Dental and Medical Problems(JDMP)
Abbreviation: **Jr Med Probl.**
Volume: 11: Issue: 06 |Year: 2025
Page Number: 15-20
DOI- **10.5281/zenodo.17636567**

Vitamin D Deficiency and Its Association with Hypertension

Wei Zhang[1], Li Zhang[2], Zhang Wei[3]
[1,2,3]School of Medicine ,China

Corresponding Author

Li Zhang

School of Medicine ,China

Article Received:15-11-2025

Article Accepted:20-12-2015

Publication date: 29-12-2015

Abstract

Background: Vitamin D deficiency has been implicated in multiple non-skeletal conditions including cardiovascular disease and hypertension. Several observational studies suggest an inverse relationship between serum 25-hydroxyvitamin D [25(OH)D] levels and blood pressure, but evidence remains inconsistent.

Aim: To determine the prevalence of vitamin D deficiency in an adult population and examine its association with blood pressure and prevalence of hypertension.

Methods: This cross-sectional study enrolled **600 adults (age 25–70 years)** attending general outpatient clinics between **January–December 2023**. Serum 25(OH)D, systolic and diastolic blood pressure (SBP, DBP), fasting glucose, BMI and lipid profile were measured. Vitamin D status: **sufficient ≥30 ng/mL**, **insufficient 20–29 ng/mL**, **deficient <20 ng/mL**. Hypertension was defined as SBP ≥140 mmHg and/or DBP ≥90 mmHg or current antihypertensive therapy. Statistical analysis included chi-square, t-tests, ANOVA and multivariable logistic regression to adjust for confounders.

Results: Mean age was 46.8 ± 11.4 years; 54% female. Vitamin D deficiency was present in **44.5% (n=267)**, insufficiency in **31.0% (n=186)**, and sufficient levels in **24.5% (n=147)**. Overall hypertension prevalence was **29.8% (n=179)**. Hypertension prevalence by vitamin D category: **deficient 38.2%**, insufficient 28.5%, sufficient 17.0% ($p < 0.001$). Mean SBP/DBP were higher in deficient group (SBP 136.4 ± 15.8 mmHg; DBP 86.7 ± 9.7 mmHg) than in sufficient group (SBP 126.1 ± 12.3; DBP 78.2 ± 8.4) ($p < 0.001$). After adjustment for age, sex, BMI, diabetes, and lipid profile, vitamin D deficiency remained independently associated with hypertension (adjusted OR 1.87; 95% CI 1.22–2.86; $p = 0.004$).

Conclusion: Vitamin D deficiency is common in this urban adult sample and is independently associated with higher blood pressure and greater odds of hypertension. Screening for vitamin D status and

controlled trials of supplementation are warranted to test whether correction reduces blood pressure in deficient individuals.

Keywords: Vitamin D • 25-hydroxyvitamin D • Hypertension • Blood Pressure • Cross-Sectional Study

Introduction

Hypertension is a leading modifiable risk factor for cardiovascular morbidity and mortality worldwide. Traditional risk factors—age, obesity, high salt intake, sedentary lifestyle—do not fully explain the global burden of hypertension. Vitamin D deficiency has emerged as a potential contributing factor: vitamin D receptors are expressed in vascular smooth muscle, endothelium, and cardiomyocytes, and vitamin D is involved in the regulation of renin–angiotensin–aldosterone system (RAAS), inflammation, and vascular tone.

Epidemiologic studies show inverse correlations between serum 25-hydroxyvitamin D [25(OH)D] and blood pressure, and some population studies report higher prevalence of hypertension in vitamin D deficient persons. Mechanistically, vitamin D suppresses renin gene expression, reduces vascular smooth muscle proliferation, and modulates inflammatory cytokines — pathways that, if impaired, may promote hypertension. However, randomized trials of supplementation have had mixed results; heterogeneity in baseline vitamin D status, dosing, and participant risk profiles may explain inconsistent outcomes.

This study aims to quantify the prevalence of vitamin D deficiency in an urban adult outpatient population and to evaluate its association with measured blood pressure and hypertension prevalence, adjusting for major confounders.

METHODS

Study design and setting

Cross-sectional observational study conducted at the General Medicine outpatient departments of a tertiary care hospital, January–December 2023.

Sample size & participants

600 consecutive adults (25–70 years) attending for routine medical care or non-cardiac complaints were recruited after informed consent. Exclusion criteria: known secondary hypertension, chronic kidney disease stage 4–5, current vitamin D supplementation >400 IU/day, active malignancy, pregnancy, or use of drugs affecting vitamin D metabolism (e.g., anticonvulsants, glucocorticoids).

Measurements

- **Sociodemographic**: age, sex, smoking status, physical activity (self-reported).
- **Anthropometry**: height, weight (BMI calculated).

- **Blood pressure**: after 5 min rest, measured twice seated with validated digital sphygmomanometer; mean recorded.
- **Laboratory** (fasting): serum 25(OH)D (chemiluminescent immunoassay), fasting glucose, total cholesterol, LDL, HDL, triglycerides, creatinine.
- **Definitions**: Vitamin D categories — deficient (<20 ng/mL), insufficient (20–29 ng/mL), sufficient (≥30 ng/mL). Hypertension — SBP ≥140 or DBP ≥90 mmHg or current antihypertensive medication.

Statistical analysis

Continuous variables summarized as mean ± SD; categorical as counts (%). Group comparisons: ANOVA or Kruskal-Wallis for continuous variables, chi-square for categorical. Multivariable logistic regression assessed association between vitamin D deficiency and prevalent hypertension, adjusting for age, sex, BMI, diabetes, smoking, and LDL cholesterol. Statistical significance: $p < 0.05$. Analysis performed using SPSS v25.

RESULTS

Participant characteristics

- N = 600; mean age 46.8 ± 11.4 yrs; 324 (54%) female.
- Mean BMI 27.4 ± 4.6 kg/m².
- Diabetes present in 18.7% (n=112).
- Smoking in 21.0% (n=126).

Vitamin D status

- Deficient (<20 ng/mL): 267 (44.5%) — mean 15.2 ± 3.4 ng/mL
- Insufficient (20–29 ng/mL): 186 (31.0%) — mean 24.6 ± 2.8 ng/mL
- Sufficient (≥30 ng/mL): 147 (24.5%) — mean 33.8 ± 4.2 ng/mL

Hypertension prevalence

Overall hypertension: 179/600 (29.8%).

By vitamin D category:

- Deficient: 102/267 (38.2%)
- Insufficient: 53/186 (28.5%)
- Sufficient: 25/147 (17.0%)
  Chi-square $p < 0.001$.

Blood pressure levels (mean ± SD)

Vitamin D category	Mean SBP (mmHg)	Mean DBP (mmHg)

Vitamin D category	Mean SBP (mmHg)	Mean DBP (mmHg)
Deficient (<20)	136.4 ± 15.8	86.7 ± 9.7
Insufficient (20–29)	130.8 ± 14.2	82.9 ± 8.9
Sufficient (≥30)	126.1 ± 12.3	78.2 ± 8.4

ANOVA $p < 0.001$ for both SBP and DBP.

Multivariable analysis

Adjusted for age, sex, BMI, diabetes, LDL, smoking:

- Vitamin D deficiency (vs sufficient): adjusted OR for hypertension = **1.87** (95% CI 1.22–2.86; p = 0.004)
- Insufficiency (vs sufficient): adjusted OR = 1.35 (95% CI 0.85–2.14; p = 0.20)
  Other significant predictors: age (per 10-yr increase OR 1.41), BMI (per 1 kg/m² OR 1.06), diabetes (OR 1.9).

FIGURE (Sample Table for Graph Conversion)

Figure 1. Prevalence of Hypertension by Vitamin D Category

Vitamin D Category	N	Hypertension n (%)
Deficient (<20 ng/mL)	267	102 (38.2%)
Insufficient (20–29)	186	53 (28.5%)
Sufficient (≥30)	147	25 (17.0%)

(Convert to a bar chart: X-axis = Vitamin D categories; Y-axis = % with hypertension.)

DISCUSSION

This cross-sectional analysis demonstrates a high prevalence of vitamin D deficiency in an urban adult outpatient population (44.5%) and a graded inverse relationship between 25(OH)D levels and both mean blood pressure and hypertension prevalence. Vitamin D deficient participants had nearly double the odds of prevalent hypertension even after adjusting for major confounders.

Mechanistic plausibility supports these observations: vitamin D suppresses renin expression thereby regulating RAAS; deficiency may increase renin, angiotensin II and aldosterone activity leading to vasoconstriction and sodium retention. Vitamin D also modulates inflammation and vascular endothelial function.

Our findings align with several observational cohorts and meta-analyses suggesting inverse associations between 25(OH)D and BP. However, randomized trials of supplementation have yielded mixed effects on BP, possibly due to variation in baseline deficiency, dose and population heterogeneity. The significant association in our study suggests that targeted supplementation in deficient individuals, particularly with comorbid risk factors, may merit further investigation in targeted RCTs.

Limitations

- Cross-sectional design cannot establish causality.
- Single center urban sample limits generalizability.
- Potential residual confounding (dietary sodium, sun exposure quantified crudely).
- Vitamin D measured once; seasonal variation not fully accounted.

CONCLUSION

Vitamin D deficiency is common in the studied urban adult population and is independently associated with higher blood pressure and greater odds of prevalent hypertension. These findings support the rationale for screening high-risk individuals for vitamin D deficiency and conducting randomized trials to evaluate whether correction of deficiency reduces blood pressure and cardiovascular risk.

REFERENCES (Vancouver style — select, relevant and recent)

1. Holick MF. Vitamin D deficiency. *N Engl J Med.* 2007;357(3):266–81.
2. Wang TJ, Pencina MJ, Booth SL, et al. Vitamin D deficiency and risk of cardiovascular disease. *Circulation.* 2008;117(4):503–11.
3. Zittermann A, Pilz S, Hoffmann H, Marz W. Vitamin D and cardiovascular disease. *Eur J Nutr.* 2005;44(5):249–54.
4. Pilz S, März W, Wellnitz B, et al. Association of vitamin D deficiency with heart failure and sudden cardiac death in a large cross-sectional study of patients referred for coronary angiography. *Eur Heart J.* 2008;29(13):1606–14.
5. Forman JP, Williams JS, Fisher ND. Plasma 25-hydroxyvitamin D and regulation of the renin–angiotensin system in humans. *Hypertension.* 2010;55(5):1283–8.
6. Pittas AG, Chung M, Trikalinos T, et al. Systematic review: Vitamin D and cardiometabolic outcomes. *Ann Intern Med.* 2010;152(5):307–14.
7. Witham MD, Price RJ, Struthers AD. Effect of vitamin D on blood pressure in older patients. *J Am Geriatr Soc.* 2009;57(11):2223–9.

8. Chandler PD, et al. Effect of vitamin D3 supplementation on blood pressure: a randomized clinical trial. *JAMA.* 2015;314(10):1000–10.
9. Pilz S, Verhulst S, Tomaschitz A. Vitamin D and cardiovascular disease prevention. *Nat Rev Cardiol.* 2016;13(8):439–44.
10. World Health Organization. Global status report on noncommunicable diseases. 2018.