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Oral health and systemic health outcomes: A call for interdisciplinary action

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Abstract

Objectives: To make the case, from periodontology and dental public health, for interdisciplinary action on oral and systemic health, and to set out recommendations for practice, policy, education, and research.

Materials and Methods: A joint working group of the European Federation of Periodontology (EFP) and the European Association of Dental Public Health (EADPH), with public-health stakeholders and delegates from organized medicine (the World Heart Federation, WONCA Europe and the European Forum for Primary Care), synthesized the epidemiological, mechanistic, preventive and health-systems evidence, and developed consensus recommendations.

Results: Oral diseases affect around 3.5 billion people and share modifiable risk factors (free sugars, tobacco, and alcohol) and social and commercial determinants with the major non-communicable diseases (NCDs); inadequate oral hygiene is an additional oral-specific factor. This argues for integrating oral health into general health through a common risk factor approach rather than disease silos. Periodontitis has the strongest evidence for systemic interactions and, unusually among oral diseases, its treatment improves glycemic control in diabetes and inflammatory or vascular surrogates, though evidence for major clinical events remains limited; other links rest largely on shared risk factors and mechanisms (an asymmetry of evidence, not of public-health importance). Prevention and integrated care remain under-implemented.

For affiliations refer to page 20.

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Conclusions: Oral health must be recognized as integral to general health and embedded within NCD strategies and universal health coverage through interprofessional, intersectoral action that also tackles the social and commercial determinants and reduces inequalities.

Clinical Relevance: Equipping all health and social-care professionals to promote oral self-care, screen and refer, and prioritize periodontal prevention and treatment, can improve both oral and systemic outcomes.

KEYWORDS

common risk factor approach, interprofessional collaboration, non-communicable diseases, oral health, periodontitis, prevention, universal health coverage

1 | INTRODUCTION

1.1 | Background and rationale

Oral diseases are among the most prevalent and most neglected of all human conditions. Three groups account for most of the global burden: dental caries, periodontal diseases, and oral mucosal diseases including oral cancer. Together they affect an estimated 3.5 billion people. Untreated caries in the permanent dentition is consistently the single most common health condition worldwide, affecting some 2–2.5 billion people, with a burden that is rising as populations age; severe periodontitis affects around 1 billion people (close to a fifth of all adults) and is a leading cause of tooth loss.^{1–4} Tooth loss and edentulism, the shared endpoint of untreated caries and periodontitis, are themselves associated with poorer general health and higher all-cause mortality.⁵ Poor oral health is closely linked to general medical condition, especially in older and medically complex patients, and periodontal disease in particular is increasingly recognized as a systemic condition.^{6,7} Despite this scale, oral conditions remain separated from the rest of medicine (conceptually, professionally, and financially), even though they are largely preventable and share their main risk factors (tobacco use, harmful alcohol use, and a diet high in free sugars) with the major non-communicable diseases (NCDs). These NCDs, principally cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes, are the leading cause of death worldwide, responsible for around three-quarters of all deaths, some 41 million each year.⁸

Oral health is also poorly integrated into routine clinical and public-health practice, and the patients at greatest risk (the socio-economically deprived, the medically complex, the very young, and dependent older adults) are often those least likely to see a dental team or to benefit from health-promotion programs with an oral-health component. Oral diseases follow a steep socio-economic gradient, making them an equity and social-justice challenge as much as a clinical one.

This gap is the reason for this white paper. Better oral health, and its contribution to preventing and managing NCDs and multiple long-term conditions, cannot be delivered by the dental

professions alone. It requires the whole health and care workforce (physicians, nurses, midwives, pharmacists, allied health professionals, social workers, carers, and teachers) to treat oral health as part of general health, and to be able to support effective prevention and risk reduction, screen opportunistically and refer. Current global policy provides both the mandate and the framework: the 2021 World Health Assembly resolution on oral health, the WHO Global Oral Health Status Report (2022), and the WHO Global Oral Health Action Plan 2023–2030 call for oral health to sit within universal health coverage (UHC) and the wider NCD agenda.⁹ Most recently, the Political Declaration of the fourth UN High-Level Meeting on the prevention and control of NCDs and the promotion of mental health and well-being, adopted at the Eightieth UN General Assembly in 2025, explicitly included oral health, a significant milestone for integrated, people-centered health systems.¹⁰

1.2 | Integrating oral health into general health through common risk factors

The central argument of this paper is the integration of oral health into general health. Oral diseases and the major NCDs are multifactorial conditions that share a small set of modifiable risk factors (above all free sugars, tobacco, and harmful alcohol) and the same social and commercial determinants; inadequate oral hygiene is an additional, oral-specific factor. Acting on these shared exposures across the upstream, midstream, and downstream levels of public-health action (Chapter 6) improves oral and general health together and avoids professional silos. This common risk factor approach, rather than a disease-by-disease or mechanism-by-mechanism account, is the organizing principle of the paper (Box 1).

Within this framework, the periodontal diseases hold a particular place. Of all the oral conditions, periodontitis has the strongest evidence for interactions with systemic disease; it is preventable and treatable with evidence-based care, and, unusually among oral diseases, its treatment also yields a measurable systemic benefit, for example improved glycemic control in

BOX 1 An integrated, common risk factor approach to oral and systemic health

The concept

Oral diseases and the major NCDs are multifactorial and share modifiable risk factors (free sugars, tobacco and harmful alcohol) and social and commercial determinants; inadequate oral hygiene is an additional oral-specific factor. Acting on these together, across upstream (policy and population), midstream (community and settings), and downstream (individual and clinical) levels, integrates oral health into general health and improves both.

Where periodontology contributes

Among oral conditions, periodontitis has the strongest evidence for systemic interactions, and the only substantial interventional evidence (an asymmetry of the evidence base, not of public-health importance). It is preventable and treatable (EFP S3-level guidelines) and a central clinical contributor to the shared approach; dental caries, the most prevalent oral disease, enters chiefly through shared risk factors and the sequelae of untreated disease.

Goal: better integration of oral health into systemic-health considerations, with the common risk factor approach as the vehicle and periodontal prevention and care as a central clinical contributor.

diabetes.^{6,11-13} Periodontitis is therefore the strongest evidence-based clinical contributor to the integrated approach rather than a separate track. The evidence has matured over two decades from association to mechanism and, for selected conditions, to intervention, and organized medicine has begun to engage: the EFP has issued joint consensus reports with the World Heart Federation (WHF), the European arm of the World Organization of Family Doctors (WONCA Europe), and the International Diabetes Federation (IDF).¹⁴⁻¹⁶ Dental caries, the most prevalent NCD, is rarely associated directly with systemic disease, but it shares the key risk factor of excessive free-sugar consumption with obesity and diabetes and contributes through the sequelae of untreated disease, for example, malnutrition from advanced tooth loss; its prevention, and that of oral cancer, must feature in any public-health program (Chapter 2).

The biological mechanisms are summarized in Chapter 2. For patients, professionals, and policymakers, however, the actionable message is the shared risk factors, not the pathways. This integrated approach is particularly relevant in aging populations, where oral diseases frequently coexist with multiple long-term conditions and contribute to reduced function, quality of life, and healthcare complexity.⁷

1.3 | Purpose and unique contribution

This document is a joint statement of the European Federation of Periodontology (EFP) and the European Association of Dental Public Health (EADPH). Its distinctive contribution is not merely to synthesize the evidence, but to bridge two perspectives that are too rarely combined: the clinical and mechanistic depth of periodontology and the population, equity and health-systems lens of dental public health. From that combined vantage point, the paper sets out what is known, what remains uncertain and, above all, what should now be done, by whom, to make interdisciplinary oral-systemic care a reality.

1.4 | Development of this white paper and evidence base

This document is a joint position statement of the EFP and the EADPH, developed by an invited multidisciplinary working group; it is not a systematic review. The evidence base was expert-curated, drawing on internal systematic appraisals of the literature carried out within the working groups, and spans the epidemiological, mechanistic, preventive, and health-systems domains, including existing systematic reviews and meta-analyses, clinical practice guidelines (in particular the EFP S3-level guidelines), WHO reports and Global Burden of Disease data. Recommendations were developed through a classical consensus-conference process followed by iterative written rounds until consensus was reached across the group; all authors had repeated opportunities to review, amend, and add. The recommendations therefore represent the consensus expert opinion of the working group and are not formally evidence-graded; where the underlying evidence is strong or limited, this is stated in the text.

1.5 | Scope

We adopt a deliberately broad definition of *oral health*, spanning the three major disease groups (periodontal diseases; dental caries and its sequelae, including odontogenic infection and tooth loss; and oral mucosal diseases including oral cancer) across the life course. Emphasis falls on those conditions with the strongest and/or most actionable links to systemic health, while signposting areas where the evidence is still emerging. Mechanisms, prevention, and disease management are treated in dedicated chapters to avoid duplication.

1.6 | Target audiences

The paper is written to reach and influence four overlapping groups: (i) health professionals, dental, and non-dental alike; (ii) the social care and education workforce, including care-home staff, teachers, and unpaid carers; (iii) policymakers, public-health authorities, and health-system administrators; and (iv) patients, patient-advocacy groups, and the wider public. Because much of the intended impact depends on

non-dental readers, we have kept technical detail proportionate and explained specialist concepts where they first appear.

1.7 | Structure and approach

The remainder of the paper is organized in six chapters. Chapter 2 synthesizes the epidemiological and mechanistic evidence linking oral and systemic disease. Chapter 3 addresses primary prevention and the common risk factor approach. Chapter 4 covers secondary prevention and the management of patients with established systemic disease. Chapter 5 examines the barriers to, and facilitators of, interdisciplinary collaboration. Chapter 6 sets out concrete recommendations for education, practice, policy, and research. Chapter 7 draws together the key messages and the call to action.

2 | EPIDEMIOLOGICAL AND MECHANISTIC EVIDENCE

Key terms in this field are understood differently by clinical specialist societies (the EFP) and dental public health (the EADPH); a glossary of terms has been compiled to support a shared framework of understanding (Box 2).

Bodies such as the WHO and the FDI World Dental Federation now frame the field around oral *health* rather than oral *disease*. The WHO defines oral health broadly:

the state of the mouth, teeth and orofacial structures that enables individuals to perform essential functions such as eating, breathing and speaking, and encompasses psychosocial dimensions such as self-confidence, well-being and the ability to socialize and work without pain, discomfort and embarrassment. Oral health varies over the life course ... is integral to general health and supports individuals in participating in society and achieving their potential.

Terms such as *systemic health*, *outcomes*, and *links* are likewise interpreted differently across groups. Two framings matter particularly here: at the patient level, the *bidirectional* link between periodontitis and diabetes; and at the population level, excessive sugar consumption as a shared fundamental cause of both dental caries and other NCDs. Many stakeholders, including within dentistry, have yet to appreciate that dental caries is itself a non-communicable disease, a recognition that is essential for integrating it into public health policy and the WHO agenda.²³

2.1 | Which oral-systemic associations are strongest, and where are the gaps?

A central message of this chapter is one of asymmetry: the great majority of the evidence linking oral to systemic health, and essentially

all of the *interventional* evidence, concerns the periodontal diseases, which are also preventable and treatable. Dental caries matters to systemic health mainly through shared risk factors and the sequelae of untreated disease, rather than through a demonstrated direct causal effect. This asymmetry concerns the *evidence base*, not the public-health importance of each disease: dental caries remains the most prevalent health condition worldwide, and its population burden is taken up in Chapter 3. Despite this asymmetry in the evidence, policy, and service responses should address the full spectrum of oral diseases (dental caries, the periodontal diseases, and oral cancer) within an integrated NCD framework rather than focusing disproportionately on periodontitis.

2.1.1 | Confounding, causality and bidirectionality

The major oral diseases (periodontal diseases, dental caries, and oral cancer) share socio-economic determinants and lower levels of self-care in their causal pathways, generating associations with systemic outcomes that share the same upstream causes. For caries especially, excessive sugar consumption is a fundamental common cause of both oral and systemic disease. The most significant knowledge gap therefore lies in disentangling associations driven by confounding and shared risk factors from true causality (established mainly through intervention trials that test whether treating the oral condition changes the systemic outcome); where causal relationships exist, some may be bidirectional, and identifying the predominant direction is essential for designing effective interventions: if true bidirectionality exists, both conditions must be addressed.

2.1.2 | Periodontal diseases

Periodontal diseases are associated with a wide range of systemic outcomes across a broad spectrum of evidence for and against causality, a literature in which the number of reviews now rivals the number of original articles. The strongest link is to reduced glycemic control in type 2 diabetes, supported by numerous longitudinal studies, and dozens of clinical trials showing that treating periodontitis produces modest but clinically significant reductions in HbA1c.³⁹ Emerging evidence further suggests that periodontitis and pre-clinical oral dysbiosis contribute to diabetogenesis, though causality is less certain given the few trials conducted to date.⁴⁰ Atherosclerotic cardiovascular diseases (coronary artery disease, peripheral artery disease and ischemic stroke) are also strongly linked, as summarized in American Heart Association scientific statements, although definitive evidence that periodontal therapy reduces major cardiovascular events remains unavailable.^{41,42}

Intermediate but as yet inconclusive evidence links periodontal diseases to rheumatoid arthritis, cognitive decline, and the dementias: hundreds of publications consistently support association, but causality remains uncertain owing to a very limited set of intervention studies.⁴³⁻⁴⁷ Growing evidence connects periodontal diseases

BOX 2 Glossary of key terms

The Frankfurt meeting revealed that key terms are used and understood differently between a federation of clinical specialist societies (EFP) and an association focused on dental and wider public health (EADPH). This glossary provides an agreed operational foundation to strengthen collaboration and improve communication with all stakeholders. Definitions reflect current thinking and will evolve with the evidence.

Health

The classical World Health Organization definition (widely cited, though also widely critiqued): "A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."¹⁷

Oral health (WHO)

"The state of the mouth, teeth and orofacial structures that enables individuals to perform essential functions such as eating, breathing and speaking, and encompasses psychosocial dimensions such as self-confidence, well-being and the ability to socialize and work without pain, discomfort and embarrassment. Oral health varies over the life course from early life to old age, is integral to general health and supports individuals in participating in society and achieving their potential."¹⁸

Oral health (FDI)

Broad, including "the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex."¹⁹

Systemic disease

"Systemic means affecting the entire body, rather than a single organ or body part"; an infection in the bloodstream is a systemic infection, whereas one affecting a single organ is localized.²⁰ Note: "Systemic health" is widely referred to but lacks a standard published definition; the medical literature generally refers to systemic *disease*.

Oral diseases and conditions

"Dental caries, severe periodontal (gum) disease, complete tooth loss (edentulism), oral cancer, oro-dental trauma, noma and congenital malformations such as cleft lip and palate. They share risk factors common to the leading NCDs and are influenced by social and commercial determinants of oral health."²¹

Dental caries

"A biofilm-mediated, diet-modulated, multifactorial, non-communicable, dynamic disease resulting in net mineral loss of dental hard tissues ... determined by biological, behavioural, psychosocial, and environmental factors. As a consequence of this process, a caries lesion develops."²² Dental caries is now classified as a non-communicable disease (NCD), important for its integration into public health policy.²³

Periodontitis

A chronic inflammatory disease of the gums and supporting structures of the teeth, caused by an imbalance of bacteria in dental plaque (biofilm). It leads to gradual breakdown of the tissues and bone that hold the teeth in place, detectable as loss of attachment between tooth and gum, bone loss on radiographs, deepened gum pockets and bleeding on examination. Diagnosis requires attachment loss at multiple teeth that cannot be explained by other causes; the disease is further described by its severity and complexity (stage I–IV), its rate of progression and risk profile (grade A–C) and its extent (localized, generalized, or molar–incisor pattern). Periodontitis is also linked to systemic diseases such as diabetes and cardiovascular disease through shared inflammatory mechanisms and bidirectional interactions.^{6,15,24}

BOX 2 (Continued)**Oral cancer**

"Cancer that forms in tissues of the oral cavity (the mouth) or the oropharynx (the part of the throat at the back of the mouth)."²⁵

Health outcomes

"Measurable changes in health status, quality of life, or functional capacity resulting from healthcare interventions, behaviours, or policies... encompassing clinical results, patient-reported experiences, and functional improvements."²⁶

Oral health outcomes

Increasingly framed around modern, evidence-informed concepts of the common dental diseases and a patient-centered model (WHO Global Oral Health Action Plan). Active work includes dental patient-reported outcomes²⁷ and a standard set of patient-centered outcomes for adult oral health.²⁸

Intra-/multi-/cross-/inter-/trans-disciplinary

A spectrum of collaboration²⁹:

- *Intra-disciplinary*: working within a single discipline.
- *Multidisciplinary*: people from different disciplines working together, each drawing on their own disciplinary knowledge (boundaries maintained).
- *Cross-disciplinary*: viewing one discipline from the perspective of another.
- *Interdisciplinary*: integrating knowledge and methods from different disciplines through a real synthesis of approaches.
- *Transdisciplinary*: creating a unity of frameworks beyond disciplinary perspectives, including non-academic stakeholders (the ultimate goal of this paper).

Interdisciplinary

"2 or more disciplines collaborating to accomplish a common goal"; a general and broad form of collaboration.³⁰

Transdisciplinary

Approaches that integrate knowledge from multiple academic disciplines and non-academic stakeholders to solve complex, real-world problems, moving beyond collaboration to create new conceptual frameworks aiming for direct societal impact.³¹

Specialist clinical practice (periodontology)

Clinical practice delivered by a formally trained and accredited periodontist, involving the diagnosis and management of complex periodontal and peri-implant diseases using advanced, evidence-based, and often interdisciplinary approaches. This includes surgical expertise (resective, regenerative and periodontal plastic procedures) as well as long-term supportive periodontal therapy to maintain treatment outcomes and prevent disease recurrence.³²

Dental public health

"The science and art of preventing oral diseases, promoting oral health, and improving quality of life through the organised efforts of society," directed at populations, groups and the individuals within them.³³

Public health

"The science and art of preventing disease, prolonging life, and promoting health through organized societal efforts," emphasizing a whole-system approach (social, commercial, and digital determinants) and health equity.^{34,35}

BOX 2 (Continued)**Planetary health**

The condition and ability of ecosystems and the Earth's natural systems (geosphere, biosphere, cryosphere, hydrosphere, and atmosphere) to support human societies.³⁶

Global health security

"The activities required, both proactive and reactive, to minimize the danger and impact of acute public health events that endanger people's health across geographical regions and international boundaries."³⁷

Sustainable dentistry

"Practising dentistry in ways that are environmentally friendly, socially responsible and accountable, and economically viable within planetary health boundaries and which safeguards the integrity of Earth systems."³⁸

to chronic kidney disease⁴⁸⁻⁵² and to several cancers, although trial data for cancer are lacking.^{53,54} Emerging but inconsistent evidence also links periodontitis to inflammatory bowel disease: systematic reviews and Mendelian-randomization analyses report an association, whereas prospective cohorts have not.⁵⁵⁻⁵⁷ Early observational work also associated periodontal diseases with adverse pregnancy outcomes (pre-term low birth weight, spontaneous abortion),⁵⁸ but a series of clinical trials did not support causality (treating periodontitis did not reduce adverse outcomes), with one critique being that treatment is often initiated too late in pregnancy to be of benefit.^{59,60}

2.1.3 | Dental caries

Excessive sugar consumption is a shared risk factor for caries and a range of other NCDs (cardiovascular disease, diabetes, obesity, and some cancers), inviting integrated public health action.^{9,61} Proving that individual interventions work is difficult; for example, early sugar intake is rarely limited without also using fluoride toothpaste, which impedes demonstrating caries-systemic relationships.⁶² Caries is not solely a childhood disease: a life-course perspective is essential, since untreated decay in adults represents the greatest global oral-health burden and tooth loss becomes prominent at older ages, often resurging among institutionalized elderly people. Edentulism (one of the four most prevalent oral conditions recognized by the WHO, to which both caries and periodontitis contribute) is itself linked to health and life expectancy, an outcome that unites the caries and periodontitis communities.^{63,64} Comorbid conditions (obesity, diabetes, and metabolic syndrome) are under exploration, but these relationships are believed to arise from common risk factors rather than causal association; the most direct connection between caries and systemic outcomes runs through the sequelae of untreated or unsuccessfully treated caries: apical periodontitis, tooth loss and altered masticatory function.

2.2 | Mechanistic pathways**2.2.1 | Periodontitis**

A growing body of research implicates the oral microbiome and periodontal inflammation as contributors to chronic systemic disease. Although specific pathways vary by condition, several unifying mechanisms recur: dysregulated immunity, chronic low-grade inflammation, bacteremia, and altered host-microbe interactions.^{40,41,65-69} Locally, periodontitis sustains gingival inflammation that upregulates host defense, apoptosis, complement, and pro-inflammatory signaling while suppressing anti-inflammatory regulators such as PPAR- α ; the resulting cytokines and chemokines (TNF- α , IL-1 β , IL-6, IL-10, sICAM-1) enter the circulation, while dysbiosis and tissue destruction increase bacteremia during routine daily activities, allowing bacterial products such as lipopolysaccharide (LPS) to trigger systemic innate responses. These signals amplify a systemic micro-inflammation that is a shared substrate across diabetes, RA, CKD, cardiovascular disease, cancer and neurodegeneration, activating NF- κ B and JNK pathways and driving production of TNF- α , IL-6, acute-phase proteins and adipokines. Condition-specific consequences follow: impaired insulin receptor signaling and β -cell stress in type 2 diabetes; heightened bacteremia, synovial inflammation and autoantibody formation in RA; endothelial dysfunction and oxidative stress accelerating renal decline in CKD; endothelial interaction, atherogenesis, plaque instability and altered lipid metabolism in cardiovascular disease; and, for cognition, cytokines and bacterial components that cross or weaken the blood-brain barrier, activate microglia and promote amyloid deposition or tau phosphorylation, with some oral pathogens detected in Alzheimer's brains, raising the possibility of direct microbial invasion alongside inflammatory signaling. In cancer, chronic low-grade inflammation is a recognized influence on tumor initiation, progression, and metastasis.

2.2.2 | Dental caries

The pathogenesis of caries is distinct. The decades-old view of *Streptococcus mutans* as the causal agent is now outdated: current science holds that a range of complex biofilms can become caries-promoting through a shift in community acid production that tips the dynamic balance of demineralization versus remineralization toward net mineral loss.^{23,70} Saliva is central to protection, which is why dry mouth (from pathology, medication, or radiotherapy) can dramatically accelerate caries; when a lesion overwhelms the pulp-dentin complex, a necrotic pulp can lead to apical periodontitis, inflammation, and sepsis. Aspiration of cariogenic and other oral bacteria also contributes to pneumonia in dependent and intensive-care patients, a further route by which poor oral health affects systemic health.^{71,72} A recent analysis of causal inference in this area concludes that links between periodontitis and systemic disease are promising while caution remains warranted for caries, and notes that the most important confounders are socio-economic, followed by behavioral factors, with genetics a major and under-addressed confounder.⁷³ Collectively, the oral microbiome, untreated caries, and periodontal inflammation appear to contribute to a multisystem network of chronic disease through shared pathways of microbial translocation, dysregulated immunity, and sustained systemic inflammation. Oral bacteria abundant in periodontitis can also translocate to and colonize the gut, where they promote intestinal inflammation through the oral-gut axis.^{74,75}

2.3 | Systemic medications and oral health: A bidirectional relationship

No randomized trials have directly evaluated the effects of systemic medications on oral health; current evidence comes from narrative reviews, observational studies, and animal models. The best-documented effect is increased caries risk from sugar-containing formulations, particularly in young children, while the relationship between caries and salivary-flow-reducing medications in older age groups remains poorly characterized. Across all ages, dry mouth (xerostomia and/or hyposalivation) is the most frequently reported outcome, arising from individual drugs, underlying conditions or polypharmacy, and increases susceptibility to caries, opportunistic infection, mucositis, and ulceration, with substantial effects on quality of life. Other medication-related effects include gingival hyperplasia, medication-related osteonecrosis of the jaw and bleeding complications; anti-osteoporotic and cardiovascular drugs have been linked to gingival pathology, and antidepressants to both caries and periodontal diseases. Beyond direct effects, systemic medications can alter the oral and gut microbiomes and the oral-gut axis, contributing to local and systemic inflammation; the oral microbiome may thus participate in the bidirectional diabetes-periodontitis relationship, with uncontrolled diabetes shifting the flora toward pathogenic taxa and non-surgical periodontal therapy improving

both microbial composition and glycemic control. These outcomes are modified by dose, duration, diet, oral hygiene, smoking, and overall disease burden.^{76,77}

2.4 | Oral cancer

Oral cancer is a substantial and often under-recognized component of the global oral-disease burden, with major implications for general health, health systems, and health equity. Global policy led by the WHO positions it as a preventable NCD that shares key risk factors (tobacco use, alcohol consumption, and social disadvantage) with other major NCDs. Beyond mortality, oral cancer and its treatment impose a heavy systemic burden through metastasis, impaired function, and malnutrition.⁷⁸ The *Lancet* Oral Health Series highlights oral cancer alongside periodontal diseases and caries as a leading contributor to morbidity and mortality, and Global Burden of Disease analyses confirm its scale and inequitable distribution, together reinforcing the need to embed oral cancer awareness, opportunistic case-finding and timely referral within general health services rather than confining them to dental care.^{1,2,78}

2.5 | Advancing research on emerging associations

2.5.1 | Intervention trials

Advancing research on oral-systemic conditions with emerging but inconclusive evidence requires studies that directly test plausible biological pathways, with populations, interventions, and follow-up matched to the hypothesized mechanism. Many studies fall short because they do not sufficiently suppress periodontal inflammation, fail to achieve durable shifts from dysbiosis to eubiosis, or intervene after substantial systemic pathology has developed. Long-term prevention trials face structural obstacles: the conditions worth testing (cardiovascular events, diabetes complications) would require very large samples and follow-up across decades, beyond conventional 5-year funding cycles, and it is ethically impermissible to withhold oral care from a control group, so the field leans on short-term surrogates.

2.5.2 | Observational cohorts

Progress is therefore likely to come from improved epidemiological methods, including better handling of attrition in longitudinal studies and advanced statistical approaches. Cardiology is instructive: much progress came from relatively simple, large-scale randomized trials, but because manipulating oral-disease exposure to test systemic effects is not ethical, well-conducted prospective cohorts will remain the best alternative, just as observational research established smoking and diabetes as causal cardiovascular risk factors.

2.5.3 | Pragmatic and policy evaluation

Maturing electronic health records that integrate dental and medical data create new opportunities for pragmatic trials, target-trial emulation, and large embedded cohorts. Evaluating real-world public-health policies and programs is equally important and depends on well-chosen, comparable indicators of oral and systemic health. These approaches will also facilitate investigation of oral health within the broader context of multimorbidity and healthy aging, where conventional disease-specific study designs are increasingly insufficient. Finally, structural and economic factors shape adoption and sustainability: aligning provider and patient incentives is critical, expanded insurance coverage can paradoxically reduce reimbursement and deter participation, and positioning oral interventions as systemic-disease strategies may introduce new liability considerations for dental providers.

2.6 | Are these associations relevant to practice, and how should we communicate them?

Oral-systemic associations have meaningful implications for practice whether or not they are causal. As a risk-prediction tool the evidence is limited (adding periodontal parameters has generally not improved discrimination for undiagnosed diabetes beyond standard factors such as age and body mass index), but dental settings are an under-used and potentially powerful touchpoint for detecting chronic disease, for example by recording blood pressure or point-of-care glycemia, since many adults attend a dentist more regularly than a physician; in high-income settings roughly one in 10 US adults report seeing a dentist but not a physician, although in many countries dental access is far more limited.^{79,80} Communication must still be careful: clinicians and public-health professionals should avoid overstating the systemic benefits of dental interventions outside well-supported contexts such as glycemic control in diabetes, and screening and implementation studies are needed to establish the clinical utility, cost-effectiveness and feasibility of embedding general-health screening into dental workflows.

Non-causal associations remain useful for understanding mechanisms and identifying groups with shared risk; for example, the association between maternal smoking and early-childhood caries appears to operate partly through earlier introduction of sugar. A safe, evidence-aligned strategy is to emphasize oral health as an integral component of overall health, function and quality of life, which supports patient understanding without implying unsubstantiated causal claims, while pursuing the genuine public-health value of opportunistic screening at dental visits. How best to convey risk, uncertainty and benefit across diverse populations and health-literacy levels remains an important knowledge gap for implementation science, and the relevance and feasibility of oral-systemic strategies will vary across health systems, countries, and policy contexts.

Oral and systemic diseases are connected primarily through shared risk factors and, for periodontitis, through plausible biological

pathways and a growing body of intervention evidence; the association is strongest and best-evidenced for periodontitis and type 2 diabetes, while for most other conditions it remains largely associational. For practice and policy, the actionable message holds regardless of where causality is finally settled: acting on the shared risk factors benefits oral and systemic health together.

3 | PRIMARY PREVENTION

3.1 | Primary prevention and the common risk factor approach

Primary prevention comprises the population- and individual-level interventions that prevent disease onset by reducing exposure to causal risk factors and strengthening protective factors.⁸¹ In oral health, it has traditionally been delivered through health promotion, behavioral, and environmental risk-factor reduction and protective measures such as fluoride exposure and effective oral hygiene, which together reduce the incidence of dental caries and periodontal diseases.

The central organizing idea of this chapter is the *common risk factor approach*: oral diseases and the major NCDs share a small set of modifiable behavioral, metabolic, and social determinants, so that addressing these shared exposures yields concurrent benefits across both.⁸² The WHO Global Strategy on Oral Health (2022) and the Global Oral Health Action Plan 2023–2030 make this explicit, stating that oral diseases “share risk factors common to the leading noncommunicable diseases, including all forms of tobacco use, harmful alcohol use, and high intake of free sugars,” and calling for oral prevention to be aligned with broader NCD strategies and embedded in universal health coverage.^{9,83} Table 1 summarizes the shared risk factors; Table 2 summarizes the strength of evidence that modifying each one changes disease outcomes.

3.2 | Evidence for the major shared risk factors

3.2.1 | Tobacco

Tobacco is one of the most firmly established shared risk factors. In people without baseline cardiovascular disease, smoking cessation substantially reduces incident cardiovascular events,^{84,85} and prospective cohorts show cessation reduces cancer incidence and mortality even when quitting in midlife.⁸⁶ At the population level, falling smoking prevalence accounts for a substantial share of prevented coronary deaths in national models.⁸⁷ In the mouth, smoking has a strong causal role in periodontitis and oral cancer, accelerating periodontal tissue destruction through vascular, immune and microbial effects,⁸⁸ and is also associated with caries (particularly root caries) via reduced salivary flow and buffering, with childhood passive exposure linked to higher caries prevalence.^{89–91} Conversely, smoking cessation improves periodontal treatment outcomes and lowers the

TABLE 1 Shared modifiable risk factors linking oral diseases and major NCDs.

= Risk factor domain	= Oral diseases affected	= Major systemic NCDs affected
= Behavioral (tobacco; harmful alcohol; free sugars; physical inactivity)	= Caries; periodontal diseases; oral cancer	= Cardiovascular disease; diabetes; cancers; chronic respiratory disease
= Metabolic (obesity; hyperglycemia/diabetes; dyslipidemia; hypertension)	= Periodontal diseases; tooth loss	= Cardiovascular disease; diabetes; chronic kidney disease; cancers
= Oral-specific biological (poor oral hygiene; periodontal inflammation)	= Caries; periodontal diseases	= Indirect links to cardiometabolic and inflammatory NCDs
= Psychosocial/social (stress; low socio-economic status; low health literacy)	= Caries; periodontal diseases; oral cancer	= All major NCDs via behavioral and access pathways

TABLE 2 Shared modifiable risk factors: Their causal role in oral and systemic disease and the strength of evidence that modifying each alters non-communicable disease outcomes.

Risk factor	Causal role	Evidence that modification changes NCD outcomes
Tobacco use	Strong causal (periodontitis, oral cancer; CVD, cancer, COPD)	Strong; cessation reduces CVD and cancer risk
Free sugars/unhealthy diet	Strong causal (caries); strong for obesity/diabetes	Lifestyle trials prevent diabetes; sugar policies reduce intake
Poor oral hygiene	Strong causal (caries, periodontitis)	Improves metabolic risk markers; limited hard-outcome data
Harmful alcohol	Strong causal (oral/oropharyngeal cancer; liver disease)	Epidemiological/policy evidence of reduced burden
Physical inactivity	Indirect (metabolic)	Lifestyle trials prevent diabetes
Obesity/metabolic dysfunction	Strong association (periodontitis)	Weight-loss trials reduce diabetes risk
Psychosocial stress/low SES	Strong social gradient	Intervention evidence heterogeneous

risk of further attachment loss and tooth loss, so quitting benefits oral as well as general health.⁸⁸ Novel nicotine products (e-cigarettes, heated tobacco, nicotine pouches) are an emerging concern: experimental and clinical data indicate that nicotine aerosols can disturb periodontal host-microbial homeostasis and gingival inflammation, while nicotine affects vascular function, immunity and wound healing relevant to both oral and cardiometabolic risk.^{92–96} Long-term population outcomes for these products remain under investigation, warranting surveillance and proportionate risk communication.

3.2.2 | Diet and free sugars

Excess free-sugar intake is the primary cause of dental caries and a major contributor to obesity, type 2 diabetes, and cardiovascular disease.⁹⁷ Frequent fermentable-carbohydrate exposure selects for an acidogenic, aciduric biofilm and repeated acid challenge that overwhelms remineralization (see Section 2.2). WHO recommends limiting free sugars to <10% of energy intake, with <5% as a conditional ideal, yet European intakes commonly reach 15%–21% in adults and 16%–26% in children, with sugar-sweetened beverages a dominant source.^{98–100} WHO-commissioned systematic reviews

confirm that reducing free sugars lowers both excess weight gain and caries.^{101,102} The growing consumption of ultra-processed foods (UPFs), high in free sugars and refined starch, is independently linked to obesity, CVD, diabetes, cancer and mortality, and to higher caries risk in children.^{103–105} Dietary choices are shaped by the *commercial determinants of health*: the sugar and food industries influence consumption through marketing, ubiquitous availability and lobbying against regulation, with tactics that mirror the tobacco industry's.^{106–109} Population-level sugar-reduction policies may therefore deliver simultaneous benefits across oral health and wider non-communicable disease prevention. Policy responses are addressed in Section 3.4.

3.2.3 | Alcohol

Harmful alcohol use is a Group 1 carcinogen for the oral cavity, pharynx and larynx, with risk rising steeply with intake and acting multiplicatively with tobacco: heavy smoker-drinkers face an order-of-magnitude higher oral-cancer risk than abstainers.¹¹⁰ Beyond cancer, it contributes to dental erosion, salivary dysfunction and the neglect of hygiene and nutrition.

3.2.4 | Other lifestyle factors

Physical inactivity acts indirectly via obesity and diabetes; stress and poor sleep are linked to periodontal disease (immune and cortisol pathways) and to bruxism; and betel-quid (areca nut) chewing is a significant cause of oral cancer and submucous fibrosis relevant to some migrant communities in Europe and warranting targeted prevention.¹¹¹

3.3 | Individual-level prevention: Core behaviors and consistent messaging

The foundation of preventing oral diseases is a small set of daily behaviors with the strongest evidence, the “non-negotiables” that every health and social-care professional should be able to communicate consistently:

- twice-daily toothbrushing with fluoride toothpaste (1000–1500ppm; a smear for under-3s, a pea-sized amount thereafter);
- daily interdental cleaning;
- reduction of free-sugar intake;
- tobacco avoidance and reduction of harmful alcohol use;
- risk-based dental attendance.

Self-performed mechanical plaque control is the cornerstone of periodontal health: effective daily biofilm disruption controls gingival inflammation and caries, while fluoride enhances remineralization and acid resistance, reducing enamel demineralization.^{112–114} Because gingivitis is the precursor of periodontitis, its control is also the single most cost-effective way to prevent periodontitis, modeled as a population-level “best buy.”¹¹⁵ The EFP S3-level clinical practice guideline on the management of dental biofilm-induced gingivitis makes three recommendations of direct relevance: it recommends an electric toothbrush over a manual toothbrush; it recommends stannous fluoride dentifrice as an adjunct to mechanical biofilm control (stannous fluoride additionally offers antibacterial, anti-hypersensitivity, and anti-erosion benefits); and it does not recommend the routine adjunctive use of mouthrinses, reserving short-term use for selected situations.¹³ Consistent with this, among electric toothbrushes the oscillating-rotating type has the most consistent evidence for reducing plaque and gingivitis, outperforming both manual brushing and other electric (e.g., sonic) designs.^{116–118} Interdental cleaning completes daily self-care (interdental brushes are often easier than, and at least as effective as, floss), and professional check-ups at risk-based intervals allow early detection (including mucosal lesions and oral cancer) and preventive interventions such as fluoride varnish and fissure sealants.^{119,120} Individual oral hygiene is thus both a personal preventive behavior promoted alongside the common risk factor approach and the foundation of periodontal prevention, a practical link between population-level, and clinical benefit (Box 1).

Knowledge alone rarely changes behavior. Motivational interviewing, digital reminders and personalized risk communication can reinforce these behaviors, and improving oral health literacy, including through consistent core messages echoed by non-dental professionals (a diabetes nurse reinforcing brushing; a smoking quitline noting oral benefits), amplifies their reach.¹²¹

3.4 | Population-level prevention strategies

Many of the largest gains in oral health have come from population-level measures that make healthy choices easier and reach people regardless of their contact with dental services.

3.4.1 | Fluoride at population scale

Community water fluoridation (to around 0.7ppm) reduces caries across all ages and narrows inequalities, with strong cost-effectiveness; where water fluoridation is not adopted, fluoridated salt schemes confer community-wide protection; the evidence for milk fluoridation is more limited and largely confined to targeted school settings.¹²² Affordable, widely available fluoride toothpaste is itself a key population measure, especially in the many European countries that have no water or salt fluoridation.

3.4.2 | Fiscal and regulatory measures on sugar

Sugar-sweetened beverage (SSB) taxes reduce consumption and drive reformulation. The UK Soft Drinks Industry Levy (2018) prompted widespread reformulation and was followed by reductions in childhood obesity and an approximately 12% fall in child tooth-extraction hospital admissions, with the largest gains in the most deprived groups; Mexico's 2014 SSB tax produced a measurable fall in SSB purchases.^{123–125} More than 50 countries now levy some form of SSB tax. Complementary measures include marketing restrictions (especially to children), front-of-pack labeling, reformulation targets and school food standards.

3.4.3 | Community and life-course programs

School- and community-based screening, sealant and fluoride-varnish programs are cost-effective preventive services. Scotland's Childsmile (supervised nursery toothbrushing, free toothpaste/brush distribution in deprived areas and twice-yearly varnish) is associated with a substantial decline in 5-year-old caries and a narrowing of the deprivation gap, and is examined further as a collaboration exemplar in Chapters 5–6.¹²⁶ Care-home oral-care programs (e.g., the UK Mouth Care Matters initiative; see Chapter 6) can reduce aspiration pneumonia and improve quality of life in dependent older adults.

3.4.4 | Financing, coverage and surveillance

Integrating essential oral care into universal health coverage, and shifting reimbursement away from pure fee-for-service toward models that reward prevention (e.g., capitation pilots), increase preventive uptake. Embedding oral health in NCD surveillance allows interventions to be targeted and evaluated. Economic analyses consistently show high returns on preventive investment.¹¹⁵ A *Health in All Policies* approach, linking oral health to cancer, diabetes and cardiovascular plans, and to food and fiscal policy, maximizes these co-benefits.

3.5 | Equity, workforce and interdisciplinary delivery

Oral diseases follow a steep social gradient: deprived children experience two-to-three times more caries, and disadvantaged adults more tooth loss, driven by reduced access, higher risk-factor exposure, and lower health literacy.¹²⁷ Equity-oriented prevention therefore prioritizes resources for those in greatest need: targeted school and outreach programs, culturally appropriate and multilingual materials and financial protection through public coverage. Following the principle of proportionate universalism, these measures should be universal but delivered with an intensity proportionate to need, so that they narrow rather than widen existing inequalities.

Delivering prevention at scale requires reorienting the workforce from a treatment-focused to a prevention-focused model: embedding public health, behavior-change, and interprofessional learning in dental and medical education; expanding the role of hygienists, therapists and mid-level providers; and integrating oral health into medical, maternal and community settings (with appropriate task-sharing and quality assurance). Integration should focus on equipping non-dental professionals to identify risk, deliver consistent preventive messages, and refer appropriately, rather than extending dental diagnostic responsibilities beyond their scope of practice. Aligning incentives, by directing resources to prevention and embedding oral health in chronic-disease care pathways, is essential to make this durable. The barriers to, and facilitators of, this interdisciplinary delivery are the subject of Chapter 5, and the concrete recommendations follow in Chapter 6.

4 | SECONDARY PREVENTION AND DISEASE MANAGEMENT

4.1 | What secondary prevention means here

Secondary prevention covers the early detection and effective management of established oral diseases (periodontitis, dental caries, odontogenic infection, oral mucosal lesions, and oral cancer) together with the integration of oral health into the care pathways of patients with chronic systemic disease. Systematic reviews and randomized trials indicate that treating these conditions can improve glycemic control (a mean HbA1c reduction of around 0.4%), cardiovascular

risk biomarkers (CRP, IL-6, and fibrinogen), endothelial function and respiratory outcomes (reduced ventilator-associated pneumonia), with the mechanistic basis set out in Chapter 2.^{14,15,128,129}

4.2 | Screening and early detection across care settings

Opportunistic screening in medical, nursing and primary care should rely on a small set of brief, standardized tools that are quick, low-cost, and feasible for non-dental professionals. A pragmatic minimum package comprises: (i) a brief structured oral-health history (bleeding gums, tooth mobility, pain, halitosis, and dental attendance); (ii) a simple visual inspection for inflammation and obvious mucosal or tongue lesions; (iii) clearly defined referral triggers (persistent gingival bleeding, suspected periodontitis, or a non-healing ulcer/patch persisting beyond 3 weeks); and (iv) reinforcement of the elements of oral self-care for which the patient is responsible (Chapter 3). In secondary and tertiary care (diabetes, cardiometabolic, respiratory, and oncology clinics), the same package can be embedded into routine outpatient review via a short checklist linked to clear referral pathways (Table 3). Screening can also run in the other direction: because many adults attend dental care regularly, dental settings offer an opportunity for opportunistic risk assessment of systemic conditions, for example, diabetes (chairside HbA1c testing or validated risk questionnaires), with onward referral to medical care.⁷⁹

Adjunctive aids such as toluidine blue and autofluorescence devices may assist but do not replace clinical examination and biopsy, and have no proven mortality benefit; high-risk patients can also be taught mouth self-examination. Universal screening for oral cancer is not currently justified by the evidence, so effort should be targeted at high-risk groups.

4.3 | Evidence that treating oral diseases improves systemic outcomes

4.3.1 | Periodontal therapy and systemic inflammation

The strongest interventional evidence concerns non-surgical periodontal therapy (NSPT: scaling and root planing with biofilm control). By reducing local microbial burden and inflammation, NSPT lowers circulating inflammatory markers (CRP and IL-6) and improves endothelial function, supporting biological plausibility for systemic benefit. Comparative data on surgical versus non-surgical approaches are limited, and most systemic-outcome evidence derives from NSPT combined with maintenance care; benefit attenuates if periodontal inflammation recurs.¹²⁸ Periodontitis is not only *linked* to systemic disease but is *treatable*: the EFP S3-level guidelines are internationally accepted, evidence-based guidelines on how to prevent and treat periodontal diseases, covering the treatment of stage I–III and stage IV periodontitis.^{12,130}

TABLE 3 Core elements of an opportunistic oral-health screening package for non-dental settings.

Element	Content
Risk assessment	Brief questions on tobacco/alcohol use, high sugar intake, poor hygiene, previous oral diseases, diabetes, and low SES to flag caries/periodontitis/oral-cancer risk
Symptom enquiry	Tooth pain or sensitivity, bleeding gums, halitosis, loose teeth, non-healing ulcers, red/white patches, dysphagia
Visual-tactile inspection	Lips, buccal mucosa, tongue (dorsal/ventral/lateral), floor of mouth, palate, gingivae and teeth under good light; palpate suspicious areas, and neck nodes
Periodontal/caries signs	Gingival redness, swelling, bleeding, recession, plaque/calculus, mobility; visible cavitated or darkened lesions, white-spot demineralization
Oral-cancer red flags	Leukoplakia, erythroplakia, non-healing ulcers, indurated, or exophytic lesions, especially in tobacco/alcohol users; refer lesions persisting >3 weeks
Referral and roles	Defined criteria and protocols linking nurses, physicians, pharmacists and dentists, with feedback to the referring team

4.3.2 | Glycemic control in diabetes

Randomized trials and meta-analyses show that treating periodontitis in people with diabetes reduces HbA1c by approximately 0.3%–0.4% within 3–6 months, a modest but clinically relevant effect, comparable to adding a second-line glucose-lowering agent and greatest in those with poor baseline control. Improvements up to 12 months depend on effective periodontal maintenance.³⁹ Joint EFP/IDF guidance translates this evidence into practice for the co-management of periodontitis and diabetes.¹⁶ Responses do not clearly differ by diabetes treatment modality (insulin vs. oral agents).

4.3.3 | Cardiovascular risk markers

Treatment of periodontitis reduces systemic inflammatory biomarkers relevant to cardiovascular risk (CRP, IL-6, and fibrinogen) and markers of endothelial dysfunction, with modest effects on blood pressure and selected lipids in some populations. Functional studies show improved flow-mediated dilation after effective therapy, and longer-term evidence suggests slower progression of subclinical atherosclerosis (e.g., carotid intima-media thickness). Evidence that periodontal therapy reduces major cardiovascular events (myocardial infarction, stroke, or cardiovascular death) remains insufficient, primarily because adequately powered, long-term, event-driven randomized trials have not yet been performed.¹²⁸

4.3.4 | Respiratory complications

In high-risk inpatient settings, oral antiseptic care reduces ventilator-associated and post-operative pneumonia. A systematic review and meta-analysis of 2265 patients undergoing elective cardiac surgery found post-operative pneumonia in 5.3% of those receiving

perioperative oral antiseptic versus 10.4% of controls (RR 0.52, 95% CI 0.39–0.71), with nosocomial infection also reduced (20.2% vs. 31.3%; RR 0.65).¹³¹

4.3.5 | Self-performed oral hygiene

Daily plaque control and interdental cleaning sustain periodontal stability after professional therapy and may underpin the durability of systemic benefits. A long-term analysis of the ARIC cohort reported that regular flossing was associated with a lower long-term risk of ischemic stroke, driven mainly by the cardioembolic subtype, and with less atrial fibrillation.¹³² For high-risk multimorbid patients, simplified self-care bundles, and recall should be built into chronic-disease self-management rather than treated as “dental advice” alone.

4.3.6 | Other oral conditions

Evidence for odontogenic infections and oral mucosal lesions is more limited: drainage or extraction achieves rapid resolution of acute odontogenic infection, while management of oral mucosal disease mainly improves tolerance of systemic therapy rather than altering the chronic-disease trajectory.

4.4 | Infective endocarditis

Infective endocarditis (IE) is a distinct case: an acute, life-threatening condition for which poor oral health and periodontal diseases are recognized risk factors, and through which a patient can deteriorate from well to critically ill within 1–2 weeks. European and American guidelines address antibiotic prophylaxis for at-risk patients.¹³³

4.5 | Integrating oral health into chronic-disease care pathways

Oral-health assessment should be integrated into existing chronic-disease review points in a proportionate, risk-based way, rather than as a parallel screening program. Natural integration points include annual diabetes reviews and complication clinics; cardiovascular risk and cardiac rehabilitation; COPD reviews (especially for older or institutionalized patients); rheumatoid arthritis follow-up; and cancer care (pre-treatment assessment and survivorship). The aim is not to replicate a comprehensive dental examination but to identify patients at risk, trigger timely referral and establish *bidirectional* communication: a trigger→referral→treatment→feedback loop rather than a one-way referral, with concise standardized feedback to the medical team (diagnosis, treatment delivered, stability, and recall interval). Delivery falls to GPs, nurses, pharmacists and specialist-clinic staff after brief targeted training, supported by decision aids and referral templates. Condition-specific emphases include patients with poor glycemic control, polypharmacy or long gaps in dental attendance (diabetes); high inflammatory burden or progressive vascular disease (cardiovascular); and pre-therapy clearance plus survivorship problems such as xerostomia and mucosal disease (cancer). This approach is particularly relevant for people living with multiple long-term conditions, where coordinated management across disciplines has the potential to improve patient-centered outcomes and healthcare efficiency.

4.6 | Referral pathways and communication structures

Timely management depends less on informal professional networks than on accountability, shared information systems and commissioning or reimbursement structures that support collaboration. Medical providers should initiate referrals using standardized protocols, such as the Oral Health Delivery Framework (Ask–Look–Decide–Act–Review) or warm hand-offs with direct scheduling, while dentists reciprocate by flagging systemic risks (e.g., uncontrolled HbA1c delaying healing) through shared care plans, with tiered escalation including urgent fast-tracks (the two-week-wait pathway for suspected oral cancer).^{134,135} The WHO Global Oral Health Action Plan (Action 62) recommends optimizing public-sector staffing and skill mix alongside referral mechanisms that engage private providers.

Mature models illustrate what works: the UK 2-week-wait oral-cancer referral system (standardized criteria, protected timelines, and feedback loops); NHS England commissioning standards for dental care in people with diabetes; integrated systems such as Kaiser Permanente that use shared electronic health records for oral-medical collaboration at scale; Nordic public models integrating dental services within primary care for high-risk groups; and pilots such as Colorado's FQHC diabetes–periodontitis bidirectional referrals.^{136,137} Persistent obstacles (incompatible EHR systems,

low referral completion, inadequate reimbursement, and workforce shortages) explain why a single universal best-practice model is hard to harmonize across health systems with different funding and insurance structures.

4.7 | The economic case

Oral diseases generate an estimated US\$710billion per year, comprising about US\$387billion in direct treatment costs and US\$323billion in productivity losses in 2019, unevenly distributed across world regions (Table 4). This burden underpins the WHO argument to integrate essential oral care into universal health coverage and NCD platforms.^{138,139} Spending is also strikingly inequitable: per-capita dental expenditure ranges from around US\$0.50 in low-income countries to US\$260 in high-income countries, a roughly 500-fold difference.¹³⁹ There is also emerging evidence that providing oral health care yields substantial cost-benefit rewards by reducing the costs of various systemic-disease outcomes.^{140–142}

Integrating oral-health management, particularly periodontal assessment and treatment, into chronic-disease pathways has a credible economic rationale, strongest for type 2 diabetes and in high-risk or frail populations where complications and hospital use concentrate. Model-based cost–utility analyses suggest that treating periodontitis in people with diabetes can be cost-effective at conventional willingness-to-pay thresholds when glycemic benefits are maintained, and claims-based studies report lower healthcare utilization and costs, with reported US savings of roughly US\$548–675 per person per year in heart-disease patients and US\$900–2840 in patients with diabetes.^{143–146}

Important caveats remain: few trials track glycemic benefits or events beyond 12months, so models rely on surrogate-to-event extrapolation; direct evidence for reduced major clinical events is limited; most data come from high-income countries and need adaptation for other settings; and observational cost savings may be

TABLE 4 Economic impact of oral conditions by WHO region in 2019: Direct treatment costs and indirect productivity losses (US\$ billion).

WHO region	Direct costs (US\$ bn)	Productivity losses (US\$ bn)
Americas	156.8	105.6
European	112.5	104.5
Western Pacific	107.0	85.1
Eastern Mediterranean	7.0	9.6
South-East Asia	0.8	13.4
African	3.1	4.6
Global	387.1	322.7

Note: Higher-income regions account for most direct spending, whereas productivity losses weigh proportionally more heavily in lower-income regions. Data from Jevdjevic and Listl (2019 estimates).

inflated by selection bias, since regular dental attenders differ systematically from non-attenders.

5 | BARRIERS TO INTERDISCIPLINARY COLLABORATION

5.1 | Interprofessional collaboration and why it is hard

The WHO defines interprofessional collaboration (IPC) as a process in which “multiple health workers from different professional backgrounds work together with patients, families, carers and communities to deliver the highest quality of care.” In this paper, we use IPC for cases where different professionals, oral-health professionals (dentists, hygienists) together with physicians, nurses, pharmacists, social workers, and others, work directly as a team, deciding with the patient what care best suits their needs.^{147,148} More broadly, throughout this paper we use *interdisciplinary* for the overall agenda of integrating oral and general health across disciplines and sectors, *interprofessional collaboration* for its operational mechanism (professionals from different fields working together in practice), and *intersectoral* for action spanning sectors such as health, education and social care (See the glossary, Box 2, for the distinction between multi-, inter-, and trans-disciplinary work).

An overview of reviews identifies barriers (and matching facilitators) at four levels.¹⁴⁹ At the *personal* level, mutual understanding, trust, respect, and small hierarchical distances ease the delegation and sharing of tasks. At the *interpersonal* level, frequent personal communication and access to joint patient records are key, as is clarity about each profession's competencies, roles, and responsibilities.¹⁵⁰⁻¹⁵² At the *organizational* level, professionals must be enabled to dedicate time to teamwork and to work to their full scope of practice, with organizational support, appropriate remuneration and their expertise acknowledged on a par with physicians. At the *system* level, political leadership, enabling legal, and financial regulation of task-shifting and digital coordination tools (shared records,

teleconsultation, and interdisciplinary dashboards) make each profession's contribution visible and continuity of care possible.^{150,153}

5.2 | Barriers specific to oral health

Within oral health, these general barriers take concrete forms, summarized in Table 5. The recurring theme is structural separation: dental and medical services are funded, recorded, governed and taught apart, so that even motivated professionals lack the mechanisms to collaborate.

5.3 | Education, curricula, and awareness gaps

Insufficient oral-health knowledge among non-dental professionals (healthcare staff, social-care workers, educators, and unpaid carers) leads to the systematic under-recognition of oral health as part of general health, disproportionately affecting young children, medically compromised individuals, and dependent older adults. The absence of oral health from undergraduate, postgraduate, and mandatory training frameworks de-prioritizes it in practice: the UK Care Certificate, for example, comprises 14 mandatory standards, none of which explicitly addresses oral health despite its relevance to nutrition, dignity, and infection prevention.^{155,156} Terminology compounds the problem: “dental health” locates responsibility within dentistry, whereas “oral health” better reflects a whole-person model and reinforces shared responsibility across the health and care workforce. A scoping review in diabetes care illustrates the downstream consequences, identifying limited human resources, weak administrative infrastructure, non-interoperable records and too few trained professionals as obstacles to embedding oral health in care pathways.¹⁵⁷

Awareness also varies markedly by disease. Periodontal disease enjoys relatively higher recognition because of its known bidirectional links with diabetes and cardiovascular disease, yet non-dental providers often cannot identify clinical signs or perform a visual screen. Dental caries attracts the *lowest* awareness, being perceived as a

TABLE 5 Barriers to interprofessional collaboration in oral health, by level.^{9,154,155}

Level	Barriers
System	Separate dental/medical funding streams; oral health absent from integrated clinical pathways; no unified grant-funding for medical-dental integration; no shared interprofessional guidelines; limited political support; absence of oral health from curricula and mandatory training
Organizational	Fragmented, non-interoperable dental and medical records; no protected time or remuneration for collaboration; no oral-health professionals embedded within integrated care teams
Interpersonal	No direct communication or referral routes between dental and other professionals; differing professional “languages”; little personal contact; unclear roles; and responsibilities
Individual	Low awareness of the importance of oral health among other professionals; limited knowledge; or skills to recognize oral-health problems

"dental-only," non-systemic condition. Oral cancer is comparatively well recognized in principle, but early mucosal signs are poorly identified and role clarity for screening in primary care is lacking.^{15,158–160}

5.4 | Facilitators and successful models

The same four-level analysis points to the facilitators. In education, the priorities are to embed oral health across the undergraduate, postgraduate and CPD continuum (tailored to role and setting); to create genuine interprofessional learning that links oral health to shared outcomes such as nutrition, infection prevention and chronic-disease management; to include oral health within *mandatory* frameworks (care certificates, induction, revalidation) so it is core rather than optional; to align curricula with condition-based pathways (frailty, diabetes, cardiovascular disease, dementia, end-of-life care); and to adopt consistent "oral health" terminology.^{161–163}

Proven service models show that IPC in oral health is achievable when backed by accountability and shared systems rather than informal goodwill: Scotland's Childsmile (a national program delivering preventive oral health through healthcare and education sectors) and the UK Mouth Care Matters initiative (training non-dental hospital staff to deliver mouth care) are the clearest examples, both introduced in Section 3.4, alongside frameworks for integrating oral health into primary care.^{154,164,165} These examples recur, with concrete recommendations, in Chapter 6.

6 | RECOMMENDATIONS FOR INTERDISCIPLINARY ACTION

Building on the evidence and barriers set out above, this chapter offers concrete recommendations across six domains. Their unifying premise is that oral health should be recognized as an integral part of general health and that no single sector can deliver it alone. Improvement requires multi-sectoral action across health, social care, education, and civil society, making oral health everybody's business (Figure 1).

6.1 | Policy and health-system reform

Governments and public institutions should embed oral health within national primary-care and NCD policy and within universal health coverage, in line with the WHO Global Oral Health Action Plan 2023–2030.⁹ Because oral diseases are shaped by the same social, commercial and planetary (environmental) determinants as other NCDs, this means acting on those determinants, including the commercial drivers of tobacco, alcohol and high-sugar food and drinks, and pooling budgets across sectors to avoid duplication and clinical silos.^{2,166} Oral health should be treated as a human right and an integral component of general health, integrated into policies on breastfeeding, healthy child programs, healthy aging,

NCD prevention and the management of multiple long-term conditions, with shared cross-sector governance and dedicated funding. Specific fiscal and regulatory measures (sugar-sweetened beverage taxation, tobacco and alcohol control, and tax relief on oral-hygiene products) are detailed in Section 3.4.

6.2 | Clinical practice integration

Health systems should standardize oral-health assessment, enable integrated records and bidirectional referral, and reward prevention. Practically, this means: incorporating a brief oral-health assessment into general health assessments in primary care (child and maternal programs, adult health checks, NCD management); adding an oral-health screening item to hospital admission templates, with daily mouth-care plans for at-risk inpatients (maternity, pediatrics, diabetes, geriatric, stroke, ICU, oncology, and long-stay wards); and requiring care homes to have oral-health policies, on-admission assessment, personalized mouth-care plans, trained staff, and access to dental services.¹⁶⁷ The screening tools, referral pathways, and workforce/task-sharing models that make this work are set out in Chapter 4; the goal is reorienting services from treatment toward prevention through integrated, multidisciplinary, and bidirectional care.

Building on the evidence in Chapter 2 (Box 1), two clinical priorities should be made explicit: (i) prioritize effective self-performed oral hygiene with fluoride toothpaste and interdental cleaning as the first-line, population-wide intervention for gingivitis, and periodontitis prevention, supported where appropriate by guideline-recommended technologies such as oscillating-rotating powered brushes and stannous fluoride dentifrice; and (ii) deliver periodontal treatment in accordance with the EFP S3-level clinical practice guidelines, and co-manage periodontitis with diabetes per EFP/IDF guidance.^{12,13,16,130}

6.3 | Education and training

Education is decisive and is addressed in detail in Chapter 5: embed oral health across undergraduate, postgraduate and continuing education for all health and social-care professions; make it part of *mandatory* training; and build genuine interprofessional education so that learning shifts "from silos to teams." Curricula should equip all professionals to perform a basic oral-health risk assessment, give brief preventive advice and refer appropriately, and should incorporate competencies in public health, prevention and health inequalities in line with the Association for Dental Education in Europe (ADEE) Graduating European Dentist framework and the Marmot principle that health professionals have a role in reducing inequalities.^{168,169} Periodontology offers a worked example of modern, outcome-based curriculum design. Through its education workshop, the EFP has defined the domains, competences, and learning outcomes for undergraduate periodontal education across

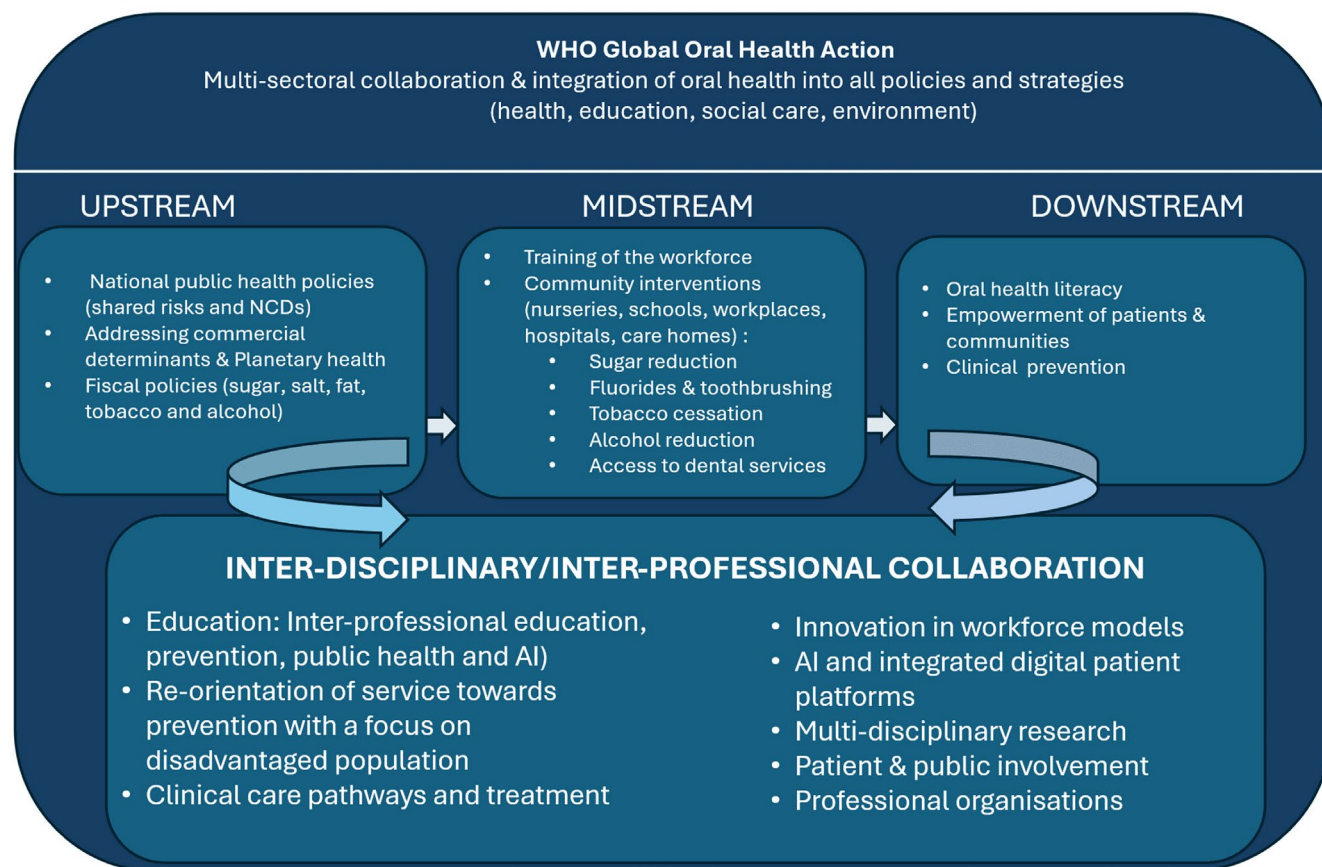


FIGURE 1 Integrating oral health into general health across upstream (policy and population), midstream (community and settings), and downstream (individual and clinical) levels, within the WHO Global Oral Health Action framework of multi-sectoral collaboration and action on the social, commercial and planetary determinants of health, and underpinned by interdisciplinary and interprofessional collaboration. Adapted from Watt & Sheiham (2000) and Fisher et al. (2024). Source: EADPH (H. Yusuf).

four domains (professionalism; safe and effective clinical practice; patient-centered care; and dentistry in society) together with contemporary teaching and assessment methods. Because its “dentistry in society” domain explicitly locates oral health within general health, prevention and the social determinants, this framework is a transferable template for embedding oral health across the wider health-professions curriculum.¹⁷⁰⁻¹⁷⁴ Beyond professional education, raising oral-health literacy in the public, through schools and community health promotion, supports informed self-care and demand for prevention.

6.4 | Public health strategies

A continuum of upstream, midstream, and downstream action is required, no single measure sufficing: fiscal and regulatory measures on sugar, tobacco, and alcohol (aligned with the WHO Framework Convention on Tobacco Control and the Global Alcohol Action Plan); community-based programs in education, workplaces, and care settings that also train the wider workforce; and individual oral-health literacy, patient empowerment, and consistent preventive advice. The underpinning evidence and exemplar programs (Childsmile, Mouth Care Matters) are presented in Chapter 3 (Section 3.4), and

Table 6 maps this integrated, common risk factor approach, with periodontal and caries prevention and care as its clinical contributors, onto the three levels of action. Because many drivers of oral and systemic NCDs lie outside the health sector, effective strategies also require governance that aligns trade, fiscal, education, and urban-planning policies with health goals and manages conflicts of interest with commercial actors whose products drive disease.

6.5 | Patient and public engagement

Patients and the public are key stakeholders in planning, delivery and evaluation. Involving lived experience improves the effectiveness and quality of care and supports behavior change and health literacy.¹⁷⁵ Engagement must be designed for equity, diversity, and inclusion, with particular attention to marginalized and disadvantaged communities, so that participation reduces rather than widens disparities.

6.6 | Research priorities

Priority areas to strengthen the evidence base for oral-systemic interventions are:

TABLE 6 Integrating oral health into general health: The common risk factor approach, with periodontal and caries prevention and care as its clinical contributors, across the three levels of public-health action.

Level of action	Common risk factor approach (oral+systemic)	Periodontal and caries prevention and care (clinical contributors)
Upstream (policy/population)	Fiscal and regulatory measures on sugar, tobacco and alcohol; food labeling; action on social and commercial determinants; water/salt fluoridation	Oral and periodontal care embedded in NCD policy and universal health coverage
Midstream (community/settings)	School, workplace and care-setting programs; training the wider workforce; community health promotion	Community periodontal and caries screening, supervised toothbrushing in targeted settings, fluoride-varnish and sealant programs and care-home mouth care
Downstream (individual/clinical)	Brief, consistent advice on diet, tobacco, alcohol and oral hygiene; oral-health literacy	Self-performed plaque control, topical fluoride and sealants, and EFP S3 periodontal therapy with maintenance

- *Life-course and vulnerable populations*: oral–systemic interactions across the life course, focused on high-risk and underserved groups.
- *Causal mechanisms and biological pathways*: mechanistic studies integrating microbiology, immunology, inflammation and host-microbiome interactions (Chapter 2).
- *High-quality intervention trials*: well-powered, multicentre RCTs testing whether prevention or treatment of oral diseases improves clinically meaningful systemic and patient-centered outcomes.
- *Standardized and core outcome sets*: harmonized clinical, biological and patient-reported measures to enable comparison.
- *Implementation and health-systems research*: real-world effectiveness, cost-effectiveness, equity and sustainability of integrated care models.
- *Digital health and AI*: AI-driven risk prediction and interoperable information systems for early detection and coordinated care.

6.7 | Digital integration and artificial intelligence

Interoperable electronic records should link dental, medical and social-care data to enable coordinated, multidisciplinary care, while AI and teledentistry can support earlier detection, risk prediction and access in underserved areas. These tools are enablers, not replacements: AI is susceptible to error and lacks clinical judgment and empathy, so human oversight, patient context and clear governance and accountability are essential.¹⁷⁶

6.8 | The role of professional organizations

Professional organizations (EFP, EADPH and partners such as the European Forum for Primary Care (EFPC), the European Public Health Association (EUPHA), ADEE, the International Association for Dental Research (IADR), WHO, the EU Platform for Better Oral Health, WONCA, and the WHF) have a central role in driving interdisciplinary action. They can provide leadership and advocacy to integrate oral health into the NCD and UHC agendas; develop joint

guidelines and consensus statements; convene clinicians, researchers and policymakers across disciplines and countries; and broker multi-sectoral partnerships that address the social and commercial determinants of oral health. The EFP's existing joint consensus reports with the WHF, WONCA Europe, and IDF provide a strong template to build on: future work should extend this model of formal collaboration with organized medicine to further specialties and to public-health bodies.^{14–16}

7 | CONCLUSION

7.1 | Key messages

Seven messages summarize this white paper:

1. Oral diseases are extraordinarily common and their impact on general health, quality of life and the economy is consistently underestimated.
2. Oral diseases and the major NCDs are multifactorial and share modifiable risk factors and social and commercial determinants; integrating oral health into general health through a common risk factor approach, across upstream, midstream and downstream levels, improves both, without silos (Box 1).
3. Within this shared approach, periodontitis has the strongest evidence for systemic interactions; it is preventable and treatable, and, unusually among oral diseases, its treatment improves a systemic outcome, glycemic control in diabetes (with inflammatory and vascular surrogate markers), although evidence for a reduction in major clinical events remains limited. It is therefore a central clinical contributor; other oral-systemic links, and dental caries, enter chiefly via shared risk factors, plausible mechanisms, and the sequelae of untreated disease.
4. Effective self-performed oral hygiene, a personal preventive behavior, is the practical link between population-level prevention and clinical periodontal care.

5. Delivering this depends on interprofessional and intersectoral collaboration: oral health must become a shared responsibility across sectors.
6. Progress requires a continuum of upstream, midstream and downstream interventions across population, community, and individual levels, rather than any single measure.
7. Progress should be judged not only by average gains in oral and systemic health but by reductions in avoidable inequalities between socio-economic groups, life stages, and vulnerable populations.

7.2 | A call to action

We therefore call to action all who shape oral and general health: health professionals, dental and non-dental alike; the social-care and education workforce, including care-home staff, teachers and unpaid carers; policymakers, public-health authorities and health-system administrators; and patients, advocacy groups and the public. We ask them to act on five fronts:

- *Recognize oral health as a public-health priority*, on the basis of its prevalence, impact on quality of life and health inequalities, and its links to systemic health, which are strongest and interventionally supported for periodontitis and diabetes.
- *Apply what works*: effective, evidence-based means to prevent, manage and rehabilitate oral diseases already exist, and must reach everyone, including the most vulnerable.
- *Educate and train*: embed oral health, prevention and interprofessional collaboration in the curricula and continuing education of all health and social-care professions.
- *Commit politically*: move to concrete implementation, interdisciplinary, interprofessional and intersectoral, that addresses the social, environmental, and commercial determinants of health.
- *Research and evaluate*: learn from previous experience, pursue innovative solutions, and adopt monitoring that is meaningful for patients and public health.

7.3 | Priorities: Immediate, medium and long term

- *Immediate*: ensure oral health is explicitly named in NCD prevention plans and in EU and national health policies.
- *Medium term*: establish competency-based interprofessional education (building on the ADEE Graduating European Dentist framework) to build mutual understanding and collaboration within and beyond the dental office.
- *Long term*: embed integrated oral-systemic care within universal health coverage, sustained by interoperable health information systems, aligned financing, and routine surveillance.

7.4 | Measuring progress and closing the implementation gap

Progress should be tracked with indicators that are easy to measure, permit regular monitoring, and are understandable to policymakers. Yet strong preventive evidence often fails to reach practice, owing to fragmented health systems, a treatment-dominated model of dental care and too little focus on upstream prevention. Implementation research, still underdeveloped in oral health, is essential to bridge this gap by studying how interventions are adopted, delivered with fidelity and sustained in real-world settings, and should be built in from the outset rather than added as an afterthought.¹⁷⁷

Table 7 sets out the three complementary levels of action, policy/population-level, primary prevention, and secondary prevention, that this paper argues must operate together.

7.5 | Looking ahead

This white paper is intended as a foundation, not an endpoint. It continues a deliberate sequence of strategic EFP and EADPH initiatives, including the joint EFP consensus reports with the World Heart Federation, WONCA Europe, and the International Diabetes Federation,^{14–16} and should connect directly to subsequent

TABLE 7 Three complementary levels of action against oral-systemic disease: Policy/population-level action, primary prevention, and secondary prevention.

Policy/population level (Chapter 6)	Primary prevention (Chapter 3)	Secondary prevention and management (Chapter 4)
Whole populations, systems and the determinants of health	Healthy individuals and communities	People with existing oral or systemic disease
Create the conditions that make healthy choices easier	Prevent disease onset	Detect early, treat and integrate care
Fiscal and regulatory measures (sugar, tobacco, alcohol), water/salt fluoridation, marketing and labeling rules, and oral health embedded in NCD and universal health coverage policy	Risk-factor modification and oral hygiene; health promotion and education	Screening and referral pathways; clinical management and care coordination for comorbid patients
Cross-sector governance; oral health mandated in curricula and workforce planning	Training non-dental professionals to advise	Training non-dental professionals to screen, refer and support care

Note: This paper argues that all three must operate together.

initiatives: a Phase 2 educational campaign, the development of clinical practice guidelines, and alignment with the WHO Global Oral Health Action Plan and national UHC and NCD prevention plans, so that the case for interdisciplinary action becomes sustained, measurable practice. Above all, it sets out what should now be done, and by whom, to translate evidence into sustainable, interdisciplinary oral-systemic care.

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