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Prevention of tooth loss and dental pain for reducing the global burden of oral diseases

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Population ageing is a global phenomenon and is predicted to become one of the most significant social transformations of the 21st century. The anticipated demographic shift provides governments the opportunity to proactively align policies with the estimated demands for housing, transportation, social protection, and health and well-being. Oral health is a fundamental component of health and physical and mental well-being, and is influenced by the individual's changing experience, perceptions, expectations and ability to adapt to circumstances. As such, prevention of oral disease and maintenance of oral health contributes to the systemic health, well-being, and quality of life of older adults. Dental caries, periodontal disease, and tooth loss in older adults are global health concerns because they are highly prevalent worldwide, socio-economic inequalities contribute to these diseases, many of the risk factors are modifiable, and these diseases result in compromised oral health-related quality of life. Oral care must be tailored to the needs and level of dependency of older adults through the use of evidence-based approaches and inter-professional collaboration. The persistence of between countries and within countries oral health disparities indicate that population-based policies are also needed to address the underlying social, environmental, and economic causes of oral diseases.

Key words: Older adults, dental caries, periodontitis, prevention

INTRODUCTION

Population ageing is a global phenomenon and is predicted to become one of the most significant social transformations of the 21st century¹. By 2050, the global population aged 60 years or older is projected to reach 2.1 billion, doubling its current size, with persons aged 80 years or older exhibiting the fastest growth of any age group¹. The anticipated demographic shifts provide governments the opportunity to proactively align policies with the estimated demands for housing, transportation, social protection, and health and well-being¹. In 2016, the World Health Assembly adopted a Global strategy and action plan on ageing and health, with strategic objectives to promote healthy ageing in every country, defined as 'the process of developing and maintaining the functional ability that enables well-being in older age'². The FDI World Dental Federation recently defined oral health as being a fundamental component of health and physical and mental well-being, which exists along a

continuum influenced by the values and attitudes of individuals and communities, and is influenced by the individual's changing experience, perceptions, expectations and ability to adapt to circumstances³. As such, prevention of oral disease and maintenance of oral health contributes to the systemic health, well-being, and quality of life of older adults.

WHY DO WE NEED TO APPROACH THE CARE OF OLDER ADULTS DIFFERENTLY THAN WE DO FOR YOUNGER ADULTS?

Social inequities follow the life course, such that childhood oral health and socioeconomic status predict adult oral health⁴. Younger adults' access to prevention and treatment, food and beverage choices, and alcohol and tobacco use are determinants of their oral health needs when aged⁵. Dental caries and periodontal disease are chronic conditions, highly prevalent, largely irreversible, and cumulative in nature^{6,7}. Therefore, maintaining or restoring the oral health of

older adults is more complicated than for younger adults, and when one considers that elders present with wide-ranging levels of well-being, chronic disease, and functional ability, patient management becomes more complex.

In addition to the social inequities that manifest in older adults, societies and providers have unconscious biases around ageing, which affects oral health expectations and delivery of care⁶. For example, a study of frail older adults found that there was a polarised delivery of dental care during the last year of life, when half of elders received no treatment while the other half received full usual care, with treatment completed within the last three months of life⁸. This study illustrates the need for a life-course approach to oral health, as receiving no treatment increases the risk of dental pain and infection which can cause life-threatening complications, limit nutritional intake, compromise quality-of-life, and accelerate functional decline; while conversely, overtreatment can cause unnecessary pain, distress, decrease functional reserves, increase risk of systemic complications, and depletes limited healthcare resources⁸. There are several existing frailty indices that can be used to provide a life-course approach to oral health – the Seattle Care Pathway was compiled and adapted to be relevant specifically to dentistry⁹. It is a structured, evidence-based approach to care, with predictive capability. The framework consists of five levels of dependency, each of which requires appropriate assessment, effective prevention, treatment linked to the level of dependency, and appropriate oral health communication⁹. The Seattle Care Pathway guides the provision of care both between individuals with differing levels of dependency and within an individual as the dependency level changes with progressive ageing, as well as provides an opportunity for an inter-professional approach to the oral care of older adults.

WHAT IS THE EXTENT AND IMPACT OF ORAL DISEASE IN OLDER ADULTS?

The Global Burden of Disease 2010 Study determined untreated caries in permanent teeth to be the most prevalent disease worldwide, affecting 35% of the global population¹⁰. This age-standardised prevalence hasn't changed between 1990–2010, and varies greatly between countries, with the Central Europe region having the highest prevalence of untreated caries at 47%, to the Australasia region having the lowest prevalence at 20%. Prevalence peaks occur at ages 25 years, perhaps due to the wash-out of school-based prevention efforts, and at 70 years as root caries emerge. Globally, 11% of adults have severe periodontitis and this age-standardised prevalence also hasn't changed between 1990–2010¹¹. Prevalence

increases gradually with age, peaking in 40-year olds, and remaining stable at older ages. There is tremendous geographic variation in the prevalence of severe periodontitis for community-dwelling older adults, ranging from 51% of those aged 65 years and older in East Sub-Saharan Africa, to only 10% of elders living in the Oceania region.

Worldwide, 2.3% of adults were found to be edentate, reflecting a 45% decrease in the prevalence between 1990–2010, which may indicate increasing effectiveness for the prevention and treatment of caries and periodontitis⁶. Not surprisingly, edentulism increases exponentially with age, with prevalence peaking in 65-year olds. Again, there is large geographic variation in the prevalence of edentulism for older adults, ranging from 30% of those aged 65 years and older in the Andean and Tropical regions of Latin America, to just 9% of elders living in East Asia. In a developed country such as the U.S.A. where edentulism is declining, older adults have an average of 19 remaining teeth¹², which is less than the 20 teeth needed for a functional dentition¹³. Fewer than 20 teeth, regardless of the use of partial or complete dentures results in: chewing longer and swallowing larger particles; compensation by over-preparing and over-cooking foods; decreased vegetable, fruit, and fibre consumption; increased fat, sugar, and calorie consumption; and results in decreased blood levels of vitamins, minerals, and serum albumin¹⁴.

The Global Burden of Disease 2010 Study also calculated the disability-adjusted life-years (DALYs) for untreated caries, severe periodontitis, and edentulism. These three oral conditions combined accounted for 15 million DALYs globally in 2010, which implies an average health loss of 224 years per 100,000 population¹⁵. DALYs due to oral conditions increased 21% between 1990–2010, principally due to population growth and population ageing. The accompanying direct treatment costs of US\$298 billion and indirect productivity loss costs of US\$144 billion represent approximately 7% of global health expenditures, indicating a high relevance for oral disease prevention¹⁶. Between and within countries oral health disparities mirror those found for general health and the inequalities follow a social gradient, signifying an underlying influence of psychosocial, economic, environmental, and political determinants on oral health¹⁷. Older adults accounted for 3.5 million of the DALYs, primarily due to edentulism, followed by severe periodontitis, and then untreated caries¹⁵.

Although the Global Burden of Disease 2010 Study reports population-based estimates of oral disease for community-dwelling older adults, disease estimates for frail elders are usually from smaller cross-sectional studies. Nevertheless, the estimates are quite similar

across studies, and indicate levels of disease 2–3 times higher than that found in community-dwelling older adults. For example, an oral health assessment of homebound older adults living in New York City found that 79% of the frail elders had untreated caries, 96% received no dental visit since becoming homebound, and only 46% could eat comfortably¹⁸. A probability sample of long-term care residents in Massachusetts were also found to have high caries prevalence (59%), 34% had major-urgent treatment needs, and half of those who were edentulous did not have any dentures¹⁹.

WHAT ARE BEST PRACTICES FOR PREVENTING DENTAL CARIES IN OLDER ADULTS?

The current approach to oral disease prevention is to identify high-risk individuals through screening and offer therapeutic interventions. The screening test must have high sensitivity, specificity, and predictive power¹⁷. Low validity of the screening test may lead to misclassification of risk, inappropriate prevention measures, incorrect periodicity of continuing care appointments, and overlooking additional diagnostics (e.g. saliva flow) which decreases the effectiveness of interventions and increases costs. Additionally, heterogeneity in how caries is defined and measured challenges the estimates of disease, accuracy of risk assessment, and measurement of clinical interventions^{20–22}. Several systematic reviews have evaluated the diagnostic accuracy of various caries risk assessments for predicting the development of coronal caries, from single-item measures to multiple-factor tools. Collecting information on a large number of factors was no more accurate than using just a few²³. Past caries experience remains the best predictor of future caries,^{17,24,25} with the caveat that previous caries may lose its predictive ability with successful interventions and risk factor reduction²³. The Caries Management by Risk Assessment (CAMBRA) tool takes into account the multifactorial nature of caries and has been found to successfully differentiate between high and extreme caries risk versus low risk to predict incident caries, but not between medium versus low caries risk to predict incident caries^{26,27}. CAMBRA assesses disease indicators (e.g. radiographic caries), caries protective factors (e.g. adequate saliva), and caries predisposing factors (e.g. snacking). Caries imbalance towards disease progression occurs when disease indicators and risk factors outweigh protective factors. Using a structured form such as CAMBRA promotes systematic assessment of multiple caries risk factors, determines therapeutic interventions, appointment frequency, and provides objective records over time²⁸.

Most studies of caries prevention and arrest have occurred in children. *Table 1* summarises root caries

prevention and arrest in older adults and includes a cost analysis. Various formulations of toothpaste used twice daily were found to be highly effective in preventing and arresting root caries: 1,100 ppm sodium fluoride was compared to placebo whereas triclosan with fluoride, amorphous calcium phosphate, and 5,000 ppm fluoride pastes were compared to 1,100 ppm sodium fluoride^{21,22}. Compared to placebo, daily rinsing with over-the-counter fluoride rinse had a low effect preventing root caries, and chlorhexidine rinse was not significant^{21,22}. Applying sodium fluoride or chlorhexidine varnishes four times per year and yearly application of silver diamine fluoride solution were moderately-highly effective preventing and arresting root caries^{21,22,29–31}. Costs per year are estimated in U.S. dollars, based on average prices found online. Varnish and silver diamine fluoride costs reflect that for only the product itself and do not take into account any professional application fee. The three over-the-counter toothpastes cost significantly less than the prescription strength, and once yearly silver diamine fluoride was the least expensive to apply clinically.

WHAT ARE BEST PRACTICES FOR PREVENTING PERIODONTAL DISEASE IN OLDER ADULTS?

There are many challenges for measuring and reporting periodontal disease, such as: how cases are defined, is pocket depth or attachment loss measured, what instrument is used for measurement, how many sites per tooth are measured, are index teeth/quadrant/half-mouth/whole-mouth measured, and how is site-specific information summarised¹¹. This heterogeneity in how periodontitis is defined and measured challenges the accuracy of risk assessment, estimates of the disease, and measurement of clinical interventions^{7,32}.

Although chronic gingivitis is recognised as a potential risk factor for developing periodontal disease, currently there is no way to predict which form will progress³³ nor is there a consensus on the definition of disease progression³². Single-item predictors of disease progression such as bleeding on probing, suppuration, or probing pocket depth only have 30% positive predictive value³². The multilevel Periodontal Risk Assessment (PRA) tool assesses bleeding on probing, pocket depth, tooth loss, periodontal support in relation to age, systemic and genetic conditions, and environmental and behavioural factors³⁴. A systematic review of the ability of periodontitis risk assessment tools to predict periodontitis progression in patients who had undergone initial treatment for periodontal disease demonstrated that PRA had good differentiation in identifying patients with low-medium risk for disease progression versus high risk^{32,35}.

Table 1 Root caries prevention: effectiveness and cost analysis

Root caries aged 65 + years old	1100 ppm NaF toothpaste	F-Triclosan toothpaste	F-ACP toothpaste	5000 ppm F toothpaste	225-900 ppm F rinse	NaF varnish	Chlorhexidine varnish	Silver diamine fluoride
Prevention	67% ²²	90% ²²	98% ²²	RR = 0.49²¹ 52%–82% ²²	MD = -0.18²¹ 36% ²²	56%–64% ^{22,31} 54–92% ²²	MD = -0.67²¹ 41% ⁶ –57% ^{22,31}	MD = -0.33²¹ 72% ^{22,31} MD = -0.24³⁰ 90% ²⁹
Cost/Year \$USD	\$36	\$48	\$72	\$365	\$64	\$7	\$12	\$1

NaF, sodium fluoride; F, fluoride; ACP, amorphous calcium phosphate; MD, mean difference; RR, relative risk. Bold, meta-analysis; otherwise randomised clinical trial.

Using the structured PRA form is useful for identifying reinfection and progression of disease, and customising the content and frequency of supportive periodontal therapy appointments³⁴.

Most periodontal disease prevention recommendations for older adults are extrapolated from studies of younger adults³⁶. *Table 2* summarises the effectiveness and cost analysis of periodontal disease prevention interventions. Comparing professional mechanical plaque removal (prophys) every three months versus yearly in adults without severe periodontitis showed a low reduction in plaque and gingivitis indices, but prophys every six or twelve months did not demonstrate any significant reduction³⁷. Using a powered toothbrush compared to a manual brush yielded a low-moderate reduction in plaque and gingivitis³⁸. Adding interdental brushing or flossing to daily tooth brushing resulted in a moderate-high reduction in plaque and gingivitis after three months³⁹. Brushing with triclosan-fluoride toothpaste compared to fluoride paste reduced plaque, gingivitis, and bleeding scores a low-moderate amount, but did not have a significant effect on attachment loss⁴⁰. Regular rinsing with chlorhexidine compared to placebo reduced plaque, gingivitis, and bleeding scores⁴¹ but had no effect on preventing tooth loss⁴². Regular rinsing with mouthwash containing essential oils reduced plaque and gingivitis scores a moderate amount⁴³. Costs per year are estimated in U.S. dollars, based on average prices found online. Daily interdental brushing or flossing appears to be the most effective for reducing plaque and gingivitis scores, and is also the least expensive preventive therapy.

HOW CAN THE ORAL HEALTH OF OLDER ADULTS BE IMPROVED?

In addition to approaching oral health risk assessment, prevention, and treatment using an evidence-based approach such as the Seattle Care Pathway⁹, inter-professional collaboration is needed to raise the awareness of oral health's contributions to systemic health and quality of life. Many chronic diseases including oral diseases share common modifiable risk factors (such as tobacco and alcohol use, sugar consumption, and poor nutrition intake), which, with a population-based, common risk factor approach, can benefit from the formation of inter-professional coalitions such as those supporting water fluoridation, tobacco regulation, nutrition guidelines at schools, and soda taxes^{17,33}.

Most older adults have at least one chronic disease and receive care from multiples providers, often in the absence of any coordination and communication between the different providers⁴⁴. Managing chronic disease, such as diabetes, benefits from a collaborative

Table 2 Periodontitis prevention: effectiveness and cost analysis

	Prophylaxis q3 <i>versus</i> 12 months	Powered toothbrush	Add interdental brushing	Triclosan toothpaste	Chlorhexidine rinse	Essential oils rinse
Plaque index	MD = -0.15³⁷	MD = -0.47³⁸ (21%) ³³	MD = -0.95³⁹ (32%) ³⁹	MD = -0.47⁴⁰ (22%) ⁴⁰	MD = -0.68⁴¹ (33%) ⁴¹	MD = -0.39⁴³
Gingivitis index	MD = -0.21³⁷	MD = -0.21³⁸ (11%) ³⁸	MD = -0.53³⁹ (34%) ³⁹	MD = -0.27⁴⁰ (22%) ⁴⁰	MD = -0.24⁴¹ (26%) ⁴¹	MD = -0.36⁴³
Bleeding index				MD = -0.13⁴⁰ (48%) ⁴⁰	MD = -0.21⁴¹	
Attachment loss				Not significant⁴⁰		
Tooth loss					Not significant⁴²	
Cost/Year \$USD	\$320	\$50	\$32	\$48	\$342	\$58

Bold, meta-analysis; otherwise randomised clinical trial
MD, mean difference.

care model, where primary care providers and specialists work together to advise and educate patients about diabetes prevention and management⁴⁵. The Centers for Disease Control and Prevention has created a diabetes toolkit for pharmacy, podiatry, optometry, and dentistry, which includes how each of the four specialties relate to diabetes, inter-professional patient education and care checklists, and collaboration strategies for providers⁴⁶.

Currently, the oral health assessments provided in long-term care facilities are typically performed by nurses, often without training or calibration¹⁹. Residents are often without basic oral hygiene supplies such as toothpaste and a toothbrush, and only a fraction of those who require help with their daily mouth care receive any assistance⁴⁷. Unfortunately, when low priority is given to oral health, it results in normalisation for providing none-minimal mouth care. Therefore, working with long-term care facilities is an inter-professional opportunity for dentistry. Dental providers (dentists, hygienists, therapists) need to perform the oral health assessment or train and calibrate nurses to do so. Dental providers also need to deliver ongoing in-service training for daily mouth care and participate in the generation of an inter-professional care plan¹⁹. A collaborative practice and referral approach between dentistry and primary care providers who make house-calls would allow physicians and nurse practitioners to provide oral health screening, referral for care, and simple preventive interventions such as fluoride varnish and silver diamine fluoride application, while dentists could provide chairside screening and referral for diabetes, hypertension, and high cholesterol⁴⁸.

The World Health Organization's (WHO) Global Oral Health 2020 Objectives aim to reduce morbidity from oral diseases and increase oral health-related quality of life; provide cost-effective prevention programmes; integrate oral and systemic health promotion using the common risk factor approach; and implement policies that are evidence-based⁴⁹. WHO

recommendations for public health policy use a combination of identifying and targeting high-risk individuals with a population-based, common risk factor approach¹⁷. Dental caries, periodontal disease, and other chronic diseases share common risk factors such as poverty, poor diet, and tobacco use⁵. The persistence of between countries and within countries oral health disparities, despite the traditional biomedical model of changing the behaviours of high-risk individuals, indicate that the causality of oral diseases extends beyond individual lifestyle and biological risk factors. Therefore, population-based policies are also needed to address the underlying social, environmental, and economic causes of oral diseases. For example, community water fluoridation is the most cost-effective and efficient means for preventing caries for all age groups, including older adults¹⁹.

CONCLUSION

Dental caries, periodontal disease, and tooth loss in older adults are global health concerns because they are highly prevalent worldwide, are increased by social inequalities, many of the risk factors are modifiable, and they result in compromised oral health-related quality of life. Oral care must be tailored to the needs and level of dependency of older adults, and health outcomes can improve with inter-professional collaboration.

Systematic reviews of root caries prevention and arrest have recommended for community-dwelling older adults the daily use of over-the-counter triclosan-fluoride or amorphous calcium phosphate-fluoride toothpaste²². Recommendations for frail older adults, who are homebound or living in long-term care include daily use of prescription-strength 5,000 ppm fluoride toothpaste and either fluoride or chlorhexidine varnish applied four times per year or silver diamine fluoride applied yearly to decrease the initiation and progression of root caries^{21,22}. Daily oral hygiene practices are more effective for removing

plaque and preventing gingivitis than are periodic dental prophylaxes⁵⁰. Powered toothbrushes, interdental brushes or floss, triclosan toothpaste, and chlorhexidine and essential oil rinses provide adjunctive plaque control to daily brushing habits^{38–41,43}. Repeated and tailored oral hygiene instruction, using a structured approach, is key for gingival health³⁵. However, interventions that reduce plaque and gingivitis have not been shown to translate into preventing attachment or tooth loss^{40,42}.

As the world's population ages, evidence-based policies are needed to address both population-based, upstream social determinants of health, as well as identifying and targeting interventions to high-risk individuals.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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