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Dietary Vitamin D in Periodontal Diseases: A Scoping Review of Interventions and Assessments

Anggun Rafisa[1*], Felisha Febriane Balafif[2], Nuroh Najmi[3], Faisal Kuswandani[4]
[1]Physiology, Department of Oral Biology, Faculty of Dentistry, Universitas Padjadjaran, Indonesia, [2]Microbiology, Department of Oral Biology, Faculty of Dentistry, Universitas Padjadjaran, Indonesia, [3]Anatomy Pathology, Department of Oral Biology, Faculty of Dentistry, Universitas Padjadjaran, Indonesia, [4]Pharmacy, Department of Oral Biology, Faculty of Dentistry, Universitas Padjadjaran, Indonesia

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ABSTRACT
Vitamin D has gained significant attention for its potential role in periodontal health. This scoping review investigates the evidence on dietary vitamin D interventions and assessments in periodontal diseases, examining their impact on periodontal outcomes and identifying research gaps. Using the PRISMA for Scoping Reviews protocols, data were sourced from PubMed and Scopus, including studies focused on dietary vitamin D interventions in periodontal diseases. Exclusions were non-peer-reviewed articles, reviews, animal studies, and inaccessible full-text articles. A total of 22 studies were included: 11 experimental and 11 observational. Among experimental studies, vitamin D supplementation (n=7) was the most common intervention. Observational studies employed various dietary assessment methods, including 24-hour dietary recall (n=2), food frequency questionnaires (FFQ) (n=3), dietary supplement intake (n=3), and combined methods (n=3). Experimental findings suggest that vitamin D supplementation may enhance periodontal health, particularly when paired with non-surgical treatments. Mixed findings from observational studies and limited research on surgical contexts underscore the complexity of establishing definitive conclusions. These findings emphasize the need for standardized methodologies and further investigation to better understand the role of vitamin D in periodontal health.

Corresponding Author:
Anggun Rafisa
Physiology, Department of Oral Biology, Faculty of Dentistry, Universitas Padjadjaran, Indonesia
anggun.rafisa@unpad.ac.id

INTRODUCTION

Periodontal diseases are among the most prevalent oral health conditions worldwide, affecting millions of individuals are associated with tooth, systemic diseases, and reduced quality of life [1]. While periodontal treatments, such as scaling and root planing or surgical interventions, primarily focus on mechanical plaque removal, increasing attention has been directed toward the role of systemic and dietary factors in periodontal health. Among these factors, vitamin D has emerged as a key nutrient of interest due to its immunomodulatory, anti-inflammatory, and bone health-promoting properties, as well as its crucial role in calcium metabolism [2-4].

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Several studies have suggested a potential link between vitamin D deficiency and an increased risk of periodontal diseases [5-7]. Moreover, vitamin D insufficiency has been associated with less effective outcomes following periodontal treatment [8]. These findings have prompted growing interest in dietary vitamin D interventions and assessment, aiming to establish adjunctive strategies that could enhance the prevention and management of periodontal conditions.

Despite the increasing volume of research in this area, the evidence remains fragmented, with varying findings across studies depending on intervention types, population characteristics, and methodologies. A comprehensive synthesis of this literature is essential to identify research gaps and inform future studies. This scoping review aims to explore the scope of evidence on dietary vitamin D interventions and assessments in periodontal diseases, with a focus on understanding their effects on periodontal outcomes and identifying areas for further investigation.

METHOD

The PRISMA for Scoping Reviews (PRISMA-ScR) protocols were employed for screening and reporting data from the utilized databases [9]. The Population, Concept, and Context (PCC) framework, as recommended by the Joanna Briggs Institute [10], was used to identify key concepts and guide the search strategy. The PCC framework in this review is defined as follows: Population: Individuals with and without periodontal disease, Concept: Dietary vitamin D interventions and assessments, Context: All settings

Information source and search strategy

Two electronic databases, PubMed and Scopus, were utilized for this review. The search strategy combined relevant keywords, including "vitamin D," "calciferol," "calciferols," "intake," "consumption," "ingestion," "supplementation," "diet," "periodontal diseases," "periodontitis," "gingivitis," and "periodontal abscess." Boolean operators were appropriately applied to refine the search.

Selection of studies

Articles retrieved from the databases were screened independently by two reviewers. The review included studies focusing on dietary vitamin D interventions and assessments in the context of periodontal diseases. Studies excluded were non-peer-reviewed articles, book chapters, reviews, animal studies, and articles not accessible in full-text format.

Data extraction and analysis

Extracted data included the year of publication, study design, population characteristics, dietary interventions and assessments, periodontal treatments, and periodontal parameters. Periodontal treatments were categorized into no treatment and non-surgical treatments, with the latter including procedures such as scaling and root planing. Clinical parameters were defined as any measurable outcomes during physical periodontal examination, such as probing depths, clinical attachment loss, bleeding on probing, tooth mobility, plaque index, gingival index, gingival recession, and furcation involvement. Other parameters were grouped based on the specific outcomes reported.

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RESULTS AND DISCUSSION

The study selection process is illustrated in Figure 1. A total of 505 records were initially identified through database searches, with 134 records from PubMed and 371 from Scopus. After removing duplicate entries, 406 records remained for screening. At the title and abstract screening stage, 193 records were excluded based on predefined criteria. Subsequently, full-text assessments were conducted for 213 articles, resulting in the exclusion of 191 articles. Twenty-two studies met the inclusion criteria and were incorporated into the final review.

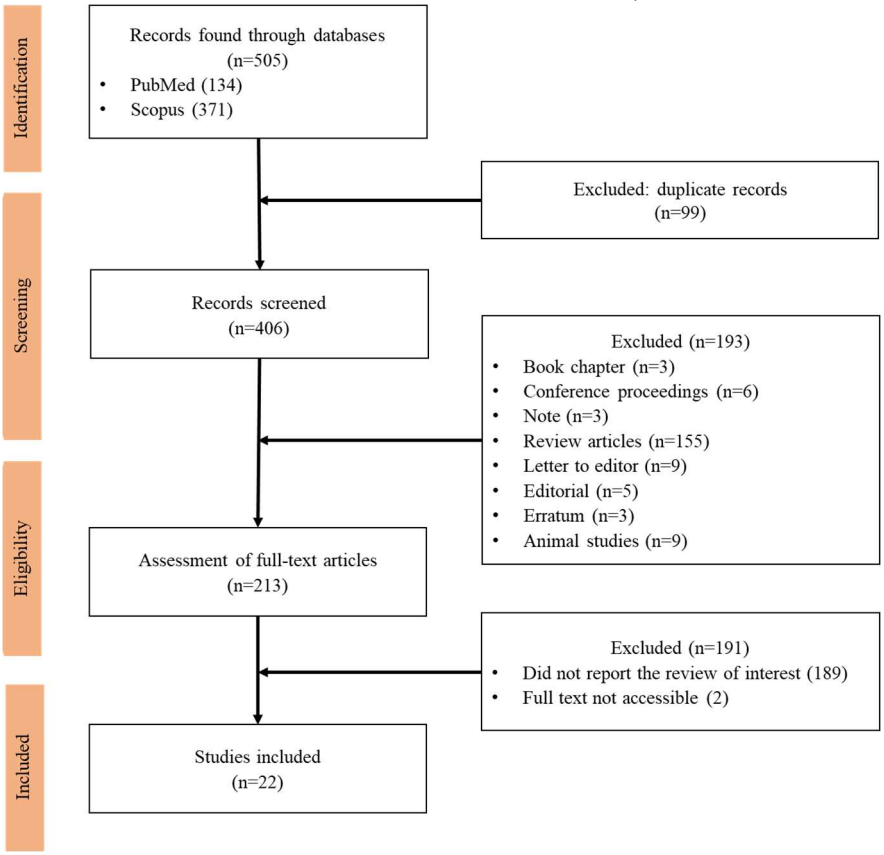

Figure 1. Overview of the study selection process following PRISMA-ScR protocols

The included studies, as summarized in Table 1, span a range of publication years from 2015 to 2024. The distribution of studies across these years indicates a steady increase in recent years, with the highest proportion (18.2%) published in 2023. Both experimental [11-21] and observational [22-32] study designs are equally represented, each accounting for 50% of the total. The age demographics of study populations vary, with most studies (36.4%) involving young adults, adults, and older adults aged over 18 years. In terms of gender, the majority of studies (77.3%) included both males and females, while studies focusing solely on males or females were less common, representing 9.1% and 13.6%, respectively. Population-specific characteristics were also diverse, with 68.2% of studies addressing non-specific or general populations. Among the studies focusing on individuals with diseases (18.2%), the conditions include diabetes, X-linked hypophosphatemia (XLH), and vitamin D deficiency.

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The equal representation of experimental and observational study designs underscores the need for both types of research to comprehensively understand the potential effects of vitamin D on periodontal outcomes. However, the variability in study designs, population characteristics, and methodologies indicates the complexity of establishing definitive conclusions. Notably, most studies focused on populations aged over 18 years, aligning with the typical onset of periodontitis, which generally begins after the age of 20 [33, 34].

Table 1. Summary of the scope of the included studies (n=22)

Category	Subcategory	Frequency	Percentage (%)
Year of publication	2015	1	4.5
	2016	2	9.1
	2017	1	4.5
	2018	2	9.1
	2019	1	4.5
	2020	3	13.6
	2021	3	13.6
	2022	2	9.1
	2023	4	18.2
	2024	3	13.6
Study Design	Experimental	11	50
	Observational	11	50
Population Age	Children and adolescents (0-18 years)	1	4.5
		1	4.5
	Young adults (19-25 years)	5	22.7
	Adults (26-65 years old)	2	9.1
	Young adults and adults (19-65 years)	5	22.7
		8	36.4
	Adults and older adults (>25 years)		
	Young adults, adults, and older adults (>18 years)		
Population sex	Male and female	17	77.3
	Male only	2	9.1
	Female only	3	13.6
Population specific characteristics	Non-specific/general	15	68.2
	Smokers and non-smokers	1	4.5
	Pregnant women	1	4.5
	Post-menopausal women	1	4.5
	Individuals with disease	4	18.2

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Figure 2 summarizes the findings of the 11 included experimental studies. The most common intervention was vitamin D supplementation (n=7). Three studies utilized dietary modification, which involved increasing dietary vitamin D alongside adjustments to other nutrients. Furthermore, no studies examined the effect of dietary vitamin D interventions combined with surgical periodontal treatments. The periodontal outcomes assessed varied, with the majority of studies focusing on clinical parameters. Key findings highlighted significant effects of dietary vitamin D modification and supplementation, both with and without periodontal treatments, on improving periodontal parameters. However, one study investigating fortification combined with non-surgical treatment reported no significant effect.

Among the seven studies on supplementation, significant effects were consistently observed, whether or not periodontal treatments were included. This underscores the potential of vitamin D as an adjunctive therapy for periodontal health. Dietary modifications incorporating vitamin D and other nutrients also yielded significant improvements in periodontal parameters, suggesting that broader nutritional interventions may benefit periodontal health. However, the absence of studies combining dietary interventions with surgical treatments leaves a gap in understanding the full therapeutic potential of vitamin D in advanced periodontal cases. The combination of non-surgical and surgical periodontal treatments has been widely employed in managing periodontitis, especially in the presence of moderate (4-6 mm) and deep pockets (≥7 mm) [35]. Evidence suggests that surgical treatment is more effective than non-surgical approaches alone in reducing moderate and deep pockets, underscoring its importance in advanced periodontal care [36]. This reinforces the need to investigate whether the integration of dietary vitamin D interventions with surgical treatments could further enhance treatment outcomes in such cases.

The single study on fortification combined with non-surgical treatment, which reported no significant effect, underscores the need for further research to determine the efficacy of such approaches in improving periodontal health. While this study did not yield positive results, the potential of vitamin D fortification remains promising. Vitamin D fortification has been shown to effectively raise circulating 25(OH)D levels across various age groups, food vehicles, settings, and seasons, though its impact is dose-dependent [37]. Moreover, fortification is considered a cost-effective and sustainable strategy, making it feasible for implementation in broader populations [38].

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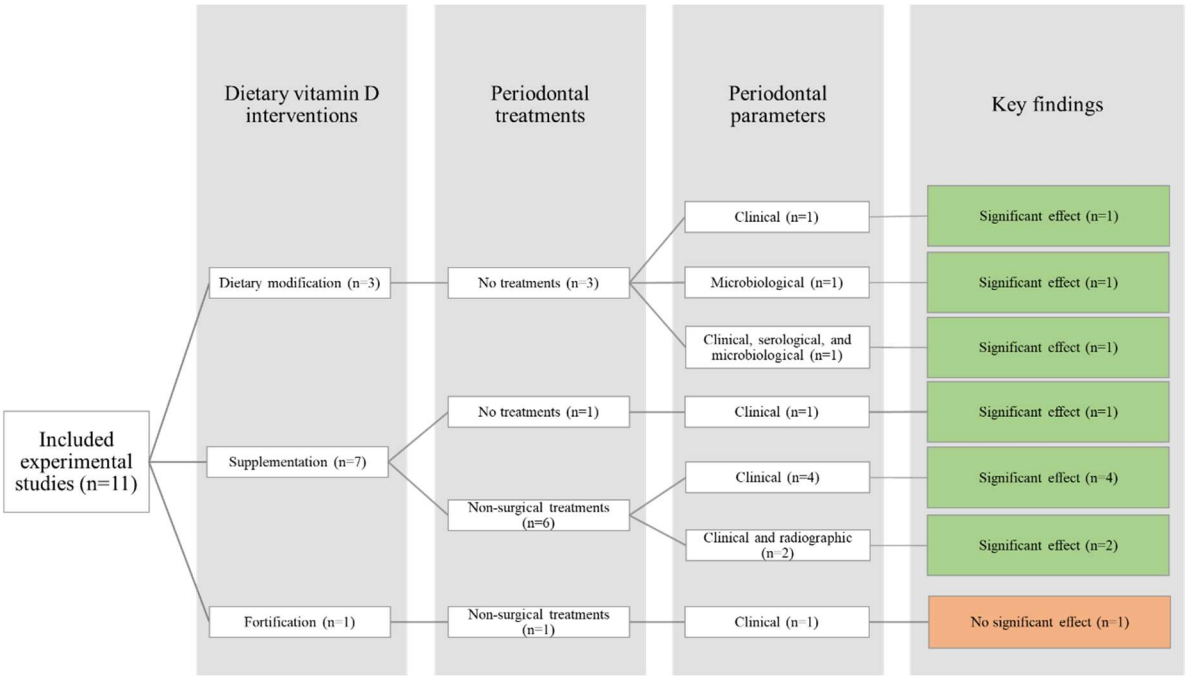

n: count

Figure 2. Summary of the included experimental studies (n=11)

Figure 3 provides a summary of the 11 included observational studies. These studies assessed dietary vitamin D using various methods, including 24-hour dietary recall (n=2), food frequency questionnaires (FFQ) (n=3), intake of dietary supplements (n=3), a combination of 24-hour dietary recall and dietary supplements intake (n=1), and a combination of FFQ and dietary supplements intake (n=2). All studies measured periodontal parameters using clinical assessments. Key findings from the observational studies were mixed. While most studies utilizing 24-hour dietary recall and FFQ reported no significant associations, one FFQ study demonstrated a significant association. Among studies assessing dietary supplement intake, two out of three found significant associations. For combined approaches, the study using 24-hour dietary recall with supplement intake found no significant association, while one of the two studies combining FFQ and supplement intake reported a significant association.

The findings from observational studies present a more mixed picture, reflecting the complexity of evaluating dietary influences on periodontal health. Discrepancies in results may arise from variations in study design, population characteristics, or the accuracy of dietary assessment methods used. These inconsistencies emphasize the critical need for standardized methodologies to enhance the reliability of such evaluations and provide more conclusive evidence. Many studies have proposed that 24-hour recall assessments provide more accurate estimates of dietary intake for various nutrients than FFQs [39-42]. For vitamin D intake, one study found that FFQs produced relatively higher estimates compared to 24-hour recalls [42]. This difference highlights the challenges in accurately capturing vitamin D intake, particularly when supplements are involved. The absence of vitamin D supplement

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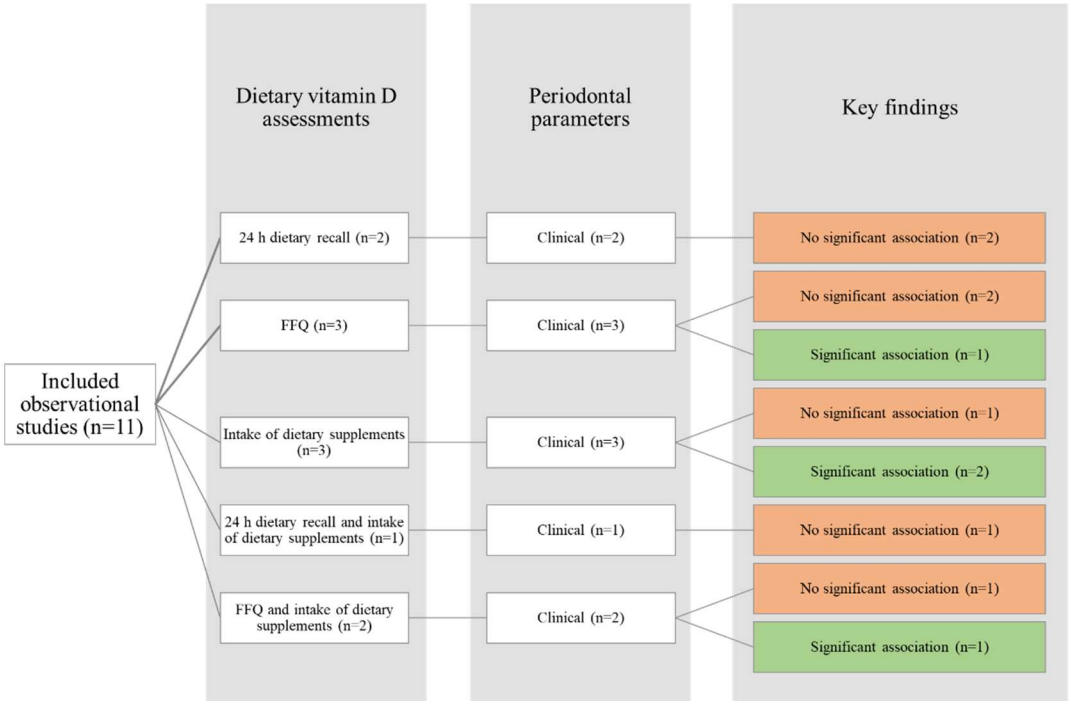
intake assessments in some included studies may have contributed to the lack of significant associations observed in these cases, further complicating the interpretation of results. Overall, these mixed findings underscore the complexity of studying dietary influences on periodontal health and the importance of addressing confounding factors in future research.



n: count
FFQ: food frequency questionnaire

Figure 3. Summary of the included observational studies (n=11)

CONCLUSION

Vitamin D supplementation shows promise in improving periodontal health, particularly in combination with non-surgical treatments, as supported by experimental studies. However, mixed findings from observational studies and the lack of research on surgical contexts highlight the need for further investigation to establish definitive conclusions.

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