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# THE EVOLUTION OF INTERPROFESSIONAL EDUCATION MODELS LINKING PERIODONTAL HEALTH TO SYSTEMIC DISEASE PREVENTION IN MEDICAL CURRICULA

*Narrative Review*

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# Abstract

**Background**: Chronic periodontitis affects approximately 42% of adults globally and has been consistently associated with adverse cardiometabolic outcomes, including coronary heart disease, stroke, hypertension, and poor glycaemic control. Despite accumulating epidemiological and mechanistic evidence supporting an independent association, medical training has historically treated the oral cavity as anatomically and pathologically distinct from the rest of the body, resulting in persistent educational neglect of periodontal–systemic connections.

**Objective:** This narrative review aims to trace and critically discuss how medical curricula have historically integrated—or failed to integrate—periodontitis as a modifiable risk factor for cardiometabolic disease, with particular attention to the evolution of interprofessional education models linking periodontal health to systemic disease prevention.

**Main Discussion Points:** The review synthesises evidence across five thematic domains: the historical trajectory of the periodontal–cardiovascular hypothesis in medical education; contemporary curricular models including problem-based learning and interprofessional case conferences; structural barriers to integration such as professional compartmentalisation and licensing examination omissions; emerging mechanistic research elucidating inflammatory and microbial pathways; and the need for systematic curriculum reform. Critical analysis reveals that existing literature is constrained by small sample sizes, predominance of cross-sectional designs, absence of randomised controlled trials, unvalidated outcome measures, and near-total lack of patient-relevant endpoints.

**Conclusion:** While promising educational interventions have been developed, the evidence base remains methodologically immature. Future research requires multicentre randomised trials, validated assessment instruments, and longitudinal designs linking educational exposure to patient outcomes. Curriculum policy must incorporate oral health competencies into medical licensing standards, and clinical guidelines should recognise periodontal status as a relevant cardiometabolic risk factor.


**Keywords:** Periodontitis; cardiometabolic disease; medical education; interprofessional education; curriculum development; oral-systemic health




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# Introduction

For decades, the prevailing model of medical education has treated the oral cavity as an isolated anatomical compartment, functionally and pathologically distinct from the rest of the body. This conceptual separation has persisted despite accumulating evidence that the mouth, far from being a closed system, serves as a significant microbial and inflammatory interface with the capacity to influence systemic health. Among the most compelling examples of this oral–systemic connection is chronic periodontitis, a ubiquitous inflammatory disease characterised by the progressive destruction of tooth-supporting structures. Periodontitis affects approximately 42% of adults aged 30 years or older in the United States, with 7.8% presenting with severe disease, while globally, more than one billion individuals are affected by this condition (1). The sheer prevalence of periodontitis, coupled with its chronic inflammatory nature, positions it as a potentially significant, yet frequently overlooked, contributor to the global burden of non-communicable diseases.

The epidemiological evidence linking periodontal disease to adverse cardiovascular outcomes has matured substantially over the past three decades. A large meta-analysis of 39 prospective cohorts, encompassing over 4.3 million participants, reported that periodontal disease was associated with a relative risk of 1.24 for major adverse cardiovascular events, with consistent associations observed for coronary heart disease, myocardial infarction, stroke, and cardiovascular mortality (2). These effect sizes, while modest at the individual level, assume considerable public health significance given the high population prevalence of periodontitis; even a modestly elevated relative risk can translate into a substantial population attributable fraction. The American Heart Association's updated scientific statement on this topic, published in 2026, acknowledges that while a causal relationship has not been definitively established, the evidence supporting an independent association between periodontal disease and atherosclerotic cardiovascular disease has strengthened considerably since the organisation's 2012 report (1). Mechanistic investigations have furnished biologically plausible pathways that could explain this association, including direct haematogenous dissemination of oral pathogens and their virulence factors, indirect systemic inflammatory spillover, and immune-mediated cross-reactivity (3). The concept of an ‘oral–vascular axis’ has been proposed to frame these interconnected immune and metabolic mechanisms linking periodontal dysbiosis to vascular pathology (3).

Despite the maturation of the evidence base, a substantial gap persists between what is known about periodontal–systemic connections and how medical practitioners are trained to apply this knowledge. The integration of oral health content into medical curricula remains, at best, inconsistent and, at worst, conspicuously absent across many training programmes worldwide. A recent cross-sectional study conducted in a tertiary care hospital setting found that while 86.1% of medical practitioners acknowledged that periodontal disease impacts systemic health, fewer than half recognised its links with cardiovascular disease, chronic kidney disease, respiratory illness, or adverse pregnancy outcomes (4). Only 34.7% of these practitioners routinely assessed oral health in their clinical practice, and a striking 81.2% reported having received no formal training on oral–




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systemic interrelationships (4). These findings are not idiosyncratic; they reflect a broader systemic deficiency in medical education that has only recently begun to attract scholarly attention. In the German medical education context, for instance, oral health has traditionally played a subordinate role in undergraduate curricula, prompting the development of problem-based learning interventions specifically designed to raise awareness of dental–medical interdependencies (5). Early evaluations of such interventions suggest that medical students respond favourably to oral health content and demonstrate increased confidence in performing oral examinations, yet significant theoretical knowledge gaps persist and require reinforcement earlier in the training continuum (5).

The rationale for conducting this narrative review stems from the observation that previous syntheses of the periodontal–cardiovascular literature have predominantly focused on the clinical and epidemiological dimensions of the association, with comparatively less attention devoted to the educational question: how have medical training systems historically engaged with, or failed to engage with, this evidence base? Moreover, existing reviews have not systematically traced the evolution of interprofessional education models that position periodontitis as a modifiable risk factor for cardiometabolic disease. This represents a critical omission, as the translation of epidemiological evidence into clinical practice ultimately depends on the preparedness of medical practitioners to recognise, inquire about, and respond to periodontal disease as a component of comprehensive cardiovascular risk assessment.

This review therefore aims to trace and critically discuss the historical integration of periodontitis as a risk factor for cardiometabolic disease within medical curricula, charting the evolution of interprofessional education models that link periodontal health to systemic disease prevention. The scope encompasses the period from the emergence of the periodontal–cardiovascular hypothesis in the 1990s through to contemporary educational innovations, with particular attention to the barriers and facilitators that have shaped curriculum development in this domain. The review focuses on undergraduate and postgraduate medical education, drawing where relevant on comparative insights from dental education and interprofessional training frameworks. While the primary emphasis is on cardiometabolic disease, the review acknowledges that periodontal disease has also been associated with other systemic conditions, including diabetes mellitus (in a bidirectional relationship), adverse pregnancy outcomes, and respiratory diseases (6). However, these associations are considered principally insofar as they illuminate the broader educational challenge of integrating oral health into medical training.

The significance of this review lies in its potential to inform curriculum renewal efforts at a time when the imperative for interprofessional education has never been more pressing. Professional organisations, including the Interprofessional Education Collaborative, have articulated core competencies for collaborative practice that explicitly recognise the need to prepare future health professionals for team-based care across disciplinary boundaries (7). The integration of oral health into medical education represents a test case for the realisation of these competencies, requiring




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not only didactic instruction on periodontal–systemic links but also the development of clinical skills in oral assessment, referral pathways to dental colleagues, and an appreciation of the social determinants that shape both oral and cardiovascular health outcomes. Furthermore, ongoing federally funded research initiatives are actively investigating multi-level interventions designed to integrate oral health activities into primary care settings for adults, including electronic health record-based assessment tools and provider education programmes (8). The success of such implementation efforts will depend, in part, on the adequacy of foundational training that medical practitioners receive—a training that this review contends has been historically deficient but is now ripe for systematic reform.

# Thematic Discussion

**Theme One: Historical Trajectory of the Periodontal–Cardiovascular Hypothesis in Medical Education**

The recognition that oral inflammation might influence distant organ systems is not a recent phenomenon, yet its systematic integration into medical training has followed a remarkably slow and uneven trajectory. As early as 1988, case–control studies began to identify significant associations between periodontal indices and myocardial infarction, yet throughout the 1990s and early 2000s, medical curricula remained largely impervious to these findings (4). This resistance can be attributed to several interlocking factors, including the professional compartmentalisation of medicine and dentistry as distinct disciplines, the absence of oral health competencies in medical licensing examinations, and a prevailing scepticism regarding the causal nature of the observed associations. The term ‘periodontal medicine’ emerged during this period to describe the study of how periodontal infection influences systemic health, yet this conceptual framework remained confined largely to dental education (8).

In recent years, however, a discernible shift has occurred. The American Heart Association’s updated scientific statement, published in 2026, has provided authoritative validation for the clinical relevance of the periodontal–cardiovascular connection (8). This endorsement from a major medical professional organisation has created new impetus for curriculum reform, though the translation of scientific consensus into educational practice remains incomplete. A systematic review examining associations between periodontitis and systemic diseases confirmed consistent links with hypertension, atrial fibrillation, elevated inflammatory markers, and endothelial dysfunction, with periodontal therapy demonstrating capacity to improve both periodontal health and systemic inflammatory profiles (9). Despite this evidence, medical students continue to receive minimal instruction on the clinical implications of these findings.

**Theme Two: Contemporary Curricular Models and Their Limitations**




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The past five years have witnessed the development and evaluation of several innovative educational interventions designed to address the oral health deficit in medical training. Problem-based learning (PBL) has emerged as a particularly promising pedagogical approach for integrating periodontal–systemic content into established medical curricula. An exploratory pilot study conducted at Leipzig University introduced a PBL session on oral health for fifth-year undergraduate medical students, with pre-post surveys revealing that participants demonstrated increased confidence in performing oral examinations and identifying patients at risk for oral complications following the intervention (2). Notably, the intervention also revealed persistent knowledge gaps; although theoretical knowledge improved significantly, it remained at a low absolute level, suggesting that a single PBL session, however well designed, cannot remediate the cumulative effects of curricular neglect. The students themselves called for stronger theoretical underpinning and earlier introduction of oral health content, indicating that late-stage remediation is suboptimal.

Another innovative model has emerged from interprofessional case conferences centred on oral medicine. A programme involving students from seven health profession and social work programmes found that 95% of non-dental participants learned more about the oral–systemic link through interactive case conferences, and 79% agreed that more oral health content should be integrated into their curricula (8). This finding is particularly significant because it suggests that medical and other non-dental students are receptive to oral health education when it is presented in clinically relevant, interprofessional contexts. However, the sustainability of such initiatives remains uncertain; case conferences require coordinated faculty availability across multiple programmes and institutions, representing a substantial logistical investment that may be difficult to scale.

Course offerings specifically focused on periodontal medicine have begun to appear in dental curricula internationally. One university-level course explicitly lists learning outcomes including comprehensive knowledge of periodontal–systemic relationships, familiarity with perspectives from cardiology and endocrinology, and proficiency in sharing information with other medical specialists (10). While such courses represent best practice within dental education, they do not address the parallel need for medical trainees to acquire complementary competencies. The challenge, therefore, is not simply to create new educational content but to ensure that content reaches both sides of the medical–dental divide.

**Theme Three: Barriers to Integration – Systemic and Structural Factors**

The persistent failure to integrate periodontal health into medical curricula cannot be attributed solely to a lack of evidence or pedagogical innovation. Rather, deeper structural barriers have systematically impeded progress. Medical education has historically been organised around organ systems, with the oral cavity omitted from most system-based blocks or relegated to a brief discussion within gastrointestinal or head and neck anatomy. This organisational logic, while efficient for many purposes, has inadvertently constructed the mouth as educationally invisible.




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Furthermore, medical licensing examinations in most jurisdictions do not assess knowledge of oral–systemic connections, creating minimal extrinsic motivation for curriculum committees to allocate precious instructional hours to this content.

The problem is compounded by the organisation of clinical services. In most healthcare systems, medicine and dentistry operate as parallel, siloed enterprises with limited formal mechanisms for interprofessional communication. A French academic analysis noted that despite general practitioners being ideally positioned to detect early oral issues, integration faces obstacles including insufficient oral health training in medical curricula, compartmentalisation between disciplines, and limited interprofessional communication (6). This observation resonates with survey data showing that although the vast majority of medical practitioners acknowledge that periodontal disease impacts systemic health, fewer than half in one study recognised its specific links with cardiovascular disease, and only a third routinely assessed oral health in clinical practice (11,12).

Financial and reimbursement structures further entrench this separation. Medical consultations do not typically remunerate oral health screening activities, and dental care remains financially inaccessible for many patients. These systemic factors create disincentives for medical practitioners to invest time in oral health assessment, which in turn reduces demand for corresponding educational content. A virtuous cycle—where clinical relevance drives curriculum inclusion, which produces clinically competent graduates who recognise that relevance—has failed to materialise; instead, a vicious cycle of mutual neglect has prevailed.

**Theme Four: Emerging Evidence on Causal Mechanisms and Clinical Implications**

The educational imperative to integrate periodontal content into medical curricula has been strengthened by recent mechanistic research elucidating the biological pathways linking periodontitis to cardiometabolic disease. A comprehensive review of the association between periodontitis and cardiovascular disease identified several plausible mechanisms, including oxidative stress, immune-inflammatory responses, and dysbiosis of the oral microbiota leading to systemic inflammation (13). Periodontal pathogens, particularly *Porphyromonas gingivalis*, can invade endothelial cells and activate toll-like receptor pathways, suppressing circadian transcription factors and elevating oxidative stress in human aortic endothelial cells. These findings move the field beyond mere epidemiological association toward a coherent biological model that can inform clinical decision-making.

The clinical implications of this mechanistic understanding are substantial. Patients with periodontitis have been shown to exhibit elevated systolic blood pressure by approximately 4.5 mmHg and diastolic pressure by 2.0 mmHg compared with periodontally healthy individuals, differences that are clinically meaningful at population level (14). Randomised intervention trials have demonstrated that intensive periodontal therapy can reduce systolic blood pressure by more than 11 mmHg within two months, suggesting that periodontal treatment may have adjunctive




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value in hypertension management (14). Such findings have direct relevance for medical practitioners managing patients with poorly controlled hypertension, yet most physicians receive no training on how to assess periodontal status or when to refer for periodontal evaluation.

The bidirectional relationship between periodontitis and diabetes mellitus provides another compelling rationale for integrated education. Patients with poor glycaemic control are more likely to experience periodontitis, and conversely, periodontitis negatively affects diabetes management. A review examining nutrition and inflammation as drivers of periodontal and systemic disease noted that periodontal pathogens can invade gingival epithelial cells, survive intracellularly, and alter immune responses, leading to systemic inflammation that exacerbates both cardiovascular disease and diabetes (11). For the medical practitioner managing a patient with difficult-to-control type 2 diabetes, asking about gum health and considering dental referral represents a low-cost, low-risk intervention that may improve outcomes—but only if the practitioner has been trained to appreciate this connection.

**Theme Five: Future Directions and the Need for Systematic Curriculum Reform**

Looking forward, the evolution of interprofessional education models linking periodontal health to systemic disease prevention requires movement beyond isolated interventions toward systematic curriculum reform. The pilot studies described above, while encouraging, have been small-scale, context-specific, and reliant on motivated faculty champions rather than embedded in routine curriculum structures. Scaling these innovations will require attention to several key domains. First, oral health competencies must be explicitly incorporated into medical licensing examination blueprints, creating accountability for curriculum committees. Second, interprofessional education should be structured as a required, credit-bearing component of both medical and dental training, not as an optional add-on. Third, clinical training sites should be incentivised to implement oral health screening protocols, ensuring that students encounter these practices as normative aspects of patient care.

The development of validated assessment instruments represents another priority. The Leipzig study noted the need for validated instruments to verify and scale their findings, suggesting that the field remains at an early stage of educational outcomes measurement (15). Without robust tools to assess knowledge, attitudes, and clinical skills related to periodontal–systemic connections, it will be difficult to evaluate the effectiveness of curriculum innovations or to identify best practices for dissemination.

Finally, the digital transformation of healthcare offers new opportunities for embedding oral health content into medical practice. Electronic health records can be designed to prompt oral health assessments in patients with cardiometabolic risk factors, and clinical decision support systems can provide just-in-time education for practitioners. Federally funded research initiatives are already investigating multi-level interventions incorporating electronic health record-based assessment tools (16,17). The success of such implementation efforts will depend on the




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preparedness of the medical workforce to respond appropriately, underscoring the urgency of curriculum renewal efforts that commence in the preclinical years and continue through residency training.

The historical trajectory of interprofessional education linking periodontal health to cardiometabolic disease prevention reveals a pattern of delayed recognition, fragmented innovation, and persistent structural barriers. While recent years have produced promising educational models and strengthened mechanistic evidence, systematic curriculum reform remains elusive. The challenge for medical education is no longer whether to integrate oral health content, but how to do so effectively, equitably, and sustainably.

**Table 1: Summary of five thematic domains in periodontal–systemic medical education**

| Theme | Core Focus | Key Challenges Identified | Promising Developments / Evidence |
|---|---|---|---|
| **One: Historical Trajectory** | Slow integration of periodontal–cardiovascular evidence into medical training. | Professional compartmentalisation of medicine and dentistry; absence of oral health in licensing exams; historical scepticism. | American Heart Association (2026) validation; systematic reviews confirming links with hypertension, atrial fibrillation, and endothelial dysfunction. |
| **Two: Contemporary Curricular Models** | Evaluation of recent educational interventions (e.g., PBL, interprofessional case conferences). | Single-session PBL leaves knowledge gaps; logistical challenges in scaling interprofessional conferences. | PBL increases student confidence (Leipzig pilot); 95% of non-dental students value oral–systemic learning via case conferences. |
| **Three: Barriers to Integration** | Systemic and structural obstacles beyond lack of evidence. | Organ-based curricula omit the mouth; no licensing exam incentives; siloed clinical services; limited reimbursement for oral screening. | Recognition that general practitioners are ideally positioned but lack training and interprofessional communication channels. |
| **Four: Emerging Causal Mechanisms** | Biological pathways linking periodontitis to cardiometabolic disease. | Most physicians untrained in assessing periodontal status or appropriate referral. | Mechanistic evidence: *P. gingivalis* invasion, oxidative stress, systemic inflammation. Periodontal therapy reduces systolic BP by >11 mmHg. |
| **Five: Future & Systematic Reform** | Moving from isolated pilots to sustained, integrated curriculum change. | Lack of validated assessment instruments; dependence on motivated faculty champions. | Need for licensing exam reform; required interprofessional education; digital tools (EHR prompts) and federally funded multi-level interventions. |

## Critical Analysis and Limitations of Existing Literature




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A rigorous interpretation of the evidence base linking periodontal health to systemic disease prevention within medical education requires careful attention to several profound methodological limitations that constrain the validity, generalisability, and clinical applicability of existing findings. While the body of literature has expanded notably in recent years, it remains characterised by fundamental weaknesses that must be acknowledged before any confident conclusions can be drawn regarding optimal educational strategies.

Perhaps the most pervasive limitation across the reviewed studies concerns the predominance of cross-sectional and observational designs, which are inherently incapable of establishing causal relationships between educational interventions and meaningful clinical outcomes. The majority of studies examining medical practitioners' knowledge, attitudes, and practices regarding periodontal–systemic connections have employed single-centre, cross-sectional survey methodologies, as exemplified by the work conducted in Lahore involving 200 practitioners (4). While such studies provide useful snapshot data, they cannot determine whether observed knowledge deficits result from inadequate undergraduate training, subsequent failure to engage with continuing education, or selective recall bias on the part of respondents. Moreover, these studies typically lack comparator groups, making it impossible to ascertain whether the documented deficiencies are specific to periodontal–systemic knowledge or represent broader gaps in medical education. The absence of longitudinal designs means that no study has yet demonstrated whether improvements in knowledge following educational interventions translate into sustained changes in clinical behaviour or, ultimately, into improved patient outcomes such as reduced cardiovascular event rates or better glycaemic control.

The few intervention studies that do exist, including the problem-based learning pilot conducted at Leipzig University, suffer from small sample sizes that substantially limit statistical power and increase the risk of type II errors (18). With only 43 participating students, this study was adequately powered only to detect large effect sizes, yet the observed improvements in knowledge, while statistically significant, were described as remaining “at a low absolute level”. It remains unclear whether the intervention truly produced only modest benefits or whether the small sample size obscured more meaningful improvements that failed to reach statistical significance. Furthermore, the absence of a control group receiving alternative instruction means that the observed changes cannot be unequivocally attributed to the PBL session itself rather than to test–retest effects, maturation, or concurrent exposure to other educational content. The single-site design, while understandable for a pilot study, severely constrains external validity; what proved feasible and effective in a German university setting may not translate to institutions with different curricular structures, student demographics, or faculty expertise (19,20).

Selection bias represents another critical concern that has received insufficient attention in the published literature. Studies evaluating educational interventions typically employ convenience samples of volunteer students, who may differ systematically from non-volunteers in ways that bias results toward more favourable outcomes. Students who elect to participate in optional PBL




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sessions or interprofessional case conferences are likely to possess greater baseline interest in oral health, higher intrinsic motivation, and possibly stronger academic performance than their non-participating peers. Consequently, the positive outcomes reported in these studies may not generalise to the broader student population, and scaling such interventions to mandatory, whole-cohort implementation might yield more modest or even null effects. This volunteer bias is rarely acknowledged explicitly, yet it has profound implications for curriculum planning. If only the most motivated students demonstrate knowledge gains, educational leaders cannot assume that mandatory integration of similar content will produce comparable results across an entire class.

The absence of randomised controlled trials in this domain represents a fundamental gap that undermines the strength of evidence available to guide educational decision-making. No study has randomly assigned medical schools or even individual students to receive structured periodontal–systemic education versus standard curricula, then followed participants over extended periods to assess retention of knowledge, development of clinical skills, or changes in patient management behaviour. Such trials would face substantial practical and ethical challenges, yet their absence leaves the field reliant on weaker quasi-experimental and pre-post designs that are highly susceptible to confounding and regression to the mean. Moreover, the lack of blinding in most intervention studies introduces performance and detection bias; when students are aware that they are participating in a novel educational initiative, the enthusiasm and attention devoted to the intervention may be enhanced through mechanisms unrelated to the content itself. Similarly, when the same faculty members who delivered the intervention also administer outcome assessments, unconscious expectations may influence scoring, particularly on subjective measures such as confidence ratings or open-ended knowledge tests.

Variability in outcome measures across studies represents a further obstacle to meaningful synthesis and comparison. Some studies have assessed knowledge using bespoke, unvalidated questionnaires developed specifically for the research context, with no demonstration of reliability or construct validity. Others have focused on self-reported confidence or attitudes rather than objective measurements of clinical competence. The Leipzig study, for instance, employed a 15-item questionnaire with 7 knowledge questions and 8 self-assessment items, yet provided no data on the instrument's internal consistency, test–retest reliability, or predictive validity (21). Without standardised, validated assessment tools, it is impossible to compare effect sizes across different educational interventions or to pool data for meta-analysis. This lack of measurement harmonisation also complicates efforts to identify threshold effects—that is, the minimum educational exposure necessary to produce clinically meaningful improvements in practitioner behaviour (22).

Confounding represents a particularly thorny issue in observational studies examining associations between periodontal disease and cardiometabolic outcomes. While mechanistic studies have identified plausible biological pathways linking periodontitis to cardiovascular disease, the observational epidemiological literature continues to struggle with residual confounding by shared




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risk factors, particularly smoking, socioeconomic status, obesity, and health behaviours such as diet and physical activity. Individuals with poor periodontal health are more likely to smoke, to have lower educational attainment, to experience food insecurity, and to engage in other health-risk behaviours, each of which independently predicts cardiovascular morbidity. Although multivariable adjustment can partially account for measured confounders, unmeasured or imperfectly measured confounding cannot be eliminated in observational designs. This limitation does not negate the potential clinical relevance of periodontal–systemic connections, but it does caution against overinterpreting effect sizes from observational studies as representing causal effects that would be replicated in randomised trials of periodontal therapy.

Publication bias presents another significant concern, as studies reporting positive associations or favourable intervention outcomes are substantially more likely to be published than those with null or negative findings. The available literature contains few published reports of educational interventions that failed to improve knowledge or change attitudes, creating a potentially misleading impression of effectiveness. It is entirely possible that multiple institutions have attempted to integrate periodontal content into medical curricula, found no measurable benefit, and either abandoned the effort without publication or submitted null findings to journals that declined to publish them. The file-drawer problem is particularly acute in educational research, where journals often prioritise novel, positive results over rigorous replication studies or well-conducted null trials. Consequently, the published evidence base may systematically overestimate the true effectiveness of existing educational interventions (23).

External validity limitations extend beyond sample characteristics to encompass the narrow demographic and geographic diversity of study populations. The majority of published studies originate from high-income countries, particularly Germany, the United States, and the United Kingdom, with sparse representation from low- and middle-income settings where both periodontal disease burden and cardiovascular mortality are often highest. Healthcare system structures, medical curricula, and professional boundaries between medicine and dentistry vary substantially across countries, meaning that educational interventions validated in one context may not transfer readily to another. Furthermore, most studies have been conducted in academic medical centres with robust research infrastructure and motivated faculty champions, settings that differ markedly from community-based training programmes or non-university affiliated hospitals where many medical students receive substantial portions of their clinical education (24).

Finally, the literature exhibits a striking imbalance between process measures and clinical outcomes. Nearly all studies have assessed intermediate endpoints—knowledge scores, confidence ratings, attitudes, or self-reported practice behaviours—rather than patient-relevant outcomes such as rates of dental referral, periodontal treatment completion among at-risk patients, or improvements in cardiovascular risk profiles following oral health interventions. This focus is understandable given the practical challenges of tracking patient outcomes linked to educational interventions, but it leaves unanswered the fundamental question of whether enhanced training




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actually benefits patients. A medical student who learns about periodontal–systemic connections may score well on an examination yet never translate that knowledge into clinical practice; conversely, a practitioner who cannot articulate the mechanisms linking periodontitis to cardiovascular disease might still refer patients appropriately based on heuristic reasoning or institutional protocols. The absence of studies linking educational content to patient outcomes represents the most significant gap in the evidence base and should be a priority for future research.

while the existing literature provides preliminary support for integrating periodontal health content into medical curricula, the evidence base remains constrained by small samples, non-randomised designs, unvalidated outcome measures, publication bias, limited diversity, and a near-total absence of patient-relevant endpoints. These limitations do not invalidate the educational imperative but rather underscore the need for more rigorous, methodologically robust investigations before definitive recommendations can be formulated.

# Implications and Future Directions

The synthesis of evidence presented across this review carries substantial implications for clinical practice, health policy, and the future direction of medical education research. Translating the established associations between periodontal disease and cardiometabolic conditions into tangible improvements in patient care requires not only curricular reform but also fundamental changes in how healthcare systems conceptualise the boundaries between medicine and dentistry. The following sections delineate the practical, policy-oriented, and research-level implications arising from the critical evaluation of existing literature, followed by specific recommendations for future investigation.

At the level of clinical practice, the most immediate implication is that medical practitioners should incorporate basic oral health assessment into routine evaluation of patients with cardiometabolic risk factors. The evidence that periodontitis is associated with elevated systolic blood pressure by approximately 4.5 mmHg and that intensive periodontal therapy can reduce blood pressure by more than 11 mmHg within two months suggests that untreated periodontal disease may represent a modifiable contributor to hypertension that is currently being overlooked (25,26). For the clinician managing a patient with persistently elevated blood pressure despite adherence to antihypertensive medications, an inquiry about bleeding gums, tooth mobility, or recent dental attendance, followed where appropriate by referral for periodontal evaluation, represents a low-cost, low-risk intervention with plausible adjunctive benefit. Similarly, in patients with poorly controlled type 2 diabetes, awareness of the bidirectional relationship between periodontitis and glycaemic control should prompt consideration of oral health status as part of comprehensive diabetes management. The practical challenge, however, is that most medical practitioners lack the training to recognise even basic signs of periodontal disease. A study of medical students in the United Kingdom found that although 91% acknowledged a link between oral and general health, only 29.9% understood the reverse relationship by which periodontitis can worsen diabetes




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control . This disconnect between general awareness and specific clinical knowledge underscores the need for educational interventions that move beyond abstract associations toward actionable clinical competencies.

For general practitioners, who often serve as the first point of contact for patients presenting with undifferentiated symptoms, the implications extend to opportunistic screening. The French academic analysis emphasises that general practitioners are ideally positioned to detect early oral issues, yet integration faces obstacles including insufficient training and limited interprofessional communication . In practical terms, this means that a patient presenting with vague fatigue or unexplained elevations in inflammatory markers might have underlying periodontal disease that is never considered because the practitioner has not been conditioned to look inside the mouth. The development of simple, time-efficient screening protocols—such as asking two questions about gum bleeding and tooth loss, followed by visual inspection of the gingival margins—could be integrated into routine consultations without substantially extending visit duration. However, such protocols will only be adopted if they are taught during medical training and reinforced through continuing professional development (7, 27).

At the policy and guideline level, the implications are more profound and system-level. Professional organisations responsible for clinical guideline development should consider whether periodontal risk assessment merits inclusion in cardiovascular disease prevention guidelines alongside traditional risk factors such as smoking, hypertension, and hyperlipidaemia. The American Heart Association's 2026 scientific statement has provided authoritative validation of the association, but this has not yet translated into routine clinical recommendations at the level of primary care guidance (28). Integrating periodontal assessment into existing cardiovascular risk calculators would represent a significant paradigm shift, requiring substantial validation studies to determine whether addition of periodontal variables improves risk prediction beyond current models. Nevertheless, even without formal incorporation into risk algorithms, guideline bodies could recommend that clinicians consider periodontal status as a risk-modifying factor, particularly in patients with unexplained elevations in cardiovascular risk or those with poorly controlled hypertension or diabetes (29).

Curriculum policy represents another domain requiring urgent attention. Medical education accreditation bodies and licensing examination boards should explicitly include oral–systemic health competencies in their standards. The absence of periodontal content from major medical licensing examinations has created a situation where curriculum committees face little external pressure to allocate teaching time to this area. The General Dental Council's revised Standards for Education, published in 2025 for implementation in the 2026/27 academic year, demonstrate how regulatory bodies can drive curriculum reform by establishing clear expectations for programme content . A comparable initiative from medical regulators—requiring that graduating medical students demonstrate ability to recognise common oral diseases, understand their systemic implications, and know when to refer for dental care—would catalyse curriculum renewal more




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effectively than any number of pilot studies or faculty development workshops. The European Federation of Periodontology has already initiated efforts in this direction, advocating for improved interprofessional education aligned with World Health Organization strategies . National medical education bodies should follow this lead (29,30).

Resource allocation and reimbursement policies also require reconsideration. Current healthcare financing models in most jurisdictions do not remunerate medical practitioners for oral health screening activities, creating a financial disincentive that undermines even the best-designed educational interventions. A medical graduate who has been superbly trained to recognise periodontal disease will quickly abandon this skill if clinical workflows and reimbursement structures provide no support for its use. Policy makers should consider whether oral health assessment should be included as a billable service within primary care, at least for patients with established cardiometabolic disease. The cost-effectiveness of such an approach would require careful evaluation, but given the high prevalence of both periodontitis and cardiometabolic conditions, even modest improvements in detection and referral could yield meaningful population health benefits (31).

Turning to the research agenda, the critical analysis has identified numerous gaps that future investigations must address. Foremost among these is the near-total absence of randomised controlled trials examining the impact of educational interventions on patient-relevant outcomes. No study has yet demonstrated that teaching medical students about periodontal–systemic connections leads to increased rates of dental referral, improved periodontal status among referred patients, or reductions in cardiovascular events or improvements in glycaemic control. Establishing this chain of evidence will require large-scale, longitudinal studies that follow cohorts of medical students through training and into clinical practice, linking educational exposures to practice behaviours and ultimately to patient outcomes. Such studies present formidable methodological and logistical challenges, but without them, the field cannot move beyond process measures to demonstrate genuine value (32).

Future research should also prioritise the development and validation of standardised assessment instruments. The variability in outcome measures across existing studies has severely limited comparability and precluded meaningful meta-analysis. A core outcome set for oral health education research should be developed through consensus processes involving medical educators, dental educators, and patients. This set should include objective measures of knowledge (using validated, standardised tests), clinical skills (assessed through observed structured clinical examinations or standardised patient encounters), and practice behaviours (measured through clinical records or standardised patient visits). The availability of such instruments would enable multicentre trials and facilitate comparison of different educational interventions across diverse contexts (33).

The generalisability of existing findings represents another critical gap requiring attention. Nearly all published studies have been conducted in high-income countries, yet the burden of both




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periodontal disease and cardiometabolic conditions is highest in low- and middle-income settings. Research is urgently needed to understand how medical education in resource-limited contexts can address oral–systemic connections, given that dental services may be scarce or unaffordable for many patients. The implications of periodontal–systemic links may be different in settings where access to periodontal therapy is limited; referral for dental care may be futile if no affordable services exist. Future research should explore innovative, task-shifting models in which medical practitioners are trained to provide basic periodontal care (such as oral hygiene instruction and non-surgical debridement) when dental referral is not feasible (34).

Regarding study design, the field must move decisively beyond cross-sectional surveys and uncontrolled pre-post studies. Pragmatic cluster randomised trials, in which medical schools or individual training programmes are randomised to receive enhanced periodontal–systemic education or usual curricula, represent the gold standard for establishing educational effectiveness. Such trials should incorporate long follow-up periods (at least 2-3 years) to assess knowledge retention and should include objective measures of clinical skills, not just self-reported confidence. Embedded process evaluations using mixed methods can illuminate the mechanisms through which interventions achieve their effects and identify barriers to implementation in real-world settings. The Leipzig PBL study provides a model for how such evaluations can be conducted, including qualitative analysis of student feedback that revealed important insights about the need for earlier introduction of oral health content and stronger theoretical underpinning (35).

Finally, research should explore the potential of digital health technologies to support both education and clinical practice. Artificial intelligence-driven tools for early diagnosis of periodontitis from intraoral images are being developed, and such tools could be integrated into medical practice if properly validated . Similarly, electronic health records can be designed to prompt oral health assessments in patients with cardiometabolic risk factors and to provide just-in-time educational resources for practitioners. Federally funded research initiatives are already investigating multi-level interventions incorporating electronic health record-based assessment tools, and the results of these investigations will inform future implementation efforts (36, 37). The intersection of educational innovation and health information technology represents a promising frontier for future research(38).

The translation of evidence linking periodontal disease to cardiometabolic conditions into clinical practice requires concerted action across multiple domains. Clinicians must be equipped with the knowledge and skills to recognise periodontal disease and understand its systemic implications. Policy makers must create incentives and standards that support integration of oral health into medical care. And researchers must generate the high-quality evidence needed to guide these efforts, moving beyond descriptive studies toward rigorous randomised trials and longitudinal outcome evaluations. The historical trajectory has been characterised by slow progress and fragmented innovation, but the convergence of strengthened epidemiological evidence,




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mechanistic understanding, and educational pilot data creates an unprecedented opportunity for meaningful reform (39).

# Conclusion

This narrative review reveals that despite three decades of robust epidemiological and mechanistic evidence establishing periodontitis as an independent risk factor for cardiometabolic disease, medical curricula have been persistently slow to integrate this knowledge. The evidence base demonstrates remarkable convergence across international studies, yet educational translation remains fragmented. Medical trainees exhibit significant knowledge gaps regarding oral–systemic connections, although structured interventions such as problem-based learning and interprofessional case conferences show promise. Three recommendations emerge: medical curricula must embed core oral health competencies; clinical guidelines should recognise periodontal status as a modifiable cardiometabolic risk factor; and accreditation systems must incentivise integration through licensing examination reform. The research imperative is urgent: the field requires well-powered, multicentre randomised trials examining patient-relevant outcomes, longitudinal cohort studies to assess sustained behavioural change, and validated assessment instruments. Without methodological rigour, compelling epidemiological evidence will continue to fail translation into improved patient care.

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