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Periodontitis and peri-implantitis in elderly people experiencing institutional and hospital confinement

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1 | INTRODUCTION

Recent epidemiologic studies clearly demonstrate that more and more elderly people are retaining their natural teeth well into old age.^{1,2} Although this evolution has been the aim of dentistry for many decades and has to be credited as a major achievement in dental public health, these natural teeth now present as a newer challenge in terms of maintenance.³ When assistance is necessary for performing activities of daily living tasks, oral hygiene is often neglected for a number of reasons. Individuals with cognitive impairment, and those who are frail and multi-morbid, are particularly affected.^{4,5} The result is a high incidence of caries and/or infection of the periodontal tissues, which cause pain, and when untreated lead to tooth loss, which ultimately affects the quality of life.^{6,7} Tooth loss-impaired chewing capacities, ill-fitting dentures, infections, and pain have a negative influence on dietary intake, potentially leading to protein calorie malnutrition, specifically among older patients.^{8,9} In addition, oral infections like periodontal disease have been the focus of research for more than two decades and strong associations—causal or coincidental—have been evinced for cardiovascular disease, diabetes, rheumatoid arthritis and, more recently, cognitive impairment.¹⁰⁻¹³ Of particular importance for elderly people who are dependent on care is the incidence of aspiration pneumonia, especially when swallowing disorders are present.¹⁴⁻¹⁷ Professional oral hygiene, performed by dental professionals, may help to significantly reduce the incidence of aspiration pneumonia

and the related death rates.¹⁸⁻²¹ Such intervention seems to be cost-effective, when weighing the cost of professional oral hygiene vs those of medical consultations, days of hospitalization, antibiotics, and imaging.²² Hence, oral health in institutionalized elderly people has to be seen in a context much larger than solely focusing on the oral cavity, and oral health cannot be separated from general health and quality of life.

2 | PERIODONTAL AND PERI-IMPLANT DISEASES IN ELDERLY PEOPLE

With time, biofilm forms on any given hard surface in the oral cavity and, consequently, natural teeth are at risk of caries and periodontal disease when it is left alone to mature. The periodontium of natural teeth present inherent defense mechanisms, such as the gingival epithelium and the gingival crevicular fluid, which is a serum exudate that comports the complementary components, antibodies, neutrophils, and plasma cells necessary to prevent periodontal destruction by the specific pathogens related to periodontitis²³ (Figure 1). Complete abstinence of oral hygiene for 21 days results in clinical signs and symptoms of gingivitis, which is completely reversible in 3 weeks after resuming meticulous oral hygiene measures²⁴; the same effect was demonstrated in people aged older than 70 years.^{3,25} Because implants are artificially inserted directly into the bone, they present an ankylotic anchorage without

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a surrounding tissue corresponding to the natural periodontium. Hence the natural defense mechanisms are different.²⁶ The reaction of the peri-implant tissues in response to the absence of oral hygiene measures has been evaluated in split-mouth design studies that compared a natural tooth with a control implant during the induction of an experimental gingivitis. Salvi et al²⁷ reported on a cohort of 58.7-year-old patients who showed increased signs of inflammation around the implant, and an incomplete remission 3 weeks after the uptake of oral hygiene measures. Meyer et al^{3,28} repeated the experiments in an elderly cohort with an average age of 77.0 years and confirmed increased clinical signs of inflammation around the

control implant when compared with the natural tooth (Table 1). Nevertheless, the prevalence of implant-supported restorations in geriatric populations is steadily increasing and, according to the available evidence, implant survival rates in elderly people are not inferior to those in younger cohorts.²⁹⁻³² Barriers to implant placement in old age frequently consist of the patient's unwillingness to proceed, typically because of a refusal of the surgical intervention or a lack of perceived need.³³⁻³⁵ New, mechanically stronger alloys, and improvements in the implant surface, have enabled the development of minimally invasive treatment concepts, which are more accessible by elderly patients with reduced general health and functional dependency.^{36,37} Hence, elderly patients can also benefit from advances in modern dentistry, and from stable and functionally optimal dentures until late in life. In an institutionalized context, oral hygiene measures in elderly people are often performed by the nursing personnel, who often have little or no relevant training or experience.³⁸ Occupational therapy may enhance the patient's autonomy for the required gestures, especially in residents with mild dementia.³⁹ The presence of natural teeth and dental implants complicate the oral hygiene interventions and therefore require more time, adequate tools and skills. As a consequence of tooth retention and implant placement, health policymakers must ensure that there are skilled personnel for dependent elderly people to address the challenges arising from these recent and very positive developments.^{40,41}

In a review, Hoben et al⁴² identified barriers and facilitators with respect to good oral hygiene in a nursing home confinement. The facilitators are related to family members, care providers, organization of care services, and social interactions. Residents resisting care, care providers' lack of knowledge, education or training in providing oral care, lack of time or staff, and also a general dislike for oral care, were the identified barriers. There is still a lack of robust

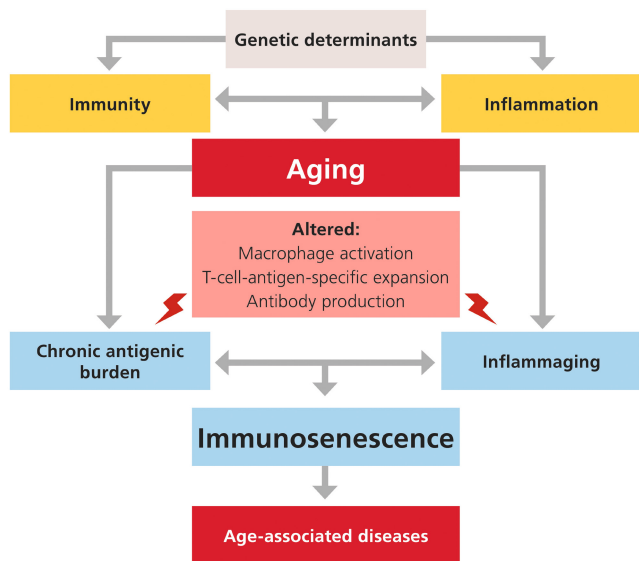


FIGURE 1 Principal pathways of immunosenescence (redrawn after Ebersole et al²³)

TABLE 1 Clinical parameters during 3 wk of experimental gingivitis/mucositis as well as 3 wk follow-up with uptake of meticulous oral hygiene (median and interquartile range); dichotomized GI: 0 or 1 vs 2 or 3 (GI > 1). (Table according to Meyer et al³)

	Plaque accumulation			Oral hygiene		
	Day 0	Day 7	Day 14	Day 21	Day 28	Day 42
Teeth						
Mean PI	0.00 [0.00; 0.08]	1.88 [1.65; 2.08] [*]	2.42 [2.13; 2.58] [*]	2.67 [2.31; 2.77] [*]	0.08 [0.00; 0.17] [*]	0.13 [0.00; 0.19] [*]
GI > 1	0.00 [0.00; 0.00]	0.17 [0.17; 0.33]	0.42 [0.25; 0.60] [*]	0.58 [0.42; 0.60] [*]	0.00 [0.00; 0.02]	0.00 [0.00; 0.02]
Mean PD [mm]	2.38 [2.23; 2.50]	-	-	2.58 [2.31; 2.67] [*]	-	2.25 [2.08; 2.44]
Mean BOP	0.00 [0.00; 0.02]	-	-	0.58 [0.48; 0.67] [*]	-	0.04 [0.00; 0.08]
Mean REC [mm]	1.13 [0.65; 1.71]	-	-	1.21 [0.56; 1.52]	-	1.25 [0.48; 1.90]
Implants						
Mean PI	0.00 [0.00; 0.00]	1.33 [1.25; 1.52] [*]	1.83 [1.42; 2.21] [*]	2.00 [1.56; 2.44] [*]	0.00 [0.00; 0.08]	0.00 [0.00; 0.08]
GI > 1	0.00 [0.00; 0.00]	0.25 [0.17; 0.42]	0.46 [0.31; 0.60] [*]	0.63 [0.50; 0.75] [*]	0.00 [0.00; 0.19] [*]	0.00 [0.00; 0.00]
Mean PD [mm]	2.83 [2.73; 3.08]	-	-	3.13 [2.88; 3.33] [*]	-	2.75 [2.56; 3.00]
Mean BOP	0.00 [0.00; 0.10]	-	-	0.71 [0.58; 0.85] [*]	-	0.00 [0.00; 0.17]
Mean REC [mm]	0.29 [0.00; 0.81]	-	-	0.33 [0.00; 0.85]	-	0.21 [0.00; 0.77]

Note: Values in bold: significant difference between implants and teeth (P < .05).

Abbreviations: BOP, bleeding on probing; GI, Gingival index; PD, Probing depth; PI, Plaque index; REC, Recession.

*Significant difference when compared with value at Day 0 (P < .05).

evidence regarding how to address these new challenges in oral care provision, especially at the large scale we are facing nowadays.⁴² Furthermore, there is no consensus on a standard of care and the corresponding oral health policy.⁴³ Given the need for frequent maintenance in terms of oral hygiene measures in implant-supported dentures, a tight recall system should be established at the time of implant insertion, and a follow-up assured, even when the patient is relocated to an institution. This follow-up should not only be limited to the prevention of peri-implantitis, but must include denture management and desophistication of the reconstruction, along with functional decline.⁴⁴

3 | AGE-RELATED REASONS FOR PERIODONTAL INFECTIONS

The question arises why old age is associated with a higher prevalence of poor oral hygiene, and consequently higher caries and periodontal disease rates than in younger adults.^{2,45-49} The main contributing factors are related to physiological aging. As vision and oral tactile perception deteriorate with increasing age, elderly people are less aware of the presence of plaque and food debris in their mouths (Figure 2).^{30,50-52} At the same time, an impaired sense of smell often renders them unaware of oral halitosis.⁵² Manual skills decline along with reduced hand strength and muscular coordination, especially when osteoarthritis is present.⁵³ Hence performing the necessary gestures for oral hygiene becomes a challenge.³⁹ Oral hygiene tools can be adapted to the needs of elderly people experiencing reduced manual dexterity, hand strength, and/or vision, but the prevalence of these tools and awareness of their existence remains low.⁵⁴

Age also affects the immune system, a phenomenon often referred to as immunosenescence. A systematic review by Preshaw et al⁵⁵ evinced three key observations that suggest the human immune system declines in effectiveness with age. Firstly, the incidence of infectious diseases increases in people aged older than 65 years compared with younger individuals, and there is increased autoimmunity and degenerative diseases that are associated with a constitutive low grade inflammation. Secondly, the effectiveness of vaccination (eg, to the influenza virus and severe acute respiratory syndrome coronavirus 2) is reduced in older age groups.⁵⁶ Thirdly, there is a delay in wound repair and healing with old age, processes linked with the function of immune cells such as macrophages. In addition to immunosenescence, other factors, such as quantitative and qualitative malnutrition, anatomic alterations (eg, prostate hypertrophy), and neurologic deficits (eg, swallowing disorders), as well as comorbidities and medications, strongly contribute to the increased risk of infection in elderly people. Malnutrition in elderly people is a major factor for decline in health, and a particularly relevant factor for the immune deficiency observed in elderly patients. The factors contributing to malnutrition in elderly people are complex (Table 2).

It is still under discussion if the higher prevalence of periodontal disease in the older age strata of the population is attributable to a diminished immune defense, or simply to the accumulation of

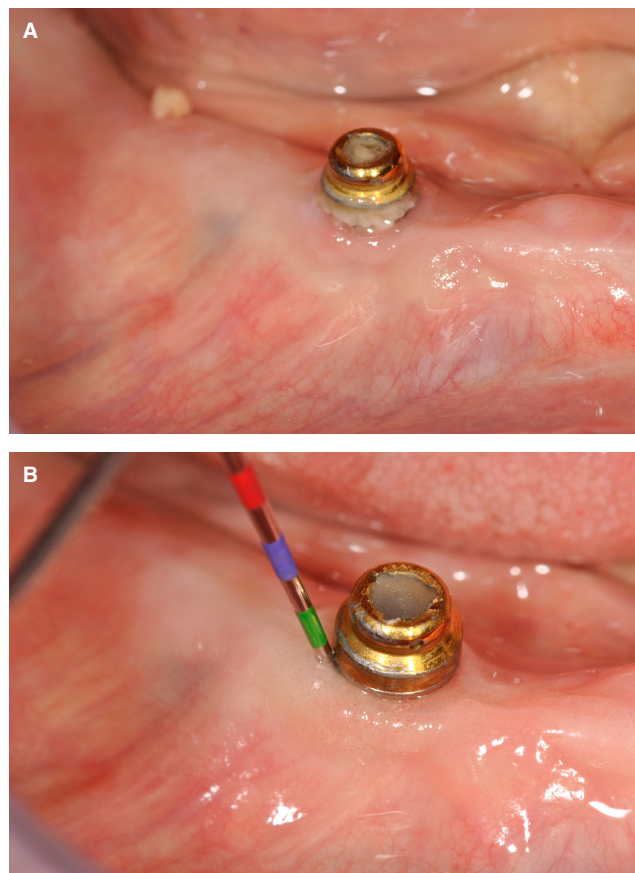


FIGURE 2 A, Typical example of biofilm accumulation around an implant in a patient aged 97 y. B, After spraying away the biofilm and simple mechanical cleaning with a toothbrush, the peri-implant mucosa proved healthy and no pathological pockets could be measured.

sequelae over the lifetime.⁵⁷ Nevertheless, bleeding on probing as a clinical key sign for periodontal inflammation is reduced in older patient populations enrolled in periodontal supportive therapy compared with younger ones.⁵⁸ The human immune system consists of various defense mechanisms against infections and there is increasing evidence that the immune response changes with increasing age. This age-related dysregulation of the immune responses was termed “immunosenescence” and refers to the innate immune system.⁵⁹ The details and mechanisms on cellular and molecular processes are not completely understood yet, but there seems to be significant alterations in neutrophils and macrophages as well as inflammatory phagocytes.⁶⁰

Periodontitis constitutes an inflammation of a mostly chronic nature that leads to destruction of tissue caused by a specific biofilm and the related inflammatory response. Thus, changes in the way the immune system forms a response to such inflammation are relevant to the individual pathogenesis and progress of the disease in the elderly individual. For example, Hazeldine et al⁶¹ reported a significant age-related decrease in neutrophil function, and suggested an increased susceptibility to periodontal infection in elderly individuals. Furthermore, Bodineau et al⁶² evinced that the ratio of CD4+

TABLE 2 Factors contributing to malnutrition in elderly people

Malnutrition in elderly people: causes
Increased protein requirement
<ul style="list-style-type: none"> • Decreased protein synthesis • Decreased nitrogen retention
Increased micronutrient requirement
<ul style="list-style-type: none"> • Synthesis of vitamin D in the skin declines • Decreased renal hydroxylation of vitamin D to dihydroxyvitamin D • Atrophic gastritis and decreased stomach acid decreases absorption of vitamin B12, calcium, iron, and folate
Decreased nutrient intake
<ul style="list-style-type: none"> • Loss of taste and smell • Food avoidance: milk products, limited food choice • Dental disorders/ill-fitting dentures • Comorbidities (eg, chronic obstructive pulmonary disease, congestive heart failure, cancer, depression, dementia) • Social isolation/living alone; rarely preparing meals • Economic factors: choosing between medications/food/rent • Medications: digoxin/other appetite suppressants

T-lymphocyte was decreased when comparing older with younger patients with periodontitis.

A further factor contributing to poor oral hygiene may be related to social withdrawal when elderly people are hospitalized or are living in institutions, as visits from family and friends become scarce.⁶³ Within a context where wearing a denture is often no longer considered a “prosthetic privacy” issue, the social pressure for a well-tended appearance is lower compared with professional adults and those who lead an active social life. When functional impairment and multi-morbidity are dominating daily life, a shift in priority may occur, and oral hygiene and oral health may no longer be in focus. A lower perception of treatment need is well documented for elderly nursing home residents, where the objective treatment need, as defined by dental “normative” standards, is in stark contrast to the patient’s subjective perception of a treatment need.⁶⁴ This general satisfaction and subjective well-being is documented well beyond oral health.⁶⁵⁻⁶⁷ The term “overadaptation” is used for a potentially traumatizing or harmful oral situation in the absence of any subjective awareness or treatment demand of the patient. The role of the dentist in this context is to provide professional information and raise awareness, rather than “talking patients into a dental treatment”.

It also has to be taken into consideration that elderly patients often present a more complex and compromised situation for osseointegration and healthy peri-implant tissues than younger patients because of their compromised general health. Peri-implant mucositis is frequently reported in age cohorts older than 80 years.³² However, in a large epidemiologic study that compared a younger with an older age cohort, time in function, and not age per se, explained bone loss around dental implants.⁶⁸ It also has to be borne in mind that many elderly patients receiving implant treatment in old age might have lost their teeth later in life and hence are unlikely to present the same risk factors as young adults who lost their teeth as a result of an aggressive periodontitis. Bryant⁶⁹ showed lower bone loss in elderly patients, and justified it with the latter argument.

Furthermore, it has to be borne in mind that the bone metabolism, and hence the turnover of bone resorption and apposition, slows down with age. Other factors, like periodontal health, the number of implants placed, and treatment by a specialist, as well as micro- and macro-design of the implant, play predominant roles in the onset and progression of peri-implant disease.⁷⁰ A recent systematic review by Schimmel et al²⁹ could not evince increased bone loss around implants or higher implant failure rates in older patients compared with younger cohorts. In a prospective cohort study, Enkling et al⁷¹ even demonstrated that peri-implant bone loss was significantly lower in the 65 years or older age cohort compared with the younger cohort.

Furthermore, high plaque scores in old age may be related to the morphology of an elderly person’s dentition. A younger person’s dental morphology promotes self-cleaning during mastication, as the interdental spaces are filled with gingival papillae and the teeth are shaped in a way that facilitates the gliding of foodstuffs into the oral vestibule. The masticatory act is performed with a muscle activity that cleans the oral cavity along with food comminution. The tongue rubs against the rugae of the palate, and again, this has a cleaning effect. With increasing age, less muscle force is used during chewing, especially when dental prostheses limit the chewing performance and suggest a diet that is easy to chew, often rich in refined carbohydrates and sugar.⁴⁸ Hence self-cleaning is less efficient because of increasing age, and this effect is further enhanced by the presence of an unfavorable morphology of “patchwork” dental restorations and gingival recession following the accumulation of loss of periodontal tissue over the lifetime.⁷² A recent tool developed in Japan tried to quantify and categorize the decline of oral function. The term “oral hypofunction” has been introduced by the Japanese Society for Gerodontology.⁷³ Its novelty includes an assessment of seven oral functions beyond just the presence of anatomic structures like teeth and dentures. Oral signs or symptoms comprise oral uncleanness, oral dryness, decline in occlusal force, decline in the motor function of tongue and lips, decline in tongue pressure, decline in chewing function, and decline in swallowing function, with oral hypofunction being diagnosed if the criteria for three or more signs or symptoms are fulfilled. This screening tool aims to identify patients at risk of oral dysfunction at a stage when oral dysfunction may still be prevented by a dental intervention.

Chronic diseases and, in particular, their treatment, may present further risk factors for poor oral hygiene and hence oral infection and disease.²⁹ Radiotherapy renders the oral mucosa sensitive and oral hygiene gestures must be performed in a gentle and not harmful manner.⁷⁴ Patients may choose not wearing their removable appliances, and treatment concepts should assure oral comfort and avoid injury without the denture. Recently, antiresorptive therapies were associated with osteonecrosis, a rare but severe complication, which may mutilate oral health.⁷⁵ Other treatments affecting oral hygiene are related to the intake of medications, especially syrups containing sugar.⁷⁶ Antihypertensives, antidepressants or monoamine oxidase inhibitors, are known to cause a salivary gland hypofunction, but may also influence implant survival through further indirect pathways (ie, bone metabolism).²⁹ These medications, as well as the

corresponding lack of saliva, foster adhesion of biofilm, render the oral mucosa sensitive, and finally diminish the repair capacity of initial carious lesions. But also the chronic disease itself (eg, diabetes) is associated with a lack of saliva in the oral cavity, and its related negative side effects.⁷⁷

4 | EFFECT OF LOW-GRADE INFECTIONS AND POOR ORAL HEALTH ON GENERAL HEALTH

There is increasing evidence that chronic low-grade inflammation increases the likelihood of developing chronic diseases. Indeed, increased levels of the inflammation markers (eg, C-reactive protein, interleukin-6) in the young and middle-aged predict the risk of later developing a number of highly relevant pathologies, including cardiovascular disease,⁷⁸ diabetes,⁷⁹ and dementia.⁸⁰ It has even been hypothesized that periodontal disease may be a risk factor for complications of coronavirus disease 2019.⁷⁶ Low-grade inflammation is typically caused by low-grade chronic infections; among these, chronic infections of the oral cavity figure prominently, in particular periodontitis. And indeed, there is increased epidemiologic evidence demonstrating a link between periodontal disease and several systemic diseases.⁸¹ Importantly, there is now emerging evidence that treatment of gum disease is efficient in improving general health.⁸² For example, intensive periodontal therapy reduced HbA1c in patients with type 2 diabetes and moderate-to-severe periodontitis after 12 months compared with a control therapy.⁸³

A second mechanism illustrating how poor oral health translates into systemic disease is the risk of developing bacterial pneumonia, which is typically caused by bacteria descending the respiratory tract and consequently infecting the pulmonary parenchyma.⁸⁴ While in younger, relatively healthy patients, the transmission of pathogenic bacteria, such as streptococcus pneumonia or mycoplasma pneumonia, is the key mechanism for the development of pneumonia, in a debilitated and frail patient, “trivial” bacteria from the oral cavity can cause aspiration pneumonia.¹⁴ Interestingly, there is not only an association between poor oral hygiene and respiratory infection, but also a decrease in pneumonia incidence upon improved oral care.⁸⁵

5 | TREATMENT OPTIONS IN OLD AGE

Several interventions have been discussed to prevent or decrease infections in elderly people (Table 3). Vaccinations in elderly people are important, but with increasing age immunosenescence decreases their efficiency.⁵⁶ For example, it is recommended that antipneumococcal vaccines are given relatively early in the course of aging. Avoiding malnutrition can contribute substantially to decrease the risk of infection in elderly people. Wherever possible, the exposure of elderly people to pathogens should be reduced. And finally, chronic infectious conditions should be treated, but these need to be distinguished from colonization.

TABLE 3 Interventions to decrease infections in elderly people

Interventions to decrease infections in elderly people
Vaccination, but <ul style="list-style-type: none"> • at what age? • immunosenescence may decrease vaccine efficiency
Avoid malnutrition <ul style="list-style-type: none"> • availability of adapted “healthy” food • oral health
Decrease exposure to pathogens <ul style="list-style-type: none"> • influenza and COVID-19 vaccination of family members and caretakers • in case of an epidemic/pandemic situation, use of face masks and increased level of hygiene rules • tuberculosis control
Treat chronic infections? <ul style="list-style-type: none"> • yes: <i>Helicobacter pylori</i>, periodontal disease • but: need to distinguish colonization from infection

Abbreviation: COVID-19, coronavirus disease 2019.

The success rates of periodontal treatment in old age have only been studied rarely. The presence of removable prostheses and poorly shaped or ill-fitting fixed restorations are the “natural enemy” of periodontal health, and make the success of a periodontal treatment especially difficult.⁸⁶ Concerning peri-implant treatment, the situation is even more difficult as, to the best of our knowledge, the treatment outcomes of peri-implant disease in elderly patients have not been studied yet.³² As previously mentioned, the clinical signs of inflammation are stronger around implants compared with natural teeth when immunosenescence is present.^{3,27,28} However, the critical point of the long-term success of periodontal therapy in elderly compared with younger patients is the maintenance. As for the survival of teeth in removable partial denture wearers, Tada et al⁸⁶ demonstrated a significant effect of regular periodontal maintenance on tooth survival. A similar effect might apply to dental implants, but this has not yet been proven in a high-level evidence clinical trial. Adherence to a systematic recall system may be difficult because of access to care, mobility problems, financial limitations, and motivation, whereas maintaining a high level of oral hygiene is a challenge in itself, for all of the aforementioned reasons. Furthermore, in an institutionalized context, the knowledge and skills of the caregivers are a limiting factor, and protected time for oral hygiene of the nursing personnel remains a crucial issue in care for the elderly.⁴¹ Professional oral hygiene regularly performed by dental personnel (ie, dental hygienists or dentists) rather than medical care staff would not only be helpful to avoid the biofilm from maturing, but could also prevent death from aspiration pneumonia.²⁰ However, the numbers of dental personnel who are skilled and interested in treating this special care population are low, and more staff need to be trained in vocational training as well as via structured undergraduate and postgraduate education programs. Considering the extent of human resources needed for preventive oral healthcare, physicians and primary healthcare providers might play a role in screening for oral disease and delivering preventive measures.⁸⁷ The presence of

natural teeth and implants in contemporary old and very old cohorts has become a public health issue, and several calls for action have been published by experts in the field.^{57,88,89}

6 | SUMMARY AND CONCLUSION

Periodontal and peri-implant diseases are very frequent and they increase with age. In old age, periodontal and peri-implant diseases should be evaluated in the context of general health, physiological aging of the immune system, and general body function. Systematic periodontal maintenance therapy, as performed in younger age cohorts, may be difficult to implement in elderly people experiencing institutional and hospital confinement because of logistics and barriers related to patients, caregivers, or cost. The scale of periodontal disease in old age represents a considerable public health issue.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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