

## Periodontal diseases and cardiovascular diseases, diabetes, and respiratory diseases

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## Periodontal diseases and cardiovascular diseases, diabetes, and respiratory diseases: Summary of the consensus report by the European Federation of Periodontology and WONCA Europe

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SYSTEMATIC REVIEW



## Periodontal diseases and cardiovascular diseases, diabetes, and respiratory diseases: Summary of the consensus report by the European Federation of Periodontology and WONCA Europe

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### KEY MESSAGES

- Periodontitis is independently associated with cardiovascular diseases, diabetes, chronic obstructive pulmonary disease, obstructive sleep apnoea, and COVID-19.
- Periodontal treatment for optimal outcomes improves diabetes outcomes and surrogate measures of cardiovascular risk.
- Closer collaboration between oral health care professionals and family doctors is important in the early case detection and management of non-communicable diseases.
- Information on the reported associations should be made available to family doctors, oral health professionals, healthcare funders, patients, and the general population.

### ABSTRACT

**Background:** Periodontitis is a chronic inflammatory non-communicable disease (NCD) characterised by the destruction of the tooth-supporting apparatus (periodontium), including alveolar bone, the presence of periodontal pockets, and bleeding on probing.

**Objectives:** To outline, for family doctors, the implications of the association between periodontal and systemic diseases; to explore the role of family doctors in managing periodontitis as an ubiquitous non-communicable disease (NCD).

**Methods:** The consensus reports of previous focused collaborative workshops between WONCA Europe and the European Federation of Periodontology (using previously undertaken systematic reviews), and a specifically commissioned systematic review formed the technical papers to underpin discussions. Working groups prepared proposals independently, and the proposals were subsequently discussed and approved at plenary meetings.

**Results:** Periodontitis is independently associated with cardiovascular diseases, diabetes, chronic obstructive pulmonary disease, obstructive sleep apnoea, and COVID-19 complications. Treatment of periodontitis has been associated with improvements in systemic health outcomes. The article

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also presents evidence gaps. Oral health care professionals (OHPs) and family doctors should collaborate in managing these conditions, including implementing strategies for early case detection of periodontitis in primary medical care centres and of systemic NCDs in oral/dental care settings. There is a need to raise awareness of periodontal diseases, their consequences, and the associated risk factors amongst family doctors.

**Conclusion:** Closer collaboration between OHPs and family doctors is important in the early case detection and management of NCDs like cardiovascular diseases, diabetes mellitus, and respiratory diseases. Strategies for early case detection/prevention of NCDs, including periodontitis, should be developed for family doctors, other health professionals (OHPs), and healthcare funders. Evidence-based information on the reported associations between periodontitis and other NCDs should be made available to family doctors, OHPs, healthcare funders, patients, and the general population.

## Introduction

Periodontitis is a chronic inflammatory non-communicable disease (NCD) characterised by the destruction of the tooth-supporting apparatus (periodontium), including alveolar bone, the presence of periodontal pockets, and bleeding on probing [1]. It is initiated by the accumulation of a microbial biofilm at and below the gingival margin, which activates the host immune-inflammatory response. The latter drives biofilm dysbiosis, triggering a dysregulation of local immune-inflammatory processes that destroy the periodontal tissues [2].

Periodontitis presents a major public health problem due to its high prevalence and associated morbidity. It is the most common NCD in humans with 1.1 billion people experiencing severe periodontitis globally (2019) [3]. If untreated, severe periodontitis progresses to tooth loss, causing disability by impairing chewing, speech, and aesthetics. It significantly impairs quality of life, is a source of social inequality, harms general health, and is associated with significant dental and medical care costs [4]. Periodontitis is also independently associated with other highly prevalent chronic inflammatory NCDs, as described later.

The treatment of periodontitis involves a step-by-step approach [5, 6]. Interventions in step 1 include professional and patient-based control of supragingival biofilms and risk factor control (e.g. smoking cessation). In step 2, subgingival instrumentation, with or without concomitant therapy, is the primary intervention. Most initial and moderate forms of periodontitis may be treated with steps 1 and 2, followed by long-term supportive periodontal care (SPC). Step 3 of therapy includes, for severe cases, different periodontal surgical approaches. SPC is the centre of secondary prevention, including risk factor control and supragingival biofilm control, either by the professional (with professional control and removal 2–3 times per year) or by the patient (with appropriate and tailored oral hygiene measures, including toothbrushing and interdental cleaning).

Previous European Federation of Periodontology (EFP) *Focused Workshops* with the International

Diabetes Federation and the World Heart Federation on the association between periodontitis and diabetes (2017) and cardiovascular diseases (2019) identified a crucial role for family doctors and oral healthcare professionals (OHP) to collaborate in managing these co-morbid NCDs. Therefore, a third EFP *Focused Workshop* was organised to define best practices in the collaboration of family doctors and OHPs in managing NCDs and in promoting healthy lifestyles, based upon expert discussions of underpinning systematic reviews and the formulation of expert opinions derived from those reviews. The current document summarises the consensus from this Workshop [7].

## Methods

The EFP-*Focused Workshop* gathered 18 experts representing the European region of the World Organisation of National Colleges, Academies and Academic Associations of General Practitioners/Family Physicians (WONCA Europe) and the EFP. It was held in Madrid (Spain) in July 2022.

The consensus reports of the previous *Focused Workshops* (and underpinning systematic reviews) on the associations between periodontitis and diabetes (2017) and periodontitis and cardiovascular diseases (2019) formed the technical reviews to underpin discussions on both topics. A systematic review was specifically commissioned for the Workshop discussions on the association with respiratory diseases. Working groups prepared proposals independently, and then the proposals were discussed and approved at plenary meetings. The primary evidence for the discussions for each Working Group is presented and described in [Table 1](#), and a summary of the guidance per condition can be found in [Table 2](#).

## Cardiovascular diseases and periodontitis

### Summary of the available evidence

**Mechanisms explaining the association.** The mechanisms underpinning the independent association between

**Table 1.** Primary references used for the discussion in each working group, with their main methodology and context.

Reference	Methodology	Additional information
Cardiovascular diseases and periodontitis		
[8]	Consensus report	EFP and WHF focused workshop
[9]	Consensus report	EFP and WHF focused workshop
[10]	Narrative review	EFP and WHF focused workshop
[11]	Narrative review	EFP and WHF focused workshop
[12]	Narrative review	EFP and WHF focused workshop
[6]	S3 level clinical practice guideline	EFP guideline for the treatment of periodontitis in stage I-III
[5]	S3 level clinical practice guideline	EFP guideline for the treatment of periodontitis in stage IV
[13]	Systematic review, intervention	impact of periodontal therapy on systemic health
Diabetes and periodontitis		
[14]	Consensus report	EFP and WHF focused workshop
[15]	Consensus report	EFP and WHF focused workshop
[16]	Systematic review, epidemiology	EFP and WHF focused workshop
[17]	Systematic review, plausibility	EFP and WHF focused workshop
[18]	Systematic review, intervention	EFP and WHF focused workshop
[13]	Systematic review, intervention	impact of periodontal therapy on systemic health
Respiratory diseases and periodontitis		
[19]	Systematic review, epidemiology	EFP and WONCA focused workshop
[19]	Systematic review, intervention	EFP and WONCA focused workshop

EFP: European Federation of Periodontology; WHF: World Heart Federation; IDF: International Diabetes Federation; WONCA: WONCA Europe.

periodontitis and CVDs have been demonstrated by the chronic entry of periodontal bacteria into the vascular system (bacteraemia) and their systemic inflammatory sequelae and by increased levels of systemic inflammation resulting from periodontitis lesions. In addition, periodontitis and CVDs share numerous common genetic and environmental risk factors (e.g. tobacco smoking).

**Evidence for an association derived from epidemiological studies.** Periodontitis increases the risk of coronary heart disease (i.e. coronary artery disease, myocardial infarction), cerebrovascular disease (i.e. ischaemic stroke, hazard ratio-HR = 2.20; 95% confidence interval-CI [1.27; 3.81] for severe periodontitis), and peripheral artery disease. It is also associated with higher mortality rates due to coronary heart disease and cerebrovascular disease, with an increased risk of a first cardiovascular event and a higher incidence of atrial fibrillation [20, 21].

**Evidence for an association derived from intervention studies.** Whilst there is no direct evidence for the benefits of periodontal treatment on complex cardiovascular outcomes, there is clear evidence for the effect of periodontal therapy on surrogate measures of cardiovascular diseases, arterial blood pressure and stiffness, and sub-clinical cardiovascular disease markers [13].

## Guidance for family doctors

**Potential role of family doctors in the early detection/screening/prevention of periodontal diseases.** Due to the robust association between periodontitis and cardiovascular diseases and the emerging associations between periodontitis and surrogate measures of cardiovascular disease observed in intervention studies, family physicians should ask patients with cardiovascular diseases about signs and symptoms of periodontitis (such as bleeding gums and loose teeth) and, where appropriate, recommend a periodontal evaluation.

**Information about periodontal diseases for family doctors.** Delivering periodontal treatment is safe regarding cardiovascular risk (in patients with established CVD). In people who have experienced a recent acute CVD event, if periodontitis is diagnosed, treatment should start as soon as their cardiovascular status permits, and a consultation with the treating family doctor/cardiologist is advised.

Irrespective of the severity of CVD or specific medications, non-surgical (steps 1 and 2) periodontal therapy should be provided, preferably in several 30–45 min sessions, to minimise the spike in the C-reactive protein, documented to arise due to the treatment-generated bacteraemia.

Surgical periodontal and implant therapy, when indicated, should be provided similarly as for patients without CVD. However, attention should be paid to hypertension and treatment with antiplatelet and anticoagulant drugs.

## Diabetes and periodontitis

### Summary of the available evidence

**Mechanisms underpinning the bi-directional association.** The periodontally-driven mechanisms negatively impacting type 2 diabetes include bacteraemia, vascular inflammation, systemic oxidative stress negatively impacting beta-cell function, and systemic inflammation. Mechanisms driving adverse periodontal outcomes in diabetes patients with hyperglycaemia include exaggerated systemic inflammation, frequency of glucose intake on systemic inflammation, reduced neutrophil functional efficiency, unbalanced T helper-1, -2, and -17 cell responses, and advanced-glycation end product formation, inhibiting periodontal wound healing.

**Evidence for associations derived from epidemiological studies.** In the diabetes–periodontitis direction, poorly controlled diabetes is associated with an increased risk and severity of periodontitis relative to normoglycemic people with diabetes or those without diabetes. In the periodontitis–diabetes direction, severe periodontitis is associated with elevated serum HbA1C levels in people

**Table 2.** Summary of the guidance agreed by the experts and proposed by the consensus report.

Potential association	Setting/ HP	Patient with	Action*	Description		
CVD and periodontitis	HP	Periodontitis therapy	Advise	May reduce CVD risk		
				Improves surrogate CVD parameters (CRP, IL6, BA-FMD, BP, cIMT)		
	OHP	Periodontitis	Advise	Safe for CVD patients		
				Consider anti-platelet and anti-coagulant drugs		
		CVD risk factors	Advise	Consider hypertension		
				Higher CVD risk		
		Periodontitis and CVD	Advise	Risk factor control		
				For CVD risk factors		
			FD	CVD	Refer	Risk factor control
						Consultation with GP
Diabetes and periodontitis	HP	Periodontitis	Advise	Higher CVD risk		
				Diabetes	Advise	Preventive periodontal care
	OHP	Diabetes	Advise	Risk factor control		
				Diabetes and periodontitis	Refer	In case of recent acute CVD event
	FD	Diabetes	Advise	For signs and symptoms of periodontitis		
				Diabetes and periodontitis	Refer	Periodontal evaluation
	HP	Diabetes	Advise	Importance of periodontitis to diabetes control and complications		
				Diabetes and periodontitis	Refer	Impact of hyperglycaemia upon periodontitis and compromised healing following periodontal therapy
	OHP	Diabetes	Advise	Bi-directional communication		
				Diabetes and periodontitis	Refer	Increased risk of periodontitis and its impact on glycemic control and its complications
FD	Diabetes	Advise	Periodontal and peri-implant condition			
			Diabetes and periodontitis	Refer	According to the periodontal and peri-implant condition	
HP	COPD and smoker	Refer	Risk for diabetes			
			COPD	Advise	For diabetes diagnosis	
OHP	COPD	Advise	Increased risk of periodontitis and its impact on glycemic control and its complications			
			COPD, risk of COPD	Advise	Periodontal treatment can improve glycemic control and reduce diabetes complications	
FD	COPD, risk of COPD	Advise	Importance of regular oral health assessments and periodontal care tailored to individual needs			
			Diabetes and periodontitis	Refer	Emerging evidence demonstrating an increased risk for peri-implantitis	
HP	COPD and smoker	Refer	For regular oral assessment			
			COPD	Advise	Improving glycemic control improves periodontal treatment outcomes	
OHP	COPD	Advise	Encourage patients to engage for regular oral healthcare appointments			
			COPD, risk of COPD	Advise	Smoking cessation	
FD	COPD, risk of COPD	Advise	Smoking cessation			
			Asthma	Advise	Oral hygiene habits	
HP	OSA	Advise	Periodontal and peri-implant condition			
			OSA in young patients	Refer	According to the periodontal and peri-implant condition	
FD	OSA	Refer	Association between COPD and periodontitis			
			Active COVID-19	Advise	Foreseeable improvements resulting from periodontal therapy	
HP	Active COVID-19	Advise	Oral/periodontal health examination			
			history of severe COVID-19	Refer	Documented oral side effects of asthma treatments	
FD	Active COVID-19	Advise	Oral/periodontal health examination in specific cases (e.g. poor oral hygiene)			
			history of severe COVID-19	Refer	Reported association between OSA and periodontitis	
HP	Active COVID-19	Advise	Strategies for weight loss and healthy life styles			
			history of severe COVID-19	Refer	Potential side effects on oral health (e.g. dry mouth, more plaque, and inflammation) of CPAP and BiPAP machine	
FD	Active COVID-19	Advise	Potential side effects on oral health of oral appliances to treat mild or moderate OSA and snoring			
			history of severe COVID-19	Refer	For orthodontic evaluation, in specific cases	
HP	Active COVID-19	Advise	Oral/periodontal health examination			
			history of severe COVID-19	Refer	Separate toothbrushes from co-habitants	
FD	Active COVID-19	Advise	Consider using virucidal mouth rinses			
			history of severe COVID-19	Refer	Oral consequences of ICU syndrome, oral lesions associated with COVID-19, periodontitis	
HP	Active COVID-19	Advise	Oral/periodontal health examination			
			history of severe COVID-19	Refer	Oral/periodontal health examination	

OHP: oral health professional; FD: family doctor; HP: health professional; CVD: cardiovascular disease; COPD: chronic obstructive pulmonary disease; OSA: obstructive sleep apnoea; CRP: C reactive protein; IL6: interleukin-6; BA-FMD: brachial artery flow mediated dilation; BP: blood pressure; cIMT: carotid intima media thickness; CPAP: continuous positive airway pressure; BiPAP: bi-level positive airway pressure; ICU: internal care unit.

Guidance is presented for each potential association [periodontitis with cardiovascular diseases (CVD), with diabetes, and with different respiratory diseases], for each health care setting [family doctor (FD), oral health professional (OHP) or both health professionals (HP)], and for different conditions/situations of patients. Actions are defined as to advise (i.e. inform); to screen, to diagnose to refer, and to treat.

The present guidance is a summary of the consensus report of the joint workshop of experts of the European Federation of Periodontology and WONCA Europe. The evidence to support the guidance was discussed during the workshop (main methodology, expert discussion on overall evidence), and it is presented in Table 1 and in the manuscript. However, the level of evidence supporting each recommendation was not properly weighted and/or analysed.

without diabetes (glycemia) and those with diabetes (hyperglycaemia). Patients with periodontitis exhibit an increased risk of developing pre-diabetes and diabetes. Moreover, there appears to be a direct relationship between the severity of the periodontitis and complications of diabetes, including retinopathy (background and proliferative), nephropathy (macroalbuminuria and end-stage renal disease), neuropathic foot ulceration, various CVDs, and mortality [14].

**Evidence for an association derived from intervention studies.** In the diabetes–periodontitis direction, periodontal disease progression over 5 years is significantly lower in diabetes patients with good versus poor glycemic control and clinical local and systemic inflammatory biomarkers improve following successful periodontal therapy, even in people with poor diabetes control [14]. In the periodontitis–diabetes direction, a recent Cochrane review [22], including 35 studies (3249 randomised participants), concluded that periodontal therapy resulted in clinically meaningful and statistically significant reductions of HbA1C levels in people with type 2 diabetes of 0.3% at 6-months and 0.5% at 12-months, similar reductions to those achieved by adding a second medication to a metformin regime.

### Guidance for family doctors

**General guidance.** There is a need to raise awareness amongst family doctors, general dentists, other healthcare professionals, patients, and health authorities of the importance of periodontitis to diabetes control and complications, the impact of hyperglycaemia upon periodontitis, and compromised healing following periodontal therapy. Two-way communication between family doctors and OHPs is key to collaborative management, and should be documented in the patient's health record and be supported by written communication between teams.

**Potential role of family doctors in the early detection/screening/prevention of periodontal diseases.** Periodontal diagnosis currently requires a clinical examination by a suitably trained OHP. In light of the importance of periodontal diagnosis and treatment for diabetes outcomes, NHS England developed a commissioning standard on dental care for people with diabetes, approved by the British Government and published in 2019 [23]. In 2022, the National Institute of Health and Care Excellence (NICE) included periodontal treatment as a key intervention in diabetes care. It includes the need for family doctors to assess the risk for periodontitis in prediabetes or diabetes patients and refer accordingly to OHPs for formal diagnosis and management as appropriate [24, 25].

**Collaboration with OHPs in the early detection/screening of diabetes in the dental practice/office.** OHPs are ideally

placed to help identify people at high risk of prediabetes or type 2 diabetes. Thus, there is a clear need for OHPs to be educated on the impact of periodontitis on diabetes risk and made aware of the most effective protocols for diabetes risk assessment [24, 25]. National and international stakeholders recommend that increased cooperation between OHPs and family doctors is essential for the successful diagnosis of diabetes following risk assessment in dental settings.

**Information about periodontal diseases for family doctors.** People with diabetes are frequently unaware of their increased risk of developing periodontitis and its impact on the control of diabetes, and they may not be engaged in regular professional oral care. Therefore, it is recommended that:

For prediabetes/diabetes patients who have not been orally examined, family doctors should discuss with them at regular reviews:

- Hyperglycaemia increases their risk of periodontitis and consequential tooth loss, as well as the effect that periodontitis may have on diabetes control and its complications.
- Periodontal treatment can improve their glycemic control and may reduce future diabetes complications.
- Regular oral health assessments and periodontal care tailored to individual needs are important.
- Emerging evidence demonstrates an increased risk for peri-implantitis affecting dental implants in people with diabetes.

Family doctors should then refer patients with type 2 diabetes to the oral health care team for regular oral health assessments [24, 25].

For prediabetes/diabetes patients who have already been diagnosed with periodontitis, family doctors should:

- Advise them that improving glycemic control improves periodontal treatment outcomes.
- Encourage patients to attend regular oral health care appointments to manage their periodontitis [23–25].

### Respiratory diseases and periodontitis

A systematic review of the evidence for associations between periodontitis and the most common respiratory diseases, chronic [asthma], and acute [community-acquired pneumonia (CAP), and COVID-19], was specifically commissioned for the Workshop [19].

### Summary of the available evidence

**Mechanisms explaining the association.** Several hypotheses have been proposed, including the role of oral and respiratory microorganisms when aspirated within oral secretions exacerbating pulmonary inflammation and endothelial dysfunction; modifications of the oral and dental plaque/biofilm and low-grade inflammation associated with periodontitis; and the impact of cytokines on pulmonary epithelial cells [19]. Furthermore, periodontal and respiratory diseases share some common risk factors, including smoking, obesity, and diabetes.

**Evidence for associations derived from epidemiological studies.** People with periodontitis are at increased risk of having/developing chronic obstructive pulmonary disease (COPD) (a meta-analysis of 11 studies, OR = 1.33, 95% CI [1.20; 1.47];  $p < 0.001$ ) [19]. In addition, a meta-analysis of the effects of periodontitis on the functional capacity of the lungs [(FEV1/FVC)\*100] demonstrated a statistically significant effect, with periodontitis patients presenting with a 4.94% lower FEV1/FVC\*100 [19]. This 5% reduction in functional lung capacity is considered highly relevant clinically.

The evidence for the association between periodontitis and asthma and asthma complications is inconsistent between studies [19]. Limitations of the selected studies (young age of patients, definitions of asthma, control of confounders) complicate the interpretation of the findings.

Periodontitis has been linked with a higher prevalence of obstructive sleep apnoea (OSA) (meta-analysis of six studies, OR = 1.65, 95% CI [1.21; 2.25];  $p = 0.001$ ) [19].

Only one case-control study and one cohort study were identified for the association with community-acquired pneumonia (CAP), which precluded any relevant conclusion on the association being made [19].

Current evidence supports a positive and significant association between periodontitis and a diagnosis of SARS-CoV-2 infection. Meta-analyses demonstrate significant associations between periodontitis with the need for assisted ventilation ( $n = 2$ , OR = 6.24, 95% CI [2.78; 13.99];  $p < 0.001$ ) and with COVID-19-associated mortality ( $n = 3$ , OR = 2.26, 95% CI [1.36; 3.77];  $p = 0.002$ ) [19].

**Evidence for associations derived from intervention studies.** Limited (one study for COPD) or no evidence was identified [19].

### Guidance for family doctors

#### Referral of patients with respiratory diseases for a comprehensive oral health assessment.

- Accepting the currently limited evidence base, it is recommended that family doctors refer patients

with COPD, or at risk of developing COPD for an oral/periodontal health examination. Family doctors should refer/recommend smokers with COPD or at risk of developing COPD, for an oral/periodontal health examination.

- A referral/recommendation for a comprehensive oral/periodontal health examination may be appropriate for some patients with asthma or OSA.

**Specific oral health care recommendations for patients' respiratory diseases.** For COPD patients, smoking cessation must be promoted in all smokers in oral care settings, directly or by a referral to the family doctor. This will decrease the risk of developing both diseases and their associated comorbidities.

For asthma patients, the potential impact on oral/periodontal health of some treatments (e.g. corticosteroid inhalers) may need to be discussed, especially if adequate oral hygiene is lacking.

For OSA patients, since obesity is an established risk factor, strategies for weight loss and healthy lifestyles should be recommended in both primary medical and dental care settings. A discussion with the patient on the potential side effects on oral health (e.g. dry mouth, increase in periodontal inflammation, increase/alteration in biofilm formation) of continuous positive airway pressure (CPAP) and bi-level positive airway pressure (BiPAP) machines, may be necessary.

## Discussion

### Main findings

This report summarises the previously published consensus document of the joint Workshop of the EFP and WONCA Europe [7], in which leading experts representing the association of family doctors and periodontologists evaluated the scientific evidence supporting the independent associations between periodontitis and different chronic inflammatory NCDs to identify the most relevant information for family doctors in the management of these patients. Discussions by experts suggested that there was sufficient relevant evidence to conclude that periodontitis is independently associated with cardiovascular diseases, diabetes, COPD, OSA, and COVID-19 complications and that treatment of periodontitis is associated with improvements in diabetes outcomes, with emerging evidence for improvements in surrogate measures of CVD and certain respiratory diseases. Furthermore, the experts highlighted the importance of future research after identifying remaining gaps in the available evidence and evaluated the practical implications



for family doctors in managing these patients with such comorbidities, highlighting their relevance for healthcare funders.

### **Guidance for healthcare funders**

The above recommendations assume that access to universal healthcare includes access to an oral health assessment and treatment, although it is understood that such access may not be universal across Europe. The recent World Health Organisation (WHO) Resolution urges Member States to address key risk factors that are shared between oral diseases and other NCDs [26], including cardiovascular diseases, diabetes, and COPD, and to enhance the scope of practice of OHPs. It also recommends that oral health be firmly embedded within the NCD agenda and that oral health care interventions should be included in universal health coverage programmes.

Specifically for diabetes, there is emerging evidence for the cost-effectiveness of periodontal treatment in diabetes patients, the available data demonstrates significant economic benefit in the populations studied [13, 23–25, 27], provided periodontal outcomes and associated HbA1C reductions are maintained. In some European countries, people with diabetes are provided with fundoscopic assessment for diabetic retinopathy and podiatry services free of charge, to support their health and well-being and to reduce diabetes complications, yet periodontal care has to be paid for out of pocket by the patient. Given the health and economic benefits of successful periodontal treatment in patients with diabetes, it is time to address this historical anomaly. State-funded periodontal examinations and treatment, if required, for patients with diabetes and prediabetes appear justified on both health and economic grounds.

Due to the negative impact of socio-economic factors on periodontitis and respiratory diseases, specifically COPD, a significant proportion of patients may not have access to appropriate medical and/or dental care, and outreach programs should be implemented.

### **Gaps in the scientific evidence**

For the association between periodontitis and cardiovascular diseases, the evidence derived from epidemiological studies and intervention studies with surrogate outcomes is consistent and robust [13]; sadly, intervention studies with ‘hard’ outcomes are not available, and it is doubtful that they will be available soon, for ethical and logistical reasons. In addition, most intervention studies on surrogate outcomes have been

performed in patients with comorbidities, and it would be desirable to understand the impact in systemically healthy population groups as well [5].

The association between periodontitis and diabetes is, without doubt, the one with more practical implications due to the bi-directional nature of the link, and to the demonstrable impact of periodontal therapy on glycemic control. However, most studies have focused on people with type 2 diabetes, and minimal information is available for type 1 diabetes. In terms of the duration of the improvements in glycemic control following periodontal therapy, there is solid evidence to demonstrate sustainable benefits for at least 12 months but longer-term results would be desirable [28].

Overall less evidence is available for the associations between periodontitis and respiratory diseases, principally the availability of intervention studies [19]. In terms of epidemiological studies, more information is needed for CAP and asthma.

### **Conclusion**

The consensus achieved between family doctors and periodontologists is that periodontitis is independently associated with CVDs, diabetes, COPD, OSA, and COVID-19 complications and that treatment of periodontitis has been associated with improvements in systemic health status.

These findings make the closer collaboration between OHPs and family doctors important and relevant in the early detection and management of NCDs: strategies for early case detection/prevention of periodontitis should be developed for family doctors, and evidence-based information on the reported associations should be made available to family doctors, OHPs, health care funders, patients and the general population.

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### **Authors contributions**

David Herrera, Mariano Sanz, Lior Shapira, and Shlomo Vinker contributed to the project’s conception and design. All authors substantially contributed to the interpretation of data and the drafting and critical review of the manuscript. All authors approved the final version of the manuscript.

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