

# Improving oral health: How industry can help



**S**ignificant advances in scientific knowledge and the commercialization of oral health products have contributed to the improvements in the oral health of millions of people across the world over the past four decades. This period has seen the introduction of more advanced toothpastes with optimal levels of fluoride to prevent caries, as well new oral care products that address a range of people's needs, including prevention of early periodontal disease (gingivitis) and reduction in tooth sensitivity. GSK Consumer Healthcare is at the forefront of innovation in oral care and in fostering oral health education with the aim of helping billions of people around the world to achieve better oral health.

Herein, we review the remarkable progress that the dental industry has made in preventing and treating oral conditions and the continuing burden of these diseases worldwide. We also discuss the role that industry can continue to play in positively influencing oral health outcomes, both through scientific research as well as partnerships with patients, dental professionals, academia and non-governmental organizations.

## THE BURDEN OF ORAL DISEASE

The act of twice daily toothbrushing has increased<sup>1</sup> from around 30–62% of people (varying by country) in the mid-1990s to around 50–72% of people in 2010. However,

despite oral diseases being considered largely preventable through such a simple self-care intervention, their incidence continues to remain stubbornly high. Caries and periodontal disease are amongst the most prevalent non-communicable diseases globally<sup>2</sup>.

Lifestyle choices (including a worrying growing consumer trend to choose non-fluoride toothpastes), the continuing shift in diets towards foods that are high in refined sugar (or contain hidden complex sugars), repeated snacking and a trend towards more acidic foods and drinks that can dissolve the mineral structure of enamel are challenging oral health worldwide.

## THE IMPACT OF POOR ORAL HEALTH ON THE INDIVIDUAL

The World Dental Federation (FDI), an organization headquartered in Geneva, Switzerland, that represents dental professionals around the world, defines oral health as “multi-faceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex [head, face, and oral cavity]”.

This 2016 definition encapsulates a change from oral health being the absence of disease to one that includes physical, mental and social wellbeing — factors important in people's day-to-day life. Oral



**Oral disease affects 3.5 billion people worldwide**

health is a significant component of quality of life and is an important indication for people's health status. The impact of oral diseases on quality of life can include physical, social and psychological factors such as pain, discomfort, functional limitations, social life, eating, exercising, insomnia, irritability and low self-esteem.

## THE PREVALENCE OF ORAL DISEASE

It is estimated that oral diseases affect 3.5 billion people worldwide, with caries the most prevalent disease affecting 2.3 billion people and severe periodontitis affecting 796 million people<sup>2</sup>.

- Caries (tooth decay) results from damage to enamel by repeatedly being exposed to acid produced by plaque, a soft sticky deposit of bacteria, on the tooth. Plaque converts free sugars into acids that dissolve the mineral components of enamel.
- Periodontal diseases (gum diseases) are ubiquitous and the most common

inflammatory disease in humans. They start with gingivitis, a superficial gum inflammation arising in response to the accumulation of dental plaque that collects on and between teeth and along the gum line. Gingivitis can lead to small, microscopic ulcers appearing between the gingiva (gum) and teeth, which allow blood to escape into saliva when we eat or brush our teeth, but conversely also allow microorganisms from the dental plaque to simultaneously enter the blood circulation, known as bacteraemia<sup>3</sup>. Over time, repeated episodes of gingivitis can cause gum recession and lead to dentine hypersensitivity, a common and painful condition of the mouth that causes a short, sharp pain in affected teeth when consuming cold or hot foods and drinks; dentine hypersensitivity has a significant impact on people's lives.

If not addressed, gingivitis can progress to periodontitis in susceptible people, leading to destruction of the bone that retains teeth in the jaws, and ultimately tooth loss and disability, compromised eating, reduced nutrition, reduced self-confidence and a lower overall quality of life.

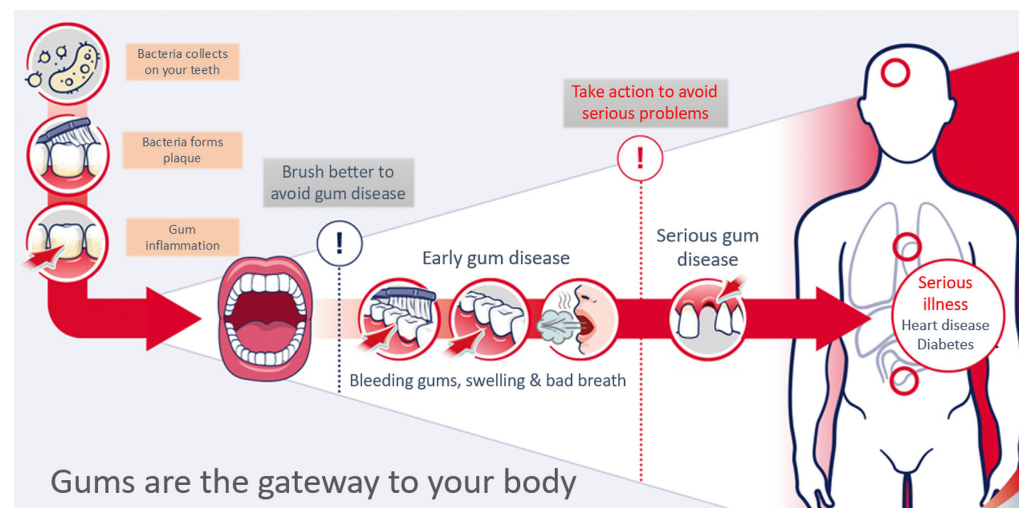
The precursor to periodontitis — gingivitis — is reversible. Effective oral care through self-administered oral hygiene and good dietary habits can prevent plaque build-up.

### ORAL HEALTH AS A SENTINEL OF SYSTEMIC HEALTH

According to a systematic review of clinical research activity conducted in 2016, periodontitis, the advanced stage of periodontal disease, has been linked to more than 57 systemic non-communicable diseases<sup>4</sup>. The strongest evidence is for an independent relationship with type 2 diabetes, in which periodontitis associates with poorer blood sugar control and greater complications of diabetes<sup>5</sup>. The relationship is bidirectional: the worse the glycaemic control, the worse the periodontitis and vice versa. Importantly, successfully treating periodontitis improves diabetes control to the same extent as certain drugs used to treat diabetes<sup>6</sup>.

### IS THE LINK BETWEEN PERIODONTITIS AND SYSTEMIC NON-COMMUNICABLE DISEASES PLAUSIBLE OR JUST A COINCIDENCE?

A question can be raised whether the link between periodontitis and non-communicable diseases is just a coincidence. Most non-communicable diseases are caused by modifiable lifestyle factors, including tobacco use, harmful use of alcohol, unhealthy diets, insufficient physical activity, being overweight and obesity, raised blood pressure,



raised blood sugar, and raised cholesterol: periodontitis is no different. Therefore, the 'common risk hypothesis' suggests that the relationship between periodontitis and systemic non-communicable diseases is in part due to a genetic predisposition to producing too much inflammation in response to a stimulus (for example, infection), but is also exacerbated by common lifestyle and behavioural factors that increase the risk of all conditions independently of each other. However, most studies linking periodontitis to other non-communicable diseases account for such common risks in their analysis, and there is emerging evidence that periodontitis may be a causal factor in a complex chain of events that may lead to certain non-communicable diseases in some (but not all) people. For example, research in people with chronic kidney disease has shown a significant relationship between periodontitis severity and stiffer arteries. The work also demonstrated a bidirectional causal link between periodontitis and chronic kidney disease and identified a biological mechanism in the blood circulation of 770 chronic kidney disease volunteers<sup>7</sup>.

There is compelling evidence that the entry of periodontal bacteria into the blood stream through the micro-ulcers that

form in periodontitis causes inflammation in the body. Several mechanisms have been identified, including elevation of C-reactive protein in the liver driving inflammation, generation of a pro-thrombotic state (an increased risk for the formation of blood clots), generation of damaging oxygen radicals by white blood cells called neutrophils and alterations in lipid balance.

In 2019, a joint consensus report by the World Heart Federation and the European Federation of Periodontology, summarized the available evidence for a link between cardiovascular disease and periodontitis and produced recommendations for dental professionals, physicians and their patients on periodontal care in cardiovascular disease patients<sup>8</sup>. The European Federation of Periodontology and the International Diabetes Federation produced similar guidance<sup>9</sup>. It seems therefore that expert scientific medical bodies are convinced by the evidence linking periodontitis to systemic non-communicable diseases, which are a major cause of global mortality and recommend that preventing periodontitis by managing gingivitis or treating periodontitis when it develops is important to improve general health as well as retain teeth.

Therefore, the benefits of effective oral hygiene and maintaining good oral health extend far beyond the mouth.

### BARRIERS TO EFFECTIVE ORAL CARE

One may ask what the barriers are to effective oral care given that its impact appears so important to human health, economics and society. Significant barriers do exist and include:

1. Effective twice-daily toothbrushing is not fully realised in many cases. It is recommended that adults brush their teeth for two minutes twice a day, but many people fall short of this goal. At least 20% of adults self-report that they brush their teeth once, or fewer, times per day<sup>1</sup>, and even when twice-daily brushing is performed it is only for an average of 30–45 seconds<sup>10</sup>. Clinical research has shown that brushing for two minutes removes 26% more plaque than brushing for 45 seconds<sup>10</sup>, highlighting a significant opportunity for improvement in many people's brushing habits. However, for people who already have periodontal disease (and who are at elevated risk of further deterioration of dental health), two minutes of brushing is inadequate, and a more personalized treatment approach is required<sup>11</sup>.

2. The mouth has long been treated separately from the rest of the body, largely due to distinct training pathways for physicians and dentists. This is slowly changing and the case for joining up oral and general healthcare pathways is becoming too compelling to ignore. In England, the National Health Service has produced a commissioning standard on oral health for people with diabetes. The plan is to encourage physicians and dental professionals to start working together on targeted early case detection for diabetes in dental settings, and on diagnosing and treating periodontitis to a high standard in people with diabetes<sup>12</sup>.

3. Public awareness of the wider benefits of effective oral hygiene remains low. Oral health has not improved over the past 25 years. The combined global prevalence of dental caries in permanent teeth, severe periodontitis and tooth loss has remained unchanged<sup>3</sup> since the 1990s at around 45%. There is a real need to drive awareness of the impact of poor oral health. If people do not take care of their mouths properly, they could be putting more at risk than their smile.

4. Oral healthcare is not affordable for many people and remains a sentinel of the ever-growing health inequalities gap<sup>13</sup>. Low socioeconomic status is associated with greater prevalence and severity of oral diseases. Caries and periodontal diseases are preventable, but the cost of accessing a dentist and receiving early treatment and preventative measures remains a barrier for many people.

5. Competing urgent priorities often mean that oral health and education in oral health is neglected within health policy and public funding<sup>13</sup>.

The urgency in addressing these remaining barriers

suggests the need for a more holistic approach to oral health, including greater integration of oral and general healthcare, increased educational outreach to patients, and the development of global programmes to facilitate affordable oral healthcare for all. The World Health Organization's Global Oral Health Programme recognizes these as key areas of necessary work to improve oral health worldwide<sup>14</sup>. The dental industry is in a unique position to help address many oral health needs through its global reach, extensive partnerships with dental professionals, researchers and non-governmental organizations and innovative medical research.

It is no longer acceptable to ignore oral health and symptoms of poor oral health (such as bleeding gums), at least, not to those who understand the implications to health and society at large.

### THE IMPORTANCE OF EFFECTIVE ORAL CARE PRODUCTS

The performance of regular oral hygiene can be traced back thousands of years, but it has only been in the past 100 years that specialist products to improve oral health have been developed and their effectiveness proven through randomised controlled clinical trials.

Today, practising good oral hygiene is something people can do every day at home, through twice daily brushing with fluoride toothpaste or a toothpaste designed for their specific needs.

Prevention of caries: Oral care products (for example, toothpastes) help prevent caries in two ways: i) by effectively cleaning teeth – removing plaque/bacteria from the teeth; and ii) by delivering the therapeutic ingredient fluoride. Fluoride protects enamel from plaque acid-induced damage. It binds directly to the enamel surface and changes the chemistry of



**Brush  
2 mins  
twice  
a day**

the enamel by making it more resistant to demineralization by plaque acids and promotes remineralization.

When used twice per day, toothpastes containing fluoride at concentrations between 1,000 and 1,500 ppm are the simplest and most effective way of preventing and treating tooth decay<sup>15</sup>, but it is critical that the toothpaste is formulated so that the fluoride is biologically available at the optimum level to promote remineralization and limit caries progression.

Over the past 40 years, the oral care industry has developed formulations that maximize the bioavailability of fluoride. Early formulations contained ingredients that could reduce the availability of fluoride and compromise the therapeutic effect<sup>16</sup>. Modern toothpastes now utilize ingredients (such as silica) that do not react with fluoride and are formulated to help promote retention of fluoride in the oral environment to provide a sustained therapeutic effect<sup>17</sup>.

Prevention of periodontal disease: Oral care products also help to prevent early periodontal disease (gingivitis). They can achieve this by effectively cleaning teeth by the action of toothbrushing with toothpaste — removing plaque/bacteria from the teeth, and by delivering therapeutic antimicrobial and anti-inflammatory ingredients.

When performed twice per day, toothbrushing is effective at preventing plaque build-up and periodontal disease; however,

cleaning teeth effectively is easier said than achieved. To help make daily oral hygiene simple and enjoyable, and thus help drive adherence with effective twice daily cleaning, the dental industry focuses on meeting the consumer's desire for easy, inexpensive and enjoyable solutions for what is often seen as a mundane and unloved task. During the development of oral health products, sensory and consumer science is applied to understand the user's experience of the product to develop products that are better suited to individual expectations.

Antimicrobials or plaque disrupters can be added to toothpastes to complement mechanical plaque removal by toothbrushing. Antimicrobial agents, typically positively charged agents such as tin ions or chlorhexidine, inhibit plaque (bacteria) growth. Plaque disrupters are ingredients such as sodium bicarbonate, which softens and physically removes plaque, enhancing the cleaning efficacy of toothbrushing. Both approaches help reduce plaque build-up in the hard-to-reach, harder to clean areas between teeth and the back of the mouth.

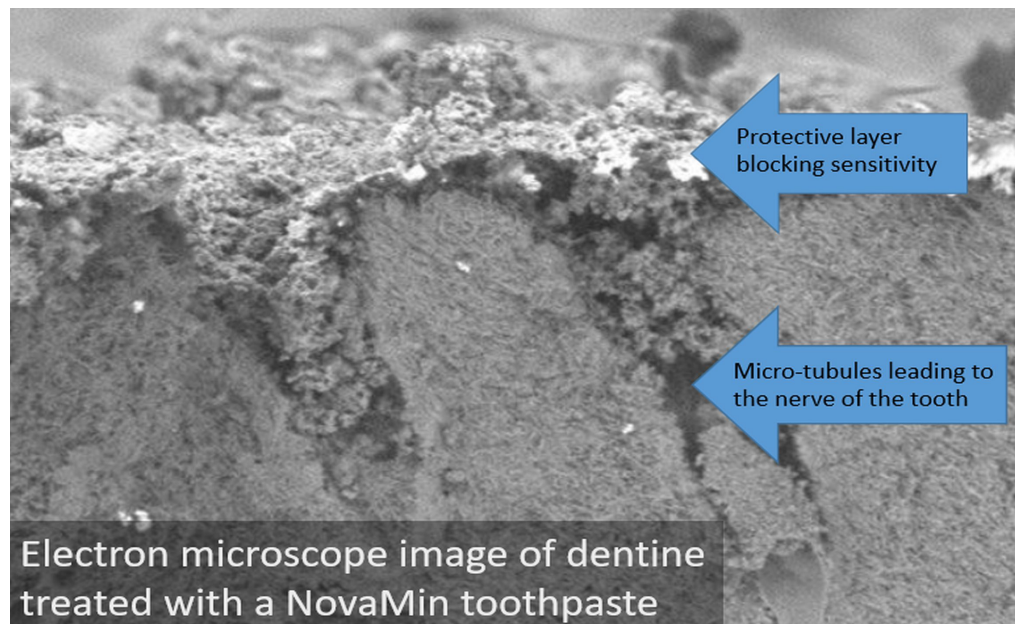
Broader oral health benefits: Today, oral care products offer more benefits than previously demanded by the consumer, for example by helping to avoid bad breath, preventing calculus (tartar) formation and whitening enamel. Modern formulations can be extraordinarily complex and contain many ingredients

to target different diseases and conditions, as well as delivering cosmetic benefits such as stain removal and delivering a satisfying experience that is gentle on the mouth and suitable for twice daily use.

Specialist oral care products have been developed to help prevent enamel erosion and lessen the pain of the related condition of tooth sensitivity. Treatments to prevent the pain of dentine hypersensitivity have been some of the most innovative in recent years. In 2011, GSK Consumer Healthcare introduced a bioactive glass material called NovaMin (calcium sodium phosphosilicate) in a daily-use toothpaste for the prevention and treatment of dentine hypersensitivity. NovaMin is a material originally engineered to slowly release calcium and phosphate in the body for the repair of bone. It was subsequently found to be effective in forming a reparative layer over exposed dentine (Fig. 1), mimicking the function of the enamel to provide relief from dentine hypersensitivity<sup>18</sup>. At least 15 clinical studies demonstrate the efficacy of NovaMin-containing toothpastes to provide relief from dentine hypersensitivity. Importantly, the clinical studies also indicate broad improvements in oral health-related quality of life by reducing the impact of the condition on everyday activities such as eating and drinking<sup>19</sup>.

### THE ROLE OF SELF-CARE

A key element in overcoming barriers to effective oral health is the principle of self-care treatment, in which patients actively participate and contribute to improving their own health. Industry can play a constructive role in promoting self-care through use of consumer insight and patient-reported outcome measures. These measures allow for analysis of an individual's



**Figure 1.** A scanning electron micrograph of a cross-section of dentine showing the layer that NovaMin forms over and within dentine (GSK data on file).

subjective assessment of a product, including health-related feelings and functions. In combination with randomized clinical studies, these measures can be used to establish clinical efficacy (reduction in disease), as well as improvements in psychological wellbeing and treatment satisfaction.

For people with caries, periodontal disease and even tooth sensitivity, the impact of these oral diseases and conditions extends far beyond the clinical disease definition. In partnership with academia, industry is playing a leading role in developing and funding research on the impact of oral diseases and conditions on quality of life, both in randomized clinical studies and real world studies whereby data is obtained outside of controlled clinical trials, often at home or during routine clinical practice. The oral care industry also has access to unique insights and data from consumer research on how people feel about their oral state and how it affects their day-to-day lives. Such insight is used to help understand the impact of oral diseases and conditions

on people's lives, and to develop more personalised products that fit with the individual's needs and expectations.

### HOW INDUSTRY IS HELPING TO IMPROVE ORAL HEALTH

The roots of industry involvement in driving innovation for improved oral health are thought to have originated in 1780, with the commercialization of the first toothbrush<sup>20</sup>.

At the time, there was a critical need to improve oral hygiene habits; the industrial revolution drove frequent and daily consumption of sugar-based products and as a result, the rates of dental caries exploded. Science did not know the cause of caries (that would have to wait another 100 years), but the thought that it was caused by consumption of certain foodstuffs had already been proposed centuries earlier by Aristotle.

Today, the consumer healthcare industry continues to play a critical role in helping to deliver better oral health thanks to:

**Disease awareness:** The industry's considerable global advertising budgets, commercial communication expertise and

global reach can successfully elevate awareness of the importance of oral health and hygiene to consumers around the world.

**Individual understanding:** The consumer healthcare industry has vast knowledge and understanding of people's oral care habits, behaviours, attitudes to oral health and the impact of oral health on people's lives. Such insight is critical to improving product development and supporting communication and education messages.

**Academic research:** Globally with governmental support of oral/dental research being constrained, the consumer healthcare industry has become one of the major contributors to academic research, enhancing scientific knowledge and clinical research. It is estimated that industry has collectively invested between £50-£100 million annually to foster the translation of research into clinical practice, people's daily hygiene routines, and wellbeing.

**Product innovation:** Industry has consistently delivered improved, clinically proven, safe and effective solutions to enhance people's oral health.

## Healthier mouths, happier moments



Partnerships: The consumer healthcare industry partners closely with healthcare professionals, non-governmental organizations and educators to raise awareness and facilitate greater understanding of the importance of oral health on whole body health (and self-care), and the prevention of oral disease through effective oral hygiene.

Partnering with academia: For many years, industry has supported (by either unrestricted grants or donations, or joint collaborations) fundamental research in oral diseases, behaviour change science and quality of life. In collaborations extending over ten years, GSK Consumer Healthcare has developed patient-centric experience questionnaires to understand the impact of oral health on people's quality of life. For dentine hypersensitivity, such research has revealed that the condition has a significant impact on people's lives. Although the pain of dentine hypersensitivity is fleeting, it can change the way people eat or drink certain foods<sup>19</sup>, and also the way people brush their teeth — they may avoid brushing sensitive areas, which can negatively impact on their oral health. Patient-centric research not only demonstrates satisfaction with treatment, but also shows the inter-relationship of conditions with broader aspects of oral health and wellbeing.

Partnering with non-governmental organizations for advocacy: In the areas of

advocacy, education and science, industry has provided long-term support for leading oral health non-governmental organizations. GSK Consumer Healthcare supports the World Dental Federation and the International Association of Dental Research, as well as significant regional organizations such as the Platform for Better Oral Health Europe and European Federation Periodontology. GSK Consumer Healthcare also actively supports the worldwide oral health charitable sector, such as Smile Train and Oral & Dental Research Trust.

### THE ORAL CARE INDUSTRY: BUILDING ON THE SUCCESS OF THE PAST

Over the past 100 years, the oral care industry has been a leader in research on the chemistry and biology of the mouth, driving the development of oral care products that have markedly improved the lives of millions of people worldwide. Despite the established efficacy of these products, the prevalence of oral disease, including caries and gingivitis, remains stubbornly high<sup>2</sup>. Several factors may account for the persistence of oral disease, including a low level of public awareness of the benefits of good oral hygiene, lack of affordable and accessible dental care, and historic separation of oral health from general healthcare.

Healthier mouths, happier moments: GSK Consumer Healthcare believes that mouths

should be a source of joy, not pain, and that everyone should be able to eat, drink, laugh, talk, kiss and enjoy life more. That is why we are at the forefront of the global fight to eradicate oral health problems.

GSK Consumer Healthcare is committed to understanding the impact of oral diseases on overall health. In partnership with scientific institutions, we are:

- Conducting research on the epidemiology and aetiology of oral diseases, the mechanism of action of established and novel ingredients, and formulation factors influencing the performance of oral care products.
- Funding research to understand the impact of oral diseases on people's overall health and quality of life, and the role of behavioural change and education in helping to deliver better oral health.
- Actively investigating the role of oral care products in maintaining oral hygiene, and how oral hygiene may be beneficial in related disease areas.

### AUTHORS

Dr. Charles Parkinson, Medical Affairs Director for Oral Health<sup>1</sup>; Dr. Stephen Mason, Medical Affairs Lead for Oral Health<sup>1</sup>; with Professor Iain Chapple, Director of Research for Institute of Clinical Sciences<sup>2</sup>

### ADDRESS

<sup>1</sup>GSK Consumer Healthcare, Research and Development, St. Georges Avenue, Weybridge, Surrey KT13 ODE, UK.

<sup>2</sup>College of Medical and Dental Sciences, The University of Birmingham, Edgbaston, Birmingham B15 2TT, UK.

### REFERENCES

1. Honkala, S., Vereecken, C., Niclasen, B. & Honkala, E. *Eur. J. Public Health* **25**, Suppl. 2: 20-23 (2015).
2. Bernabe, E. *et al. J. Dent. Res.* **99**, 362-373 (2020).
3. Tomás, I., Diz, P., Tobías, A., Scully, C. & Donos, N. *J. Clin. Periodontol.* **39**, 213-228 (2012).
4. Monsarrat, P. *et al. J. Clin. Periodontol.* **43**, 390-400 (2016).

5. Chapple, I. L. C., Genco, R. & working group 2 of the joint EFP/AAP workshop. *J. Clin. Periodontol.* **40**, Suppl. 14: S106-S112 (2013).
6. D'Aiuto, F. *et al. Lancet Diabetes Endocrinol.* **6**, 954-965 (2018).
7. Sharma, P. *et al. J. Clin. Periodontol.* **48**, 357-367 (2021).
8. Sanz, M. *et al. Global Heart* **15**, 1 (2020).
9. Sanz, M. *et al. Diabetes Res. Clin. Pract.* **137**, 231-241 (2018).
10. Creeth, J. E. *et al. J. Dent. Hyg.* **83**, 111-116 (2009).
11. Chapple IL, *et al. J Clin Periodontol.* **2015** : **42**(s16) ; 71-76 (2015).
12. National Health Service England. Dental care for people with diabetes. 2019.
13. The Economist Intelligence Unit. Report: Time to take gum disease seriously: The societal and economic impact of periodontitis (The Economist, 2021).
14. World Health Organization. 148th Session 2021. Agenda Item 6 EB148/8.
15. Wong, M. C. *et al. J. Dent. Res.* **90**, 573-579 (2011).
16. Lynch, R. J. & ten Cate, J. M. *Int. Dent. J.* **55**, (3 Suppl 1): 175-178 (2005).
17. Parkinson, C.R. *et al. J. Dent.* **106**:103587 (2021).
18. Greenspan, D. C. *J. Clin. Dent.* **21**, 61-65 (2010).
19. Dhelfeson, W. D. *et al. J. Dent.* **71**, 1-8 (2018).
20. Tadinada, A., Kilham, J., Bysani, P. & Gopalakrishna, A. *J. Dent Health Oral Disord. Ther.* **2**, 127-130 (2015).