

# Plant-based food consumption and bone integrity in college-aged students

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## Introduction

The popularity of vegetarian diets among Americans has increased from 2014.<sup>1</sup> In the U.S. population, 6% reported following a vegetarian diet and 3% reported following a vegan diet. While these percentages of the population are low, the number of people who are incorporating plant-based foods into their diet is substantially higher, at 39%.

Research suggests that individuals who follow plant-based diets may be vulnerable to low bone integrity due to under consumption of important nutrients necessary for building bone, specifically calcium, vitamin D, vitamin B-12, zinc, protein, and n-3 fatty acids.<sup>1-4</sup> Individuals that follow these diets during a critical time of accruing bone may increase their risk of developing osteoporosis later in life.

## Purpose

To determine if college students (aged 18-24 years old) following a plant-based diet have decreased bone integrity compared to individuals not following a plant-based diet.

## Methods

### Study Design:

The College Health and Nutrition Assessment Survey is an on-going, cross-sectional project examining diet and lifestyle factors of young adults at a public New England college (UNH IRB 5524).

### Participants:

- Students (18-24) were recruited from a nutrition introductory course between 2007-2018
- Provided informed consent and excluded if pregnant or had medical conditions that prevented participation in related activities

### Procedure:

- Diet information collected via 3-day food records (two weekdays and one weekend nonconsecutively)
- Diet Analysis Plus averaged food and nutrient intakes
- Bone Ultrasound Analyzer (BUA) assessed bone health and integrity of the left and right calcaneus

### Data management:

- Plant-based food intake was measured by 3-day food recall; students were categorized as high plant-food eaters (HPFE) or low plant-food eaters (LPFE) according to fiber and cholesterol intakes.
- HPFE were defined as those that consumed  $\leq 300$  mg/day of dietary cholesterol and  $\geq 38$  g/day (men) or 26 g/day (women) of fiber.
- Z-scores, T-scores, and BUA scores were averaged
- Data are reported as percentages or means (SE)

### Data Analysis:

- Chi-square analysis to compare between groups and ANCOVA to control for covariates
- Covariates: family history of osteoporosis, smoking, exercise, alcohol intake, body mass index, gender, and total calories

## Why is Bone Health Important?

Peak bone mass is achieving full genetic potential of bone development by making sure that the skeleton size and mass has not been altered by insufficient supply of nutrients during its development.<sup>5</sup> It is the amount of bone tissue present at the end of skeletal maturation.<sup>6</sup> Typically, full bone maturation peaks prior to age 20, and total skeleton mass peaks six to ten years afterwards.<sup>5</sup> Achieving optimal peak bone mass during these critical years is important because it is protective against fragility fractures that occur later in life.

Osteoporosis is characterized by the thinning and deterioration of bone tissue, which can lead to fractures that is associated with adverse outcomes, such as risk of mortality, disability and loss of productivity.<sup>7</sup> In order to achieve optimal bone integrity, peak bone mass needs to be procured during the college years.

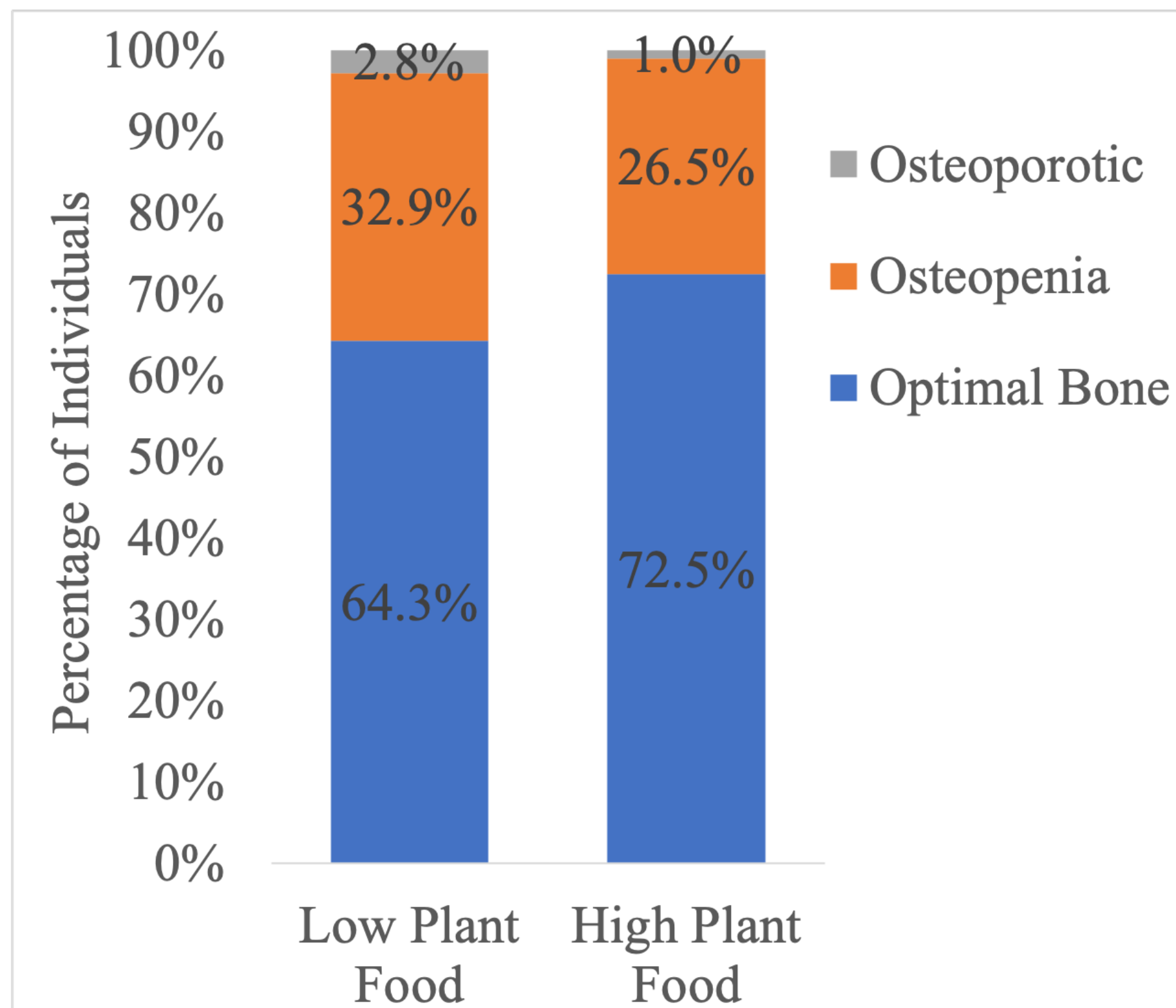
## Subject Characteristics

Demographics	High Plant Food Consumption (n=878)	Low Plant Food Consumption (n=6,596)
Age	18.84 (0.3)	18.88 (0.01)
Female, No. (%)	842 (95.9)	4435 (67.2)
Freshmen, No. (%)	522 (59.5)	3762 (57.0)
Race, No. (% White)	678 (97.1)	4836 (93.9)
Major, No. (%)		
Nutrition	105 (12.0)	318 (4.8)
Allied Health	173 (19.7)	1379 (20.9)
All other majors	600 (68.3)	4899 (74.3)
Body mass index, kg/m <sup>2</sup>	22.68 (0.1)	23.66 (0.04)
Family members with osteoporosis, No. (%)		
None	678 (87.1)	5220 (89.6)
1	87 (11.2)	532 (9.1)
2 or more	13 (1.7)	77 (1.3)
Smoking status, No. (% yes)	(31) 4.1	(401) 7.3
Exercise, No. (% yes)	840 (97.6)	5981 (92.7)
Alcohol intake, No. (% yes)	545 (72.3)	4210 (77)
Total calories, kcals	470.6 (8.7)	619.8 (4)

## Results

- 2.5% of individuals had osteoporotic bone
- No significant difference in mean Z-scores were seen between the two dietary groups
- Significant difference between groups in vitamin and mineral intake

## Bone Status According to Dietary Pattern, Low vs. High Plant Consumption



## Conclusion

- Findings suggest a high-plant food intake may not be detrimental to bone integrity in young adults.
- The high fiber, low dietary cholesterol group had significantly higher intake of certain vitamins and minerals (vitamin B12, iron, vitamin C, zinc, calcium, and magnesium)
- Assessed diets from actual intake, not reported dietary habits, which may be a more accurate way to determine dietary patterns
- Longitudinal research is needed to further examine the impact of plant-based dietary patterns on bone integrity.

## Dietary Patterns and Bone Scores

Dietary Patterns	High Fiber and Low Dietary Cholesterol	Low Fiber and High Dietary Cholesterol	P value
Fiber	33.6 (0.8)	18.9 (0.3)	P < 0.01
Dietary cholesterol	193.9 (24.9)	316.9 (9.6)	P < 0.01
% Lean Body Mass	76.8 (0.43)	75.0 (0.2)	P < 0.01
BUA	83.3 (1.8)	84.1 (0.7)	P = 0.7
T-scores	-0.58 (0.11)	-0.56 (0.04)	P = 0.85
Z-scores	-0.52 (0.11)	-0.48 (0.04)	P = 0.76

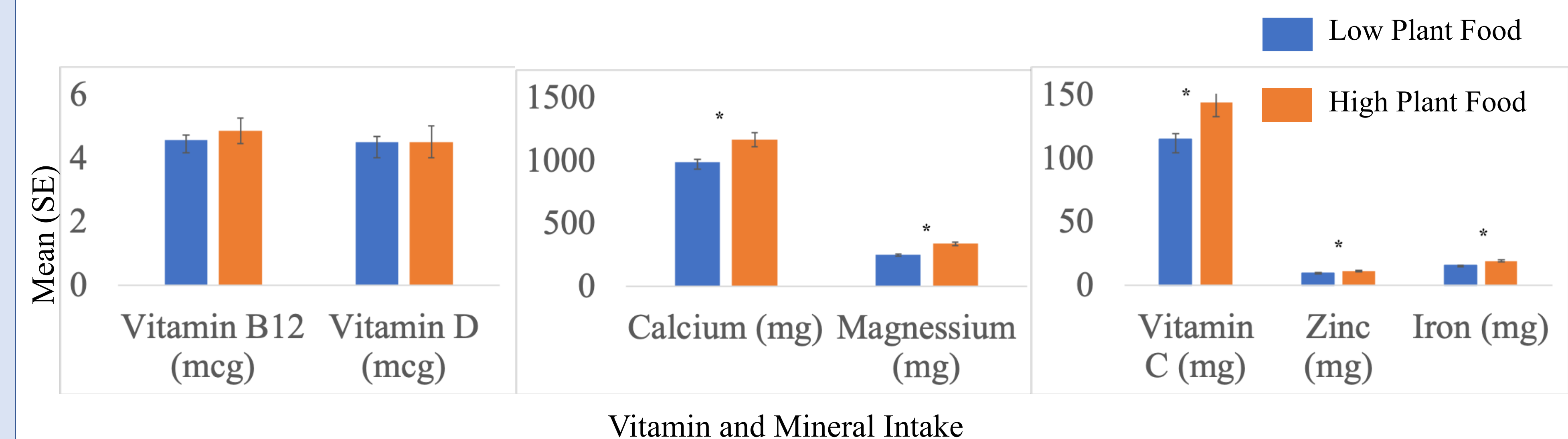
Adjusted for gender, BMI, family history of osteoporosis, smoking, exercise, alcohol intake, and total calories

## Acknowledgements

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## Vitamins and Minerals

### Average Nutrient Intake across Dietary Patterns



\* P < 0.05

Adjusted for gender, BMI, family history of osteoporosis, smoking, exercise, alcohol intake, total calories, and multivitamin use

## References

1. Plant-Based Food Options Are Sprouting Growth for Retailers. <https://www.nielsen.com/us/en/insights/article/2018/plant-based-food-options-are-sprouting-growth-for-retailers>. Accessed December 2, 2019. 2. Mangels AR. Bone nutrients for vegetarians. *Am J Clin Nutr*. 2014;100(suppl\_1):469S-475S. 3. Palacios C. The Role of Nutrients in Bone Health, from A to Z. *Critical Reviews in Food Science and Nutrition*. 2006;46:621-628. 4. Tucker KL. Vegetarian diets and bone status. *The American Journal of Clinical Nutrition*. 2014;100(suppl\_1):329S-335S. 5. Henney RP, Abrams S, Dawson-Hughes B, et al. Peak Bone Mass. *Osteoporos Int*. 2000;11:985-1009. 6. Bonjour J-P, Theintz G, Law F, Slosman D, Rizzoli R. Peak bone mass. *Osteoporos Int*. 1994;4:57-513. 7. Ho-Pham LT, Nguyen ND, Nguyen TV. Effect of vegetarian diets on bone mineral density: a Bayesian meta-analysis. *Am J Clin Nutr*. 2009;90:943-950.