Interdisciplinary Strategies for Integrating Oral Health in National Immune and Inflammatory Disease Control Programs

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Abstract: Oral health has long been siloed from systemic disease management, despite robust evidence linking periodontal conditions to a wide range of chronic, immune, and inflammatory diseases such as diabetes, cardiovascular disorders, and rheumatoid arthritis. This paper proposes a comprehensive interdisciplinary framework for integrating oral health into national immune and inflammatory disease control programs. Starting from a global health perspective, the study outlines the burden of oral-systemic interactions and the consequences of neglecting dental care in public health strategies. As chronic inflammation and immune dysregulation underpin a multitude of systemic diseases, early detection and management of oral inflammation present a significant opportunity to enhance national disease prevention efforts. Drawing from epidemiological evidence, implementation science, and comparative health policy models, the paper presents a systems-based approach that aligns dental care with chronic disease surveillance, prevention, and care delivery. It advocates for the incorporation of oral health screenings in primary care settings, the development of integrated electronic health records linking dental and medical data, and the training of allied health professionals in oral-systemic care principles. Furthermore, the paper highlights successful models from Scandinavian, Canadian, and select sub-Saharan African health systems that demonstrate scalable pathways for interdisciplinary collaboration. The proposed framework emphasizes policy reforms to facilitate reimbursement structures, interdisciplinary referral systems, and health promotion campaigns targeting both professionals and the public. Ultimately, this research calls for the institutionalization of oral health within national public health agendas—particularly those addressing immune and inflammatory diseases—to achieve holistic, equitable, and sustainable health outcomes across populations.

Keywords: Oral-Systemic Health; Interdisciplinary Care; Chronic Inflammatory Disease; Public Health Policy; Immune Disease Control; Dental Integration Models

1. INTRODUCTION

1.1 Background: Oral-Systemic Health Nexus

The interconnection between oral health and systemic health has gained increasing attention in medical and public health research. Historically, the mouth was viewed as separate from the rest of the body in healthcare planning and policy, but growing evidence now reveals that poor oral health can exacerbate or contribute to systemic diseases, especially those involving immune and inflammatory responses [1]. Periodontal disease, a chronic inflammatory condition affecting the supporting structures of the teeth, has been linked to cardiovascular disease, diabetes, rheumatoid arthritis, and adverse pregnancy outcomes [2].

At the biological level, the oral cavity acts as a portal for pathogenic bacteria and pro-inflammatory mediators, which can enter systemic circulation and contribute to chronic low-grade inflammation [3]. This mechanism is particularly concerning in individuals with compromised immune regulation, where systemic inflammation may escalate or trigger disease flares.

Moreover, individuals with systemic diseases often experience impaired immune function that worsens their oral health. For instance, diabetic patients are more susceptible to periodontitis due to hyperglycemia-induced immune dysfunction, which in turn aggravates glycemic control—a two-way relationship that exemplifies the oral-systemic health nexus [4].

The World Health Organization (WHO) and global dental bodies now advocate for a more integrated view of health, one that recognizes the bidirectional influence between the oral cavity and systemic physiology [5]. Understanding this nexus is critical for designing healthcare interventions that address both the symptoms and the underlying systemic links. It also supports a shift from siloed medical care toward more comprehensive, interdisciplinary health promotion strategies aimed at reducing the overall disease burden in populations.

1.2 The Burden of Immune and Inflammatory Diseases

Immune-mediated and inflammatory diseases, including rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, and psoriasis, represent a significant global health burden. These conditions affect hundreds of millions of individuals worldwide and are often

characterized by chronic inflammation, immune dysregulation, and multisystem involvement [6].

The rising incidence of autoimmune disorders is linked to both genetic susceptibility and environmental triggers, including microbiome imbalance, lifestyle factors, and socioeconomic stressors. These diseases are typically lifelong, requiring complex management and placing long-term strain on health systems [7]. They are also frequently associated with comorbidities such as cardiovascular disease, infections, and mental health challenges, amplifying both clinical and economic burdens.

Importantly, oral health complications are common yet under-addressed in this population. Studies have shown that individuals with immune-mediated diseases are more likely to experience periodontal disease, xerostomia (dry mouth), oral ulcers, and increased susceptibility to infections [8]. These oral manifestations can serve as early indicators or exacerbating factors of systemic illness.

Furthermore, chronic inflammation in periodontal tissues may contribute to systemic disease progression by releasing cytokines, endotoxins, and bacterial products into circulation [9]. This bidirectional relationship suggests that ignoring oral health in the management of immune disorders may compromise therapeutic outcomes.

Given the shared inflammatory pathways and mutual risk factors, oral health must be considered an integral component of managing immune-mediated diseases. Addressing this link may help reduce disease severity, improve quality of life, and lower the cumulative healthcare cost associated with long-term disease control [10].

1.3 Rationale for Integration of Oral Health into National Programs

Despite growing evidence of its systemic importance, oral health is frequently omitted from national healthcare agendas, particularly in low- and middle-income countries. This gap results in fragmented care, missed opportunities for early diagnosis, and suboptimal outcomes for patients with chronic immune and inflammatory diseases [11]. Integrating oral health into national health programs offers a strategic opportunity to improve population-level outcomes and reduce healthcare disparities.

Primary care settings can serve as effective points of integration. By training general practitioners, nurses, and community health workers to screen for oral conditions and refer patients appropriately, healthcare systems can detect inflammatory markers and disease precursors earlier [12]. Moreover, interdisciplinary approaches can foster collaboration between dental and medical professionals, ensuring a holistic view of patient health and facilitating co-management of diseases with overlapping pathophysiology.

Cost-effectiveness studies have demonstrated that periodontal treatment may reduce medical costs and hospitalization rates in patients with diabetes and cardiovascular disease, reinforcing the economic rationale for integration [13]. Preventive oral care interventions—such as scaling, oral hygiene education, and microbial monitoring—can mitigate systemic inflammation and potentially reduce the severity of immune conditions.

Additionally, national surveillance systems that track oral health alongside chronic diseases can improve epidemiological understanding and guide resource allocation [14]. Public education campaigns, when aligned with systemic health messaging, also offer synergistic opportunities for behavior change. Integration is no longer optional but essential in building resilient, equitable, and preventive health systems [15].
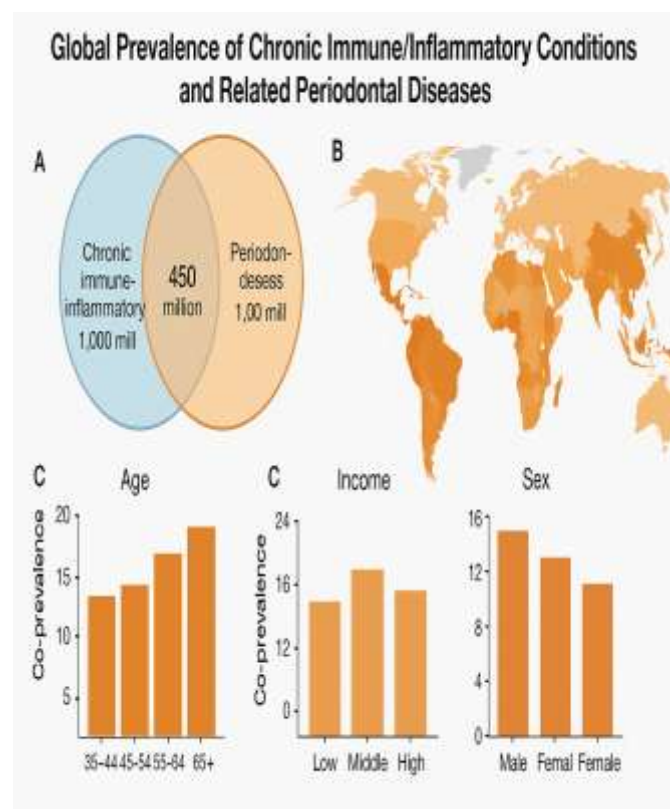

Figure 1: *Global prevalence of chronic immune/inflammatory conditions and related periodontal diseases*

2. SCIENTIFIC EVIDENCE LINKING ORAL HEALTH WITH IMMUNE AND INFLAMMATORY DISEASES

2.1 Biological Pathways: From Periodontal Inflammation to Systemic Disease

Periodontitis, a chronic inflammatory condition affecting the gingival and periodontal tissues, has been increasingly recognized as a contributor to systemic disease through several biological mechanisms. The primary pathway involves the translocation of oral pathogens and inflammatory mediators into the systemic circulation from the periodontal

pockets, where microbial biofilm triggers a local immune response [6]. These pathogens—particularly *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans*—release endotoxins such as lipopolysaccharides (LPS) that breach epithelial barriers and stimulate systemic inflammation [7].

In response to microbial challenge, periodontal tissues secrete pro-inflammatory cytokines like interleukin-1β (IL-1β), tumor necrosis factor-alpha (TNF-α), and interleukin-6 (IL-6), which can disseminate via the bloodstream and activate systemic inflammatory pathways. These mediators contribute to endothelial dysfunction, insulin resistance, and altered lipid metabolism, laying the foundation for broader pathophysiological effects [8].

Another route involves molecular mimicry, whereby bacterial antigens resemble host proteins, leading to an autoimmune response that exacerbates systemic inflammatory disorders. Additionally, systemic inflammation may be perpetuated by activated macrophages and Th17 cells originating from periodontal tissues, which continue to produce pro-inflammatory cytokines after migrating to distant organs [9].

Persistent periodontal inflammation also disrupts immune regulation, promoting oxidative stress and impairing the resolution of inflammation—a critical component in maintaining systemic homeostasis. Collectively, these mechanisms explain how a localized oral infection can amplify systemic inflammation, affect vascular and metabolic pathways, and contribute to the onset or worsening of chronic diseases. Understanding these biological pathways provides the foundation for therapeutic strategies that target both oral and systemic health in an integrated framework [10].

2.2 Immunological Mechanisms and Oral Microbiome Dysbiosis

The oral cavity is home to a highly diverse microbiome that plays a crucial role in immune homeostasis. Under healthy conditions, commensal bacteria regulate immune tolerance and prevent colonization by pathogens. However, dysbiosis—a shift in microbial composition favoring pathogenic species—can disrupt this balance and initiate chronic inflammation, particularly in periodontal tissues [11].

In dysbiotic states, keystone pathogens like *P. gingivalis* manipulate the host immune response to evade clearance. This bacterium expresses virulence factors such as gingipains, which degrade complement proteins, inhibit neutrophil-mediated clearance, and promote a pro-inflammatory environment conducive to sustained infection [12]. As inflammation escalates, epithelial barriers break down, facilitating the entry of oral bacteria and their antigens into systemic circulation.

Immunologically, the host response to dysbiosis is characterized by a predominance of Th17 and Th1 cells, which secrete IL-17 and interferon-gamma (IFN-γ), driving tissue destruction and systemic immune activation.

Meanwhile, regulatory T cells (Tregs), which normally suppress excessive inflammation, are diminished in both periodontitis and systemic autoimmune conditions, creating an imbalance that favors chronic immune stimulation [13].

Toll-like receptors (TLRs), particularly TLR2 and TLR4, are key players in recognizing pathogen-associated molecular patterns (PAMPs) from oral microbes. Activation of these receptors leads to NF-κB-mediated transcription of pro-inflammatory genes in dendritic cells and macrophages. This results in systemic cytokine release that can exacerbate distant inflammatory conditions such as atherosclerosis and rheumatoid arthritis [14].

Thus, oral microbiome dysbiosis serves not only as a trigger for local periodontal disease but also as a driver of systemic inflammation. Targeting microbial composition and immune modulation presents a promising strategy for controlling both oral and systemic disease burden [15].

2.3 Clinical Correlates: Diabetes, Cardiovascular Disease, Rheumatoid Arthritis, etc.

The association between periodontitis and systemic diseases is supported by a growing body of clinical evidence. Among the most well-documented relationships is the bidirectional link between diabetes mellitus and periodontal disease. Chronic hyperglycemia impairs neutrophil function, collagen synthesis, and wound healing, making diabetic patients more susceptible to severe periodontitis. Conversely, systemic inflammation from periodontal disease increases insulin resistance, complicating glycemic control. Several longitudinal studies have demonstrated that periodontal therapy can reduce HbA1c levels by up to 0.4%, underscoring the metabolic impact of oral inflammation [16].

Cardiovascular disease (CVD) also shows strong associations with periodontitis. The inflammatory cytokines produced during periodontitis—such as IL-6 and CRP—contribute to endothelial dysfunction, a precursor to atherogenesis. Oral bacteria have been detected in atherosclerotic plaques, suggesting a direct microbial invasion in addition to systemic inflammation. Cohort studies indicate that individuals with periodontitis have a 25–50% increased risk of developing CVD, independent of other risk factors [17]. Periodontal treatment has been linked to improved endothelial function and reduced levels of systemic inflammatory markers like CRP and fibrinogen, supporting the cardiovascular benefits of oral care interventions [18].

Rheumatoid arthritis (RA) shares pathogenic mechanisms with periodontitis, including elevated Th17 responses and autoantibody production. *P. gingivalis* has been implicated in citrullination—a key process in RA autoimmunity—through its expression of peptidylarginine deiminase (PAD). This bacterial enzyme can modify host proteins, promoting the generation of anti-citrullinated protein antibodies (ACPAs) in genetically susceptible individuals. Clinical trials have shown that periodontal therapy reduces disease activity scores in RA

patients, suggesting a potential role in adjunctive treatment [19].

Other immune-related conditions such as inflammatory bowel disease, psoriasis, and systemic lupus erythematosus also exhibit higher prevalence of periodontal disease. While causal pathways remain under investigation, shared inflammatory signatures—particularly TNF-α and IL-1β—reinforce the link. Integrating oral assessments into the management of systemic inflammatory diseases can enhance early detection, personalize treatment strategies, and improve overall health outcomes [20].

Table 1: *Summary of clinical studies showing associations between periodontitis and systemic diseases*

| Systemic Disease	Key Clinical Findings	References
Diabetes Mellitus	Periodontal therapy reduces HbA1c by 0.3–0.4% in 3–6 months	[16]
Cardiovascular Disease	25–50% increased risk with periodontitis; oral bacteria found in plaques	[17]
Rheumatoid Arthritis	*P. gingivalis* citrullinates proteins; treatment lowers RA activity	[19]
Inflammatory Bowel Disease	Increased periodontal disease severity in Crohn's and UC patients	[20]
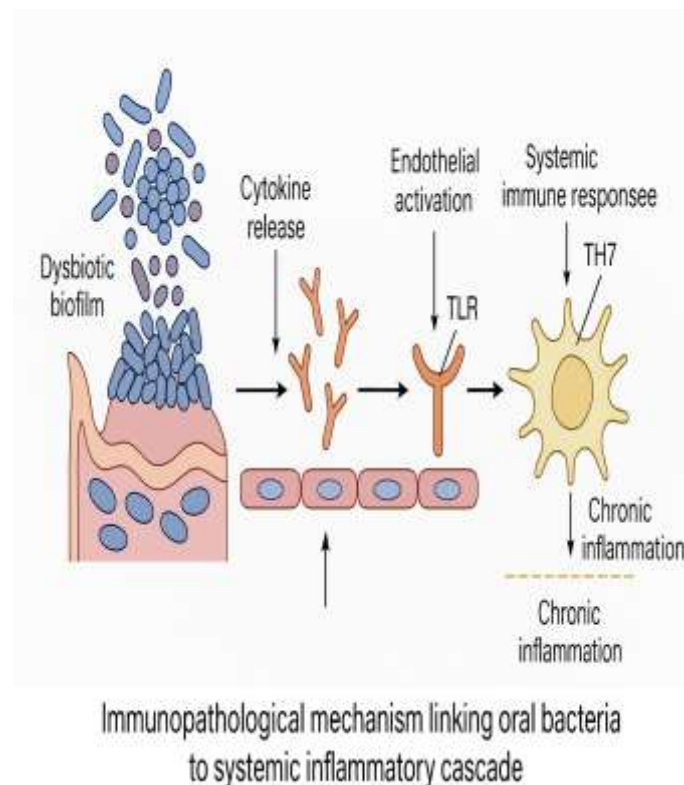
Figure 2: *Immunopathological mechanism linking oral bacteria to systemic inflammatory cascade*

3. CURRENT GAPS IN HEALTH SYSTEMS AND POLICIES

3.1 Fragmentation of Oral and General Health Services

The separation of oral health from general health services remains a critical barrier to achieving universal and equitable healthcare. Historically, dental care has developed as a parallel system, with distinct financing structures, clinical guidelines, and workforce planning, resulting in fragmentation that undermines comprehensive care delivery [11]. This structural divide is evident in many health systems where dental services are excluded from primary care packages or only partially covered under public health insurance schemes, limiting access for low-income and rural populations [12].

The siloed approach to oral health neglects the growing evidence linking oral diseases—such as periodontitis and dental caries—to systemic conditions including cardiovascular disease, diabetes, and adverse pregnancy outcomes [13]. Despite the shared risk factors, most healthcare models fail to integrate dental screening, prevention, or treatment into general health programs, leading to missed opportunities for early intervention and disease control [14].

Moreover, patients are often required to navigate separate facilities, records, and referral systems to access dental services, which contributes to inefficiencies and discontinuity

of care. This disconnected infrastructure disproportionately affects vulnerable groups who may lack the financial or logistical means to engage with multiple providers [15].

Efforts to integrate services, such as colocating dental clinics within primary health centers or training general practitioners in basic oral health screening, remain limited and fragmented themselves. Without systemic reform, the current model perpetuates inequity and fails to harness the preventive potential of oral healthcare as a pillar of overall well-being [16].

3.2 Policy Blind Spots: Lack of Oral Health in NCD and Immune Control Programs

One of the most significant blind spots in global and national health policy is the omission of oral health in noncommunicable disease (NCD) and immune system control programs. While NCD frameworks routinely include diabetes, cardiovascular diseases, cancers, and chronic respiratory illnesses, oral health is rarely given equal priority—despite its epidemiological relevance and shared behavioral risk factors such as tobacco use, poor diet, and alcohol consumption [17].

This oversight is especially problematic given the bi-directional relationship between oral conditions and systemic diseases. Periodontal disease, for example, has been shown to exacerbate glycemic control in diabetic patients and increase systemic inflammation, contributing to cardiovascular risks [18]. Nonetheless, oral screenings, education, or interventions are seldom included in diabetes management protocols or broader NCD guidelines.

Similarly, immune-compromised individuals—such as those living with HIV/AIDS, cancer patients undergoing chemotherapy, or organ transplant recipients—face increased susceptibility to oral infections that can compromise treatment outcomes or overall health. Yet, most immunological health programs lack dedicated oral care pathways, and funding for integrated services remains minimal [19].

The absence of oral health in national strategic plans and global funding mechanisms also reflects a lack of political will and awareness. Unlike other health domains, oral care has limited representation in policy-making bodies, reducing its visibility and resulting in underinvestment [20].

Closing these gaps will require stronger advocacy, updated clinical guidelines, and cross-sectoral health planning that recognizes the oral-systemic health nexus. Without this integration, health systems will continue to fall short of delivering holistic, person-centered care [21].

3.3 Barriers to Interdisciplinary Collaboration in Health Systems

Interdisciplinary collaboration is critical to addressing complex health needs, yet persistent barriers hinder cooperation between oral health professionals and general healthcare providers. A key issue lies in the educational and professional silos that separate training pathways for medical

and dental professionals. From undergraduate curricula to postgraduate specialization, healthcare providers are typically trained in isolation, which limits mutual understanding and weakens collaborative competencies [22].

This divide is often reinforced in clinical practice, where structural hierarchies and distinct professional cultures discourage interprofessional dialogue. Physicians may underestimate the relevance of oral health, while dentists often operate outside integrated care teams, with minimal communication with other clinicians involved in a patient's treatment [23].

Moreover, electronic health records (EHRs) and information systems frequently lack interoperability between medical and dental platforms, creating logistical barriers to collaboration. In many settings, dental records are not accessible to general practitioners and vice versa, resulting in fragmented knowledge about a patient's health status and duplicated or missed care opportunities [24].

Payment models and incentives also play a role. Fee-for-service systems rarely reward interprofessional collaboration or preventive care, instead encouraging siloed services that meet billing codes rather than holistic health goals. Without financial structures that promote team-based approaches, collaboration remains the exception rather than the norm [25].

Cultural attitudes, lack of institutional support, and absence of shared performance indicators further impede interdisciplinary progress. Advancing integration will require targeted policy reforms, interprofessional education, shared IT systems, and incentive realignment to enable and normalize collaborative care models across health disciplines [26].

4. INTERDISCIPLINARY MODELS FOR INTEGRATION

4.1 Global Models: Scandinavian, Canadian, and African Experiences

Several countries have made significant strides in integrating oral health into broader health systems, offering valuable models for global adaptation. In Scandinavian nations, such as Sweden and Finland, oral health is treated as an essential component of public health, with strong governmental support for prevention, access, and integration. Sweden's national dental insurance provides subsidized care for children, adolescents, and adults, with routine dental checkups incorporated into primary care schedules [15]. School-based oral health education and outreach services reinforce this integration, emphasizing early intervention and population-wide equity [16].

Similarly, Canada offers a mixed public-private model that has achieved considerable success in certain provinces. Programs like Healthy Smiles Ontario and Alberta's School Dental Program target vulnerable populations, providing access to preventive and restorative services for children and low-income families. Canadian efforts to link oral health with

community health centers and Indigenous health programs illustrate the value of locally tailored integration strategies [17]. Interdisciplinary teams—including physicians, dental hygienists, and public health workers—collaborate to provide holistic care, particularly in underserved rural areas.

In Africa, promising models have emerged despite systemic resource constraints. Rwanda, for example, has piloted the inclusion of oral health in its community-based health insurance (Mutuelle de Santé), training nurses in basic oral screening and expanding access to fluoridation programs. South Africa's National Oral Health Strategy emphasizes decentralizing dental care through mobile clinics and integrating oral assessments in maternal and child health services [18].

These international experiences show that successful integration is achievable through strong policy commitment, financing mechanisms, and interprofessional collaboration. Each model—whether government-led, community-anchored, or insurance-based—demonstrates the value of embedding oral care within the fabric of primary and preventive health services, tailored to each country's demographic, cultural, and infrastructural realities [19].

4.2 Integrating Dental Health into Primary Care Networks

Embedding dental services into primary care networks can significantly enhance the accessibility, efficiency, and equity of health systems. One of the most effective methods involves the co-location of dental and medical services, allowing patients to receive comprehensive care during a single visit. Such integration reduces logistical barriers and increases uptake of preventive services, particularly for populations with limited mobility, transportation, or time [20].

Primary care providers play a pivotal role in this integration. By equipping family physicians and nurse practitioners with training in oral health screening, early detection of caries, gingivitis, and oral lesions can occur alongside standard medical evaluations. Referral systems that connect patients with dental professionals when necessary complete the care continuum and ensure timely intervention [21]. This team-based approach is particularly beneficial for managing comorbidities, as oral health issues often intersect with chronic conditions such as diabetes and cardiovascular disease.

Integrating electronic health records (EHRs) between medical and dental teams further strengthens care coordination. Shared access to patient histories, risk factors, and treatment plans enhances continuity and reduces duplication of services. In the United States, initiatives like the Integration of Oral Health and Primary Care Practice (IOHPCP) model provide training modules and implementation frameworks for primary care organizations [22].

Payment reform is also necessary. Value-based care models that reward preventive services and interdisciplinary collaboration can incentivize integration more effectively than traditional fee-for-service structures. This includes bundled payments, risk-based contracts, or oral health quality metrics embedded in primary care performance evaluations [23].

Policy mandates, professional education, and system-level enablers must converge to fully realize the benefits of oral health integration in primary care. This requires sustained investment, intersectoral planning, and a shift in mindset—from viewing dentistry as a specialty to recognizing it as a core element of whole-person care [24].

4.3 Lessons from Immunization and HIV Programs for Oral Health Inclusion

Immunization and HIV/AIDS programs have long served as global exemplars of disease-specific vertical programs successfully integrated into broader health systems. These programs offer key lessons for the inclusion of oral health in primary care and population health strategies. One critical lesson is the use of outreach and community-based delivery platforms to reach vulnerable and hard-to-access populations. Mass immunization campaigns and HIV testing drives often rely on mobile units, school settings, and community health workers—structures that could easily be adapted to deliver oral screenings, fluoride varnish applications, and health education [25].

Another insight is the value of task-shifting and training. Just as HIV programs empowered lay health workers and nurses to administer testing, counseling, and even antiretroviral therapy under specific protocols, similar strategies could train primary care providers or community workers to conduct basic oral health assessments and preventive interventions [26]. This approach is particularly crucial in low- and middle-income countries, where the dental workforce may be limited or concentrated in urban areas.

Additionally, both HIV and immunization programs have benefited from global funding mechanisms such as GAVI and PEPFAR, which enabled large-scale impact through resource mobilization and standardized performance indicators. Advocates for oral health integration can learn from these models to lobby for dedicated funding streams, monitoring frameworks, and integration benchmarks at national and international levels [27].

Importantly, both programs emphasize data-driven planning and continuous evaluation. Oral health programs can replicate this by integrating surveillance systems that monitor oral disease trends, treatment outcomes, and care disparities. This allows for adaptive programming and evidence-based policy-making [28].

Finally, immunization and HIV programs highlight the importance of political will and cross-sector collaboration. The global success of these programs was not solely technical but deeply political. Replicating this success for oral health will require building coalitions among health professionals, educators, donors, and communities to elevate oral care to a priority public health agenda [29].

Table 2: Comparative Review of National Health Systems with Successful Oral Health Integration

Country	Integration Strategy	Target Populations	Delivery Mechanism	Outcomes Achieved
Sweden	Public dental insurance and school-based prevention	Children, adults	Primary care and school clinics	High access, reduced inequalities
Canada (Ontario)	Subsidized preventive dental programs	Low-income families	Community health centers	Improved pediatric oral outcomes
Rwanda	Oral health in community insurance schemes	Rural populations	Nurse-led screenings in clinics	Increased access, early detection
South Africa	Mobile dental units, MCH integration	Women, children	Outreach through rural hospitals	Expanded coverage, awareness
United States	IOHPCP and HRSA-funded pilot programs	Medicaid populations	EHR-integrated primary clinics	Improved referrals, cost savings

5. STRATEGIC HEALTH SYSTEMS APPROACHES

5.1 Workforce Development and Interprofessional Training Models

Developing a workforce capable of delivering integrated oral-systemic care requires a reorientation of professional education and interprofessional collaboration. Traditional training models reinforce disciplinary silos, with dental and medical professionals often educated in isolation, rarely interacting during their formative years. This separation contributes to a persistent lack of coordination and limited mutual understanding of shared health responsibilities [19].

Innovative interprofessional training models are emerging as a solution. Academic institutions in countries like the United States, Canada, and the United Kingdom have begun piloting integrated curricula where dental, nursing, medical, and allied health students engage in shared coursework, clinical

simulations, and community-based projects. These initiatives foster collaborative competencies and deepen understanding of how oral health impacts systemic health [20].

Programs such as Harvard's Initiative to Integrate Oral Health and Medicine and the Interprofessional Education Collaborative (IPEC) in the U.S. exemplify structured approaches that embed oral-systemic integration into pre-licensure and postgraduate education. These models prioritize communication, team-based care planning, and reciprocal referral systems—skills essential for successful interdisciplinary practice [21].

Moreover, continuing professional development plays a critical role. Offering certification modules, workshops, and joint grand rounds in oral-systemic health allows current practitioners to update their knowledge and refine collaborative skills. Tele-mentoring models like Project ECHO have been successfully applied to bring dental and medical professionals together to learn about co-managing patients with chronic diseases linked to oral conditions [22].

Beyond curriculum changes, faculty development and institutional incentives are key. Faculty must be equipped to teach interprofessional content, and accreditation bodies should include oral-systemic care competencies in standards for both medical and dental programs. Long-term investment in workforce development ensures that integration becomes embedded in professional identity and practice norms, creating a generation of clinicians capable of delivering coordinated, patient-centered care [23].

5.2 Integrated Electronic Health Records (EHRs) and Data Sharing Mechanisms

The integration of electronic health records (EHRs) across dental and medical services is a cornerstone of unified, person-centered care. Historically, dental records have been maintained separately from general health records, often using incompatible systems. This separation limits care coordination, creates redundancies, and obscures key insights into the patient's holistic health status [24].

Integrated EHRs enable a comprehensive view of patient information, allowing providers to track systemic conditions alongside oral health data. For example, a physician managing a diabetic patient can monitor periodontal status—an important comorbidity—while a dentist treating gum disease can access glucose control data to adjust treatment accordingly [25]. This bidirectional flow of information supports shared decision-making and timely interventions, improving outcomes and reducing healthcare costs.

Leading healthcare systems and pilot programs have begun implementing shared platforms. Kaiser Permanente and HealthPartners in the U.S. have explored linking dental and medical data within unified records, facilitating real-time alerts, common medication lists, and integrated care planning [26]. Similarly, Canada's Pan-Canadian EHR Blueprint includes oral health integration in some provinces, especially

within community health centers serving underserved populations.

Technical and regulatory barriers persist, including differing data standards, software platforms, and privacy frameworks. The Health Level Seven (HL7) Fast Healthcare Interoperability Resources (FHIR) standard is emerging as a promising solution for harmonizing data exchange across systems, including dental charting [27]. Ensuring compliance with privacy laws like HIPAA and PIPEDA is essential, but so is enabling seamless and secure sharing of patient information across clinical domains.

Investments in interoperability infrastructure, training for providers, and incentives for adoption are critical to scaling integrated EHRs. These systems not only bridge the communication gap but also support research, surveillance, and population health management by providing a unified database of oral and general health indicators [28].
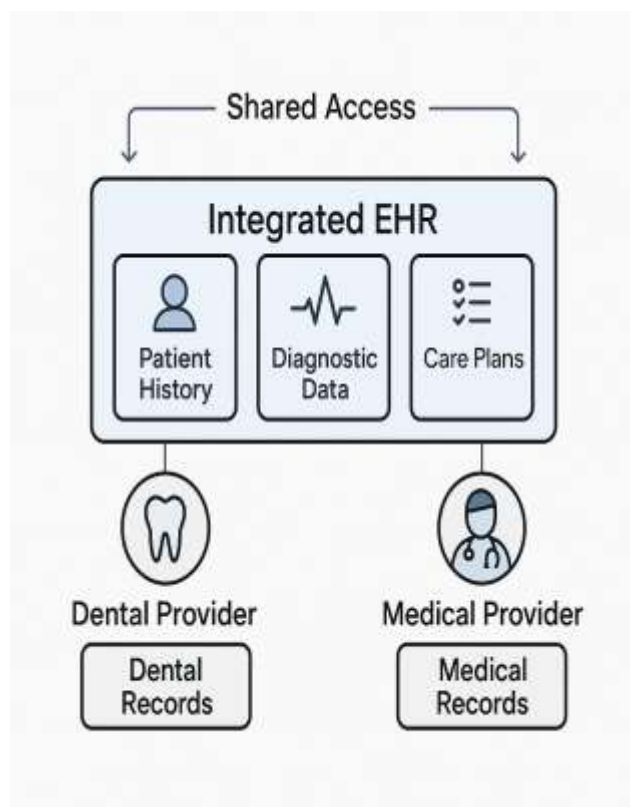

Figure 3: *Schematic model of integrated EHR linking dental and medical health records*

5.3 Payment and Reimbursement Policy Reforms for Oral-Systemic Care

Financial incentives profoundly shape healthcare delivery patterns. Current reimbursement models largely maintain the divide between dental and general healthcare, with separate billing systems, codes, and funding streams. In many countries, oral health services are treated as optional or supplementary, leading to underutilization and inequity in access [29].

Reforming payment systems to support integrated care is essential for aligning financial drivers with clinical goals. Value-based payment models—such as bundled payments or capitation—can promote coordination by rewarding outcomes rather than volume. For instance, a bundled payment for diabetes management could include both medical and dental components, recognizing the link between periodontal health and glycemic control [30].

Some U.S. Medicaid programs and accountable care organizations (ACOs) have experimented with models that reimburse for oral health screenings in medical settings or co-located care. Similarly, Medicare Advantage plans increasingly include dental benefits, signaling a gradual shift toward bundled service offerings [31].

To advance integration, insurers and health systems must revise fee schedules to support preventive oral health services delivered in primary care settings, such as fluoride varnish applications or risk assessments. Moreover, quality metrics and reporting systems should include oral-systemic indicators—such as changes in oral health status among patients with chronic diseases—to incentivize accountability [32].

By aligning payment structures with integrated care delivery, health systems can eliminate silos, promote collaboration, and make comprehensive oral-systemic care financially sustainable.

5.4 Oral Health Promotion and Patient Engagement Campaigns

Effective integration of oral health into systemic care also depends on public awareness and patient engagement. Many individuals continue to view dental care as separate from general health, leading to lower prioritization, especially among populations with financial or educational barriers [33].

Health promotion campaigns that emphasize the connection between oral and systemic diseases—such as diabetes, cardiovascular conditions, and adverse pregnancy outcomes—can reshape public perceptions. Messaging that positions oral care as essential to chronic disease management increases patient demand for integrated services and reinforces healthy behaviors [34].

Successful campaigns draw from behavioral science and digital health strategies. Personalized reminders, gamification apps, and culturally tailored content can drive adherence to oral hygiene practices and routine dental visits. Programs like "Smile for Life" in the U.S. and "Brush Day & Night" supported by FDI World Dental Federation demonstrate how multimedia outreach can engage diverse audiences across age groups [35].

Schools, workplaces, and community centers serve as ideal platforms for health literacy initiatives. Embedding oral health education in chronic disease prevention programs ensures alignment and broadens reach. Empowering patients with

tools for self-assessment, goal setting, and risk awareness fosters ownership of oral health as part of overall well-being [36].

Crucially, patient engagement must be coupled with systemic support—integrated records, coordinated care plans, and affordable services—to convert awareness into action. A well-informed public, supported by accessible and responsive care systems, is foundational to the success of oral-systemic health integration [37].

6. IMPLEMENTATION SCIENCE AND POLICY TRANSLATION

6.1 Frameworks for Scaling Oral-Systemic Interventions Nationally

Scaling oral-systemic interventions from pilot programs to national implementation requires structured frameworks that align policy, financing, workforce, and infrastructure. A widely recognized model is the WHO's Health Systems Framework, which outlines six building blocks: service delivery, health workforce, health information systems, access to essential medicines, financing, and leadership/governance [23]. Applying this model to oral health integration ensures that efforts are embedded within the broader health system rather than functioning as standalone programs.

For example, service delivery must shift from fragmented care to coordinated models, emphasizing co-location of dental services within primary care and using interoperable systems. Workforce strategies should include interprofessional training and role expansion for non-dental professionals in basic oral health promotion. Health information systems must support bidirectional data flow between medical and dental providers, while financing mechanisms must ensure affordability through bundled payments or value-based care models [24].

Another useful framework is the RE-AIM model (Reach, Effectiveness, Adoption, Implementation, Maintenance), which guides implementation research by assessing the scalability and sustainability of public health programs. By evaluating oral-systemic initiatives against these five dimensions, policymakers can identify context-specific barriers and enablers [25].

Integration efforts must also include community-based delivery channels. National scale-up should build on local innovations—such as mobile units or school programs—while ensuring consistent standards, centralized monitoring, and cross-sector coordination. National health plans should formalize oral health goals within chronic disease strategies, linking them to NCD targets and health equity indicators [26].

Ultimately, successful national scaling demands a systems-thinking approach that accounts for complexity, aligns with broader health reforms, and builds capacity at all levels of service delivery. The objective is not just expanding coverage, but transforming the way oral health is valued, financed, and practiced across national healthcare landscapes [27].

6.2 Stakeholder Engagement: Public Health Officials, Professional Bodies, NGOs

Effective national integration of oral health into chronic disease frameworks relies on strong, coordinated stakeholder engagement. Public health officials play a central role by championing oral-systemic integration within national policy agendas and health budgets. Ministries of Health must include oral health in strategic plans, allocate dedicated funding, and ensure representation in national health commissions or task forces [28].

Professional associations—such as national dental, medical, and nursing bodies—serve as key catalysts in reshaping clinical norms and education standards. Their endorsement of interdisciplinary care models lends credibility to reform efforts and facilitates adoption across frontline providers. For instance, when dental associations advocate for oral health training in medical curricula, it reinforces the importance of shared competencies and collaborative practice [29].

Non-governmental organizations (NGOs) also contribute significantly by piloting community-based interventions, mobilizing public awareness, and advocating for policy change. NGOs often have deep ties to local populations and can test innovative models that public systems later adopt and scale. Partnerships with international NGOs can also secure external funding and technical assistance for countries with limited domestic capacity [30].

Stakeholder engagement should be structured through formal mechanisms such as steering committees, public consultations, and cross-sectoral coalitions. These platforms allow for inclusive dialogue, shared goal setting, and role clarity. Importantly, patient and community voices must be included to ensure services reflect lived experiences and cultural relevance.

Coordinated engagement fosters legitimacy, transparency, and buy-in—crucial ingredients for sustained reform. Aligning stakeholder interests and building mutual accountability transforms integration from a technical project into a shared national mission [31].

6.3 Policy Instruments: Guidelines, Funding Models, Regulatory Levers

The development and deployment of targeted policy instruments are fundamental to embedding oral health into national chronic disease frameworks. Evidence-based clinical guidelines represent a primary tool, standardizing how oral health is screened, documented, and managed in non-dental settings. Integrating these protocols into chronic disease management—for example, by including oral exams in diabetes care pathways—ensures that oral health becomes a routine part of systemic care [32].

Funding models must reinforce integration. Traditional reimbursement schemes that silo dental and medical services are misaligned with the goals of person-centered care.

Policymakers should adopt blended or bundled payment systems that reward preventive, coordinated care. For instance, capitation models covering both medical and oral health services incentivize comprehensive care planning. Likewise, public insurance schemes should explicitly include oral-systemic services in benefit packages, particularly for high-risk populations such as the elderly, children, and people with chronic conditions [33].

Regulatory levers are equally powerful. Accreditation standards for health facilities can be revised to mandate oral health inclusion in primary care. Scope-of-practice regulations can be expanded to allow non-dental health workers to perform basic screenings and refer patients appropriately. Such regulatory adjustments promote service flexibility and reduce access barriers [34].

National performance metrics and monitoring frameworks should also include oral health indicators linked to chronic disease outcomes. These metrics incentivize compliance and make it possible to track integration progress at national, regional, and facility levels.

Combined, these instruments—guidelines, financial incentives, and regulatory mandates—create a comprehensive policy ecosystem. They ensure that integration is not left to local discretion but institutionalized through enforceable, evidence-based, and sustainable mechanisms that drive systemic change [35].

Table 3: Implementation Readiness Checklist for Integrating Oral Health into National Chronic Disease Frameworks

Component	Key Actions	Status Check (✓/✗)
Governance	Oral health included in NCD national strategy	
	Interministerial working group established	
Workforce	Interprofessional training programs launched	
	Task-shifting policies adopted for oral screening	
Service Delivery	Co-location of dental and primary care services piloted	
	Referral protocols formalized across disciplines	
Information Systems	EHR interoperability between dental and medical records established	
	Oral health data integrated into NCD registries	
Financing	Bundled payment models tested	
	Oral health covered in public insurance for high-risk groups	
Monitoring and Evaluation	Oral-systemic health indicators included in national health dashboards	
	Periodic national reporting on oral health integration outcomes	

7. FUTURE TRENDS AND TECHNOLOGICAL ENABLERS

7.1 AI and Predictive Analytics in Oral-Systemic Risk Detection

Artificial intelligence (AI) and predictive analytics are revolutionizing the early detection and prevention of oral-systemic diseases by identifying patterns in large, complex datasets that would otherwise go unnoticed. AI models, including machine learning and deep learning algorithms, can analyze structured and unstructured data—ranging from electronic health records (EHRs) and dental imaging to behavioral and socioeconomic indicators—to predict the onset or progression of conditions such as diabetes, cardiovascular disease, and rheumatoid arthritis, all of which have links to oral health [27].

Predictive algorithms can assess periodontal disease severity and correlate it with systemic inflammatory markers, enabling risk stratification at both individual and population levels. Tools like convolutional neural networks (CNNs) are already being applied to panoramic radiographs and intraoral images to detect alveolar bone loss and early signs of systemic complications [28]. Integrating oral health indicators—such as gum inflammation or tooth mobility—into broader clinical risk models increases the precision of chronic disease surveillance and preventive care planning.

Moreover, AI-powered dashboards allow real-time monitoring of oral-systemic risks, helping clinicians prioritize high-risk patients for intervention. These tools can continuously learn from new data inputs, adjusting risk profiles as patient conditions change over time. AI applications also support personalized care by suggesting tailored interventions, such as

dietary changes, oral hygiene regimens, or referral to specialists based on combined risk factors [29].

The integration of AI into clinical workflows ensures timely identification of patients who would benefit from interdisciplinary care, reinforcing the link between oral and systemic health while improving outcomes and resource allocation across health systems.

7.2 Telehealth and Mobile Dentistry for Remote Management

Telehealth and mobile dentistry technologies are bridging geographic, economic, and logistical barriers to oral-systemic healthcare, particularly in rural and underserved regions. These platforms expand access to oral health assessments, education, and referral services, reducing delays in care and enabling earlier interventions for systemic conditions influenced by oral health status [30].

Teledentistry platforms allow patients to consult with dental professionals via video calls, share intraoral photographs, and receive remote diagnoses and treatment recommendations. For chronic disease patients—such as those with diabetes or cardiovascular disease—routine teleconsultations can include oral health screenings that inform overall disease management plans. Integrating teledentistry with medical telehealth visits fosters cross-disciplinary coordination and allows primary care providers to identify oral health issues in real-time [31].

Mobile dentistry units further enhance reach by delivering in-person preventive and basic restorative services directly to schools, eldercare facilities, or remote clinics. These units often incorporate digital technologies for diagnostics, record-keeping, and data sharing with central health systems. When synchronized with national EHR systems, mobile platforms can contribute to centralized databases used for predictive analytics and health surveillance [32].

Telehealth tools also play an educational role by promoting oral-systemic health literacy through interactive applications, multilingual content, and automated reminders for follow-ups or hygiene practices. These services empower individuals to maintain oral health between in-person visits, reducing complications from chronic diseases exacerbated by poor dental hygiene [33].

Together, telehealth and mobile dentistry are vital enablers of equitable, continuous, and integrated oral-systemic care, offering scalable solutions for health systems looking to expand reach and improve chronic disease outcomes.

7.3 Genomics and Biomarkers Linking Oral Health to Inflammatory Conditions

Recent advances in genomics and biomarker research have unveiled critical links between oral health and systemic inflammatory conditions, offering new pathways for early diagnosis and targeted therapy. Salivary biomarkers, such as interleukin-6 (IL-6), C-reactive protein (CRP), and matrix metalloproteinases (MMPs), have demonstrated strong associations with both periodontal disease and systemic inflammation seen in cardiovascular disease and diabetes [34].

Genomic studies have further revealed polymorphisms in genes regulating immune responses—such as TNF-α and IL-1β—that predispose individuals to both aggressive periodontitis and heightened systemic inflammation. These genetic markers enable risk prediction models that can guide personalized prevention strategies in susceptible individuals [35].

By incorporating salivary and genomic testing into routine dental and medical assessments, healthcare providers can detect elevated systemic risk before clinical symptoms appear. This approach supports precision medicine and integrated care, allowing early intervention and reducing the burden of chronic disease across populations [36].

Figure 4: *AI-powered predictive risk dashboard for oral-systemic disease forecasting*

8. CASE STUDIES IN INTERDISCIPLINARY ORAL HEALTH INTEGRATION

8.1 Finland: School-Based Periodontal Surveillance in National Health Strategy

Finland has long been recognized for its proactive and integrated approach to health promotion, and its inclusion of

school-based periodontal surveillance within its national health strategy serves as a benchmark for oral-systemic integration. As part of the Finnish Student Health Service, all children receive routine dental checkups, including assessments for periodontal conditions such as gingivitis and early periodontitis, beginning in primary school and continuing through adolescence [32].

These screenings are conducted by dental hygienists and general dentists embedded within school health teams, allowing early identification of risk factors linked to systemic conditions such as type 1 diabetes and obesity. By integrating oral health into school wellness records, Finland creates a longitudinal dataset that supports early intervention, parental engagement, and evidence-based policymaking [33].

Moreover, school-based oral health data feeds into Finland's national health information systems, facilitating real-time surveillance of oral-systemic risk indicators and supporting predictive public health planning. Cross-sector collaboration between the Ministries of Education and Health ensures sustained funding and shared accountability, while public awareness campaigns reinforce oral hygiene as part of Finland's holistic child development model [34].

This approach not only enhances oral health outcomes but contributes to the national goal of reducing the long-term burden of chronic diseases through early detection and behavioral interventions during the formative years of life.

8.2 Canada: Oral Health Integration in Indigenous Immunity Programs

In Canada, efforts to reduce health disparities among Indigenous populations have increasingly emphasized the integration of oral health into broader immunity and chronic disease initiatives. Indigenous communities in provinces such as British Columbia and Ontario face disproportionately high rates of diabetes, respiratory infections, and cardiovascular diseases—all of which are exacerbated by untreated oral infections [35].

Health Canada's First Nations and Inuit Health Branch (FNIHB) supports programs that embed oral health services into community-based health centers where immunization, maternal health, and chronic disease screening take place. Mobile dental units and rotating hygienists provide preventive services—including fluoride varnish, sealants, and periodontal assessments—alongside vaccine administration during community health events [36].

A notable example is the Aboriginal Health Access Centres (AHACs), which operate using a culturally grounded model that integrates dental care with immunization records and systemic disease management. These centers train Indigenous health workers to provide oral hygiene education, identify risk factors such as gingival inflammation, and facilitate referrals for more complex dental care—all within the scope of primary care interactions [37].

Data integration has also played a key role. Several regions are piloting shared health record systems that align oral health indicators with immunity tracking, allowing real-time visibility into care gaps. Moreover, oral health messaging is incorporated into public health campaigns targeting vaccine uptake and chronic disease prevention, using Indigenous languages and community-based outreach to build trust and engagement [38].

This holistic, culturally sensitive approach demonstrates the potential of aligning oral health with immune protection strategies to reduce disease burdens and promote wellness in historically underserved populations.

8.3 Ghana: Rural Deployment of Oral Health Units in Immunization Campaigns

Ghana's rural health strategy offers a promising example of integrated service delivery, combining oral health interventions with immunization campaigns to reach remote and underserved populations. Recognizing the barriers to dental care access in rural areas—including workforce shortages, transportation challenges, and low health literacy—the Ghana Health Service (GHS) developed a model that deploys mobile oral health units alongside existing Expanded Programme on Immunization (EPI) outreach teams [39].

These oral health units, staffed by dental therapists and nurses trained in basic dental care, accompany EPI teams during child immunization visits. While infants and children receive routine vaccines, their caregivers undergo oral screenings, receive hygiene supplies, and participate in brief education sessions linking oral hygiene to systemic health outcomes, such as respiratory infections and maternal health risks [40].

The integrated approach maximizes limited resources and improves service uptake. By bundling services, GHS reports increased attendance at immunization events, enhanced caregiver engagement, and earlier identification of oral-systemic conditions like oral thrush or untreated caries in both children and adults [41].

Additionally, GHS collects oral health data during these outreach activities, contributing to a centralized monitoring system that informs planning and identifies underserved communities. Partnerships with local NGOs and faith-based organizations support health promotion through community radio and market-day education sessions, increasing public awareness and reinforcing consistent messages [42].

This model illustrates how interdisciplinary integration within existing health infrastructure can strengthen prevention, reduce access disparities, and promote oral health as a pillar of comprehensive rural healthcare.
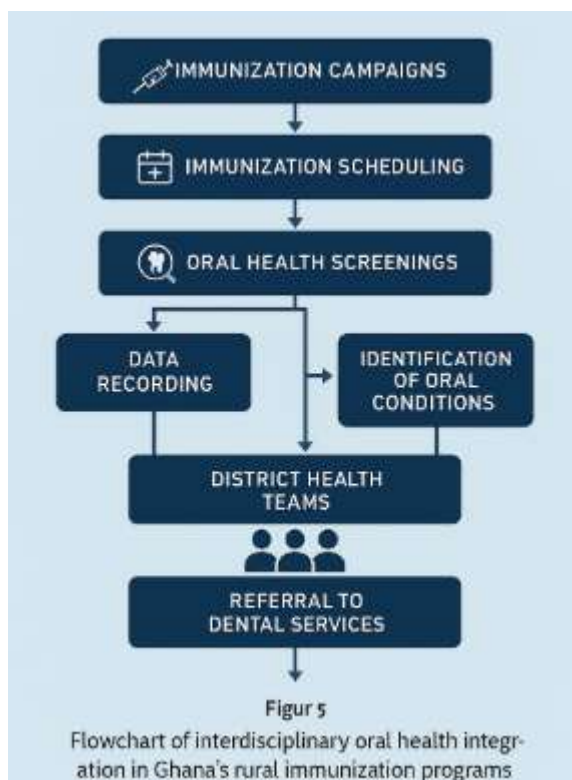
Figure 5: *Flowchart of interdisciplinary oral health integration in Ghana's rural immunization programs*

9. DISCUSSION AND POLICY RECOMMENDATIONS

9.1 Synthesis of Findings Across Sections

The findings across this report collectively highlight the urgent need to integrate oral health into national and global health systems as a critical component of chronic disease prevention and management. Section 3 demonstrated how the persistent fragmentation between dental and general health services results in poor coordination, inequities in access, and overlooked comorbidities, especially in underserved populations [34]. Despite robust evidence linking periodontal disease to diabetes, cardiovascular disorders, and adverse pregnancy outcomes, oral health remains largely excluded from noncommunicable disease (NCD) strategies, immunological protocols, and primary care infrastructures [35].

Global case studies in Section 4 illustrated that integration is feasible and impactful. Finland, Canada, and Ghana have each employed unique but effective models to link oral health to school, Indigenous, and rural care systems, respectively, enhancing both service efficiency and health outcomes [36]. Section 5 reinforced the role of workforce development, EHR interoperability, and value-based payment reforms in operationalizing oral-systemic care at scale. Interdisciplinary training, shared data systems, and aligned reimbursement models were shown to drive sustainable collaboration between medical and dental sectors [37].

Moreover, emerging technologies reviewed in Section 7—including AI, genomics, and mobile health platforms—present transformative opportunities to scale oral-systemic integration. These tools enable proactive, personalized, and data-driven care that can bridge longstanding gaps across disciplines and geographies [38].

Overall, this synthesis confirms that integrating oral health is not only medically necessary but also operationally achievable. It requires a convergence of political will, strategic investment, and systems thinking to redesign care delivery in ways that reflect the inseparability of oral and systemic health.

9.2 Strategic Priorities for National Health Agencies

To address the longstanding neglect of oral health within systemic care, national health agencies must adopt a set of strategic priorities focused on institutionalizing oral-systemic integration. First, oral health should be explicitly incorporated into national NCD action plans, primary care protocols, and population health targets. This inclusion affirms its importance and ensures resource allocation in alignment with broader health system goals [39].

Second, agencies must promote interprofessional training and scope-of-practice reform, enabling non-dental professionals to conduct basic oral screenings and referrals. This strategy is particularly critical in rural and low-resource settings, where dentists are scarce. National workforce development programs should embed oral-systemic competencies into pre-service and in-service curricula across all health disciplines [40].

Third, public reimbursement mechanisms must evolve to cover integrated services. Bundled payments for chronic disease management that include oral assessments, preventive treatments, and hygiene education will incentivize collaboration and reduce long-term care costs. Policies should prioritize high-risk groups such as children, older adults, and individuals with diabetes or cardiovascular disease [41].

Finally, national agencies must invest in data infrastructure and digital platforms that support bidirectional information sharing between dental and medical providers. Such systems will allow for joint care planning, performance tracking, and real-time risk management, thereby improving continuity and quality of care [42].

These strategic actions, collectively implemented, can transform oral-systemic integration from pilot experimentation into institutional standard.

9.3 Call for Unified Global Standards on Oral-Systemic Integration

The global health community must coalesce around a shared vision and unified standards for oral-systemic integration. Despite growing evidence and local innovations, the lack of globally recognized benchmarks hinders scalable, equitable progress. Organizations such as the WHO, FDI World Dental Federation, and UN bodies should collaborate to establish

minimum integration criteria—covering data interoperability, cross-training guidelines, essential service packages, and oral health metrics within NCD reporting frameworks [43].

Standardization would support cross-country learning, benchmarking, and pooled investments in technologies and training platforms. It would also strengthen advocacy by aligning national strategies with global commitments to universal health coverage and sustainable development goals [44].

Only with coordinated global leadership can the full potential of oral-systemic integration be realized—ensuring that no population remains excluded from comprehensive, equitable, and person-centered care.

10. CONCLUSION

10.1 Summary of Strategic Imperatives

The imperative to integrate oral health into broader health systems has never been clearer. As mounting evidence reveals the profound interconnections between oral and systemic health—particularly in the context of chronic conditions such as diabetes, cardiovascular disease, and respiratory illnesses—it becomes increasingly unsustainable for national and global health agencies to treat dental care as separate or secondary.

A strategic, systemic approach must prioritize the incorporation of oral health into national noncommunicable disease (NCD) strategies, primary healthcare services, and population-based prevention programs. This starts with embedding oral health screenings and treatment protocols into chronic disease pathways, maternal and child health services, and aging care systems. Such integration will enhance early detection, improve long-term health outcomes, and reduce the economic burden of untreated dental conditions.

Workforce transformation is equally essential. National education policies should embed oral-systemic competencies into the training of all health professionals, promoting interprofessional collaboration from the earliest stages of clinical development. Nurses, community health workers, and general practitioners should be empowered with the skills and authority to conduct basic oral assessments and refer appropriately.

On the infrastructure front, the modernization of electronic health records (EHRs) must prioritize interoperability between medical and dental systems. Shared data access facilitates coordinated care, reduces duplication, and allows providers to co-manage patients with holistic awareness. These systems also serve as powerful tools for surveillance, evaluation, and population health planning.

Payment and policy reform must align with these clinical and technological shifts. Governments and insurers should adopt bundled and value-based payment models that reward preventive care and collaboration, making integrated service delivery financially viable and sustainable.

Together, these imperatives form a roadmap toward an inclusive, efficient, and outcomes-driven health system that acknowledges the critical role of oral health in individual and population wellness. Integration is not only a clinical necessity but also a strategic opportunity to strengthen public health infrastructure for the future.

10.2 The Path Forward for Integrated, Equitable Public Health

Moving forward, a decisive shift is required—one that reimagines oral health not as an isolated service, but as a foundational component of public health. The path ahead calls for a unified vision among healthcare leaders, educators, policymakers, and communities to treat oral health as integral to preventing and managing chronic diseases, reducing health inequities, and advancing universal health coverage.

At the core of this transformation is a commitment to equity. Integration must prioritize those historically marginalized by fragmented systems—rural communities, Indigenous populations, low-income groups, and individuals with complex health needs. By embedding oral health services into schools, community centers, primary care clinics, and mobile health units, we bring care closer to where people live, learn, and work.

Technological innovations, from AI-driven predictive tools to interoperable digital records, will enable smarter, more responsive systems—but only if access and literacy are equitably distributed. Similarly, empowered health workers—equipped with the training, tools, and authority to collaborate—will drive forward culturally competent, person-centered care.

Ultimately, a resilient public health system is one that sees the whole person. By dissolving the artificial boundaries between dental and general healthcare, we move closer to that ideal—ensuring that all individuals, regardless of circumstance, can access the full spectrum of care they need to live healthy, dignified lives. The integration of oral health into systemic care is not only achievable—it is essential for a just and sustainable future in global health.

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