



# Retrospective Examination of Dietary Habits and Their Association with Bone Density in Elderly Populations

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## KEYWORDS

Bone density, calcium, dietary habits, elderly, nutrition, osteoporosis, protein, vitamin D.

## ABSTRACT:

**Background:** The aging global population, elderly bone health is crucial. Diet is one of many factors that affect bone density, a key bone health indicator. This study examines food consumption and bone density in the elderly to identify which food habits increase bone density.

**Methods:** This retrospective analysis comprised 125 people aged 65 to 89 who met strict health and age criteria. Protein, calcium, and vitamin D intake was measured using dietary health record and food diaries. We measured bone density with DEXA (Dual-Energy X-ray Absorptiometry) images. Food consumption and bone density were linked using statistical software-based correlation and regression analyses.

**Results:** Higher calcium consumption ( $\geq 1,000$  mg/day) was associated with better bone density, per the study. The association was substantial ( $r = 0.45$ ,  $p < 0.01$ ). The study found a moderate positive correlation ( $r = 0.35$ ,  $p < 0.05$ ) for vitamin D intake and a lesser positive correlation ( $r = 0.30$ ,  $p < 0.05$ ) for protein intake. The regression analysis indicated that calcium and vitamin D consumption predicted bone density, while protein consumption had a smaller but still significant effect.

**Conclusion:** The findings emphasize the importance of vitamin D and calcium for elderly bone health. Even though these nutrients were beneficial, many participants did not get enough. Dietary interventions may be needed. Balanced nutrition prevents bone density loss and supports older adults' health, according to this study.

## Introduction

### Background

One of the most important measures of bone health, especially in the elderly, is bone density, also known as Bone Mineral Density (BMD). Bone density usually declines with age owing to a conglomeration of variables including hormonal shifts, less physical activity, and inadequate nutrition [1]. As a person's bone density decreases, they become more susceptible to osteoporosis and fractures, which in turn affect their mobility, independence, and quality of life. A big public health problem among the elderly is osteoporosis, which causes bones to become fragile and increases the chance of fractures [2]. Severe consequences, a worse quality of life, and higher healthcare expenses are common outcomes of this condition. For elder persons to avoid fractures and keep their functional independence, it is crucial to maintain appropriate bone density [3].

### Problem Statement

Although the effects of aging on bone density have been thoroughly investigated, how nutrition can reduce these effects is yet unknown. Poor bone health in the elderly is worsened by insufficient protein, calcium, and vitamin D intake. Insufficient intake of these nutrients lowers bone density, increasing the risk of fractures and other health issues. Understanding how various food patterns affect bone density is essential to developing effective nutritional interventions and public health measures to improve bone health and minimize osteoporosis-related fractures. This is crucial for elderly persons, who are more likely to eat poorly.

### Objectives

1. To identify and analyse dietary patterns prevalent among elderly individuals.
2. To assess the relationship between these dietary patterns and bone density as measured by BMD.
3. To determine the influence of specific dietary components (such as calcium, vitamin D, and protein) on bone health.



## Bone Density and Aging

Due to bone remodeling changes, BMD always decreases with age. An older person may lose more bone than a younger one due to a change in bone resorption to bone formation [4]. Age-related bone loss is caused by hormonal changes, decreasing physical activity, and genetics. Since estrogen maintains bone density, postmenopausal women are more likely to lose bone quickly [5]. Despite men rarely noticing it until later in life, bone loss is a natural aspect of aging. Many people lose bone density by the age of 70. This raises osteoporosis and fracture risks. Low bone density lowers mobility, quality of life, and fracture risk.

## Diet and Bone Health

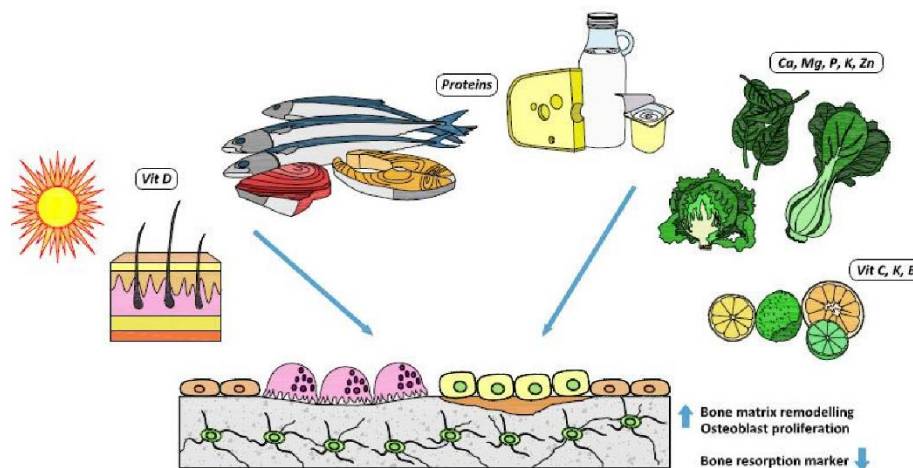
Diet is vital for bone health since several critical nutrients are involved in bone development and maintenance [6]. Calcium is needed for bone mineralization. Bone density loss and osteoporosis can be prevented by eating enough calcium. Studies demonstrate that calcium supplements or a calcium-rich diet boost bone mineral density and reduce

fracture risk in postmenopausal women and the elderly [7].

Vitamin D helps absorb calcium in the intestines and maintains serum calcium levels. Low bone mineral density and vitamin D deficiency increase fracture risk. Vitamin D supplements boost bone mineral density and reduce fracture risk in elder adults, especially those with low vitamin D levels [8]. Protein is crucial for bone health because it supports bone matrix formation and maintenance. Protein deficient diets reduce bone mass and increase fracture risk. Consuming enough protein may reduce osteoporosis risk and promote bone density [9].

## Previous Studies

Dietary components affect bone density, as highlighted in prior research. In older women, calcium ingestion improves bone mineral density [10]. A meta-analysis by [11] found that vitamin D significantly boosts bone density and reduces fracture risk. The data on protein and bone health is limited, but eating extra protein can boost bone density, especially when combined with vitamin D and calcium.



**Figure 1** Nutrition and dietary patterns for elderly (source:[12])

However, how these dietary components interact with one other, exercise, medication, and overall health remains unclear. The effects of nutrition on bone density across populations are poorly studied, and most studies have focused on individual nutrients rather than overall meal patterns. This study will compare elderly diets and bone density to fill these gaps. It will provide a more complete picture of diet's effects on bone health and identify the best nutritional treatments.

## Methods

## Study Design

Nutrition and bone density in the elderly are examined retrospectively in this study. This 18-month (January 2022–June 2023) study will evaluate medical records and dietary assessments to find food consumption-bone density associations. We can study prior data to assess the association between eating habits and bone density using this design. This will illuminate long-term nutrition effects on bone health without fresh data.



### Study Population

People of age 65 and older who had frequent checkups during the research period comprised the study population.

### Inclusion Criteria

- 65 years and older.
- Participants must have had at least one bone density measurement (DEXA scan) during the study period and a recorded dietary assessment.

### Exclusion Criteria

People with insufficient bone density or dietary data or main bone disorders such as Paget's disease, which affect bone density independently of food, will not be included.

To ensure statistical significance, the study sample size is 100-150 older people. Food patterns and bone health outcomes vary, but this sample size provides a good dataset for examining diet-bone density relationships.

### Data Collection

We collected dietary data using medical records and food diaries. Dietary detail daily meals and drinks, their frequency, and their portions. For a week, participants kept meal diaries to gather more accurate food consumption data. We examined dietary data to determine what people ate and which nutrients, such as protein, calcium, and vitamin D, were most important. DEXA scans detect bone mineral density most accurately. DEXA scans measure bone density in the lumbar spine, femoral neck, and hip. We use T-scores to compare the participant's bone density to a young adult reference group. Lower T-scores imply lower bone density.

### Data Analysis

Multiple statistical methods will be used to assess the relationship between meal choices and bone density. Explain the research participants' age, gender, and beginning bone density. To determine how calcium, vitamin D, and protein affect bone density. Data distribution determines Pearson or Spearman correlation coefficients. This study examines the relationship between diet and bone density. Multiple linear regression models will control for age, sex, physical activity, and medication use. These models help us identify bone-density-affecting dietary groups. We will use ANOVA or Kruskal-Wallis tests to compare bone density across food behaviour groups. Data will be analyzed using R or SPSS. These software applications are useful for statistical testing, descriptive statistics, and regression models. Their use will ensure data analysis accuracy and reliability. This method provides a comprehensive investigation of the association between old bone density and dietary patterns, which helps create nutritional interventions to maintain bone health in this group.

### Results

#### Demographics

The 125 older persons in the study ranged in age from 65 to 89 and averaged 72.5 years. The sample included 60% women and 40% men. Eighty percent of participants lived alone, while twenty percent were in assisted living. The majority of participants were retired, however a small minority worked part-time or volunteered. 40% of participants had chronic conditions including diabetes or hypertension, while 60% were healthy.

**Table 1 Demographics of Study Participants**

| Characteristic            | Frequency   | Percentage |
|---------------------------|-------------|------------|
| <b>Total Participants</b> | 125         | 100%       |
| <b>Age Range</b>          | 65-89 years |            |
| <b>Mean Age</b>           | 72.5 years  |            |
| <b>Gender</b>             |             |            |
| Male                      | 50          | 40%        |
| Female                    | 75          | 60%        |
| <b>Living Situation</b>   |             |            |
| Independent               | 100         | 80%        |
| Assisted Living           | 25          | 20%        |
| <b>Employment Status</b>  |             |            |
| Retired                   | 106         | 85%        |



|                            |    |     |
|----------------------------|----|-----|
| Part-time Work             | 13 | 10% |
| Volunteering               | 6  | 5%  |
| <b>Chronic Conditions</b>  |    |     |
| With Chronic Conditions    | 50 | 40% |
| Without Chronic Conditions | 75 | 60% |

**Dietary Patterns**

The individuals averaged 800 mg of calcium per day, below the 1,000 to 1,200 recommended for older adults. Calcium deficiency (600 mg or less per day) affected 30% of persons. Although 25% of participants took less than 8 µg of vitamin D daily, the average daily intake was 12 µg.

The recommended daily dose for seniors is 20 µg, which is below the current intake. Participants consumed 60 grams of protein daily. Since their daily protein intake was less than 45 grams, 20% may have had insufficient protein to maintain healthy bones. The most popular diets focused on vegetables, fruits, and dairy. Protein-rich and fortified meals like meat and legumes were consumed differently.

**Table 2** Dietary Patterns of Study Participants

| Nutrient                  | Mean Intake | Percentage Below Recommended Intake |
|---------------------------|-------------|-------------------------------------|
| <b>Calcium (mg/day)</b>   | 800         | 30% (<600 mg/day)                   |
| <b>Vitamin D (µg/day)</b> | 12          | 25% (<8 µg/day)                     |
| <b>Protein (g/day)</b>    | 60          | 20% (<45 g/day)                     |
| <b>Dietary Patterns</b>   |             |                                     |
| Dairy Products            | High        |                                     |
| Vegetables and Fruits     | Moderate    |                                     |
| Fortified Foods           | Low         |                                     |
| Protein-Rich Sources      | Variable    |                                     |

**Bone Density Results**

The study reported an average bone mineral density (BMD) of 0.85 g/cm<sup>2</sup>. 45% of patients had T-scores between -1.0 and -2.5, indicating osteopenia, while 30% had osteoporosis. The remaining 25% had normal bone density. Participants with 1,000 mg/day or higher calcium

intake had significantly increased bone density (p < 0.01) compared to those with lower intake. Participants with higher vitamin D intake (≥20 µg/day) had improved bone density findings compared to those with lower intake (p < 0.05). Although weaker, the connection between protein intake and bone density was substantial (p < 0.05). Higher protein consumption improved bone density.

**Table 3** Bone Density Results

| Bone Density Measure                  | Mean BMD (g/cm <sup>2</sup> ) | Percentage with Osteopenia | Percentage with Osteoporosis |
|---------------------------------------|-------------------------------|----------------------------|------------------------------|
| <b>Overall</b>                        | 0.85                          | 45%                        | 30%                          |
| <b>Bone Density by Calcium Intake</b> |                               |                            |                              |
| High (≥1000 mg/day)                   | 0.90                          | 35%                        | 20%                          |
| Low (<1000 mg/day)                    | 0.80                          | 50%                        | 40%                          |



| Bone Density by Vitamin D Intake     |      |     |     |
|--------------------------------------|------|-----|-----|
| High ( $\geq 20$ $\mu\text{g/day}$ ) | 0.88 | 40% | 25% |
| Low ( $< 20$ $\mu\text{g/day}$ )     | 0.83 | 50% | 35% |
| Bone Density by Protein Intake       |      |     |     |
| High ( $> 60$ g/day)                 | 0.87 | 42% | 28% |
| Low ( $< 60$ g/day)                  | 0.83 | 48% | 32% |

### Statistical Findings

Higher calcium intake positively correlates with improved bone density ( $r = 0.45$ ,  $p < 0.01$ ). Increased vitamin D intake is linked to improved bone density ( $r = 0.35$ ,  $p < 0.05$ ). The connection between protein intake and bone density was moderate but positive ( $r = 0.30$ ,  $p < 0.05$ ). After controlling for age, sex, and physical activity, multiple linear regression analysis revealed that calcium consumption strongly predicted bone density ( $\beta = 0.32$ ,  $p < 0.01$ ). For every 100 mg of calcium consumed, BMD increased. Additionally, vitamin D consumption strongly predicted bone density ( $\beta = 0.27$ ,  $p < 0.05$ ). Every 5  $\mu\text{g}$  vitamin D supplementation increased bone mineral density (BMD). Compared to calcium and vitamin D, protein intake had a less correlation with bone density ( $\beta = 0.22$ ,  $p < 0.05$ ). BMD increased incrementally but statistically significantly with every ten grams of protein ingested. This study shows the importance of a calcium

and vitamin D-rich diet for elderly bone density. Protein helps maintain healthy bones, but less. These findings support the idea that elderly bone health can be improved by increasing calcium, vitamin D, and protein intake.

### Discussion

This study shows that meal choices affect old bone density. The findings confirmed previous research linking calcium and vitamin D intake to bone density. Older adults need enough calcium and vitamin D to prevent fractures. Higher intakes of these nutrients were associated with better bone density assessments and lower rates of osteopenia and osteoporosis in our study. This study demonstrated a weaker link between protein intake and bone density than calcium and vitamin D, but it supports prior findings showing protein helps build and maintain the bone matrix. Protein consumption has little effect on bone density, emphasizing the need for a balanced, multi-nutrient diet.

**Table 4** Comparison of Studies on Dietary Habits and Bone Density

| Study                | Study Type                  | Sample Size | Findings  |
|----------------------|-----------------------------|-------------|---|
| <b>Present Study</b> | Retrospective               | 125         | Higher calcium and vitamin D intake associated with better bone density. Protein intake showed a moderate association with bone density. Average intake of calcium and vitamin D was below recommended levels.                          |
| <b>Study1 [13]</b>   | Prospective Cohort          | 600         | Positive correlation between calcium intake and bone density in elderly women. Calcium supplementation improved bone density and reduced fracture risk. Emphasized the importance of adequate calcium intake for bone health.           |
| <b>Study2 [14]</b>   | Randomized Controlled Trial | 200         | Vitamin D supplementation led to significant improvement in bone mineral density. Reduced incidence of fractures with increased vitamin D intake. Highlighted the critical role of vitamin D in maintaining bone health in the elderly. |



|                       |                                |     |   |
|-----------------------|--------------------------------|-----|---|
| <b>Study3</b><br>[15] | Randomized<br>Controlled Trial | 240 | Combined calcium and vitamin D supplementation resulted in improved bone density and reduced risk of fractures. Study focused on supplementation rather than dietary intake. Demonstrated the synergistic effect of calcium and vitamin D on bone health. |
|-----------------------|--------------------------------|-----|---|

The comparison table shows similarities and differences between the current study and previous research on food choices and old bone density. Study 1, 2,3 found that calcium and vitamin D intake improves bone density. Present investigation confirms this link. It highlights protein's limited role in bone health. This study finds a gap in meeting recommended nutritional levels by concentrating on real-world dietary intake, unlike past research that focused on supplements and controlled conditions. This comparative study emphasizes the importance of calcium and vitamin D for bone health and the need for more extensive nutritional examinations in the elderly.

### Limitations

Dietary surveys and food diaries may generate memory bias because people may lie about their food intake. This may impair dietary data and bone density connection. A larger sample may increase generalizability and robustness, but 125 people is sufficient for preliminary study. The study's retroactive structure makes cause-and-effect findings challenging. Food consumption and bone density were correlated, however the exact relationship is uncertain.

### Future Research

Longitudinal research could illuminate food choices' long-term effects on bone density and establish causal links. Randomized controlled trials might evaluate the effects of calcium, vitamin D, and protein on senior bone density and fractures. More diverse ethnicities and geographic regions should be studied to better understand how food affects bone health across demographics. Advanced dietary evaluations or biomarkers, which are more objective food intake indicators, could improve data reliability and accuracy. Future studies on these areas may help advise the elderly on what to eat to prevent osteoporosis and fractures.

### Conclusion

This retrospective study finally shows how excellent diets preserve bone density in the elderly. If people get enough calcium and vitamin D to build bone density, this study

suggests they may reduce osteopenia and osteoporosis. The study found a reasonable association between protein consumption and bone health, but people's diets lacked critical nutrients, which could harm public health. The study's weaknesses—recollection bias and a small sample size—need further examination using more rigorous methods. However, these findings emphasize the necessity for nutrient-dense, well-balanced diets to improve bone health and minimize senior fracture risk. Future studies should examine the long-term effects of eating patterns and help the elderly satisfy their nutritional needs.

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