

Global Trends in Vitamin D Research From 1985 to 2024

Mudasir Umer | Syed Mustafa Ali Shah | Camille Moeckel, BA | Erum Azhar, MD, MSPHS, MHQS, CPPS, FACOG | Faisal Aziz, MD, MBA | Abdul Waheed, MD, MS

PRiMER. 2025;9:33.

Published: 6/30/2025 | DOI: 10.22454/PRiMER.2025.538113

Abstract

Introduction: Despite the importance of vitamin D, the number of vitamin D-related research publications has declined since 2020. This study examines trends in vitamin D-related research and National Institutes of Health (NIH) funding over 4 decades.

Methods: We conducted a PubMed search using medical subject headings terms to identify vitamin D-related papers published between 1985 and 2024. NIH funding data were from NIH Reporter; statistical significance was determined using negative binomial regression.

Results: Vitamin D-related publications rose steadily from 1985 to 2000, surged from 2008 to 2021, peaked at 6,019 in 2021, and then declined. A similar trend was seen in research on vitamin D-associated diseases. NIH funding for vitamin D research peaked at \$52.4 million in 2013 but decreased to \$10.5 million by 2024. A negative binomial regression showed a significant difference in publication rates ($P < .001$) in Vitamin D-related publications with “year” being a significant predictor across all models ($P < .05$). Negative binomial regression across 4 decades showed an annual publication growth of Vitamin D-related papers of 1.44% ($P = .002$) from 1985 to 1994, 4.78% ($P < .001$) from 1995 to 2004, and 12.88% ($P < .001$) from 2005 to 2014. In contrast, during the years 2015 to 2024, the annual increase dropped to 0.63% ($P = .389$), indicating a decline in publication activity.

Conclusions: Vitamin D research output surged through 2014 but has since lost momentum, declining from its 2021 peak and showing no significant annual growth from 2015 to 2024 ($P = .389$). These findings regarding vitamin D-related research raise important questions that remain unanswered.

Introduction

Vitamin D is a fat-soluble vitamin essential for human health. It is unique because it can be synthesized in the skin through exposure to ultraviolet B light and obtained through diet and supplements.¹ Beyond its well-known role in bone health, vitamin D influences myriad biological processes, including immune function, cell growth regulation, and inflammation modulation.^{2,3}

The importance of vitamin D for human health has been recognized for decades, with ongoing research exploring its involvement in musculoskeletal health,⁴ endocrine functions,⁵ mental health,⁶ and cancer.⁷

Although prior studies have shown a growing interest in vitamin D research,⁸ no comprehensive analysis to date has examined the recent decline in the number of new publications on this topic. To address this gap, this study examined 40 years of vitamin D research to assess publication trends, shifting focus, and public health implications.

Methods

Data Source and Literature Search

We performed a PubMed literature search to analyze vitamin D-related publications from 1985 to 2024. We extracted qualitative and quantitative data to classify articles by publication type (ie, randomized controlled trials, review articles, and total publications on vitamin D) and by conditions associated with vitamin D (ie, osteoporosis, hyperparathyroidism, vitamin D deficiency, and hypervitaminosis). Additionally, we examined National Institutes of Health (NIH) funding using the NIH Reporter to identify patterns in government funding for vitamin D-related studies. Funding data included contributions from NIH, Centers for Disease Control and Prevention, Food and Drug Administration, Agency for Healthcare Research and Quality, and Administration for Children and Families. The Penn State College of Medicine Institutional Review Board deemed this study exempt from review and approval under Study ID STUDY00025684.

Data and Statistical Analyses

To investigate shifts in vitamin D research, the annual data were graphically represented in Google Sheets (Google LLC). Statistical analyses were performed using SPSS version 24 (IBM), RStudio (Posit Software), and JMP Pro 17 (JMP Statistical Discovery LLC). Significance was assessed with negative binomial regression ($P < .05$), with “year” and “NIH funding” as predictors. A four-phase negative binomial regression was used to evaluate publication trends by decade.

Results

The number of vitamin D-related publications increased by 43.4% from 894 in 1985 to 1,282 in 2000. This growth continued, rising 88.7% from 2,263 in 2008 to 4,271 in 2012. Publications peaked at 6,019 in 2021, followed by a 16.8% decline to 5,008 in 2023, and further dropped to 4,896 by the end of 2024, marking an overall 18.7% decrease from the 2021 peak (Figure 1). This downward trend was consistent across publications on vitamin D-associated conditions (Figure 2).

NIH funding for vitamin D research peaked at \$52.4 million in 2013 but decreased to \$10.5 million by 2024 (Figure 3). Regression analysis revealed that “year” was consistently a significant predictor across all models ($P < .05$), whereas “NIH funding” significantly predicted overall vitamin D publication volume ($P < .05$) but had no significant association with hypervitaminosis-focused research ($P > .05$; Table 1).

Four-phase negative binomial regression analysis revealed that vitamin D publication rates increased significantly over the first 3 decades, with annual increases of 1.44% ($P = .002$) from 1985 to 1994, 4.78% ($P < .001$) from 1995 to 2004, and 12.88% ($P < .001$) from 2005 to 2014. In contrast, from 2015 to 2024, the annual increase dropped to 0.63% ($P = .389$), indicating a decline in publication activity. This trend can be visualized further in Figure 4.

Conclusions

Vitamin D is essential for maintaining health and preventing diseases,⁹ including cardiovascular disease,¹⁰

atherosclerosis,¹¹ diabetes,¹² obesity,¹³ depression and seasonal affective disorder,^{14,15} Alzheimer's disease,¹⁶ and osteoporosis.¹⁷ This study analyzed vitamin D research from 1985 to 2024, showing an annual growth in Vitamin D research since 1985, a peak in 2021, and a decline thereafter, indicating a shift in research priorities. Importantly, NIH funding significantly predicted overall vitamin D publication volume but had no significant association with hypervitaminosis-focused research; this finding highlights funding impact on the broader field rather than this specific area, indicating its limited effect on publication trends related to vitamin D.

Although pinpointing a single cause for the post-2021 dip in total vitamin D publications is challenging, several factors might have contributed to this trend. Notably, media wields significant influence over public health and research by determining which topics receive attention and how they're presented, thereby shaping both debate and public perception.¹⁸ In 2014, studies reported a marked increase in vitamin D coverage across newspapers,¹⁹ television hosts, and other media outlets, a surge that likely drove its widespread popularity—which is evident in rising rates of testing and supplement use despite limited, evidence-based guidelines.²⁰⁻²²

When COVID-19 emerged, media attention and public interest likely shifted to pandemic-related health concerns, contributing to a subsequent decline in vitamin D discourse. The COVID-19 pandemic also was noted to disrupt research work and redirect scientific focus away from basic science and clinical research.²³

The decline also may suggest research saturation; however many questions about vitamin D's mechanisms, optimal levels, and health effects remain unanswered. Mendez and colleagues reported Vitamin D deficiency to be a growing global health concern in 2020.²⁴ Prior research has demonstrated that among middle-aged and older adults in the United States, roughly one-fifth are vitamin D deficient, a risk correlated with increased mortality.²⁵

Despite extensive research, significant gaps²⁶ remain in our understanding of vitamin D, including—but not limited to—its optimal levels and dosages, testing strategies, and clinical applications.²⁷ Emerging extraskelatal research on vitamin D's role in the gut microbiome and cardiovascular disease highlights ongoing uncertainties and the evolving nature of the field.²⁸ A 2024 systematic review highlighted the need for large-scale, multiethnic studies to uncover genetic variations in vitamin D pathways, crucial for understanding its role in autoimmune diseases and personalized treatment.²⁹ Further investigation is warranted, as much remains unknown. Thus, a shift back toward increasing vitamin D research is required, and future research should focus on trends in serum 25-hydroxyvitamin D testing,³⁰ vitamin D supplement use,³¹ genetic analysis,²⁶ nonskeletal outcomes,³² and the prevalence of both vitamin D deficiency and hypervitaminosis D.³³

Limitations of this study included the reliance on PubMed, which may miss relevant publications in nonindexed journals. In addition, the analysis of funding via the NIH Reporter provided insight into government support but overlooks private and international funding sources. Acknowledging the significant increase in the total number of publications is important due to the emergence of new journals and faster publication processes over the past 5 decades. Ghasemi et al reported a linear growth in the number of papers and journals over the last 2 decades.³⁴ The analysis in this paper did not account for the differential comparison to this overall rate of expansion in publications.

Despite its limitations, this study is the first to map 4 decades of vitamin D research, highlighting important questions that still need to be explored. Given the global prevalence of vitamin D deficiency and its broad health implications, strategic efforts—including interdisciplinary collaboration, long-term studies, and supportive policies—are essential to reinvigorate research and inform public health priorities.

Tables and Figures

Figure 1. Trends in Vitamin D Publications Based on Publication Type

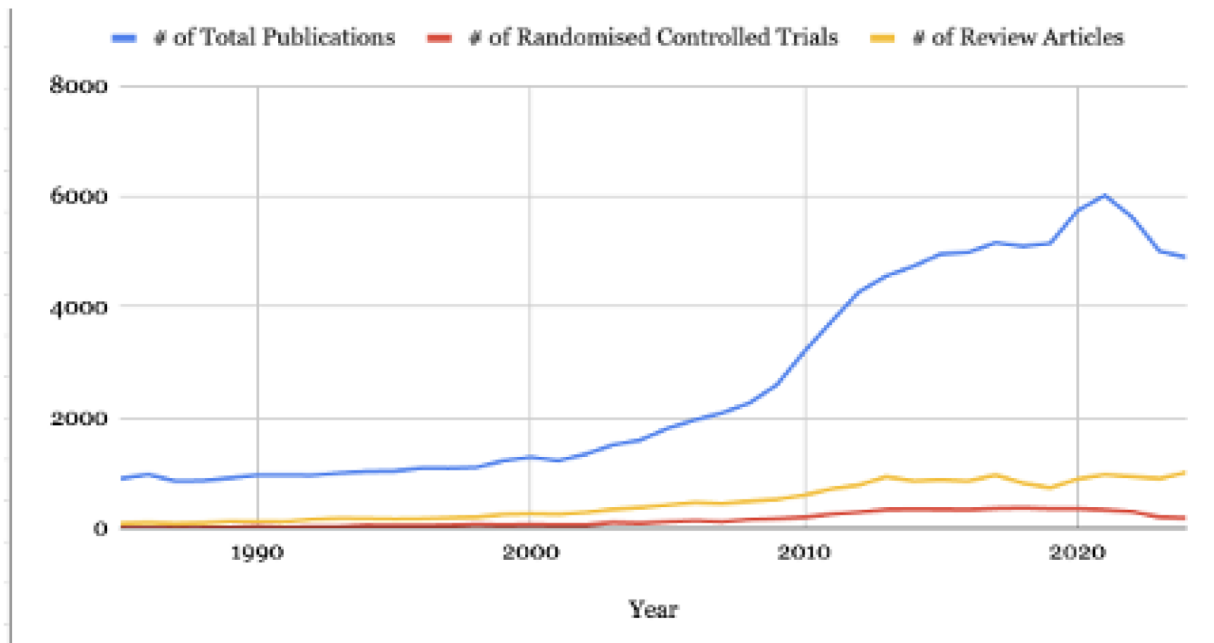


Figure 2. Trends in Vitamin D Research by Associated Conditions

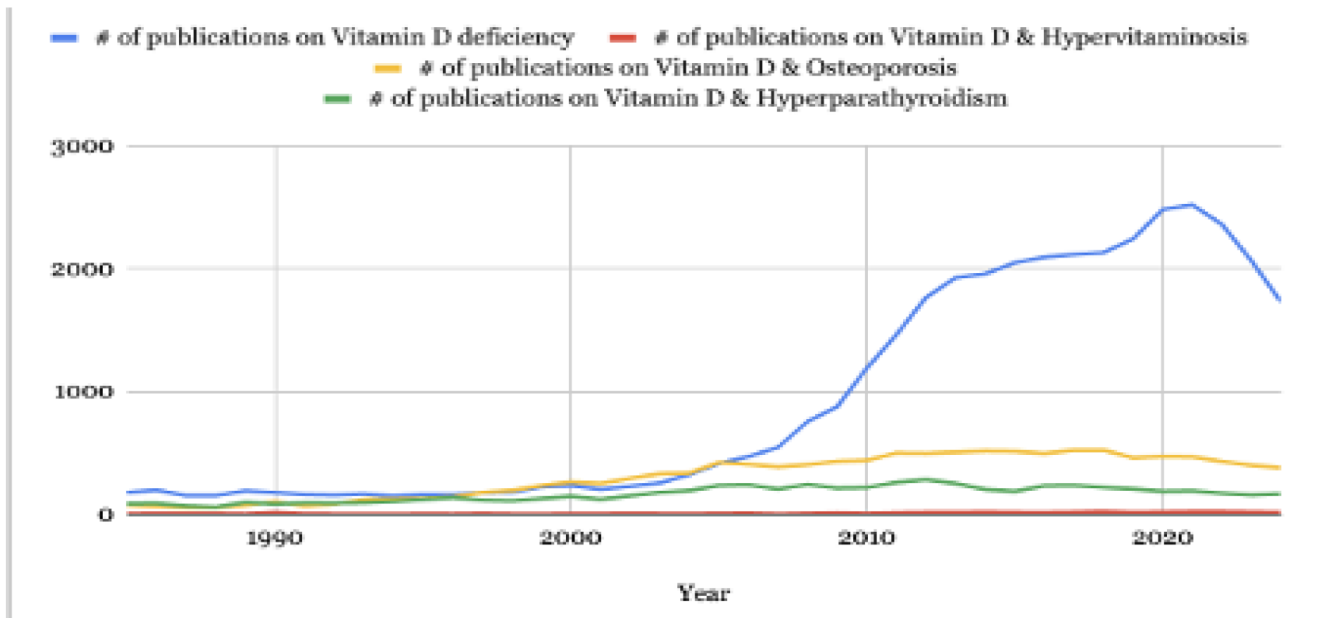
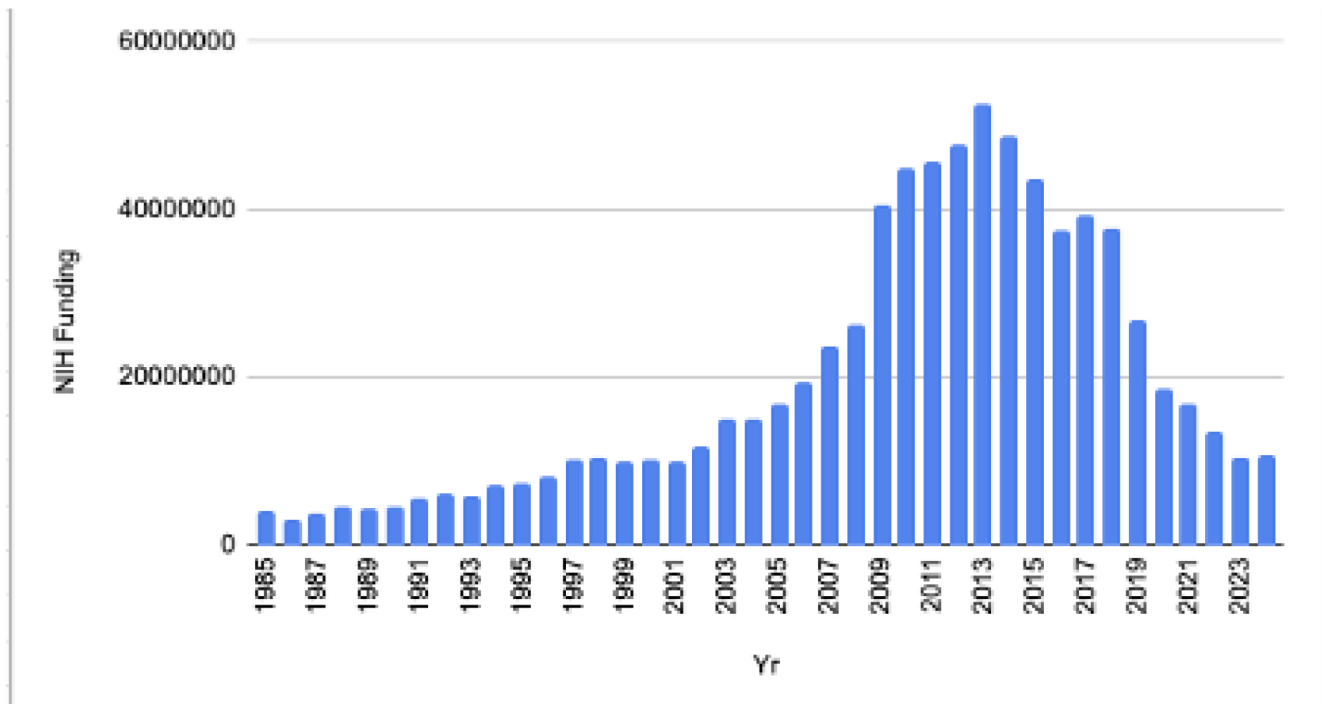


Figure 3. NIH Funding Per Year



Abbreviation: NIH, National Institutes of Health

Table 1. Negative Binomial Regression Analysis of Vitamin D Research Trends

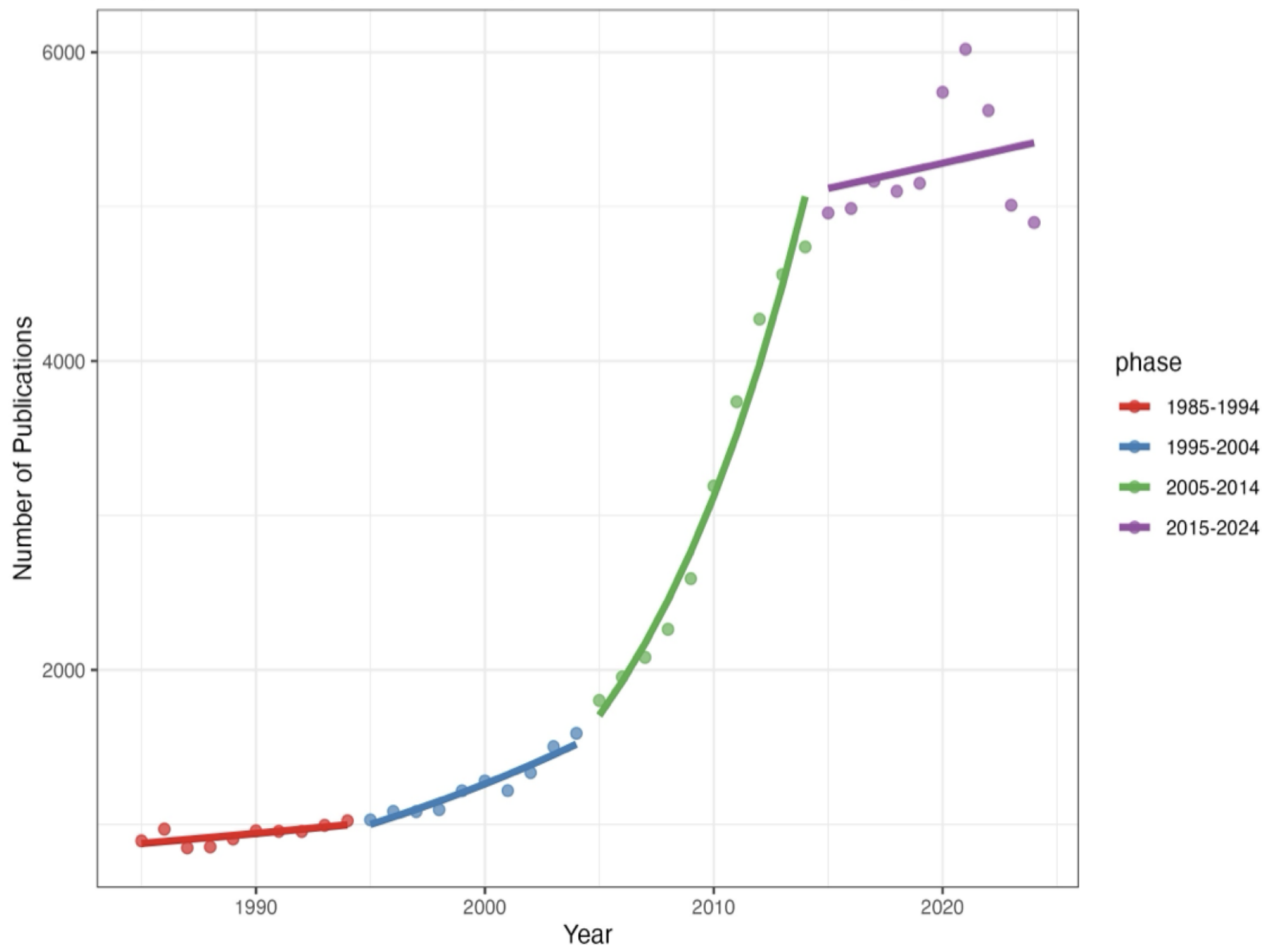
Dependent variables/response variables	Independent variables/predictors (<i>P</i> values ^a)	
	Year	NIH funding
Number of total publications	<.001*	<.001*
Number of randomized controlled trials	<.001*	<.001*
Number of review articles	<.001*	<.001*
Number of publications on vitamin D deficiency	<.001*	<.001*
Number of publications on vitamin D and osteoporosis	<.001*	<.001*
Number of publications on vitamin D and hyperparathyroidism	<.001*	<.001*
Number of publications on vitamin D and hypervitaminosis	<.001*	.192

^a*P* value calculated using negative binomial regression

*Statistical significance (*P*<.05)

Abbreviation: NIH, National Institutes of Health

Figure 4. Negative Binomial Regression of Total Vitamin D Publications per Decade



Acknowledgments

The authors have no conflicts of interest to disclose.

Corresponding Author

Mudasir Umer

International University of Kyrgyzstan, Bishkek, Kyrgyzstan

umerh10987@gmail.com

Author Affiliations

Mudasir Umer - International University of Kyrgyzstan, Bishkek, Kyrgyzstan | 2Department of Family Medicine, Dignity Health Medical Group, AZ

Syed Mustafa Ali Shah - Department of Family Medicine, Dignity Health Medical Group, AZ | Ziauddin Medical College, Karachi, Pakistan

Camille Moeckel, BA - Penn State College of Medicine, Pennsylvania State University, Hershey, PA

Erum Azhar, MD, MSPHS, MHQS, CPPS, FACOG - Creighton University School of Medicine, Phoenix, AZ | Dignity Health East Valley Obstetrics and Gynecology Residency Program, Gilbert, AZ

Faisal Aziz, MD, MBA - Penn State College of Medicine, Pennsylvania State University, Hershey, PA

Abdul Waheed, MD, MS - Dignity Health Medical Group, Phoenix, AZ | Department of Family Medicine, Creighton University School of Medicine, Phoenix, AZ

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