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REVIEW ARTICLE

The value-for money of preventing and managing periodontitis: Opportunities and challenges

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Abstract

This article gives an overview of the societal and economic aspects of periodontitis and periodontal care. Despite its largely preventable nature, periodontitis is highly prevalent worldwide and imposes a substantial health and economic burden on individuals and society as a whole. The worldwide estimated direct treatment costs and productivity losses due to periodontitis (including for periodontitis-related tooth loss) amounted to US\$ 186 billion and US\$ 142 billion in 2019, respectively. The burden of periodontitis is particularly evident in low and disadvantaged populations. Smoking, dietary habits, and presence of systemic diseases along with social and commercial determinants are considered as risk factors for the periodontal diseases. The cost-effectiveness of preventing and managing periodontitis has been explored in several studies but it has been highlighted that there is scope for improvement in defining the methodology and quality of reporting of such studies. A recent report by The Economist Intelligence Unit examined the cost-effectiveness of interventions to prevent and manage periodontal diseases, suggesting that prevention of periodontitis through prevention of gingivitis by means of individual home care would be more cost-efficient than four other examined approaches. Future research in this field is recommended to further decipher the economic burden of periodontitis to society and to assess the value for money of alternative approaches to address periodontitis with particular emphasis on public health preventive strategies and intersectoral care approaches that address the common risk factors of periodontitis and other non-communicable diseases simultaneously.

KEYWORDS

cost-effectiveness analysis, economic burden, health economics, health expenditures, health resources, oral health promotion, periodontal diseases

1 | INTRODUCTION

Periodontitis is a complex disease with multiple component causes,¹ many of which represent shared risk factors for other systemic non-communicable diseases (NCDs) of aging. Unsurprisingly,

periodontitis has therefore been studied as a risk indicator for over 57 NCDs in clinical trials with varying levels of association demonstrated,² the strongest being with type-2 diabetes, where evidence demonstrates tangible health economic as well as human benefits from improving periodontal health.^{3,4} However, given the

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mentioned shared risk factors, periodontitis is also widely regarded as a social disease, clustering in those individuals with specific behaviors and from areas of high deprivation⁵⁻⁷ rendering the periodontium and oral cavity in general, markers of people's social position and future disease risk. Klinge and Norlund identified stark associations between low-socioeconomic circumstances and poor periodontal health in a review⁷ and demonstrated that those affected by socioeconomic disadvantages are likely to have fewer teeth when compared to population groups with higher socioeconomic status and education levels.⁸ Recent evidence is confirmatory of a causal relationship between socioeconomic status and oral health.^{6,9}

Monitoring the true prevalence of periodontitis has been hampered for decades by a lack of consensus case definitions until the publication of the 2018 International Classification of Periodontal Diseases and Conditions.¹⁰ The most universally accepted definition, and hence that employed by the Global Burden of Disease studies has been that of "severe periodontitis" based upon probing pocket depths of 6 mm or greater, a threshold defined as a code 4 in the Community Periodontal Index of Treatment Need.¹¹ Age-standardized prevalence rates for severe periodontitis between 1990 and 2010 were static at 11.2%¹² and in 2015 were estimated at 7.8%, approximating 573 million people and accounting for 3.5 million disability-adjusted life years (DALYs).¹³ The 2022 WHO Global Health Status Report calculated the prevalence of severe periodontitis in people over 15 years of age in 2019 as 18.18%, representing more than 1 billion cases worldwide, with the highest case numbers being in lower-middle-income countries, using the World Bank definitions for country income groups.¹⁴

The human cost of periodontitis has traditionally been underappreciated, with the disease regarded as being a "silent disease". However, increasing attention to patient-reported outcomes (PROs), including quality of life, has demonstrated that periodontitis negatively impacts speech, nutrition, self-confidence, and overall well-being.^{15,16} Sharma and colleagues employed mixed-effects logistic regression to examine associations between different states of periodontal health and disease and PROs of pain/discomfort, dietary restriction, and dissatisfaction with appearance in a longitudinal study of 13 162 dentate patients. The setting was 238 non-specialist dental practices and 162 dentists across the UK. They demonstrated that the odds of all PROs tended to increase with worsening periodontal parameters.¹⁷

Periodontitis incurs a significant economic burden and has a substantial effect on patient's general health and quality of life.^{13,18-20} Rising prevalence rates and the demonstrated strong association between periodontitis and systemic diseases further contribute to the economic burden of these diseases.²¹ It also gives rise to the question regarding the optimal use of available resources. Identifying economic information in the context of periodontitis is critical for resource allocation and policy decision making.²² Policymakers rely on economic evaluation for optimal distribution of resources and maximization of oral health gains. Economic evaluation involves comparing outcomes across

different types of health programs using preference-based measures such as quality-adjusted life years (QALY)/quality-adjusted tooth years (QATY), and healthy year equivalent (HYE). The lack of preference-based measures such as QALY is a limitation in dentistry. If utility maximization is the objective, a potential solution is the measurement of outcomes in the form of 'willingness to pay' which allows meaningful comparisons across various programs within and outside healthcare.²³

Another influencing factor for the cost burden is the role of payment systems in oral health care provision. Previous studies support the supplier inducement hypothesis within dentistry where the demand for care remains influenced by supply. Service utilization is typically increased when the supply of dentists increases, therefore impacting negatively on oral health.²³ Reforming the provider payment systems with a focus on the results rather than services is deemed beneficial. A further issue is the failure to prioritize needs based oral health care programs and services, particularly in low-resource settings. This requires sound epidemiological data for identifying a population's oral health needs as a basis for developing, testing, and implementing oral health interventions and programs.^{23,24}

Given the prominent impact and implications of periodontal diseases, attention to the aforementioned economic insights and their application in preventing and promoting oral health is appropriate. This article aims to summarize the global, societal, and economic aspects of periodontitis and economic evaluations in periodontal care while exploring future opportunities for reducing the economic burden and improving the quality of health economic research.

2 | ECONOMIC BURDEN OF PERIODONTITIS

The economic burden of periodontitis encompasses direct (treatment expenditures), indirect (productivity losses due to absence from work and school), and intangible costs (pain, self-esteem, problems with chewing, eating, and speaking, aesthetics, quality of life).

Direct treatment costs due to dental diseases worldwide were previously estimated at US\$ 298 billion in 2010, US\$ 356.80 billion in 2015, and US\$ 387 billion in 2019.^{19,20,25} A considerable proportion of worldwide dental expenditures is arguably attributable to periodontitis, but exact estimates are complicated by the limited availability of country-level data on periodontal expenditure. By using the previously published estimates on the global burden of dental disease¹³ and considering the nature of periodontitis being closely linked with tooth loss (with 35.7% of the tooth loss being attributable to periodontitis),²⁶ it was estimated that 48% of the global burden of dental disease is attributable to periodontitis. This resulted in economic direct costs of severe periodontitis amounting to US\$ 186 billion. Excluding the costs due to tooth loss as a consequence of periodontitis resulted in a total of US\$ 104 billion. The method of estimation is analogous to a previous report²⁷ taking global

TABLE 1 Total costs attributable due to severe periodontitis.

Cost categories	Description	Costs (US\$) (directly attributable to periodontitis) (billion)	Costs (US\$) (directly attributable to periodontitis & indirectly attributable to tooth loss due to periodontitis) (billion)
Direct costs	Expenditures associated with treatment and management of periodontitis	104	186
Indirect costs (productivity losses)	Expenditures associated with absence from school and work	82	142

economic costs for 2019 into account.²⁵ This methodology takes into account the assumption that treatment costs are distributed in proportion to the burden of disease (i.e. DALYs) for the dental conditions.²⁷ A detailed description of estimation of costs is presented in [Appendix 1](#). In an attempt to identify the treatment costs of periodontal diseases, a previous study estimated periodontal treatment costs in 2018 as US\$ 3.49 billion for the US and US\$ 2.52 billion for 32 European countries.²⁸

Indirect costs are costs related to the productivity losses arising due to periodontitis. The worldwide productivity losses directly attributable to periodontal diseases were estimated at US\$ 82 billion in 2019.²⁵ It has been suggested that productivity losses would be higher if also considering edentulism and caries as a consequence of periodontitis.²⁸ Total productivity costs were US\$ 142 billion when edentulism was also considered as a consequence of periodontitis (see [Appendix 2](#) for details). Botelho et al. reported the indirect costs due to periodontitis amounted to US\$ 150.57 billion in the US and US\$ 156.12 billion in European countries with the majority of projected indirect costs being attributable to edentulism related to periodontal diseases and periodontitis.²⁸ Direct and indirect costs attributable to periodontitis are presented in [Table 1](#).

Intangible costs resulting from periodontal diseases and their consequences should also not be disregarded. From a functional perspective, sensitivity, loss of gingival and periodontal tissue, and loose or lost teeth may affect a patient's ability to chew or speak efficiently. These symptoms combined with severe side effects such as bleeding gums and halitosis can give rise to embarrassment, shame, and anxiety affecting self-confidence and emotional well-being.

3 | VALUE FOR MONEY OF PREVENTING AND MANAGING PERIODONTITIS

3.1 | Frameworks for health economic evaluation

Decision-makers face challenges when seeking to maximize health outcomes from available resources. In such instances, certain opportunities will be taken up while others must be foregone, and the benefits are associated with foregone opportunities.²³ Health economic evaluation of various routes of action for preventing and managing oral diseases is essential to inform health care decision making. An economic evaluation compares both the costs and health benefits of two or more interventions in a systematic manner which helps to identify the value for money of alternative routes of action. Depending

on how the health outcomes are measured, different types of economic evaluations can be distinguished. Cost-effectiveness analysis measures outcomes in natural units, such as the number of deep periodontal pockets avoided. The incremental cost-effectiveness ratio (ICER) is a summary measure that is calculated to assess the most cost-effective option.^{23,29} In cost-utility analysis, the effects of treatment are measured in terms of quality-adjusted life years (QALY) gained, which take both quality of life and life expectation of time into account.²⁹ A cost-benefit analysis expresses the health benefits in monetary units. Costs and benefits are directly compared with each other.²³ Program budgeting and marginal analysis can play a role in the efficient allocation of available resources where costs and benefits of various healthcare activities are considered through deliberative dialog with the involvement of various stakeholders.^{23,30}

Several strategies to control and prevent periodontitis such as a public health approach for improving people's health behaviors (e.g. public campaigns to reduce tobacco consumption and to raise oral health awareness),³¹ promotion of home-based oral hygiene (e.g. digital tools that help empower patients alongside their journey through periodontal care),³² chairside oral health prevention (chairside advice and counseling)³³ and clinical treatment of periodontitis (surgical and non-surgical procedures)³⁴ have been recognized. In addition to improving periodontal health status, the prevention and management of periodontitis are known to control and ameliorate several chronic systemic diseases.³⁵⁻³⁷ Evidence suggests that glycemic control in patients with type 2 diabetes improved after periodontitis treatment.³ This is a potentially promising aspect from public health and economic viewpoints.

3.2 | Overview of previous literature on the value-for money of approaches to address periodontitis

Based on recent literature that provided an overview of existing economic evaluations about periodontal diseases,^{38,39} the current knowledge on the value for money of approaches to prevent and manage periodontal diseases presents as follows: Tay et al. examined the types and quality of reporting of health economic evaluations in the clinical management of periodontal diseases over 32 years from 1987 to 2019. The studies included interventions ranging from periodontal treatment approaches to oral health instruction delivery and used all the main methods such as cost-effectiveness, cost-utility, and cost-benefit analysis. The quality of

the economic evaluations was assessed using the CHEERS checklist. The authors stressed that although there has been an increase in the number of health economic studies in clinical periodontology in the past decade, several of them did not report the study perspective, characterizations of heterogeneity, and measurement of effectiveness. In contrast, comparators, choice of health outcomes and estimations of resources and costs, and key study findings were always fully reported.³⁸

In studies related to dental caries and periodontitis, dental outcome measures are generally emphasized due to their specificity and relevance to oral health conditions. However, there is a growing recognition of the importance of incorporating generic outcome measures. A review by Nguyen et al.³⁹ examined the economic evaluation methodology for preventive interventions for dental caries and periodontitis with studies covering post 2000 to April 2021. The interventions were included based on a framework that was developed for dental caries and periodontitis which included universal, selective, and indicated interventions. Supportive periodontal therapy with oral health education was the frequently evaluated preventive intervention for periodontitis. Drummond's 10-point checklist was used to appraise the quality of the studies which showed that most trial-based and model-based studies were of good quality. The authors emphasized that the methods used in the economic evaluations were diverse relating to the cost components, the consequences, and health outcomes giving rise to difficulty in comparing the interventions. Future research using generic health outcome measures was recommended by the authors.

Economic evaluations of interventions focusing on the prevention and treatment of periodontitis have been published previously. A study conducted in the UK explored the cost-utility of periodontal treatment in diabetic patients and showed that the incremental cost-effectiveness ratio (ICER) was £26 000–£28 000 per QALY which is

below the accepted threshold of £30 000 per QALY.⁴⁰ Recently, a microsimulation model to estimate the cost-effectiveness of periodontal treatment among type 2 diabetes patients showed that providing periodontal treatment would be cost saving from a healthcare perspective at a total net savings of \$5904 and a gain of 0.6 QALY per capita.⁴¹ Another study that investigated the economic evaluation of a community based oral health promotion program to improve the gingival health of older adults in Australia reported the program to be highly cost effective and an efficient use of society's financial resources.⁴²

3.3 | The “Time to Take Gum Disease Seriously” report by The Economist Intelligence Unit

Given the persistent prevalence and its costs to individuals and society, the European Federation of Periodontology (EFP) commissioned The Economist Intelligence Unit (now Economist Impact) in 2020 to undertake an analysis of the economic and societal impact of periodontitis across 6 major European economies.⁴³ The EFP's objectives were to:

- raise awareness of periodontitis, to drive policy and behavior change on periodontal health,
- develop new ways of thinking about periodontal health to increase public engagement,
- increase the commitment of public health bodies at the European level,
- improve patient outcomes.

The Economist Impact (EI) published its White Paper in June 2021. The remainder of this section will present the objectives and outcomes of that analysis, focusing on the pathway of care model (Figure 1) that underpinned the analysis.

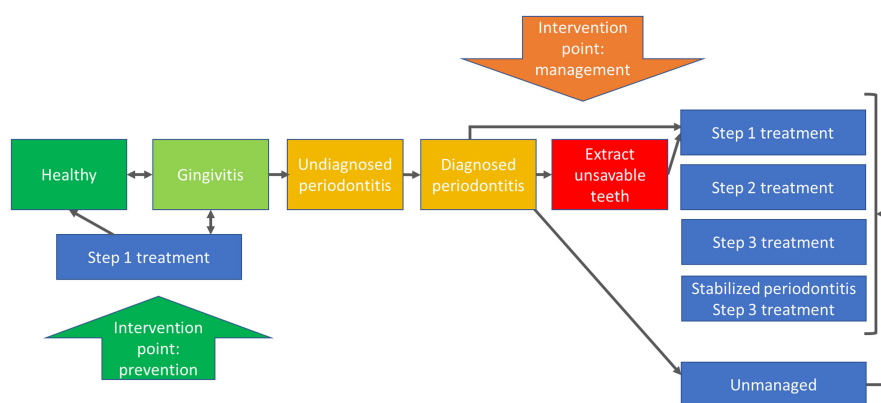


FIGURE 1 Care pathway for periodontal diseases based on the S3-level clinical guideline for stages I–III periodontitis.⁴⁶ The pathway includes a preventive intervention point to maintain periodontal health or to restore it by managing gingivitis, and a periodontitis intervention based upon the EFP's “Steps of Care” within the S3-level guideline. The model permits individuals to transition from health to gingivitis; gingivitis back to health, or forward to undiagnosed periodontitis (that is unmanaged); to diagnosed periodontitis; diagnosed periodontitis that is unmanaged or to step one of treatment; step one to step two, or to step four management, or remain unmanaged; step two to step three or to step four management or remain unmanaged; step three to step four management or remain unmanaged. Individuals can also return from step four management to step three or become unmanaged. Importantly, individuals cannot return to clinical health once they have developed periodontitis, but they can become “stable”.

There were four phases to accomplishing the White Paper:

1. The EI team undertook an independent narrative literature review to evaluate the prevalence and burden of periodontitis and to review the clinical care pathways and policies for prevention. EFP experts provided additional supplemental literature to facilitate the review.
2. An expert panel was convened by the EI team to discuss and help understand the critical issues for policy change to help prevent poor oral health.
3. A quantitative analysis was conducted to assess the health and economic costs of periodontitis in each of the six countries included in the study, which were France, Germany, Italy, the Netherlands, Spain, and the UK. The choice of countries to underpin the modeling was based on major European economies for which financial data to underpin the economic model was available.
4. The white paper was written and published providing a summary of findings from the literature review, expert panel discussions, quantitative analysis, and summary recommendations.

The primary outcome of the economic analysis was the return on investment (ROI) from each of the five scenarios, when compared with "business as usual," where treatment rates, dental coverage, and management of gingivitis and periodontitis for the population were assumed to continue as current.

Secondary outcomes included:

- Total HLYs gained.
- Total costs (in Euros).
- Cost per HLY.
- Incremental cost-effectiveness ratio.

Stage II periodontitis C8 was chosen as the most prevalent form of the disease upon which to base the cost analysis and costs were calculated over 10 years. The costs included in the model were direct costs of care, indirect costs (e.g. time away from work), and intangible costs (pain, difficulties with speech, low self-confidence, problems with expressing emotions such as smiling).⁵ The care pathway

model (Figure 1) included intervention points that were preventative and also those designed to treat periodontitis once established. The scenario's modeled were:

Scenario 1 – Baseline comparator: *Business as usual.*

Scenario 2 – Extreme negative scenario: *Reduce rate of gingivitis management to 10%.*

Scenario 3 – Extreme positive scenario: *Incident gingivitis is eliminated through improved oral homecare.*

Scenario 4 – Extreme negative scenario: *No periodontitis is managed.*

Scenario 5 – Extreme positive scenario: *90% of periodontitis is diagnosed and managed.*

The cost of continuing with scenario 1 (business as usual) ranged from €18.7 billion in the Netherlands to €96.8 billion in Italy over the 10-year time horizon. The high costs in Italy relate to care being provided exclusively privately and involving high levels of periodontal surgery. In the UK and France, while public funding for care is provided to a degree, there remain significant out-of-pocket costs (patient contributions), although the latter has changed and been removed in France since the White Paper was published. Scenario 2, of reducing gingivitis management, resulted in a reduction in healthy life years in all countries and yielded a negative ROI. Eliminating gingivitis through professionally coached home care (scenario-3) led to increases in healthy life years, reduced costs, and a strong ROI in all countries studied, irrespective of their funding model (Table 2). Scenario 4 of not managing periodontitis, resulted both in reductions in healthy life years and a negative ROI for all countries. The final scenario of diagnosing and managing 90% of periodontitis was predictably the most expensive to deliver, due to the additional time and resources required (Table 2).

Interestingly, both scenarios 3 and 5 provided a positive ROI in all countries modeled, the magnitude being substantially higher for scenario 3 focusing on prevention of periodontitis by preventing or treating gingivitis. Given that behavior change for risk factor control, including improvements in oral hygiene provides substantial reductions in periodontal inflammation and also reduce probing pocket depths without subgingival instrumentation,⁴⁴ step-1 of periodontal

TABLE 2 Modeled costs for each of the 6 European countries for all 5 scenarios.

Country	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
France	€19bn	€21bn	€9bn	€5bn	€55bn
Germany	€22bn	€21bn	€11bn	€5bn	€66bn
Italy	€97bn	€119bn	€61bn	€6bn	€387bn
Netherlands	€19bn	€23bn	€11bn	€1bn	€72bn
Spain	€26bn	€31bn	€13bn	€4bn	€86bn
UK total	€64bn	€72bn	€33.5bn	€11bn	€195bn
Out of pocket	€55bn	€66bn	€30bn	€5.5bn	€176bn
NHS	€9bn	€5.5bn	€3.5bn	€5.5bn	€19bn

Note: The UK was modeled separately for state-funded care costs (NHS) and out of pocket expenses by patients.

care is fundamental to the overall success of a periodontal care pathway. While step 1 of care relates to the S3-Level guideline for managing periodontitis, the same components of prevention are vital for managing gingivitis. Taken alongside the economic benefits of managing gingivitis, and the improvements in markers of systemic inflammation achieved when managing gingivitis,^{45,46} it appears to be time to shift the periodontal management paradigm to the left, i.e. to focus on treating gingivitis as the primary prevention strategy for managing periodontitis.⁴⁷ Indeed, neglecting to manage gingivitis led to increased costs of care and a significant reduction in healthy life years, leading the EI team to conclude that an emphasis on self-care and prevention is critical from both an individual and a societal perspective.⁴³ The EI called for a greater emphasis on self-care and prevention, including nursery-based dental care and tooth brushing workshops in schools. While the latter would primarily target caries prevention in children, instilling good oral hygiene regimens into the daily routine from a young age should also benefit periodontitis prevention in the adult years.

The EI White Paper made four key recommendations for public healthcare funders:

- The prevention, diagnosis, and management of periodontitis is cost-effective
The role of home care by patients is of paramount importance to prevent gingivitis and periodontitis.
Making efforts to eliminate gingivitis, thus preventing progression to periodontitis, would save considerable costs over a 10-year time period compared with “business as usual” – ranging from €7.8bn in the Netherlands to €36bn in Italy.
Neglecting to manage gingivitis can significantly increase costs and reduce healthy life years, so “an emphasis on self-care and prevention is critical from both an individual and a societal perspective.”
- Better integration of dental and general healthcare is required
Sharing information across disciplines may both improve patient care (due to the shared risk factors between periodontitis and systemic NCDs) and contribute significantly to oral and general health research.
Integration may also encourage shared responsibility across healthcare disciplines to address unmet oral health needs in vulnerable and marginalized communities.
- A synergy of societal and individual public-health campaigns is needed
One without the other would serve to exacerbate rather than help resolve the associated health inequalities both within and across countries.
Societal level prevention is crucial to the prevention of periodontitis, especially given its high prevalence in deprived areas.
Individual public health campaigns also need to focus on less affluent communities and embed prevention and early intervention interventions into community settings such as schools (for the prevention of caries) and health centres (for the prevention of periodontal disease).

- The affordability of dental care needs to be improved
For many people, the cost of accessing a dentist is a barrier to receiving early treatment and, as a result, they are more likely to access the dentist when there is something wrong rather than for check-ups or preventative treatment that is essential for avoiding periodontitis.

In the UK and France, not all procedures for treating periodontitis are covered by the public health system and the remainder is paid for by the patient. In Spain and Italy, most (if not all) periodontal treatment is paid for by the patient or via private insurance.

As a result, periodontitis treatment for a low-income family is rendered almost unaffordable.

In summary, the findings of the EI study suggest that professionally managed periodontal care is cost-efficient and therefore the concept of publicly funded periodontal care would deserve further review from policymakers and care commissioners Europe-wide.⁴³

4 | DISCUSSION & CONCLUSIONS

Periodontal diseases are a major global health problem affecting more than a billion people worldwide. They not only reduce the quality of life but also impose huge costs on the patients, families, and society. Direct treatment costs were estimated at US\$ 104 billion while the productivity losses related to periodontitis were estimated at US\$ 82 billion in 2019. When tooth loss was additionally considered as a consequence of periodontitis, direct treatment costs amounted to US\$ 186 and productivity losses to US\$ 142 billion.

Social and commercial determinants along with the risk factors that are shared with systemic NCDs such as age, dietary habits, tobacco, alcohol use, and smoking are known to be the key drivers of periodontitis. Previous research suggests smoking cessation therapy to be a cost-efficient strategy about avoid tooth loss among persons with periodontitis.⁴⁸ Social determinants such as lower income and socioeconomic status are considered to be important factors for periodontitis. Similarly, commercial organizations such as the sugar and tobacco industries play a major role in undermining public health efforts. The risk factor sharing between other NCDs and periodontitis warrants the need to integrate general and oral health care systems. Sharing of data electronically is likely to achieve this integration to a great extent.

Modifications in the periodontal classification system can frequently lead to challenges. Checklists and multidisciplinary collaboration with public health, primary care, and methodologically-orientated experts including patient and community involvement should be considered. Raittio and Baelum raised concerns over the impact of the 2018 classification system for periodontitis, particularly the potential for overdiagnosis and overtreatment.⁴⁹ The expansion of disease definitions may lead to a situation where relatively healthy and low-risk individuals undergo unnecessary examinations and treatments. The authors emphasize that individuals with slight, symptomless, or modest inflammation, especially those in stages I and II of periodontitis

are most likely to be over diagnosed.⁴⁹ This is particularly relevant in countries where patients bear the financial burden of oral care, as the costs associated with diagnosing, treating, and monitoring periodontitis can impose a significant financial strain on individuals and societies. One critical aspect to consider is the economic incentive for dentists, whose revenue is often derived from performing dental procedures. If over diagnosis and over-treatment become prevalent, it may contribute to unnecessary procedures, leading to increased costs for patients and a potential strain on the healthcare system. The economic implications of over diagnosis should be weighed against the actual benefits and risks associated with expanded disease definitions. In countries where the payment system plays a significant role in healthcare, discussions around the financial impact of diagnosing mild cases of periodontitis become crucial. Dentists' reliance on performing procedures for revenue may create a conflict of interest, and addressing this issue is essential for ensuring that patients receive appropriate and evidence-based care.⁴⁹

Although the EI report serves as an elaborate guide showcasing economic and societal implications associated with periodontal health across European countries, advice on public health preventive strategies such as reduction in tobacco consumption and nutritional campaigns such as food labeling would have been beneficial. In addition, there continue to be knowledge gaps as to concretely actionable approaches for behavior change which lead to more widespread implementation of home-based oral hygiene. Evidence on the cost-effectiveness of interventions is an important criterion to assist decision makers in health investment decisions. A paucity of economic evaluations in the field of periodontal health has been highlighted in previous studies.^{39,50} Although the existing economic evaluation studies cover dental caries and periodontitis interventions ranging from public health approaches to clinical preventive and treatment strategies, there is a scope for improvement in methodology definitions and reporting quality in these studies.^{38,39} Furthermore, most of the existing studies were conducted in high-income countries. Extrapolation of the EI findings to low- or middle-income settings may not be possible as the EI report modeled real-world data from six European countries and therefore data may not be generalizable, but the principles may still apply.

To address the shortage of cost-effectiveness evidence, there is a need for further research particularly focusing on public health and preventive interventions. Equally important is that the studies follow a standardized guideline from an economic evaluation perspective. The ISPOR CHEERS checklist optimizes and facilitates consistent and transparent reporting of health economic evaluations.⁵¹ Furthermore, increased research in low-income countries could bring a balance to the existing focus on high-income countries. More generally, iterative cycles of improvement could offer opportunities for continuous optimization of periodontitis care drawing from step-wise identification, prioritization, implementation and evaluation of cost-efficient periodontal interventions.

Considering potential efficiency gains, a shift from the currently predominant curative approach to a more preventively oriented approach with a stronger emphasis on public health would seem to be

economically advantageous. The traditional individual care and clinical prevention approaches may not always be available and affordable giving rise to a significant economic burden even in high-income countries. These approaches may also not be efficient in effecting changes to the prevalence of disease at a population level, and moreover, they also do not address the inequalities. Additionally, dental professionals will be unable to tackle the burden of periodontal diseases in most countries.²⁴ Since such approaches have not tackled the global burden of oral diseases, a radical preventive approach is needed.⁵² Upstream policy interventions that tackle oral health inequalities focusing on social determinants of health and risk factors shared with other NCDs are recommended to prevent and control periodontitis.^{31,52} Attention and focus on oral health promotion and maintenance programs and on achieving equity for oral health using a public health approach is essential. To set up community programs, especially in low-resource settings, sound epidemiological data to identify people's oral health needs and accordingly tailored human resource planning is essential.^{24,53}

In conclusion, periodontal diseases are a major global public health problem with a high prevalence and economic burden worldwide. Integration of general health and oral health systems, upstream policies tackling social inequalities, and common risk factors could be important considerations for reducing the burden of periodontitis. A wide gap in evidence on the cost-effectiveness of public health and preventive periodontal interventions is recognized. Future research should particularly explore the cost-effectiveness of population-level interventions in comparison to individual-level strategies. There is a strong need for further awareness raising and professionalizing health economic research in periodontology. Beyond the use of generic health outcome measures to enhance the comparability of health economic evaluations across all domains of health care, the economics of periodontal health and care also entails central topics such as provider payment, insurance coverage, and needs-based (human) resource planning.²³

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1. Chapple IL, Bouchard P, Cagetti MG, et al. Interaction of lifestyle, behaviour or systemic diseases with dental caries and periodontal diseases: consensus report of group 2 of the joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. *J Clin Periodontol*. 2017;44(Suppl 18):S39-S51.
2. Monsarrat P, Blazot A, Kémoun P, et al. Clinical research activity in periodontal medicine: a systematic mapping of trial registers. *J Clin Periodontol*. 2016;43(5):390-400.

3. Simpson TC, Clarkson JE, Worthington HV, et al. Treatment of periodontitis for glycaemic control in people with diabetes mellitus. *Cochrane Database Syst Rev.* 2022;4(4):CD004714.
4. National Institute of Health and Care Excellence. *Periodontal Treatment to Improve Diabetic Control in Adults with Type 1 or Type 2 Diabetes Evidence Review D for Periodontal Treatment to Improve Diabetic Control in Adults with Type 1 or Type 2 Diabetes.* NICE guideline NG17 & NG28. NICE; 2022.
5. Peres KG, Thomson WM, Chaffee BW, et al. Oral health birth cohort studies: achievements, challenges, and potential. *J Dent Res.* 2020;99(12):1321-1331.
6. Matsuyama Y, Aida J, Tsuboya T, et al. Are lowered socioeconomic circumstances causally related to tooth loss? A natural experiment involving the 2011 great East Japan earthquake. *Am J Epidemiol.* 2017;186(1):54-62.
7. Klinge B, Norlund A. A socio-economic perspective on periodontal diseases: a systematic review. *J Clin Periodontol.* 2005;32(Suppl 6):314-325.
8. Elani HW, Harper S, Thomson WM, et al. Social inequalities in tooth loss: a multinational comparison. *Community Dent Oral Epidemiol.* 2017;45(3):266-274.
9. Matsuyama Y, Jürges H, Listl S. The causal effect of education on tooth loss: evidence from United Kingdom schooling reforms. *Am J Epidemiol.* 2019;188(1):87-95.
10. Caton JG, Armitage G, Berglund T, et al. A new classification scheme for periodontal and peri-implant diseases and conditions – introduction and key changes from the 1999 classification. *J Clin Periodontol.* 2018;45(Suppl 20):S1-s8.
11. Ainamo J, Barmes D, Beagrie G, Cutress T, Martin J, Sardo-Infirri J. Development of the World Health Organization (WHO) community periodontal index of treatment needs (CPITN). *Int Dent J.* 1982;32(3):281-291.
12. Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJ, Marcenes W. Global burden of severe periodontitis in 1990–2010: a systematic review and meta-regression. *J Dent Res.* 2014;93(11):1045-1053.
13. Kassebaum NJ, Smith AGC, Bernabé E, et al. Global, regional, and national prevalence, incidence, and disability-adjusted life years for oral conditions for 195 countries, 1990–2015: a systematic analysis for the global burden of diseases, injuries, and risk factors. *J Dent Res.* 2017;96(4):380-387.
14. WHO. *Global Oral Health Status Report: Towards Universal Health Coverage for Oral Health by 2030.* World Health Organization; 2022. Licence: CC BY-NC-SA 3.0 IGO.; 2022.
15. Chapple IL. Time to take periodontitis seriously. *BMJ (Clinical Research Ed).* 2014;348:g2645.
16. Tonetti MS, Jepsen S, Jin L, Otomo-Corgel J. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: a call for global action. *J Clin Periodontol.* 2017;44(5):456-462.
17. Sharma P, Yonel Z, Busby M, Chapple IL, Dietrich T. Association between periodontal health status and patient-reported outcomes in patients managed in a non-specialist, general dental practice. *J Clin Periodontol.* 2018;45(12):1440-1447.
18. Vos T, Lim SS, Abbafati C, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. *Lancet.* 2020;396(10258):1204-1222.
19. Listl S, Galloway J, Mossey PA, Marcenes W. Global economic impact of dental diseases. *J Dent Res.* 2015;94(10):1355-1361.
20. Righolt AJ, Jevdjevic M, Marcenes W, Listl S. Global-, regional-, and country-level economic impacts of dental diseases in 2015. *J Dent Res.* 2018;97(5):501-507.
21. Smits KPJ, Listl S, Plachokova AS, Van der Galien O, Kalmus O. Effect of periodontal treatment on diabetes-related health-care costs: a retrospective study. *BMJ Open Diabetes Res Care.* 2020;8(1):e001666.
22. Listl S, Birch S. Reconsidering value for money in periodontal treatment. *J Clin Periodontol.* 2013;40(4):345-348.
23. Listl S, Grytten JI, Birch S. What is health economics? *Community Dent Health.* 2019;36(4):262-274.
24. Clauss A, Sie A, Zabre P, Schmoll J, Sauerborn R, Listl S. Population-based prevalence of oral conditions as a basis for planning community-based interventions: an epidemiological study from rural Burkina Faso. *Front Public Health.* 2021;9:697498.
25. Jevdjevic M, Listl S. *Economic Impacts of Oral Diseases in 2019 – Data for 194 Countries [Database].* Heidelberg University Hospital, Heidelberg Open Research Data (heiDATA); 2022.
26. Passarelli PC, Pagnoni S, Piccirillo GB, et al. Reasons for tooth extractions and related risk factors in adult patients: a cohort study. *Int J Environ Res Public Health.* 2020;17(7):2575.
27. Vujicic M, Listl S. An economic perspective of the global burden of dental caries, acffglobal.org 2021.
28. Botelho J, Machado V, Leira Y, Proença L, Chambrone L, Mendes JJ. Economic burden of periodontitis in the United States and Europe: an updated estimation. *J Periodontol.* 2022;93(3):373-379.
29. Drummond MF, Sculpher MJ, Claxton K, Stoddart GL, Torrance GW. *Methods for the Economic Evaluation of Health Care Programmes.* Oxford University Press; 2015.
30. Ruta D, Mitton C, Bate A, Donaldson C. Programme budgeting and marginal analysis: bridging the divide between doctors and managers. *BMJ (Clinical Research Ed).* 2005;330(7506):1501-1503.
31. Janakiram C, Dye BA. A public health approach for prevention of periodontal disease. *Periodontology 2000.* 2020;84(1):202-214.
32. Weinert L, Listl S, Dannewitz B, et al. Engaging patients to develop a customized digital health companion for periodontitis: study protocol. *Front Oral Health.* 2022;3:1004091.
33. Yevlahova D, Satur J. Models for individual oral health promotion and their effectiveness: a systematic review. *Aust Dent J.* 2009;54(3):190-197.
34. Teughels W, Dhondt R, Dekeyser C, Quirynen M. Treatment of aggressive periodontitis. *Periodontology 2000.* 2014;65(1):107-133.
35. Vidal F, Cordovil I, Figueredo CM, Fischer RG. Non-surgical periodontal treatment reduces cardiovascular risk in refractory hypertensive patients: a pilot study. *J Clin Periodontol.* 2013;40(7):681-687.
36. Teeuw WJ, Slot DE, Susanto H, et al. Treatment of periodontitis improves the atherosclerotic profile: a systematic review and meta-analysis. *J Clin Periodontol.* 2014;41(1):70-79.
37. D'Aiuto F, Nibali L, Parkar M, Suvan J, Tonetti MS. Short-term effects of intensive periodontal therapy on serum inflammatory markers and cholesterol. *J Dent Res.* 2005;84(3):269-273.
38. Tay JRH, Ng E, Nair R, Tan ZS, Tan SHX. Economic evaluations in the treatment and evaluation of patients with periodontal disease: a critical review. *J Clin Periodontol.* 2021;48(5):679-694.
39. Nguyen TM, Tonmukayakul U, Le LK, Calache H, Mihalopoulos C. Economic evaluations of preventive interventions for dental caries and periodontitis: a systematic review. *Appl Health Econ Health Policy.* 2022;21:53-70.
40. Solowiej-Wedderburn J, Ide M, Pennington M. Cost-effectiveness of non-surgical periodontal therapy for patients with type 2 diabetes in the UK. *J Clin Periodontol.* 2017;44(7):700-707.
41. Choi SE, Sima C, Pandya A. Impact of treating oral disease on preventing vascular diseases: a model-based cost-effectiveness analysis of periodontal treatment among patients with type 2 diabetes. *Diabetes Care.* 2020;43(3):563-571.
42. Mariño RJ, Fajardo J, Calache H, Morgan M. Cost-minimization analysis of a tailored oral health intervention designed for immigrant older adults. *Geriatr Gerontol Int.* 2014;14(2):336-340.
43. The Economist Intelligence Unit. Time to take gum disease seriously. The societal and economic impact of periodontitis. 2021. Accessed January 3, 2023. <https://impact.economist.com/perspectives/sites/default/files/eiu-efp-oral-gum-disease.pdf>

44. Turner Y, Ashley FP, Wilson RF. Effectiveness of oral hygiene with and without root planing in treating subjects with chronic periodontitis. *Br Dent J*. 1994;177(10):367-371.
45. Roberts HM, Yonel Z, Kantarci A, Grant MM, Chapple ILC. Impact of gingivitis on circulating neutrophil reactivity and gingival crevicular fluid inflammatory proteins. *Int J Environ Res Public Health*. 2022;19(10):6339.
46. Perić M, Marhl U, Gennai S, Marruganti C, Graziani F. Treatment of gingivitis is associated with reduction of systemic inflammation and improvement of oral health-related quality of life: a randomized clinical trial. *J Clin Periodontol*. 2022;49(9):899-910.
47. Chapple IL, Van der Weijden F, Doerfer C, et al. Primary prevention of periodontitis: managing gingivitis. *J Clin Periodontol*. 2015;42(Suppl 16):S71-S76.
48. Souto MLS, Carrer FCA, Braga MM, Pannuti CM. Smoking cessation therapy is a cost-effective intervention to avoid tooth loss in Brazilian subjects with periodontitis: an economic evaluation. *BMC Oral Health*. 2021;21(1):616.
49. Raittio E, Baelum V. Justification for the 2017 periodontitis classification in the light of the checklist for modifying disease definitions: a narrative review. *Community Dent Oral Epidemiol*. 2023;51(6):1169-1179.
50. Fransson H, Davidson T, Rohlin M, Christell H. There is a paucity of economic evaluations of prediction methods of caries and periodontitis – a systematic review. *Clin Exp Dent Res*. 2021;7(3):385-398.
51. Husereau D, Drummond M, Petrou S, et al. Consolidated health economic evaluation reporting standards (CHEERS)—explanation and elaboration: a report of the ISPOR health economic evaluation publication guidelines good reporting practices task force. *Value Health*. 2013;16(2):231-250.
52. Watt RG, Daly B, Allison P, et al. Ending the neglect of global oral health: time for radical action. *Lancet (London, England)*. 2019;394(10194):261-272.
53. Ahern S, Woods N, Kalmus O, Birch S, Listl S. Needs-based planning for the oral health workforce – development and application of a simulation model. *Hum Resour Health*. 2019;17(1):55.

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APPENDIX 1

ESTIMATION OF DIRECT COSTS DUE TO SEVERE PERIODONTITIS

BACKGROUND

Treatment costs due to dental diseases (caries, periodontal diseases and tooth loss): US\$ 387 billion.²⁵

According to the global burden of disease study,¹³ 26.9% of DALYs due to untreated caries, severe periodontitis, and total tooth loss in 2015 are attributable to periodontal diseases (3518/13 033 = 26.9%; see table below).

DALYs due to untreated caries, severe periodontitis and total tooth loss (in thousands; source: Kassebaum et al.,¹³)

Untreated caries in permanent teeth	1.743	777-3315
Untreated caries in deciduous teeth	147	63-292
Severe periodontitis	3.518	1357-7247
Total tooth loss	7.625	5088-10540
Other oral conditions		
All oral conditions		

APPROXIMATE TREATMENT COSTS DIRECTLY ATTRIBUTABLE TO SEVERE PERIODONTITIS

Assumption: distribution of the global burden of disease (GBD) disability-adjusted life years (DALYs) is in proportion to the distribution of treatment costs:

Thus, 26.9% of US\$ 387 billion corresponds to US\$ 104 billion of treatment costs which are directly attributable to severe periodontitis.

APPROXIMATE DALYs INDIRECTLY ATTRIBUTABLE TO TOOTH LOSS DUE TO SEVERE PERIODONTITIS

According to the study by Passarelli et al.,²⁶ 35.7% of tooth extractions are attributable to severe periodontitis. Assuming that 35.7% of DALYs due to total tooth loss in 2015 are attributable to severe periodontitis, this corresponds to 2722 DALYs.

APPROXIMATE DALYs DIRECTLY AND INDIRECTLY ATTRIBUTABLE TO SEVERE PERIODONTITIS

(2722 DALYs + 3518 DALYs)/13 033 = 48% of DALYs are attributable to periodontitis.

TAKING THE ABOVE INTO ACCOUNT

Treatment costs directly and indirectly attributable to severe periodontitis → 48% of US\$ 387 billion = US\$ 186 billion.

APPENDIX 2

ESTIMATION OF PRODUCTIVITY LOSSES ATTRIBUTABLE TO PERIODONTITIS

BACKGROUND

Indirect costs due to periodontitis and edentulism are US\$ 82 billion and US\$ 167 billion respectively.²⁵

As described in [Appendix 1](#), 35.7% of tooth extractions are attributable to severe periodontitis.²⁶

Thus, assuming that 35.7% of DALYs due to tooth loss are attributable to severe periodontitis, this corresponds to estimated productivity losses of US\$ 59.6 billion.

TAKING THE ABOVE INTO ACCOUNT

Estimated productivity costs directly and indirectly attributable to severe periodontitis: US\$ 82 billion + US\$ 59.6 billion = US\$ 141.6 billion.