

Lifestyle and Dietary Factors Associated with Bone Mineral Density among University Faculty Members in Kazakhstan

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ABSTRACT

Objective

This study was aimed to assess the relationship between lifestyle and dietary factors with bone mineral density (BMD) among faculty members of Asfendiyarov Kazakh National Medical University, with a focus on identifying modifiable risk factors for osteoporosis.

Materials and Methods

A cross-sectional survey, including 100 faculty members (basic sciences department n=50, clinical science department n=50) over the age of 40, was conducted using a 30-item questionnaire assessing knowledge and behaviors related to bone health. Bone mineral density (BMD) was measured using the SONOST-3000 ultrasonic osteometer at the calcaneus. Demographic information, dietary, and lifestyle factors were recorded. Statistical analyses included descriptive statistics, χ^2 tests, Spearman's correlation, and Cramér's V, with significance level set at $p \leq 0.05$.

Results and Discussion

Normal BMD was observed in 46% of basic sciences and 38% of clinical science faculty members, while low BMD was identified in 54% and 62%, respectively. Age was negatively associated with BMD in both groups ($r = -0.26$ to -0.39 , $p < 0.05$). Among basic sciences faculty members, lower frequency of fermented dairy consumption was linked to decreased BMD (Cramér's $V = 0.34$), and reduced BMD correlated with higher fracture incidence ($V = 0.37$). In clinical science faculty members, low seafood intake ($V = 0.31$), high coffee consumption ($V = 0.52$), and smoking ($V = 0.35$) were significantly associated with reduced BMD and higher prevalence of osteopenia or osteoporosis. These findings support previous evidence on the protective role of calcium-rich and vitamin D-containing foods, and the adverse effects of caffeine and smoking on bone health.

Conclusion

The study highlights the critical role of nutrition and lifestyle in maintaining bone mineral density. Preventive strategies emphasizing fermented dairy and seafood consumption, reduced caffeine intake, and smoking cessation may help mitigate osteoporosis risk among university faculty and broader populations.

Keywords

Osteoporosis; bone mineral density; fermented dairy; seafood; lifestyle factors

INTRODUCTION

Osteoporosis is a chronic metabolic bone disease marked by progressive loss of bone mineral density (BMD) and deterioration of bone microarchitecture, leading to increased bone fragility and a heightened risk of fractures—even from minimal trauma or ordinary movements¹. These osteoporotic fractures pose a significant global health issue, as they are associated with substantial morbidity and mortality, particularly among the elderly population². In Kazakhstan, regional epidemiological data reveal a consistent increase in the prevalence of osteoporosis and associated fractures. A population-based study conducted in Taldykorgan between 2015 and 2017 documented a 26.4% rise in musculoskeletal disorders within three years, disproportionately affecting women¹. Research from Kazakhstan has also highlighted the significant impact of environmental factors on population health³. Additionally, the country continues to struggle with micronutrient deficiencies, notably iodine deficiency among women of reproductive age^{4,5}. According to national registry data, hip fractures remain a major contributor to disability, with many patients unable to undergo surgical treatment due to financial limitations¹.

Global research demonstrates comparable trends. In Bulgaria, Boyanov et al. reported that

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women over the age of 50 exhibited a 32.5% prevalence of osteopenia and a 20.5% prevalence of osteoporosis⁶. Similarly, Borisova et al. identified a 16.8% prevalence of femoral neck osteoporosis among Bulgarian women aged 50–89⁷. On a global scale, Kanis et al.² estimated that osteoporosis affects around 200 million individuals and leads to approximately 8.9 million fractures each year. In the United States, prevalence rates are estimated at 13–18% among women over 50 and 3–6% among men of the same age group, with men demonstrating higher post-fracture mortality rates⁸.

Projections suggest a substantial rise in fracture incidence with population aging. For example, Turkey is expected to experience a 50% increase in hip fractures from 2010 to 2020⁹, and EU figures indicate an increase from 27.5 million affected individuals in 2010 to 33.9 million by 2025². In Kazakhstan, FRAX-based modeling predicts a 140% increase in hip fractures by 2050¹.

Risk factors contributing to low bone mineral density (BMD) include both non-modifiable and modifiable elements. Non-modifiable factors encompass age, sex, and ethnicity, while modifiable lifestyle factors include inadequate calcium intake, vitamin D deficiency, physical inactivity, smoking, and excessive alcohol consumption^{2,10}. Smoking has been shown to disrupt calcium balance, increase parathyroid hormone levels, and inhibit osteoblast activity¹¹. Similarly, chronic alcohol use suppresses bone formation and enhances bone resorption¹². Insufficient physical activity is associated with decreased bone and muscle mass, thereby elevating the risk of fractures¹³. Body mass index (BMI) also influences bone health—low BMI (<20 kg/m²) increases fracture risk, while obesity may exert either protective or detrimental effects depending on fat distribution¹⁴.

Diet plays a pivotal role in maintaining skeletal health. Adequate consumption of calcium, vitamin D, protein, and polyunsaturated fatty acids is linked to improved BMD and a lower likelihood of fractures^{15,16}. Dairy products serve as the main source of bioavailable calcium and are consistently associated with reduced osteoporosis risk¹⁷. Additionally, regular consumption of fish and seafood—especially in Asian populations—has been correlated with better bone health outcomes^{16,18}. In contrast, high intake of soft drinks can replace nutrient-dense beverages in the diet, potentially contributing to bone demineralization and loss¹⁹.

In Kazakhstan, dietary assessments indicate inadequate

dairy consumption and unbalanced micronutrient intake, particularly in rural populations, where the prevalence of osteoporosis and osteopenia among adults remains high²⁰. As the nation's population continues to age, the incidence of osteoporosis and related fractures is expected to place an increasing strain on the healthcare system, highlighting the importance of early diagnosis, risk assessment, and preventive measures².

Osteoporosis—often described as the “silent epidemic” of the 21st century—represents a pressing medical, social, and economic challenge. Tackling this issue requires comprehensive public health initiatives, focused education of healthcare professionals, and the promotion of lifelong bone-supportive habits.

Accordingly, the present study aimed to examine the association between lifestyle and dietary factors and bone mineral density (BMD) among faculty members of Asfendiyarov Kazakh National Medical University, with particular emphasis on identifying modifiable risk factors for osteoporosis.

METHODS AND MATERIALS

A questionnaire was developed to assess the awareness regarding factors affecting bone mineral density (BMD) and dietary habits, of faculty members at Asfendiyarov Kazakh National Medical University. The study was conducted between September – November 2023. Ethical approval for the study was taken from The Local Bioethics Committee (LBC) of Asfendiyarov KazNMU 30.01.2022 №3(126).

The survey comprising of 30 questions was administered both offline and online via the Google Forms platform. The initial section of the questionnaire focused on demographic information, followed by questions assessing participants' knowledge about BMD and factors influencing bone health. The study sample included faculty members over the age of 40 from various ethnic backgrounds. A total of 100 voluntary participants were recruited for the study, using convenience sampling method.

In the subsequent phase, BMD of the participants were measured using the SONOST-3000 ultrasonic osteometer (OsteoSys Co., Ltd., Korea). The device (615 × 293 × 310 mm), weighed 12 kg and consisted of two sensors for emitting and receiving ultrasonic waves. These were integrated with a liquid crystal display and a support to secure the lower ankle during measurement.

The SONOST-3000 featured an integrated printer and a protective cover for its internal components.

The device outputs comprised of the following parameters: Speed of Sound (SOS), Broadband Ultrasound Attenuation (BUA), Bone Quality Index (BQI), and Bone Mineral Density (BMD). SOS represented the velocity of an ultrasonic wave passing through bone, BUA indicated the change in wave intensity through bone (dB/MHz), and BQI reflected bone density and structure based on analysis of the transmitted ultrasonic pulse. BMD results were automatically interpreted using the T-score, which reflected the deviation of the measured value from a young healthy reference population, and the Z-score indicated deviation from an age-, sex-, and weight-matched reference.

In this study, the calcaneus was selected for measurement due to its accessibility and convenience. The ankle bone was positioned between the two sensors, and participant demographic data were entered into the device. The emitting and receiving sensors were aligned perpendicularly at the measurement site.

Scanning took approximately 15 seconds, with total test time around 60 seconds. Results were displayed on the device's screen as color-coded charts (OsteoSys Co., Ltd., 2022).

Statistical Analysis

Questionnaire responses and BMD measurements were entered into Microsoft Excel 2019 and analyzed using IBM SPSS Statistics version 23. Both parametric and non-parametric statistical methods were applied. Statistical significance was set at $p \leq 0.05$.

Normality of continuous variables was assessed using the Shapiro–Wilk test ($n < 50$). Normally distributed variables were presented as mean $\pm$ standard deviation ($M \pm SD$) with 95% confidence intervals (CI). Non-normally distributed variables were reported as median (Me) and interquartile range (IQR). Categorical variables were expressed as absolute frequencies and percentages.

Spearman's rank correlation coefficient (r) was used to assess relationships between variables. Pearson's χ^2 test was applied to compare frequencies of categorical variables between groups.

For multiway tables, Cramér's V was calculated as:

$$V = \sqrt{\frac{\chi^2}{n \times \min(p-1, c-1)}}$$

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where n is the number of observations, p the number of rows, and c the number of columns.

The strength of association for Cramér's V was interpreted according to Rea and Parker (1992) as follows:

Cramér's V	Association Strength
< 0.1	None
0.1–<0.2	Weak
0.2–<0.4	Moderate
0.4–<0.6	Relatively strong
0.6–<0.8	Strong
0.8–1.0	Very strong

Ethical clearance

Ethical approval for the study was taken from The Local Bioethics Committee (LBC) of Asfendiyarov KazNMU 30.01.2022 №3(126).

RESULTS

A survey was conducted to assess the level of awareness regarding factors affecting bone mineral density (BMD) and dietary habits among faculty members of Asfendiyarov Kazakh National Medical University regarding factors influencing bone mineral density. The survey included 100 respondents aged over 40 years of age.

Regarding distribution of age of the participants, majority were between 40–50 years: 64% from the faculty of basic sciences (95% CI: 58.46–69.54) and 70% from the faculty of clinical sciences (95% CI: 64.7–75.3). For the age group of 51–60 years, 30% were from the faculty of basic sciences (95% CI: 24.7–35.3) and 24% from the faculty of clinical sciences (95% CI: 19.06–28.94). Only 6% of participants from each of the two faculties belonged to the age group of 61–70 years (95% CI: 3.26–8.74). The mean age of members from the faculty of basic sciences was 49.1 years ($SD = 6.5$; 95% CI: 47.27–50.97), while the mean age of members from faculty of basic sciences was 48.18 years ($SD = 6.9$; 95% CI: 46.26–50.26).

Among the participants, 95% (95% CI: 90.64–99.36) were identified as Kazakh, while 5% (95% CI: 0.64–9.36) were identified as Russian.

Table 1 Characteristics of study participants

Variables	Frequency (n)	Percentage (%)
Age		
40-50	67	67
51-60	27	27
61-70	6	6
Ethnicity		
Kazakh	95	95
Russian	5	5
Department		
Basic sciences	50	50
Clinical sciences	50	50

Among faculty members of the basic sciences department, 64% (95% CI: 50.42–77.58) reported fractures due to minor trauma, compared with 78% (95% CI: 66.28–89.72) among clinical science department. Nearly all participants consumed calcium-rich foods: 98% of basic science and 100% of clinical science department members, with dairy products as the primary source (58% and 50%, respectively). A history of fractures was reported by 78% of the participants of basic sciences and 60% of clinical science departments. The most frequent were ankle fractures (12% vs. 16%) and hand fractures (8% vs. 24%), while no pelvic fractures were observed. Medical consultation for fractures or surgeries was infrequent. Only 2% of participants from basic sciences and 6% of clinical science departments reported visiting a physician several times per year. Annual consultations were noted in 24% and 46% of the participants in the two departments respectively. The majority of participants of basic sciences (74%) and nearly half of clinical science (48%) departments reported never seeking medical care for fractures or related surgical interventions.

Table 2. Prevalence of Bone Fractures, Medical Consultations and Some Food Consumption Patterns of Participants

	Basic Sciences % [95%CI]	Clinical Science % [95%CI]
Prevalence of fractures caused by minor trauma		
Yes	64% [50,42–77,58]	78% [66,28–89,72]
No	36% [22,42–49,58]	22% [10,28–33,72]
Distribution of bone fractures by type		

	Basic Sciences % [95%CI]	Clinical Science % [95%CI]
Any fracture (Yes)		
Ankle fracture	78% [66,28–89,72]	60% [46,14–73,86]
Hand fracture	12% [2,8–21,2]	16% [5,64–26,36]
Frequency of medical visits related to fractures	8% [0,32–15,68]	24% [11,92–36,08]
	74% [61,6–86,4]	48% [33,86–62,14]
Food Consumption		
Calcium-rich foods	98% [94,04–101,96]	100%
Dairy Products	58% [44,04–71,96]	50% [35,86–64,14]
Vegetables	32% [18,8–45,2]	44% [29,96–58,04]
Dried fruits	4% [1,54–9,54]	4% [1,54–9,54]
Legumes	6% [0,72–12,72]	2% [1,96–5,96]

Daily consumption of fermented dairy products was reported by 38% of participants from basic sciences and 50% of clinical science departments, while 2–3 times per week was reported by 44% and 28%, respectively. Daily milk consumption was common (76% vs. 72%). Fish consumption was generally low; only 2% of participants from basic sciences department consumed fish 2–3 times per week, with the majority consuming it 2–3 times per month (50% vs. 52%). Seafood intake was infrequent, with most reporting rare or no use (62% basic sciences, 42% clinical science department). Legumes were consumed weekly by 36% of basic sciences and 58% of clinical science department participants. Coffee was consumed daily by 36% and 34%, while tea was consumed daily by the majority (88% basic sciences, 96% clinical science department participants). Weekly or monthly consumption of sugar-sweetened beverages was reported by more than half of participants in both groups, with daily use being uncommon (4% basic sciences department). Compote prepared from dried fruits was consumed 2–3 times per month by 34% of participants from basic sciences and 46% of clinical science departments. Most respondents were non-smokers (84% basic sciences, 58% clinical science departments). Alcohol consumption was rare, with 86% of participants from basic sciences and 78% of clinical science departments reporting little or no use. Regarding physical activity, daily exercise was reported by 29% of participants from basic sciences and 21% of clinical science departments, while the most frequent pattern overall was exercising three times per week (32% vs. 37%).

Table 3. Frequency of Consumption of Some Food Products of Participants

Food Product	Basic Sciences (%) [95% CI]	Clinical Science (%) [95% CI]
Fermented dairy products		
Daily	38 [24.28–51.72]	50 [35.86–64.14]
2–3 times/week	44 [29.96–58.04]	28 [15.3–40.7]
Once/week	16 [5.64–26.36]	16 [5.64–26.36]
2–3 times/month	–	6 [0.72–12.72]
Rare/never	2 [1.96–5.96]	–
Milk		
Daily	76 [63.92–88.08]	72 [59.3–84.7]
2–3 times/week	14 [4.18–23.82]	20 [8.68–31.32]
Once/week	6 [0.72–12.72]	4 [1.54–9.54]
2–3 times/month	4 [1.54–9.54]	–
Rare/never	–	4 [1.54–9.54]
Fish		
Daily	–	–
2–3 times/week	2 [1.96–5.96]	–
Once/week	34 [20.6–47.4]	24 [11.92–36.08]
2–3 times/month	50 [35.86–64.14]	52 [37.86–66.14]
Rare/never	14 [4.18–23.82]	24 [11.92–36.08]
Seafood		
Daily	–	–
2–3 times/week	2 [1.96–5.96]	–
Once/week	12 [2.8–21.2]	30 [17.04–42.96]
2–3 times/month	24 [11.92–36.08]	28 [15.3–40.7]
Rare/never	62 [48.28–75.72]	42 [28.04–55.96]
Legumes		
Daily	2 [1.96–5.96]	–
2–3 times/week	22 [10.28–33.72]	12 [2.8–21.2]
Once/week	36 [22.42–49.58]	58 [44.04–71.96]
2–3 times/month	24 [11.92–36.08]	24 [11.92–36.08]
Rare/never	16 [5.64–26.36]	6 [0.72–12.72]
Coffee		
Daily	36 [22.42–49.58]	34 [20.6–47.4]
2–3 times/week	12 [2.8–21.2]	18 [7.14–28.86]
Once/week	20 [8.68–31.32]	6 [0.72–12.72]
2–3 times/month	6 [0.72–12.72]	18 [7.14–28.86]
Rare/never	26 [13.6–38.4]	24 [11.92–36.08]
Tea		
Daily	88 [78.8–97.2]	96 [90.46–101.54]
2–3 times/week	6 [0.72–12.72]	–
Once/week	–	4 [1.54–9.54]
2–3 times/month	2 [1.96–5.96]	–
Rare/never	4 [1.54–9.54]	–

Food Product	Basic Sciences (%) [95% CI]	Clinical Science (%) [95% CI]
Sugary drinks		
Daily	4 [1.54–9.54]	–
2–3 times/week	28 [15.3–40.7]	28 [15.3–40.7]
Once/week	24 [11.92–36.08]	32 [18.8–45.2]
2–3 times/month	30 [17.04–42.96]	32 [18.8–45.2]
Rare/never	14 [4.18–23.82]	8 [0.32–15.68]
Compte		
Daily	2 [1.96–5.96]	–
2–3 times/week	4 [1.54–9.54]	6 [0.72–12.72]
Once/week	16 [5.64–26.36]	8 [0.32–15.68]
2–3 times/month	34 [20.6–47.4]	46 [31.9–60.1]
Rare/never	44 [29.96–58.04]	40 [26.14–53.86]

In the second stage of the study, during the assessment of bone mineral density (BMD) using the SONOST 3000 ultrasound device, participants were asked to provide body weight and height information. Based on these measurements, the body mass index (BMI) was calculated.

According to the World Health Organization (WHO) recommendations, the following interpretation of BMI (kg/m^2) values was applied:

- <16 – severe underweight
- 16–18.5 – underweight (deficit)
- 18.5–25 – normal weight
- 25–30 – overweight
- 30–35 – obesity class I
- 35–40 – obesity class II
- 40 – obesity class III

As per the results, 2% of the participants from clinical science department were found to be underweight, 28% had normal weight, 34% were found to be overweight, class I obesity was identified in 32% and obesity class II in 4%. Of the participants from the departments of basic sciences, 50% had normal body weight, overweight was observed in 40%, obesity class I was present in 6%, while obesity class II was found in 4%. Normal bone mineral density was identified in 46% of the participants of basic sciences as compared to 38% in clinical science department. Low bone mineral density was observed in 54% and 62% respectively in both.

Among participants from basic sciences department with normal BMI, 14% had normal BMD, 34% had reduced BMD, and 2% were diagnosed with osteoporosis. Among overweight individuals 26% had normal BMD, 12% had reduced BMD, and osteoporosis was identified in 2%. In those with obesity class I, 4% had normal BMD and 2% had osteoporosis. Among individuals with obesity class II, 2% had normal BMD and 2% had reduced BMD. Correlation analysis showed no significant relationship between BMD and BMI among the participants of basic sciences department ($r = -0.037$; $p = 0.664$).

Among participants from clinical science department, 2% of underweight participants were diagnosed with osteoporosis. Of those with normal BMI, 8% had normal BMD, 16% had osteopenia, and 4% had osteoporosis. Among overweight participants, 14% had normal BMD and 20% had osteopenia. In the group with obesity class I, 14% had normal BMD, 12% had osteopenia, and 6% had osteoporosis. Among individuals with obesity class II, 2% had osteopenia and 2% had osteoporosis. Correlation analysis revealed a weak negative association between BMD and BMI among the participants from clinical science department ($r = -0.371$; 95% CI: -0.147 to -0.724 ; $p < 0.001$), indicating BMD decreased as BMI increased in individuals ($r = -0.371$; $p = 0.009$).

Age-related differences in BMD were also observed among the individuals. Among the participants from basic sciences department who were aged 40–50 years, 26% had normal BMD, while 38% had osteopenia. Among those aged 51–60 years, 18% had normal

BMD, 8% had reduced BMD, and 2% had osteoporosis. In the 61–70 year group, 2% had normal BMD, 2% had reduced BMD, and 4% had osteoporosis. Correlation analysis showed that BMD decreased with age but had a weak negative correlation ($r = -0.261$; $p = 0.04$; 95% CI: -0.11 to -0.537).

Among participants from clinical sciences department, aged 40–50 years, 24% had normal BMD, 42% had reduced BMD, and 4% had osteoporosis. In the 51–60-year group, 14% had normal BMD, 8% had reduced BMD, and osteopenia was identified. In the 61–70-year group, 8% were diagnosed with osteoporosis. Correlation analysis revealed that BMD decreased with age, but had a weak negative correlation ($r = -0.391$; $p = 0.003$; 95% CI: -0.227 to -0.747).

Among the participants from basic sciences department, lower frequency of fermented dairy product consumption was associated with decreased bone mineral density (BMD), showing a moderate relationship (Cramer's $V = 0.34$). A significant association was also observed between BMD and fracture incidence due to minor trauma (Cramer's $V = 0.37$). Among participants from clinical sciences department, reduced seafood consumption was correlated with lower BMD, with a moderate association (Cramer's $V = 0.31$). Coffee intake demonstrated an inverse relationship with BMD, where higher consumption was linked to lower BMD, showing a strong association (Cramer's $V = 0.52$). Smoking frequency was also related to BMD. Frequent and occasional smokers had higher prevalence of low BMD and osteoporosis, with a moderate association (Cramer's $V = 0.35$).

Table 4. Associations Between Some Food Consumption, Lifestyle Factors and Bone Mineral Density (BMD) in Participants

Factor	Category	Normal BMD (%)	Osteopenia (%)	Osteoporosis (%)	Statistics
Fermented Dairy (Basic Sciences)	Daily	24%	14%	0%	Cramer's $V=0.34476$
	2–3 times/week	14%	28%	2%	
	Once/week	8%	4%	4%	
	Monthly/rarely/never	0%	2%	0%	
Fractures (Basic Sciences)	Normal BMD	28% fracture	18% no fracture	0%	Cramer's $V=0.36631$
	Osteopenia	18% fracture	12% no fracture	0%	
	Osteoporosis	0%	6% no fracture	0%	

Factor	Category	Normal BMD (%)	Osteopenia (%)	Osteoporosis (%)	Statistics
Seafood (Clinical Science)	Weekly	24%	2%	4%	Cramer's V=0.31416
	2–3 times/month	12%	10%	6%	
	Monthly/rarely/never	2%	38%	2%	
Coffee (Clinical Science)	Daily	6%	22%	6%	Cramer's V=0.51523
	2–3 times/week	4%	10%	4%	
	Once/week	0%	4%	2%	
	2–3 times/month	4%	14%	0%	
	Monthly/rarely/never	24%	0%	0%	
Smoking (Clinical Science)	Frequent	2%	4%	8%	Cramer's V=0.34741
	Occasional	8%	6%	4%	
	Never	18%	38%	0%	
	Former smoker	10%	2%	0%	

DISCUSSION

Our study demonstrated that the frequency of fermented dairy product consumption was positively associated with normal bone mineral density (BMD), whereas lower intake correlated with osteopenia and osteoporosis ($V = 0.345$) among participants of basic sciences faculty. This aligns with evidence suggesting that regular consumption of fermented dairy supports bone remodeling and reduces fracture risk [21, 22]. A moderate association was also observed between reduced BMD and minor trauma-related fractures ($V = 0.366$), consistent with established risk mechanisms²³.

Among participants from clinical science department, lower seafood consumption was linked to higher rates of osteopenia and osteoporosis ($V = 0.314$), highlighting the importance of calcium and vitamin D sources. Fish bones are rich in calcium and bioactive peptides having a positive effect on bone health²⁴. Coffee intake showed the strongest negative association with BMD ($V = 0.515$), in line with studies suggesting that excessive caffeine may impair calcium metabolism^{25,26}. Smoking similarly demonstrated an adverse effect. Frequent smokers were found to have a lower BMD and more cases of osteoporosis ($V = 0.347$), reflecting nicotine's negative impact on bone turnover^{27,28,29,30,31,32}.

When comparing dietary and lifestyle behaviors between

the two groups, Clinical faculty participants generally demonstrated healthier eating patterns—characterized by higher intake of dairy products and seafood, reduced consumption of sugary drinks, and slightly greater levels of physical activity. These differences were statistically significant ($p < 0.05$), likely reflecting their stronger clinical understanding of health and nutrition. Nevertheless, despite these favorable habits, bone mineral density (BMD) values were not consistently higher among the Clinical faculty group, suggesting that detrimental lifestyle factors—such as smoking and excessive coffee consumption—may offset the positive effects of a nutritious diet. This underscores that bone health depends on a complex interplay of protective and risk factors, rather than dietary habits alone. The findings align with current dietary guidelines, which recommend consuming two to three servings of milk or dairy products daily, at least two servings of fish per week, regular inclusion of legumes and dried fruits, and limiting coffee intake to two or three cups per day, combined with a minimum of 150 minutes of physical activity weekly as advised by the World Health Organization. Overall, our results highlight the essential role of diet and lifestyle in maintaining bone health and emphasize that balanced nutrition, together with the avoidance of smoking and excessive caffeine consumption, are key strategies for preserving optimal bone mineral density.

This study has several limitations that should be considered. First, information on dietary intake and lifestyle behaviors was collected through self-reported questionnaires, which may be influenced by recall bias and inaccuracies in reporting. Second, although the participants were university faculty—a relatively homogenous group in terms of educational background—the sample size was limited and may not accurately represent other professional or demographic populations. Additionally, the small cohort size (100 participants divided between Basic Sciences and Clinical faculty) restricted the power of subgroup analyses, such as those based on age, diet, or smoking status, making it difficult to identify weaker associations. A larger sample would enhance statistical robustness, narrow confidence intervals, and increase the generalizability of the results. The limited number of participants also constrained the ability to perform stratified analyses by gender, ethnicity, or other osteoporosis risk factors.

Despite these limitations, the study reinforces the importance of nutrition and lifestyle in maintaining bone health. The findings support preventive strategies that emphasize the consumption of calcium-rich foods, moderation of caffeine intake, and avoidance of smoking as key measures to reduce the risk of osteoporosis.

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Authors's contribution

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