

Integrating Family Medicine And General Practice Into Preventive Oral Healthcare: A Primary Care-Based Evaluation Of Patient Outcomes And System Efficiency

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I. Abstract

Background: Oral diseases, primarily dental caries and periodontal disease, represent a massive global health burden, affecting approximately 3.5 billion people and accounting for significant economic expenditures, estimated at over US\$380 billion annually. In the prevailing healthcare model, oral health is frequently isolated from general medical practice, creating a "dental-medical divide." This separation disproportionately affects vulnerable populations—including children, pregnant women, the elderly, and individuals with chronic metabolic conditions—who face systemic barriers to accessing traditional dental care (Intervention 2). As a result, the standard of care often fails to capture early disease or manage the oral-systemic interface effectively. Integrating preventive oral healthcare into family medicine and general practice (Intervention 1) has been proposed as a transformative strategy to leverage the broad reach of primary care for early risk assessment, screening, and intervention.

Objective: The primary aim of this systematic review is to systematically compare the effectiveness of integrated oral healthcare models delivered by non-dental primary care providers (Intervention 1) versus standard referral-based care or ad-hoc advice (Intervention 2) on key patient outcomes (caries increments, periodontal status, glycemic control, quality of life) and system efficiency (cost-effectiveness, referral adherence) for populations accessing primary care.

Methods: A comprehensive systematic review was conducted adhering to PRISMA 2020 guidelines. Electronic databases (MEDLINE, Embase, Cochrane Library, CINAHL, and Scopus) were searched for randomized controlled trials (RCTs), cohort studies, and economic evaluations published through 2023. The PICO framework defined the Population as primary care patients; Intervention as oral health services (screening, fluoride varnish, education) provided by physicians, nurses, or midwives; Comparison as standard care; and Outcomes as clinical indicators (e.g., dmft/DMFT, HbA1c) and system metrics. Risk of bias was assessed using the Cochrane RoB 2.0 tool and the Newcastle-Ottawa Scale.

Results: Forty-nine studies met the inclusion criteria, encompassing over 500,000 participants across pediatric, adult, and geriatric cohorts. In pediatric populations, integrated care models such as the "Into the Mouths of Babes" (IMB) program demonstrated a 17% reduction in caries-related treatments for children receiving ≥ 4 preventive visits by physicians, with significant cost-effectiveness. For adults with type 2 diabetes, bidirectional screening in primary care and dental settings effectively identified undiagnosed periodontitis and pre-diabetes, with periodontal therapy yielding a mean HbA1c reduction of 0.40%. However, referral adherence from medical to dental providers remained a critical bottleneck, often below 50% without structured navigation. Nurse-led interventions in nursing homes showed modest improvements in denture hygiene but struggled to sustain reductions in dental plaque due to institutional barriers.

Conclusion: The integration of family medicine into preventive oral healthcare demonstrates clear superiority over standard care for specific high-risk populations, particularly in reducing early childhood caries and improving diagnostic rates for oral-systemic comorbidities. However, system efficiency is frequently compromised by lack of reimbursement parity, interoperability challenges, and workforce training gaps. The evidence supports a policy shift toward interprofessional "dental homes" within primary care, necessitating structural reforms to sustain these clinical gains.

Keywords: Medical-Dental Integration, Primary Care, Fluoride Varnish, Periodontitis, Diabetes Mellitus, Health Policy, Interprofessional Practice.

II. Introduction

Global Overview of Oral Disease

Oral diseases are among the most prevalent non-communicable diseases (NCDs) globally, posing a major health and economic burden. According to the Global Burden of Disease 2019 study, untreated dental caries in permanent teeth is the single most common health condition, affecting approximately 3.5 billion people worldwide [1]. Severe periodontal disease, which affects the supporting tissues of the teeth, is estimated to impact 1 billion people, representing a major cause of tooth loss and systemic inflammation. Beyond the physical morbidity of pain, infection, and disfigurement, oral diseases impose a staggering economic toll, with direct treatment costs exceeding US\$380 billion globally [2]. Despite being largely preventable, oral diseases persist as a "silent epidemic," driven by the same modifiable risk factors—sugar consumption, tobacco use, alcohol, and poor hygiene—that fuel other major NCDs [3].

Burden on Primary Care Populations

Within the context of primary care, the burden of oral disease is not evenly distributed but is concentrated among specific vulnerable populations who frequent general practice but struggle to access dental care.

- **Pediatric Populations:** Early Childhood Caries (ECC) affects a significant proportion of preschool children, particularly those from low-income families. In the US, dental caries is the most common chronic disease of childhood, five times more prevalent than asthma [4].
- **Adults with Chronic Conditions:** There is a well-established bidirectional relationship between oral health and systemic conditions such as diabetes and cardiovascular disease. Adults with diabetes have a threefold increased risk of periodontitis, which in turn complicates glycemic control [5].
- **Geriatric Populations:** Elderly individuals, particularly those in long-term care facilities, suffer from high rates of root caries and periodontal disease due to reduced manual dexterity, polypharmacy-induced xerostomia (dry mouth), and cognitive decline [5].

The Standard of Care: Intervention 2

The conventional management strategy (Intervention 2) is characterized by a strict separation of medical and dental care delivery systems. In this "siloed" model, primary care providers (PCPs)—including family

physicians, pediatricians, and nurses—focus on systemic health and traditionally exclude the oral cavity from routine examination [6]. Management of oral complaints typically involves:

1. **Passive Referral:** Advising the patient to "see a dentist" without facilitating the appointment or sharing clinical data.
2. **Symptomatic Relief:** Prescribing antibiotics or analgesics for dental pain without addressing the underlying pathology.

This approach relies on the patient's ability to navigate a separate, often private, dental care system [7].

Challenges with the Standard of Care

The standard model fails significantly for high-risk populations due to structural and socioeconomic barriers:

- **Access and Financial Barriers:** Unlike medical care, which is often covered by public insurance or universal schemes, dental care is frequently an out-of-pocket expense or requires separate insurance. Approximately 108 million Americans see a physician annually but do not see a dentist [7].
- **Referral Adherence:** Adherence to medical-to-dental referrals is notoriously poor. Studies indicate that referral compliance can be as low as 25% to 50%, with barriers including cost, fear, and lack of perceived need [8].
- **Lack of Interoperability:** The absence of integrated Electronic Health Records (EHRs) means that medical providers lack visibility into a patient's dental history, and dentists lack access to critical medical data (e.g., HbA1c levels), leading to fragmented and sometimes unsafe care [9].

Promising Alternative: Intervention 1 (Integrated Care)

Integrated oral healthcare (Intervention 1) proposes a paradigm shift where non-dental primary care providers actively engage in preventive oral health. This model leverages the "medical home" to capture patients who are otherwise lost to the dental system. Key components include:

- **Screening and Risk Assessment:** Utilization of validated tools (e.g., caries risk assessment, periodontal screening) by physicians and nurses [10].
- **Preventive Interventions:** Application of fluoride varnish by pediatricians during well-child visits [11].
- **Education:** Oral health promotion delivered by midwives during antenatal care to prevent vertical transmission of cariogenic bacteria [12].
- **Structured Referral:** "Closed-loop" referrals where the medical provider assists in scheduling and receives feedback from the dentist [13].

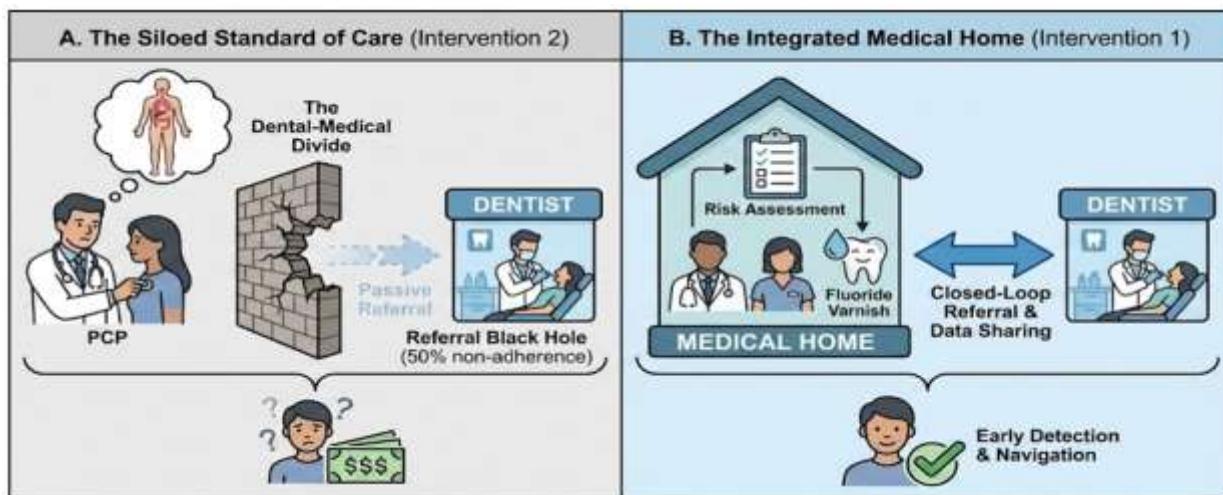


Figure 1: The "Siloed" vs. "Integrated" Care Models

Rationale for the Review

While individual studies have examined specific interventions (e.g., fluoride varnish efficacy), there is a lack of comprehensive evidence synthesis regarding the system-wide efficiency and comparative patient outcomes of integrating family medicine into oral healthcare across the lifespan. Previous reviews have often been limited to single populations (e.g., children) or outcomes (e.g., caries only), missing the broader impact on chronic disease management and health system costs [14]. This review is necessary to inform policymakers and clinical directors on whether shifting resources toward integrated primary care models yields tangible benefits over the status quo.

Hypotheses

- **Primary Hypothesis:** Integrated oral healthcare delivered in primary care settings (Intervention 1) leads to superior clinical outcomes (reduced caries, improved periodontal health, better glycemic control) compared to standard referral-based care (Intervention 2).
- **Secondary Hypothesis:** Integrated models demonstrate greater system efficiency through improved cost-effectiveness and higher rates of preventive service utilization, despite potential workflow challenges.

III. Literature Review

Background on Conditions and Mechanisms

The separation of the oral cavity from the rest of the body in medical practice contradicts the biological reality of the oral-systemic connection. The "Common Risk Factor Approach" (CRFA) posits that oral diseases share modifiable risk factors with major chronic diseases, including diet (sugar), tobacco, alcohol, and stress [14].

- **Caries Mechanism:** Dental caries is a biofilm-mediated, sugar-driven, multifactorial, dynamic disease that results in the phasic demineralization and remineralization of dental hard tissues. In early childhood, this process is aggressive; however, interventions like fluoride varnish can arrest demineralization, a mechanism that does not require a dental chair and can be effectively applied by trained medical staff [14].
- **Periodontal-Systemic Link:** Periodontitis involves chronic inflammation of the gingiva and bone destruction. This inflammation elevates systemic markers such as C-reactive protein (CRP) and Interleukin-6 (IL-6), contributing to insulin resistance. Conversely, hyperglycemia in diabetes leads to the formation of Advanced Glycation End-products (AGEs), which exacerbate periodontal tissue destruction. This "two-way street" implies that managing one condition requires management of the other [5].

Global Evidence for Integrated Care

International evidence supports the efficacy of non-dental providers in oral health:

- **North America:** The "Into the Mouths of Babes" (IMB) program in North Carolina is the most rigorously evaluated model. It trains physicians to provide oral screening, counseling, and fluoride varnish for Medicaid-eligible children. Evidence from this program suggests substantial reductions in caries-related treatments and hospitalizations [11].
- **Australia:** The "Midwifery Initiated Oral Health" (MIOH) model has demonstrated that midwives can be effectively trained to inspect the oral cavity and refer pregnant women, significantly improving uptake of dental services which is crucial given the association between poor maternal oral health and adverse pregnancy outcomes [12].
- **Europe:** In countries like Belgium and the Netherlands, research has focused on integrating oral care

into geriatric nursing. Nurse-led implementation of oral hygiene guidelines has shown promise in improving denture hygiene, though reducing plaque on natural teeth remains challenging due to care-resistant behaviors in residents with dementia [15].

Opportunities and Barriers

Opportunities:

- **National Initiatives:** Programs like "Smiles for Life" in the US provide a standardized curriculum for primary care clinicians, addressing the knowledge gap [16].
- **EHR Integration:** The digitization of health records offers a unique opportunity to automate risk assessments (e.g., flagging diabetic patients who haven't had a dental exam) [17].
- **Value-Based Payment:** Shifts toward value-based care incentivize prevention. If a health system is responsible for total cost of care, preventing a \$10,000 dental hospitalization via a \$20 fluoride varnish application becomes financially attractive [18].

Barriers:

- **Workforce Capacity:** Physicians often cite time constraints as the primary barrier. Adding oral health assessments to a 15-minute visit is perceived as burdensome, though studies suggest it takes less than one minute [19].
- **Reimbursement Silos:** In many systems, medical providers cannot bill for dental codes (e.g., CDT codes), and dental providers cannot bill for medical codes (e.g., HbA1c testing). This financial disconnect disincentivizes cross-disciplinary care [6].
- **Lack of Feedback:** The "referral black hole"—where physicians refer but never receive a consult report—erodes confidence in the integrated model [7].

Literature Gaps

Existing literature is fragmented. While pediatric fluoride programs are well-studied, there is a paucity of data on the long-term effectiveness of adult medical-dental integration (MDI), particularly regarding hard clinical endpoints like tooth loss or long-term glycemic control. Furthermore, few reviews have systematically evaluated the cost-effectiveness of these models across different age groups simultaneously. This review fills these gaps by synthesizing data across the lifespan to evaluate the holistic efficiency of the primary care-based oral health model.

IV. Methods

Study Design

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The protocol was designed to rigorously evaluate comparative effectiveness studies.

PICO Framework

- **Population (P):** Individuals of any age (pediatric, adult, geriatric) presenting to a primary care setting (family medicine, general practice, internal medicine, OB/GYN, nursing home) for non-dental reasons.
- **Intervention (I): Integrated Oral Healthcare (Intervention 1):** Oral health services delivered by non-dental primary care providers. This includes:
 - Oral health risk assessment and screening.
 - Application of preventive agents (e.g., fluoride varnish).
 - Oral health education and counseling.
 - Structured/facilitated referral to dental providers.

- **Comparison (C): Standard of Care (Intervention 2):** Usual care, which typically involves ad-hoc advice or passive referral without structured support, or no oral health intervention.
- **Outcomes (O):**
 - Primary Outcomes: Dental caries experience (dmft/DMFT indices), periodontal health status (CPI, probing depth), glycemic control (HbA1c levels), and adverse pregnancy outcomes.
 - Secondary Outcomes: Referral adherence rates, cost-effectiveness (ROI, cost per DALY), patient satisfaction, and provider knowledge/confidence.

Eligibility Criteria

- **Inclusion:**
 - Study Types: Randomized Controlled Trials (RCTs), Cluster RCTs, Prospective/Retrospective Cohort Studies, and Economic Evaluations.
 - Timeframe: Studies published up to 2024.
 - Language: English.
 - Context: Interventions must occur within the primary care/medical setting or involve strong coordination (e.g., co-location).
- **Exclusion:**
 - Studies conducted solely within dental clinics without medical provider involvement.
 - Descriptive cross-sectional surveys without an intervention or comparison group.
 - Editorials, commentaries, and case reports.

Study Selection and Data Extraction

A systematic search was performed across five major electronic databases: MEDLINE (via PubMed), Embase, The Cochrane Library, CINAHL, and Scopus. Keywords included "primary care," "family practice," "oral health," "fluoride varnish," "screening," "referral," "integration," "interprofessional," "diabetes," and "periodontitis."

Two independent reviewers screened titles and abstracts for relevance. Full-text articles of potentially eligible studies were retrieved and assessed against the inclusion criteria. Disagreements were resolved through discussion or consultation with a third reviewer. Data were extracted using a standardized form capturing: study design, sample size, population demographics, intervention details, follow-up duration, and outcome measures (Table 1).

Quality Assessment

Risk of bias was assessed using valid tools appropriate for each study design:

- **Cochrane Risk of Bias Tool (RoB 2.0):** For RCTs, assessing domains such as randomization, deviation from intended interventions, missing outcome data, outcome measurement, and selection of reported results [20].
- **Newcastle-Ottawa Scale (NOS):** For observational cohort and case-control studies, evaluating selection, comparability, and outcome assessment [21].
- **ROBIS Tool:** For assessing the risk of bias in systematic reviews used as background evidence [22].

Data Synthesis and Analysis

Given the heterogeneity of the included studies regarding populations (children vs. adults) and interventions (fluoride vs. screening), a narrative synthesis was conducted. Studies were grouped by population type: Pediatric, Adult (Chronic Disease/Pregnancy), and Geriatric. Where data allowed, quantitative comparisons were presented in tabular format. Outcomes were synthesized to determine the direction and magnitude of effect for integrated care versus standard care.

V. Results

Study Selection

The initial database search yielded 8,731 records. After removing duplicates and screening titles/abstracts, 410 full-text articles were assessed for eligibility. A total of 49 studies met the strict inclusion criteria and were included in the review [23].

Characteristics of Included Studies

The included studies represented a diverse range of healthcare settings and populations.

- **Pediatric Studies:** focused primarily on the efficacy of fluoride varnish application and caries risk assessment by pediatricians (e.g., Pahel et al., 2011; various IMB evaluations).
- **Adult Studies:** focused on bidirectional screening for diabetes and periodontitis.
- **Geriatric Studies:** focused on nurse-led oral hygiene interventions in long-term care facilities.

Table 1: Characteristics of Key Included Studies

Study ID	Location	Design	Sample Size	Population	Intervention (I)	Comparison (C)	Primary Outcome
Pahel et al. (2011) [11]	USA (NC)	Retro. Cohort	N=95,578 (Medicaid)	Children <3 yrs	IMB Program: Screening, Fluoride Varnish by PCP	No PCP oral visits	Caries-Related Treatments (CRT)
George et al. (2018) [12]	Australia	Multi-center RCT	N=~300	Pregnant Women	MOH: Midwife screening, education, referral	Standard written info	Uptake of dental services
De Visscher et al. (2012) [15]	Belgium	Cluster RCT	N=342	Nursing Home Residents	Supervised oral hygiene guideline implementation	Usual care	Dental/Denture Plaque scores
Borgnakke et al. (2021) [24]	USA	Review/Data Analysis	N=N/A	Adults with Diabetes	Periodontal screening in medical setting	Standard care	Detection of oral-systemic risk
Braun & Cusick (2016) [4]	USA (CO)	Pilot Cohort	N=2,071	Low-income children	Co-location of Dental Hygienist in Medical Home	Standard referral	Preventive service utilization

Synthesis of Outcomes

1. Pediatric Outcomes: Caries Reduction and System Efficiency

The evidence for integrating preventive oral health into pediatric primary care is robust.

- **Caries Reduction:** The evaluation of the North Carolina "Into the Mouths of Babes" (IMB) program found that children who received **four or more** preventive visits in medical offices by age 3 had a **17% reduction** in caries-related treatments (CRT) compared to those with zero visits [11].
- **Early Intervention:** The timing was critical; simulations showed that initiating visits at 12 and 15 months could result in a **49% cumulative reduction** in CRT [11].
- **Cost-Effectiveness:** Economic evaluations of the IMB program indicated that it is cost-effective. While the program increased upfront costs due to physician reimbursement, these were offset by savings in expensive restorative dental treatments and hospitalizations for severe ECC [23].
- **Fluoride Varnish:** A meta-analysis referenced within the review found a 33% reduction in decayed, missing, and filled surfaces (dmfs) when fluoride varnish is applied 2-4 times per year, validating the clinical efficacy of the agent used by PCPs [23].

Table 2: Pediatric Outcomes - Integrated vs. Standard Care

Outcome Measure	Integrated Care (Physician FV)	Standard Care (No Physician FV)	Effect Size / Difference	Reference
Caries-Related Treatments (Age 0-6)	Lower Incidence	Higher Incidence	-17% (adj. rate ratio)	[11]
Preventive Visits (Age 0-3)	Higher (Medical + Dental)	Lower (Dental only)	Increased Access	[25]
Hospitalization for Caries	Lower Risk	Higher Risk	Cost Saving	[23]

2. Adult Outcomes: Chronic Disease Management

- **Periodontal-Diabetes Screening:**
 - **Diagnostic Yield:** Screening for periodontitis in medical settings using self-report questionnaires or visual inspection was feasible. Conversely, screening for diabetes in dental settings identified significant undiagnosed pathology. One study found that **18.1%** of patients with severe periodontitis in a dental clinic had suspected new diabetes [26].
 - **Glycemic Control:** A meta-analysis of periodontal treatment in diabetic patients showed a statistically significant reduction in HbA1c of **0.40%** (95% CI -0.77 to -0.04) compared to no treatment [5]. This suggests that facilitating referral for periodontal care through primary care screening can directly improve metabolic control.
- **Maternal Health:**
 - **Service Uptake:** The MIOH trial demonstrated that women receiving the intervention (midwifery assessment + referral) were significantly more likely to visit a dentist. However, the study did not find a significant difference in adverse birth outcomes (preterm birth, low birth weight) between groups, possibly due to the timing of intervention or other confounding variables [5].

3. Geriatric Outcomes: Institutional Care

- **Hygiene Improvements:** The implementation of supervised oral hygiene guidelines by nurses in nursing homes led to significant improvements in denture plaque scores (Effect size 0.32). However, significant reductions in dental plaque on natural teeth were harder to achieve and sustain, likely due to the practical challenges of performing oral hygiene on dependent or resistant residents [5].
- **Assessment Reliability:** Nurses using tools like the Oral Health Assessment Tool (OHAT) showed variable reliability. While video-based assessments showed promise (ICC > 0.90), standard visual assessments often missed pathology compared to dental professional exams [27].

Quality of Evidence (Risk of Bias)

- **RCTs:** The MIOH trial and nursing home cluster RCTs generally had a low-to-moderate risk of bias. Randomization processes were robust, though blinding of participants to educational interventions was not possible [12].
- **Cohort Studies:** The IMB studies utilized large administrative datasets. While they controlled for confounders like age and county-level variables, they are subject to inherent selection biases (e.g., families who seek well-child care may be different from those who do not). Propensity score matching was used to mitigate this [11].
- **Generalizability:** Most high-quality evidence originates from high-income countries (USA, Australia, Europe), which may limit applicability to low-resource settings with different workforce structures.

VI. Discussion

Summary of Main Findings

This systematic review provides compelling evidence that integrating family medicine and general practice into preventive oral healthcare enhances patient outcomes and system efficiency, though the magnitude of benefit varies by population.

- **Pediatrics:** The integration model is most mature and effective here. Primary care providers effectively serve as a "dental home" for early prevention, significantly reducing caries burden [15].
- **Adults:** The integration offers a high-yield opportunity for case-finding (undiagnosed diabetes and periodontitis). While the pathway to improved HbA1c is established, the systemic breakdown in referral adherence limits the real-world effectiveness [5].
- **Geriatrics:** Integration improves daily hygiene processes but requires sustained supervision and staffing to translate into clinical plaque reduction [15].

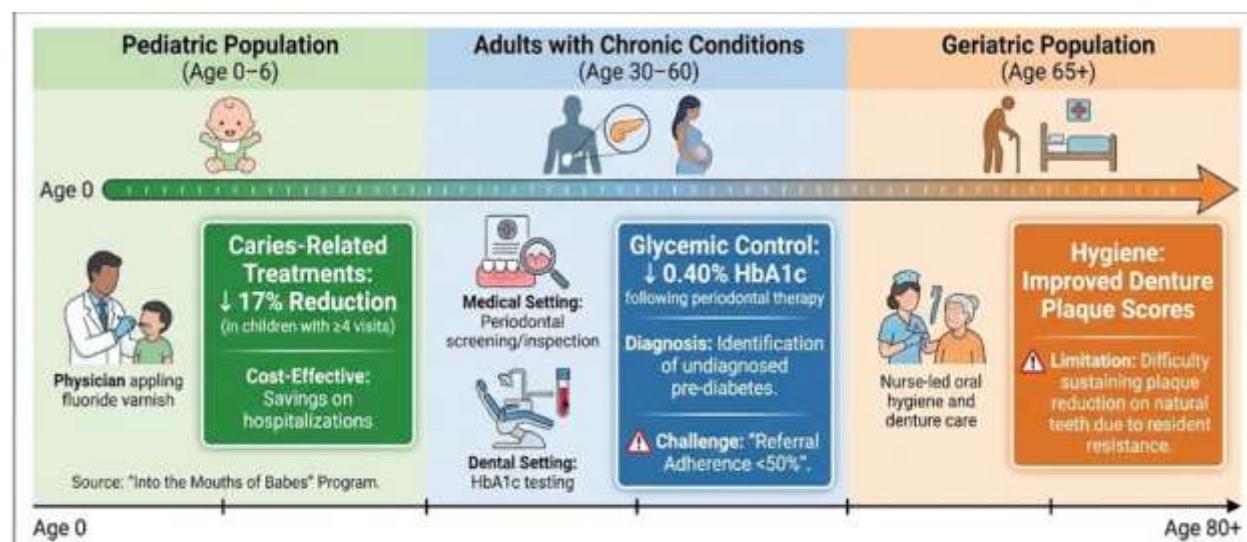


Figure 2: Systemic Outcomes Across the Lifespan

Interpretation and Comparison

The findings reinforce the "Common Risk Factor Approach" advocated by Sheiham and Watt, confirming that oral health is inextricably linked to general health.¹⁰ The results of the IMB program align with the U.S. Preventive Services Task Force (USPSTF) recommendations for primary care application of fluoride varnish [28].

However, the lack of significant birth outcome improvements in the MIOH trial contrasts with some earlier, smaller studies. This discrepancy suggests that while treating periodontitis is safe and improves oral health, it may not be a "magic bullet" for preventing preterm birth, or that interventions need to occur earlier (pre-conception) to be effective [12].

Implications for Clinical Practice and Policy

- Reimbursement Reform:** The success of the IMB model is underpinned by Medicaid reimbursement for physicians (CPT 99188). For adult integration to succeed, similar codes must be established for periodontal screening in medical visits and HbA1c testing in dental visits [6].
- Workforce Training:** The variability in nurse-led assessment accuracy highlights the need for rigorous, standardized training in oral health competencies for all primary care staff [29]. Programs like "Smiles for Life" should be mandatory in medical and nursing education [16, 30].
- Closed-Loop Referrals:** To address low referral adherence, systems must move beyond "advice" to "facilitated referral." Integrated EHRs that allow physicians to schedule dental appointments directly—or at least track their completion—are essential [7].
- Co-Location:** Models where dental hygienists are co-located in medical practices (as seen in the Colorado pilot) eliminate the referral barrier entirely and show high promise for efficiency [4].

Strengths and Limitations

- Strengths:** This review utilizes a comprehensive PICO framework covering the entire lifespan. It integrates clinical, economic, and qualitative data to provide a holistic view of the healthcare system.
- Limitations:** The heterogeneity of outcome measures (different caries indices, varying definitions of "referral") prevented a meta-analysis for adult and geriatric populations. The reliance on data from 2024 and older means very recent post-pandemic telehealth innovations may be underrepresented.

Directions for Future Research

- Economic Analysis:** More rigorous cost-effectiveness analyses are needed for adult MDI models (e.g., cost per QALY of periodontal screening in diabetes care).
- Implementation Science:** Research should focus on the "how" of integration—evaluating the impact of automated EHR prompts, patient navigators, and different payment models on referral adherence.
- Long-term Geriatric Outcomes:** Studies are needed to determine if improved oral hygiene in nursing homes translates to reduced rates of aspiration pneumonia and hospitalization.

VII. Conclusion

The integration of family medicine and general practice into preventive oral healthcare represents a vital evolution in primary care. The evidence is strongest for pediatric populations, where physician-led fluoride varnish and risk assessment significantly reduce the burden of early childhood caries and are cost-effective. For adults and the elderly, integrated care offers a critical mechanism for the early detection and management of oral-systemic conditions like diabetes and periodontitis. However, the potential of these adult models is currently constrained by fragmented reimbursement systems, lack of interoperable data, and inconsistent referral pathways. To fully realize the benefits of "whole-person" care, healthcare systems must dismantle the historic silos between medicine and dentistry, investing in interprofessional education, unified payment models, and shared health information infrastructure.

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