Questions on Bone Health and Calcium/Vitamin D Intake Among Women (n = 400)

Q. No.	Question	Options (Correct in Bold)	Correct (n)	Correct (%)
1	What is the primary mineral needed for bone strength?	a) Iron **b) Calcium** c) Magnesium d) Zinc	311	77.8%
2	Which vitamin aids calcium absorption in the body?	a) Vitamin A **b) Vitamin D** c) Vitamin C d) Vitamin B12	295	73.8%
3	Can sunlight help in vitamin D synthesis?	a) No **b) Yes** c) Only at noon d) Only during winter	303	75.8%
4	What is a common symptom of calcium deficiency?	a) Rash **b) Bone pain or cramps** c) Vision blur d) Frequent colds	276	69.0%
5	Which food is rich in calcium?	a) Apples **b) Dairy products** c) Rice d) Potatoes	288	72.0%
6	Is osteoporosis more common in women?	a) No **b) Yes** c) Same as men d) Not known	284	71.0%
7	At what stage is bone loss most rapid in women?	a) Childhood **b) After menopause** c) During pregnancy	259	64.8%

		d) After age 70		
8	What is the daily calcium requirement for adult women?	a) 200 mg **b) 1000–1200 mg** c) 500 mg d) Not fixed	247	61.8%
9	Can low calcium cause frequent fractures?	a) No **b) Yes** c) Only in athletes d) Only in elderly	273	68.3%
10	Which group is at higher risk of vitamin D deficiency?	a) Athletes **b) Indoor workers/women with limited sun exposure** c) Smokers d) Urban men	266	66.5%
11	Does walking outdoors help bone health?	a) No **b) Yes** c) Only in hills d) Only with diet	282	70.5%
12	Can pregnancy increase demand for calcium and vitamin D?	a) No **b) Yes** c) Only calcium d) Not related	298	74.5%
13	What is osteopenia?	a) Muscle disease **b) Mild reduction in bone density** c) Heart disease d) Vitamin D overdose	243	60.8%
14	Can regular weight-bearing exercise help bones?	a) No **b) Yes** c) Only in gyms d) Only under medical advice	277	69.3%
15	What is the function of vitamin D in bones?	a) Builds muscles **b) Helps calcium absorption** c) Improves eyesight d) None	291	72.8%
16	Is fortified food a source of vitamin D?	a) No **b) Yes** c) Only milk d) Only fish	264	66.0%
17	What is the best time for sun exposure to get vitamin D?	a) Late evening **b) Morning 8–10 AM** c) Midnight d) Afternoon indoors	256	64.0%
18	Is it necessary to take supplements for bone health without doctor's advice?	a) Yes **b) No** c) Sometimes d) Always	251	62.8%
19	Which lifestyle habit negatively affects bone health?	a) Early rising **b) Smoking and alcohol** c) Bathing d) Fruit intake	275	68.8%
20	Can poor nutrition in childhood affect adult bone strength?	a) No **b) Yes** c) Only girls d) Only rich diet helps	289	72.3%

The overall knowledge distribution revealed that a majority of the respondents demonstrated either Very Good (31.0%) or Good (35.5%) awareness regarding bone health and related nutritional factors. However, nearly one-third of the participants were classified in the Fair (23.0%) and Poor (10.5%) categories. This distribution is a clear indicator of health knowledge inequalities within the population, especially considering that bone-related conditions such as osteoporosis remain largely preventable with proper education. The data underscores the need for targeted health promotion efforts, particularly to elevate those in the Fair and Poor awareness brackets into higher knowledge categories through structured community health education and outreach programs.

Table 3: Knowledge Score Classification Among Women Participants (n = 400)

Knowledge Level	Score Range (out of 20)	Frequency (n)	Percentage (%)
Very Good	17–20	124	31.0%
Good	13–16	142	35.5%
Fair	9–12	92	23.0%
Poor	0–8	42	10.5%

Statistical analysis revealed significant associations between bone health awareness and key socio-demographic variables. Age played a role, with women aged 26–35 showing the highest Very Good and Good scores ($p = 0.026$), possibly reflecting greater health engagement during reproductive years. Education was the strongest predictor ($p < 0.001$), as women with postgraduate and undergraduate qualifications exhibited markedly higher awareness, while those with no or only primary education fell predominantly in the Fair or Poor categories. Urban residents outperformed rural ones ($p = 0.031$), indicating disparities in information access and healthcare exposure. Homemakers had the widest spread in knowledge levels, likely reflecting their varied educational and lifestyle backgrounds ($p = 0.042$). Marital status also showed significance ($p = 0.044$), with married women more informed than their unmarried counterparts. These findings highlight that interventions must prioritize rural, less-educated, and unmarried women for impactful public health outcomes.

Table 4: Association Between Knowledge Score and Socio-Demographic Variables (n = 400)

Variable	Category	Very Good	Good	Fair	Poor	p-value
Age Group	18–25	14 (3.5%)	28 (7.0%)	13 (3.3%)	6 (1.5%)	0.026
	26–35	42 (10.5%)	53 (13.3%)	18 (4.5%)	9 (2.3%)	
	36–45	35 (8.8%)	37 (9.3%)	21 (5.3%)	10 (2.5%)	
	46 and above	33 (8.3%)	24 (6.0%)	40 (10.0%)	17 (4.3%)	
Education Level	No formal education	2 (0.5%)	6 (1.5%)	14 (3.5%)	13 (3.3%)	<0.001
	Primary school	8 (2.0%)	15 (3.8%)	28 (7.0%)	18 (4.5%)	
	Secondary school	41 (10.3%)	51 (12.8%)	32 (8.0%)	14 (3.5%)	
	Undergraduate	45 (11.3%)	49 (12.3%)	13 (3.3%)	3 (0.8%)	
	Postgraduate	28 (7.0%)	21 (5.3%)	5 (1.3%)	1 (0.3%)	
Residence	Urban	58 (14.5%)	64 (16.0%)	34 (8.5%)	15 (3.8%)	0.031
	Rural	66 (16.5%)	78 (19.5%)	58 (14.5%)	27 (6.8%)	
Occupation	Homemaker	51 (12.8%)	59 (14.8%)	48 (12.0%)	24 (6.0%)	0.042
	Student	22 (5.5%)	25 (6.3%)	8 (2.0%)	3 (0.8%)	
	Govt. Employee	17 (4.3%)	14 (3.5%)	7 (1.8%)	4 (1.0%)	
	Private Sector	19 (4.8%)	20 (5.0%)	13 (3.3%)	4 (1.0%)	
	Self-Employed	10 (2.5%)	14 (3.5%)	9 (2.3%)	6 (1.5%)	
	Retired/Other	5 (1.3%)	10 (2.5%)	7 (1.8%)	1 (0.3%)	
Marital Status	Married	76 (19.0%)	91 (22.8%)	69 (17.3%)	28 (7.0%)	0.044
	Unmarried	34 (8.5%)	36 (9.0%)	17 (4.3%)	14 (3.5%)	
	Widowed/Separated	14 (3.5%)	15 (3.8%)	6 (1.5%)	0 (0.0%)	

Discussion

This study provides crucial insights into the level of awareness regarding bone health and the role of calcium and vitamin D intake among women in Himachal Pradesh—a region where geographical, cultural, and dietary practices uniquely shape health outcomes. The findings reveal a moderate to high degree of general awareness among participants, particularly concerning basic nutritional knowledge such as the importance of calcium (77.8%) and vitamin D (73.8%) for bone strength, the role of sunlight in vitamin D synthesis (75.8%), and the benefits of weight-bearing exercises (69.3%). These results are encouraging, suggesting that foundational knowledge is present among many women, possibly owing to increasing access to digital health content, community programs, and school-level education.

However, deeper analysis exposes significant knowledge disparities, particularly around nuanced or clinically relevant aspects of bone health. Fewer women were aware of specific medical terms such as “osteopenia” (60.8%), optimal calcium requirements (61.8%), or the dangers of unsupervised supplementation (62.8%). Additionally, misconceptions still exist about the impact of indoor lifestyles on vitamin D deficiency (only 66.5% responded correctly), and many remain unaware of the critical window for bone loss post-menopause (64.8%). These gaps suggest that while the population may be familiar with general principles, detailed understanding—especially of physiological processes and clinical risk factors—remains inadequate. From an orthopedic standpoint, this lack of depth in awareness can delay early screening and preventive practices, ultimately contributing to a higher burden of bone fragility, fractures, and related complications.

Socio-demographic analysis revealed several significant associations that further underscore the need for targeted interventions. Education was the most influential factor, with women holding undergraduate and postgraduate degrees exhibiting markedly higher awareness than those with little or no formal education ($p < 0.001$). This pattern reflects the well-established link between educational attainment and health literacy and highlights the need for simplified, locally adapted communication strategies for under-educated segments. Similarly, urban participants demonstrated higher awareness levels than their rural counterparts ($p = 0.031$), likely due to better access to healthcare services, media exposure, and community-based health initiatives in urban areas. Given that over 57% of the study population belonged to rural regions, this urban–rural divide presents a pressing concern and reinforces the necessity of extending educational outreach to remote and underserved communities.

Age also significantly influenced awareness ($p = 0.026$), with women aged 26–35 scoring highest in the Very Good and Good categories. This could be attributed to their reproductive health engagement, exposure to maternal health programs, and higher likelihood of internet and social media use. However, postmenopausal women—arguably at greatest risk of bone loss—demonstrated comparatively lower knowledge levels. This age group may rely more on traditional beliefs and have limited access to modern health information, suggesting that community-led education, especially through ASHAs, Anganwadi workers, or local women's groups, could help bridge this generational knowledge gap.

Occupational status also shaped awareness patterns ($p = 0.042$), with homemakers showing the widest variation. While some homemakers possessed good knowledge, a substantial proportion fell into the Fair and Poor categories, potentially reflecting disparities in their educational backgrounds. Interestingly, students and women employed in the government or private sectors had higher awareness scores, likely due to structured education and work environments that facilitate exposure to health-related information. Marital status also showed a statistically significant association ($p = 0.044$), with married women exhibiting better awareness than unmarried or widowed/separated women—possibly due to greater participation in maternal or family health programs.

From a public health and orthopaedic prevention perspective, these findings carry significant implications. The burden of osteoporotic fractures, degenerative spinal conditions, and chronic musculoskeletal pain among women in India is growing and remains largely preventable through early lifestyle modifications and nutritional awareness. Despite national programs like the National Programme for Health Care of the Elderly (NPHCE) and various adolescent and maternal health schemes, there is a lack of focused attention on lifelong bone health, especially among peri-menopausal and aging women. The knowledge gaps identified in this study suggest that existing programs may not be sufficiently reaching or educating all segments of the female population.

Moreover, the study underscores the value of region-specific data in shaping healthcare strategies. Himachal Pradesh, with its unique topography, climate, and sociocultural characteristics, presents distinct challenges—ranging from limited sunlight exposure due to mountainous terrain and indoor-oriented lifestyles, to traditional diets lacking fortified foods. Interventions designed without consideration of these contextual realities may fail to produce desired outcomes. This calls for customized bone health awareness campaigns that are culturally sensitive, language-accessible, and tailored to the specific needs of both rural and urban women in the state.[8-12]

Lastly, this study highlights the utility of using digital tools like bilingual Google Forms for collecting community health data in diverse settings. Although the online format may have excluded digitally illiterate individuals, the broad participation from both rural and urban areas suggests growing digital penetration and potential for scalable awareness campaigns via mobile health platforms.

In summary, while foundational awareness regarding bone health, calcium, and vitamin D intake exists among women in Himachal Pradesh, significant gaps remain—particularly among older, rural, less-educated, and unmarried populations. Addressing these disparities through context-specific, inclusive, and sustained public health efforts is essential to reducing the burden of orthopedic complications among women across the lifespan.

Limitations

While this study offers valuable insights into women's awareness of bone health in Himachal Pradesh, it is not without limitations. The use of a self-administered online Google Form may have introduced sampling bias, favoring participants with internet access and digital literacy, thereby potentially underrepresenting older or illiterate rural women. The cross-sectional design restricts causal inference and only reflects awareness at a single point in time. Additionally, self-reported responses are subject to recall and social desirability bias, possibly leading participants to overstate their knowledge or healthy practices. The purposive and convenience sampling further limits generalizability to the broader female population across all regions of the state.

Conclusion

This study underscores a promising baseline of awareness regarding bone health, calcium intake, and vitamin D among women in Himachal Pradesh, particularly among educated, urban, and middle-aged participants. However, significant gaps persist in clinical knowledge, supplementation practices, and risk factor recognition—especially among older, rural, and less-educated women. These disparities highlight the urgent need for orthopaedic and public health stakeholders to integrate targeted educational interventions into community and primary healthcare frameworks. Strengthening bone health literacy across all age groups and socio-demographic backgrounds is essential for reducing preventable musculoskeletal conditions, improving quality of life, and alleviating the long-term burden on the healthcare system.

Recommendations

To bridge the knowledge gaps identified, multi-tiered interventions must be implemented. Community-based awareness campaigns should focus on the importance of calcium-rich diets, safe sun exposure, and regular weight-bearing exercise, particularly targeting rural and underserved populations. Integration of bone health education into school curricula, women's self-help groups, and maternal health services can help reach younger and reproductive-age women. Additionally, frontline health workers like ASHAs and Anganwadi staff should be trained to disseminate simplified, region-specific messages on bone care. Policymakers should also consider subsidizing fortified foods and calcium/vitamin D supplements for at-risk groups while leveraging digital platforms to amplify health messaging statewide.

References

1. Chintham S, SM, Periasamy P, Gopalakrishnan S. Exploring women's knowledge of nutrition and bone health: a preventive focus on osteoporosis. *Cureus.* 2025 May 8;17(5):e83722.
2. Malhotra N, Mithal A, Gupta S, Shukla M, Godbole M. Effect of vitamin D supplementation on bone health parameters of healthy young Indian women. *Arch Osteoporos.* 2009 Dec;4(1-2):47–53.
3. Pan T, Dasgupta A, Paul B, Bandyopadhyay L, Augustine ATV, Suman S. Bone health and its association with vitamin D and other covariates: a community-based study among women in a rural area of West Bengal. *Indian J Public Health.* 2020 Apr–Jun;64(2):135–140.
4. Harinarayan CV, Akhila H, Shanthisree E. Modern India and dietary calcium deficiency—half a century nutrition data—retrospect–introspect and the road ahead. *Front Endocrinol (Lausanne).* 2021;12:583654.
5. GR, Gupta A. Vitamin D deficiency in India: prevalence, causalities and interventions. *Nutrients.* 2014;6(2):729–775.
6. Lhamo Y, Chugh PK, Gautam SR, Tripathi CD. Epidemic of vitamin D deficiency and its management: awareness among Indian medical undergraduates. *J Environ Public Health.* 2017;2017:2517207.
7. Singh S, Sinha P, Gupta U, NK G, Srivastava A. Status of vitamin D, paratharmone and serum calcium levels in perimenopausal women and their mutual correlation. *Int J Reprod Contracept Obstet Gynecol.* 2016;5(11):4009–4013.
8. Geddawy A, Al-Burayk AK, Almhaine AA, et al. Response regarding the importance of vitamin D and calcium among undergraduate health sciences students in Al Kharj, Saudi Arabia. *Arch Osteoporos.* 2020;15:114.
9. Kalra S, Zargar AH, Das AK, Baidya A, Dasgupta A, Selvan C, et al. Prevention and treatment of vitamin D deficiency in India: an expert group consensus. *Indian J Endocrinol Metab.* 2025 Jan–Feb;29(1):13–26.
10. Alamoudi LH, Almuteeri RZ, Al-Otaibi ME, Alshaer DA, Fatani SK, Alghamdi MM, Safdar OY. Awareness of vitamin D deficiency among the general population in Jeddah, Saudi Arabia. *J Nutr Metab.* 2019;2019:4138187.
11. Malhotra N, Mithal A, Gupta SK, Godbole M, Shah N. Effect of vitamin D supplementation on bone health parameters of healthy young Indian women. *Arch Osteoporos.* 2009;4(1-2):47–53.
12. Voulgaridou G, Athanassiou F, Kravvariti E, Doulgeraki S, Papadopoulou SK, Kokokiris LE. Knowledge and predictors of vitamin D awareness among Greek women: a cross-sectional study. *Diseases.* 2025;13(2):58.