

# Association between Serum Vitamin D and Bone Mineral Density in US Population

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## Background

Osteoporosis is a health condition where the bones become weak. It affects 12.6% of the United States (US) population over 50 years of age (Sarafrazi et al., 2021). Vitamin D helps to improve bone health as it functions in helping reabsorb calcium from the gut.

## Purpose

To determine a relationship between serum vitamin D and BMD of the femoral neck in the US population.

## Methods

**Study sample:** A cross-sectional study, using existing data from National Health and Nutrition Examination Survey (NHANES) 2013-2014, US healthy adults ( $N = 2748$ , 18 years and older, 49.2% males).

**Data collection:** Questionnaires were utilized to collect demographic and personal information (age, sex, race/ethnicity, income). Serum vitamin D was measured using spectrometry. BMD was measured using x-ray bone densitometer. Race was recoded from five race categories to three categories for this analysis. Annual household income in thousands of dollars, was recoded from 15 strata to three strata (< \$25,000, \$25,000-\$55,000 and \$55,000+). Physical exam included measurement of weight (scale) and height (stadiometer) to derive body mass index (BMI). The statistical analysis was conducted overall and by gender.

### Statistical procedures:

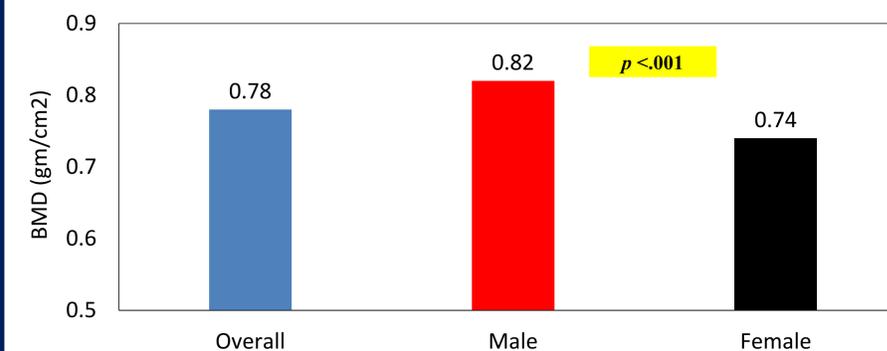
- **Univariate analysis:** Descriptive statistics for continuous variables included measures of centrality (mean) and dispersion (standard deviation). Bar charts were created to display the distribution of BMD.
- **Bivariate analysis:** Statistical significance was determined across gender using two-sample t-test (continuous) or chi-square test (categorical).
- **Multivariable analysis:** Adjusted multivariable linear regression analyses were performed to describe independent associations between serum Vitamin D and BMD.
- Analyses were performed using Statistical Package for the Social Sciences (SPSS) IBM Corp. Released 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp.

## Results

The mean BMD for overall sample was  $0.78 \text{ gm/cm}^2$  and it was significantly higher in males than females.

**Figure 1**

Mean Femoral Neck Bone Mineral Density (BMD) Overall and by Gender



Serum vitamin D levels were significantly higher for female's vs males.

**Table 1**

Characteristics of NHANES 2013-2014 Participants, Overall, and by Gender

Characteristic, mean $\pm$ sd	Overall	Male	Female	p-value
BMD (gm/cm <sup>2</sup> )	0.78 $\pm$ 0.15	0.82 $\pm$ 0.14	0.74 $\pm$ 0.14	<.001
Serum Vitamin D (nmol/L)	70.41 $\pm$ 29.51	66.45 $\pm$ 25.73	74.25 $\pm$ 32.31	<.001
Age (years)	58.57 $\pm$ 12.01	58.78 $\pm$ 12.00	58.36 $\pm$ 12.02	.355

In adjusted linear regression, serum vitamin D was not statistically significantly associated with BMD in overall as well as in gender stratified analysis.

**Table 2**

Adjusted Multivariable Regression Showing association Between Bone Mineral Density Levels and Serum Vitamin D Concentration, NHANES 2013-2014

Variable	Coefficient (95% CI)	p-value
Serum Vitamin D (nmol/L)	0.000 (0.000, 0.000)	.416
BMI (kg/m <sup>2</sup> )	0.008 (0.007, 0.008)	<.001
Age (years)	-0.004 (-0.004, -0.004)	<.001

## Discussion and Conclusion

- The result of this study shows that serum vitamin D was not associated with BMD in US general population. Existing research reports contradictory evidence between serum vitamin D level and BMD. A cross sectional study published in 2011 from Saudi Arabia showed that lower serum vitamin D was associated with low BMD in both men and women (Sadat-Ali et al., 2011).
- Similar to our research, a 2017 publication cited cross sectional research finding from Saudi Arabia showing no relationship between serum vitamin D level and BMD (Alkhenizan et al., 2017).
- The current study was internally valid as a nationally representative data was used. NHANES uses very vigorous protocols to prevent information/selection biases. We adjusted for confounders in the regression model. The results are externally valid and generalizable for the US population as both genders, various races, and socio-economic strata were analyzed. A strength of this analysis is that we used a large sample.
- **Conclusion:** We did not observe any significant association between serum vitamin D levels and BMD of the femoral neck. Further studies can be carried out in larger samples to explore this association.

## References

- Alkhenizan, A., Mahmoud, A., Hussain, A., Gabr, A., Alsoghayer, S., & Eldali, A. (2017). The Relationship between 25 (OH) D Levels (Vitamin D) and Bone Mineral Density (BMD) in a Saudi Population in a Community-Based Setting. *PloS One*, 12(1), e0169122. <https://doi.org/10.1371/journal.pone.0169122>
- Sadat-Ali, M., Al Elq, A. H., Al-Turki, H. A., Al-Mulhim, F. A., & Al-Ali, A. K. (2011). Influence of vitamin D levels on bone mineral density and osteoporosis. *Annals of Saudi Medicine*, 31(6), 602–608. <https://doi.org/10.4103/0256-4947.87097>
- Sarafrazi, N., Wambogo, E. A., & Shepherd, J. A. (2021). Osteoporosis or low bone mass in older adults: United States, 2017–2018. NCHS Data Brief, no 405. Hyattsville, MD: National Center for Health Statistics. <https://dx.doi.org/10.15620/cdc.103477>