



# Global oral health status report

Towards universal  
health coverage for  
oral health by 2030



World Health  
Organization

Global oral health status report: towards universal health coverage for oral health by 2030

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for oral health by 2030



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# Foreword



Oral diseases are among the most common noncommunicable diseases worldwide, affecting an estimated 3.5 billion people. The burden is increasing, particularly in low- and middle-income countries.

Good oral health is essential for eating, breathing and speaking, and contributes to overall health, well-being and confidence in interacting with others. But oral health is challenged by a range of diseases and conditions, and stark and persistent inequalities in the burden of disease and access to oral health care. Disadvantaged and marginalized people are more likely to be at risk of oral diseases and their negative consequences.

The good news is that many oral diseases can be prevented and treated. Cost-effective preventive and clinical interventions are available, together with approaches to tackle risks common to all noncommunicable diseases, with the potential to be effective in a range of contexts, including low- and middle-income countries.

Oral health has long been neglected in the global health agenda. Our biggest challenge now is ensuring that all people, wherever they live and whatever their income, have the knowledge and tools needed to look after their teeth and mouths, and access to prevention and care when they need it. For this to happen, all countries need sufficient staff trained in oral health, and oral health services must be included in national health coverage packages, either free of charge or at a price that people can afford.

The adoption by WHO Member States of a historic resolution on oral health at the World Health Assembly in 2021 was an important step forward. The development and adoption of a comprehensive Global Strategy on Oral Health, with a bold vision for universal coverage of oral health services by 2030 was another milestone. The Global Oral Health Action Plan to be discussed in 2023 will include a monitoring framework, with clear targets to be achieved by 2030. These policies will provide us with a clear path towards ensuring oral health for all.

This WHO *Global oral health status report* provides a comprehensive picture of the oral disease burden, the resources available for oral health, and the challenges ahead.

The report also includes country profiles, and will serve as a baseline for tracking progress. Integrating oral health promotion and care into primary health care and UHC benefit packages will be key to success. WHO is committed to providing guidance and support to countries to help make this happen.

I am confident that this report will contribute to continued and increased efforts to improve oral health globally, so that no one is left behind with preventable and treatable oral diseases.

A handwritten signature in white ink, reading "Tedros Adhanom Ghebreyesus". The signature is stylized and fluid.

Dr Tedros Adhanom Ghebreyesus  
Director-General, World Health Organization





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# List of abbreviations

<b>AMR</b>	Antimicrobial resistance
<b>CCS</b>	Country Capacity Survey
<b>CPI</b>	Community Periodontal Index
<b>DALY</b>	disability-adjusted life year
<b>DATs</b>	dental assistants and therapists
<b>DMFT</b>	decayed, missing and filled teeth
<b>DPTs</b>	dental prosthetists/technicians
<b>GBD</b>	Global Burden of Disease
<b>GSHS</b>	Global School-based Student Health Survey
<b>HPV</b>	human papillomavirus
<b>HTA</b>	health technology assessment
<b>IARC</b>	International Agency for Research on Cancer
<b>IHME</b>	Institute of Health Metrics and Evaluation
<b>ILO</b>	International Labour Organization
<b>IPC</b>	infection prevention and control
<b>ITU</b>	International Telecommunication Union
<b>mHealth</b>	mobile health
<b>NCD</b>	noncommunicable disease
<b>NGO</b>	nongovernmental organization
<b>NHWA</b>	National Health Workforce Account
<b>OFC</b>	orofacial clefts
<b>PHC</b>	primary health care
<b>SDGs</b>	Sustainable Development Goals
<b>SSB</b>	sugar-sweetened beverage
<b>UHC</b>	universal health coverage
<b>UN</b>	United Nations
<b>UNICEF</b>	United Nations Children's Fund
<b>WB</b>	World Bank
<b>WHO</b>	World Health Organization
<b>WHO EML/c</b>	WHO model list of essential medicines for adults and children

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# Introduction

The WHO defines *oral health* as the state of the mouth, teeth and orofacial structures that enables individuals to perform essential functions, such as eating, breathing and speaking, and encompasses psychosocial dimensions, such as self-confidence, well-being and the ability to socialize and work without pain, discomfort and embarrassment. Oral health varies over the life course from early life to old age, is integral to general health and supports individuals in participating in society and achieving their potential (1).

Untreated oral diseases affect almost half of the world's population. Global case numbers have increased by 1 billion over the last 30 years – a clear indication that many people do not have access to appropriate oral health care, which includes prevention, risk protection and restorative and rehabilitative services. The consequences of untreated oral diseases – including physical symptoms, functional limitations and detrimental impacts on emotional, mental and social well-being – are severe and debilitating. For those able to obtain treatment, the costs are often high and can lead to significant economic burden. Oral health plays a major role in well-being and self-esteem, while oral diseases heavily affect quality of life, productivity and ability to work as well as social participation.

Stark and persistent socioeconomic inequalities in oral diseases exist with a higher disease burden found in disadvantaged and marginalized population groups. At the same time, public and private expenditures for oral health care are reaching almost US\$ 390 billion globally, with a very unequal distribution among regions and countries. Despite these challenges, oral diseases are largely preventable with population-based public health measures.

Concerned about the lack of attention to oral diseases, the World Health Assembly adopted in May 2021 a historic resolution (WHA74.5) recognizing that oral health should be firmly embedded within the noncommunicable disease (NCD) agenda and that oral health care interventions should be included in universal health coverage (UHC) programmes (2). The World Health Assembly delegates asked WHO to develop a draft global strategy for tackling oral diseases that was adopted during the seventy-fifth session of the WHA in May 2022, to develop by 2023 an action plan including a monitoring framework for tracking progress with clear measurable targets to be achieved by 2030; to develop “best buy” interventions on oral health; and to explore the inclusion of noma in the road map for neglected tropical diseases 2021–2030. This WHO *Global oral health status report* is part of WHO's series of data reports and is an important milestone in the larger process of mobilizing political action and resources for oral health.

The report has three broad aims:

1. outline the global public health importance and impact of oral diseases over the life course;
2. contribute to the process of implementing the World Health Assembly 74.5 resolution on oral health at global, regional and country levels by providing baseline information; and
3. encourage commitment and action from governments, United Nations (UN) organizations and nonstate actors such as nongovernmental organizations (NGOs), academic institutions, philanthropic foundations, private-sector entities and other stakeholders to address oral diseases in the context of global health agendas.

To achieve these aims, the report will:

- highlight the global burden of oral disease and inequalities using the latest available data from the Global Burden of Disease (GBD) project and the International Agency for Research on Cancer (IARC);
- emphasize social and commercial determinants and common risk factors that oral diseases and other NCDs share as a foundation for concerted action;
- highlight challenges and opportunities for oral health within the wider global health context requiring engagement of stakeholders to accelerate progress towards universal coverage for oral health; and
- provide country oral health profiles based on key health and oral health indicators for monitoring and evaluation covering all WHO Member States.

The report is not a textbook on oral health and disease and does not aim to cover all topics comprehensively. Instead, the report reviews the most recent global data on major oral diseases and comes to a clear conclusion: the status of global oral health is alarming and requires urgent action by all stakeholders on global, regional, national and local levels. The target audiences are policy leaders and decision-makers; planners and managers in health, public health and oral health at different levels; oral health stakeholders, such as oral health professionals, academics and researchers; and other nonstate actors, populations, communities and anyone affected by or interested in oral diseases. Moreover, the report is not a guidance document proposing concise policy recommendations but rather is intended to provide fundamental data and a basis to initiate discussion and generate commitment towards changing the current situation of neglect. As such, the report is part of a set of tools and processes in the wider context of strengthening oral health awareness and action, together with the 2021 World Health Assembly resolution on oral health (WHA74.5), the WHO Global Strategy on Oral Health (WHA75/10 Add. 1) and others.

Section 1 of the report highlights oral diseases as largely preventable global public health problems, focusing on their combined burden, shared risk factors and determinants as well as their impacts on individuals, populations, health systems and economies globally.

Section 2 details the latest data on burden and trends for the five main oral diseases and conditions – untreated caries of deciduous and permanent teeth, severe periodontal disease, edentulism and cancer of the lip and oral cavity – as well as other conditions of public health relevance.

Section 3 analyses some of the key challenges and opportunities related to health systems: challenges for the oral health workforce, challenges related to oral health information and persisting issues of public health relevance, including a renewed focus on primary oral health care.

Section 4 situates the report as part of a global process towards improving oral health and connects oral health improvement to general development and progress towards agreed-upon international goals.

The report is complemented by country oral health profiles with key health and oral health information for each WHO Member State. It will be made available as a separate online resource. Information on the data sources used, indicator definitions and the details of references used are also provided.

The report presents the latest available data and information using different sources with the best possible global coverage. However, limitations of oral health data and information must be acknowledged and emphasized. For many aspects of oral epidemiology, surveillance, health system analysis, economic data and others, the scope and depth of information available are neither as comprehensive nor as reliable as for other NCDs. This is largely because of inadequate attention to and awareness of oral diseases combined with a lack of resources, guiding policies and health system investments as well as insufficient political prioritization. Despite these limitations, many aspects highlighted in the report will be new and previously unknown to many readers.

It is equally important that the report uses metrics and data that align with global health metrics (such as disability-adjusted life years) rather than specific oral health indicators that require specialist knowledge to be understood. Oral health specialists may miss such indicators in the report's text, yet integration will be greatly facilitated when using a unified global public health language to describe burden and challenges.

As a status report, this document is part of WHO's series of data reports and hence presents a snapshot of the current situation (editorial closure March 2022). Some of the information presented will be useful in the context of the future monitoring framework aiming to track the implementation of the Global Oral Health Action Plan (2023-2030). By highlighting data and information gaps, the report may also serve as an incentive to strengthen and improve surveillance and information systems for oral health, one of the strategic objectives of the WHO *Global Strategy on Oral Health*.





1

Oral diseases  
are global public  
health problems



Oral diseases are a major public health problem for countries and populations worldwide, although they often are not publicly recognized as such. Globally, these diseases affect almost 3.5 billion people, with three out of four people affected living in middle-income countries. Oral diseases are a group of distinct disease entities with their own aetiology and burden as well as different options for prevention, care and rehabilitation. The oral diseases and conditions (herein referred to collectively as *oral diseases*) representing the highest burdens include untreated caries of deciduous (primary) and permanent teeth, severe periodontal disease, edentulism (total tooth loss) and cancer of the lip and oral cavity.

Each of these diseases is a significant public health problem on a global, regional and national level, compromising the health of individuals and populations. With their unparalleled burden, stark inequalities and risk factors shared with other NCDs, oral diseases have a major impact on health, well-being, health care systems and economies, adding to the increasing burden of NCDs. Most oral diseases are preventable through self-care or with simple, evidence-based and cost-effective population-wide measures including action on the wider social, economic and political determinants of health, making it possible to reduce the disease burden significantly and limit negative impacts.

This section highlights the combined challenges from the main oral diseases. The specific global burden, key features and risk factors of each of the five major oral diseases as well as selected other diseases and conditions of public health relevance are further detailed in Section 2 of this report.

### **Box 1. Oral diseases – a large group of diseases and conditions**

Apart from the five main diseases (caries of deciduous and permanent teeth, severe periodontal disease, edentulism and lip and oral cavity cancer), many other diseases and conditions are relevant for oral health. These include oral manifestations of systemic diseases (metabolic, allergic and immunologic diseases, including HIV infection); oral mucosa diseases; erosion and tooth wear; oral impacts of substance abuse; noma; congenital malformations of teeth and the enamel; viral, fungal and bacterial infections; trauma (including physical

and chemical injuries) of the teeth, jawbones and adjacent maxillofacial structures; cysts and tumours of odontogenic origin; salivary gland diseases; and disturbances in the development and growth of oral structures (3). These diseases and conditions are not comprehensively covered in the global estimations of disease burden from the Institute of Health Metrics and Evaluation (IHME) GBD project (4). This report relies on the latest available GBD data from 2019. The latest available cancer data from 2020 were provided by the IARC (5).



## Box 2. Data sources for the burden of oral diseases and other information

This report uses the latest available data from sources with a wide coverage of countries. Data on caries (deciduous and permanent teeth), severe periodontal disease and edentulism are provided by the IHME GBD Model for Oral Disorders (4). The Model reports estimated disease burden (prevalence, case numbers and other metrics) for all WHO Member States based on rigorously selected data from 130 countries. As of the time of this report's publication, the GBD Model provided data for 1990–2019 – the most comprehensive dataset on the burden of oral diseases using the standard GBD metrics. Other databases available using different metrics more specific to oral health, such as the decayed, missing and filled teeth (DMFT) index, the Community Periodontal Index (CPI) and others, are not regularly updated and do not provide comparable coverage of countries. The GBD Model calculates estimations

for all 194 WHO Member States using a complex modelling approach. For a detailed description of the methodology see Kassebaum et al. 2017 and GBD 2017 Oral Disorders Collaborators 2020 (4, 6).

The IARC, a specialized WHO organization, provided the data on lip and oral cavity cancer using their latest available dataset from the Global Cancer Observatory (2020) (5). Their estimations of incidence, case numbers and other metrics for all cancers, including lip and oral cavity cancer, are the most comprehensive and are widely used.


Data and other information extracted from relevant scientific publications and databases are referenced where used, complementing the two main data sources. Specific challenges to surveillance and data analysis for oral health decision-making are described in Section 3.4.

### 1.1 Oral diseases: an increasing global burden

About 3.5 billion people worldwide were affected by oral diseases in 2019, making them the most widespread conditions among the more than 300 diseases and conditions that affect humanity (4). Oral diseases have remained the most dominant conditions globally since 1990, the first year of oral disease data available from the GBD dataset (see Fig. 1). Among the major oral diseases, untreated caries of permanent teeth is the most prevalent with around 2 billion cases, severe periodontal disease follows with around 1 billion cases, then untreated caries of deciduous teeth with about 510 million cases and edentulism with 350 million cases (all in 2019). The combined estimated number of cases of oral diseases globally is about 1 billion higher than cases of all five main NCDs (mental disorders, cardiovascular disease, diabetes mellitus, chronic respiratory diseases and cancers) combined (see Fig. 2) (4).

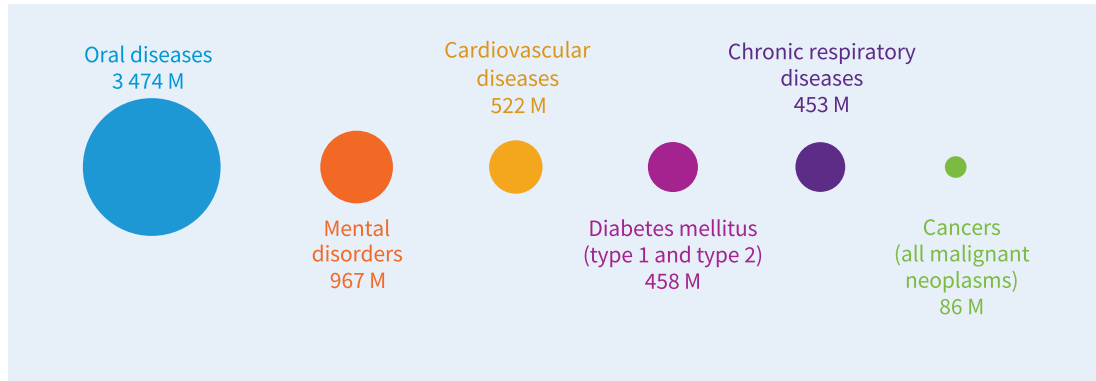


**Fig. 1 Ranking of most prevalent conditions per WB country income level**

Higher rank  Lower rank

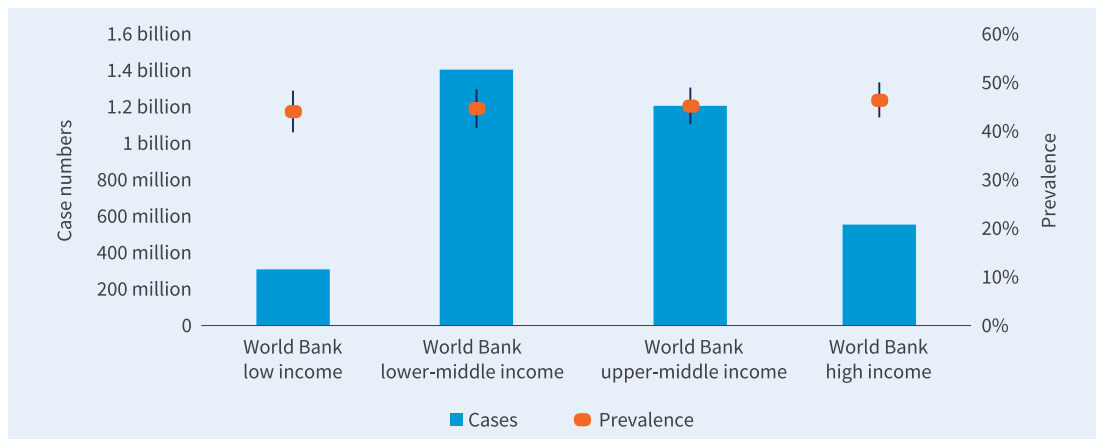
	Global	World Bank low income	World Bank lower-middle income	World Bank upper-middle income	World Bank high income
Oral diseases	1	1	1	1	1
Neurological disorders	2	5	2	3	2
Digestive diseases	3	7	4	2	6
Respiratory infections & TB	4	4	3	4	9
Skin diseases	5	3	5	6	5
Sense organ diseases	6	9	8	5	7
Musculoskeletal disorders	7	11	9	7	3
NTDs & malaria	8	2	7	12	19
HIV/AIDS & STIs	9	8	10	8	10
Nutritional deficiencies	10	6	6	13	15
Unintentional injury	11	13	13	9	4
Diabetes & CKD	12	14	12	10	8
Mental disorders	13	10	11	11	11
Cardiovascular diseases	14	16	14	14	13
Neoplasms	15	17	18	15	12
Chronic respiratory	16	15	15	17	14
Self-harm & violence	17	12	17	16	18
Transport injuries	18	19	16	18	17
Substance use	19	22	22	19	16
Maternal & neonatal	20	18	19	20	20
Enteric infections	21	21	21	21	21
Other infectious	22	20	20	22	22

Note. Data are for all ages and both sexes from GBD 2019 (4).

**Fig. 2 Comparison of estimated global case numbers for selected NCDs**

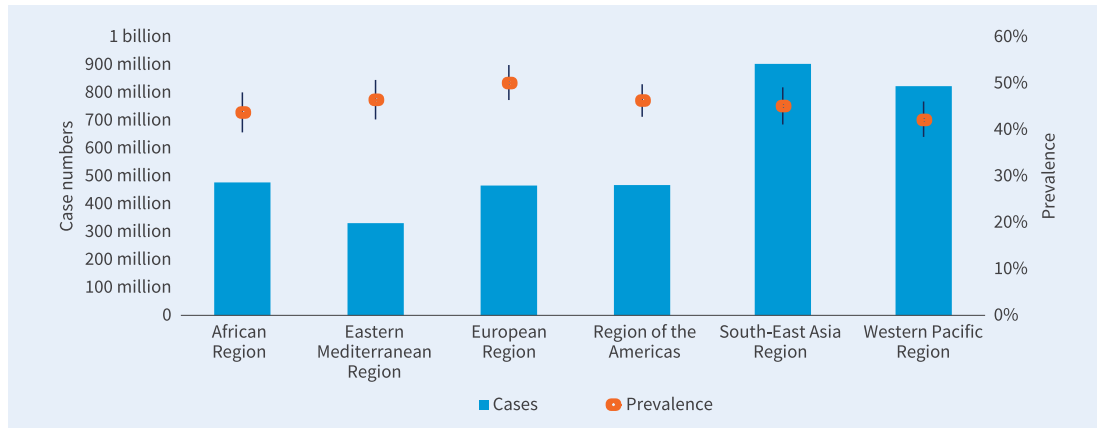
Note. Data are for all ages and both sexes from GBD 2019; oral diseases do not include lip and oral cavity cancer (4). A standard method has been applied to incorporate the latest UN population estimates.

Three quarters of people affected by oral diseases live in lower- and upper-middle income countries, followed by 16% in high-income countries and 9% in low-income countries. Oral diseases have a high global average prevalence of 45%, which is very similar across World Bank (WB) country income groups and WHO regions (see Figs. 3 and 4). Both the South-East Asia Region and Western Pacific Region have the highest case numbers among the WHO regions as they include countries with large population sizes. The other four WHO regions have similar yet still high case numbers (see Fig. 4). This share of disease burden among countries is also mirrored in the respective proportions of disability-adjusted life years (DALYs) for oral conditions combined.

**Fig. 3 Estimated case numbers and prevalence of the major oral diseases combined per WB country income group (excluding lip/oral cavity cancer)**

Note. Data are from GBD 2019 (4).

**Fig. 4 Estimated case numbers and prevalence of the major oral diseases combined per WHO region (excluding lip/oral cavity cancer)**



Note. Data are from GBD 2019 (4).

Between 1990 and 2019, estimated case numbers of oral diseases grew by more than 1 billion – a 50% increase, higher than the population increase of about 45% during the same period (see Figs. 5 and 6) (7). During the same period, case numbers in low-income countries more than doubled (114%), and they increased by 70% in lower-middle income countries and by 33% and 23% in upper-middle and high-income countries, respectively, outpacing the demographic growth in those countries. Similar trends are observed for DALYs resulting from oral diseases, with a global average increase of 75% (see Table 1). The highest increase was observed in low-income countries (123%), followed by lower-middle income countries (98%), upper-middle income countries (78%) and high-income countries (37%). Details and challenges of the DALY concept in the context of oral diseases are highlighted in Box 3.

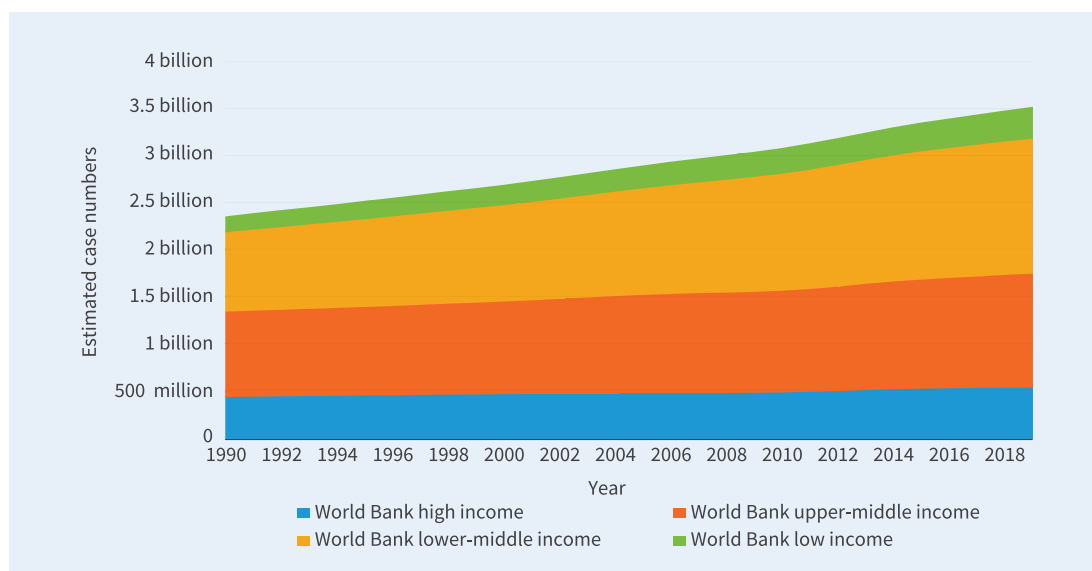


**Table 1. Percentage change in estimated prevalence, case numbers and DALYs of the major oral diseases (except lip and oral cavity cancer) and change in population by WB country income group**

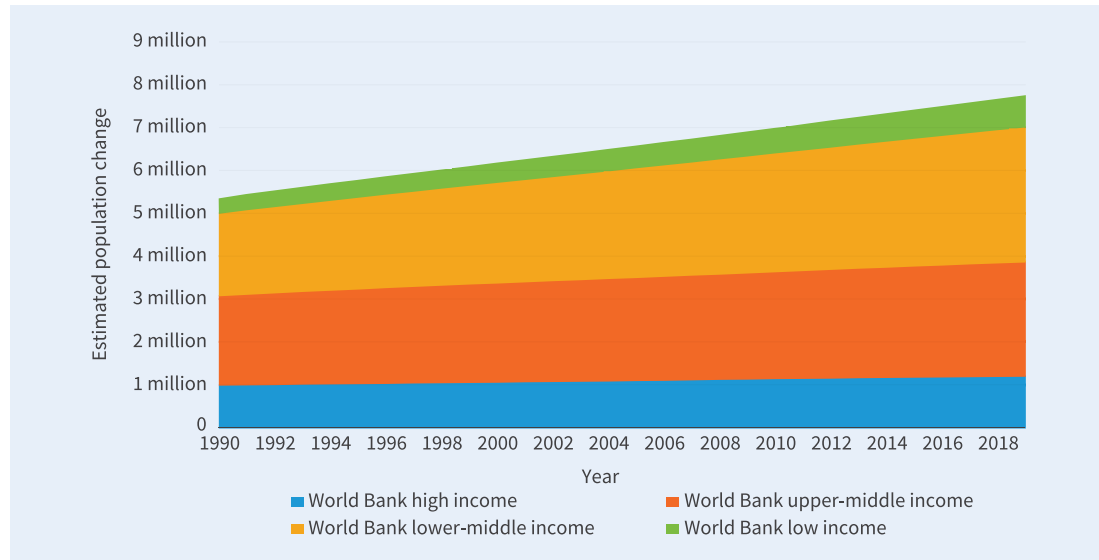
WB country income group	Percentage change in prevalence rates (1990–2019)	Percentage change in case numbers (1990–2019)	Percentage change in DALYs (1990–2019)	Percentage change in population (1990–2019)
Low income	0.1%	114.0%	123.0%	118.0%
Lower-middle income	2.6%	70.0%	98.3%	63.2%
Upper-middle income	5.4%	33.0%	78.1%	28.0%
High income	2.2%	22.7%	37.0%	20.6%
Global	3.2%	49.3%	75.0%	44.8%

Note. Data are from GBD 1990–2019 and UN DESA 2019 (4, 7).

**Fig. 5 Estimated case numbers of the major oral diseases combined between 1990 and 2019 per WB country income group (excluding lip/oral cavity cancer)**



Note. Data are from GBD 2019 (4).

**Fig. 6 Estimated population change between 1990 and 2019 by WB country income group**

Note. Data are from UN DESA 2019 (7).

### Box 3. Understanding and interpreting the oral disease burden

Understanding and interpreting the burden of oral disease can be challenging. Using different indicators and metrics can lead to different conclusions and narratives, particularly for dental caries.

The GBD model used in this report provides data on prevalence, case numbers and DALYs for oral diseases. When considering changes of the time, these indicators are best interpreted together with demographic information. Table 1 therefore lists the percentage changes between 1990 and 2019 of estimated prevalence rates, case numbers and DALYs of the major oral diseases together with percentage changes in population. Selected tables in Section 2 also include information on changes in population size. Data provided may differ from published GBD data because a standard method has been applied to incorporate the latest UN population estimates instead of GBD population estimates.

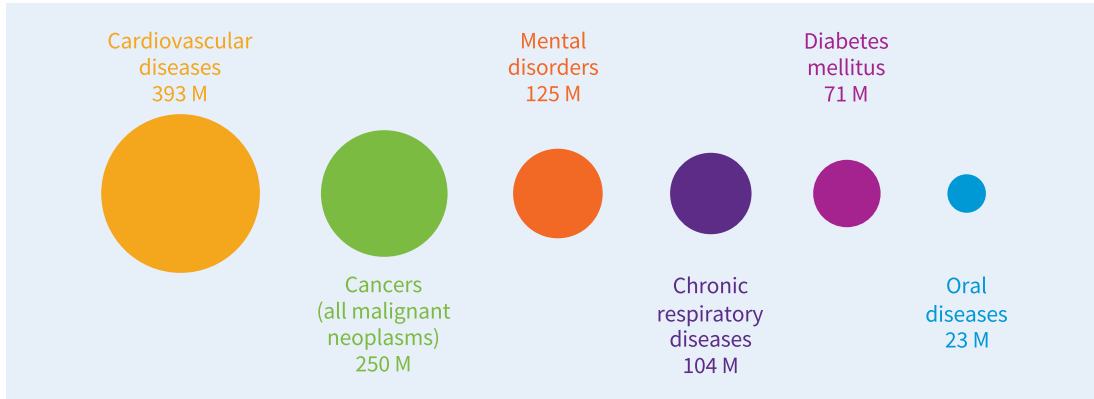
The global population grew by 45% between 1990 and 2019 (7). At the same time, the estimated age-standardized global prevalence of oral diseases increased by 3.2%, resulting in a 50% increase in

estimated case numbers, which represents about 1 billion additional cases (see Figs. 5 and 6) (4).

The quite similar prevalence rates of oral diseases across country income level groups or WHO regions (see Figs. 3 and 4) may be surprising, given that population and health system profiles across countries vary markedly. A possible reason lies in the definition of “case” and “prevalence” used by the GBD model, which focuses only on the presence or absence of a disease and does not consider its severity.

Estimated DALYs increased by 75%, likely reflecting a disproportionate increase in cases of severe periodontal disease, which has higher DALYs than dental caries, although caries still has the highest case numbers of all oral diseases. Fig. 7 shows estimated DALYs for selected NCDs, highlighting the comparably low number of DALYs for oral diseases despite their high case numbers and prevalence. WHO and IHME are planning a review of the methodology for calculating DALYs for oral conditions to reflect their burden in a more realistic way (see also Box 4 on DALYs).

**Fig. 7 Comparison of estimated global DALYs for selected NCDs**



Note. Data are for all ages and both sexes from GBD 2019, oral diseases do not include lip and oral cavity cancer (4, 7). A standard method has been applied to incorporate the latest UN population estimates.

Traditional oral health measurements, such as the frequently used DMFT index or the CPI, document aspects of disease severity, usually for specific age groups. In the absence of comprehensive, comparable data with global coverage, this report uses only the metrics of the GBD model (see also Boxes 1 and 2).

The dramatic increases in global case numbers since 1990 present a huge burden to health systems. It appears that measures to prevent and control oral diseases have not been successful. The result is an all-time high in case numbers, representing billions of people with unmet needs across all countries. This challenges health care systems everywhere, but particularly in low- and middle-income countries.

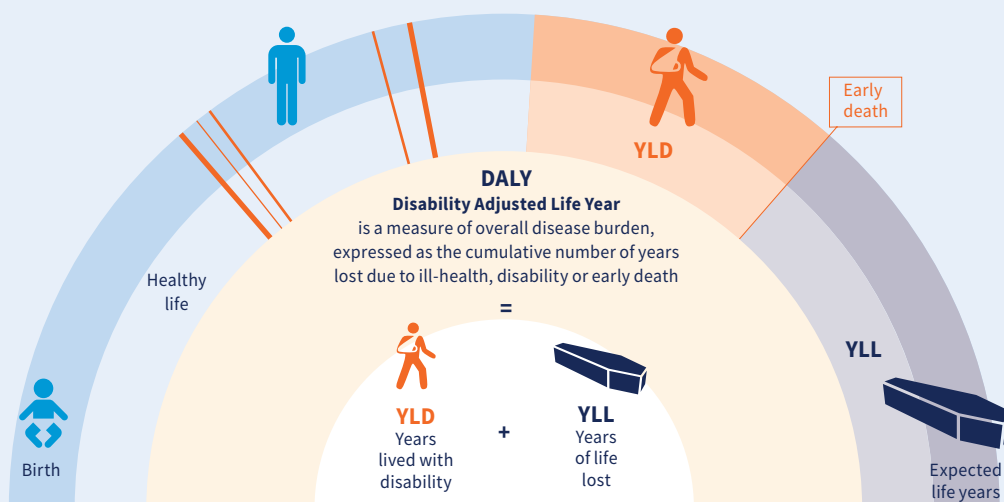


#### Box 4. What is a disability-adjusted life year?

The DALY was developed in the context of the GBD project to provide a summary measure of population morbidity and account for mortality and nonfatal health consequences. DALY is the unit of analysis for measuring the relative magnitude of losses of healthy life associated with different causes of disease and injury (8, 9).

One DALY represents the loss of the equivalent of one year of full health. DALYs accumulate when individuals die prematurely or when they live with the health consequences of chronic diseases, injuries or risk factors. For a particular cause of disease or injury, DALYs are computed as the sum of years of life lost (YLLs), which capture premature mortality and health losses, and years lived with disability (YLDs), which capture lost healthy life due to living in states worse than perfect health (8, 9).

Applying the DALY concept to oral diseases allows for comparison with other disease groups. However, the approach also has limitations: the methodology emphasizes diseases with high mortality, which is not the case for the most prevalent oral diseases. Despite high case numbers and global prevalence, DALY values for oral diseases (except lip and oral cavity cancer) are comparatively low. Moreover, the underlying epidemiologic data sources for oral diseases are often incomplete and not recent, requiring advanced estimation techniques with considerable uncertainties. WHO and IHME are planning to review the methodology for calculating DALYs for oral conditions to reflect their burden in a more accurate way.



Source: Adapted from Public Health England, 2015.



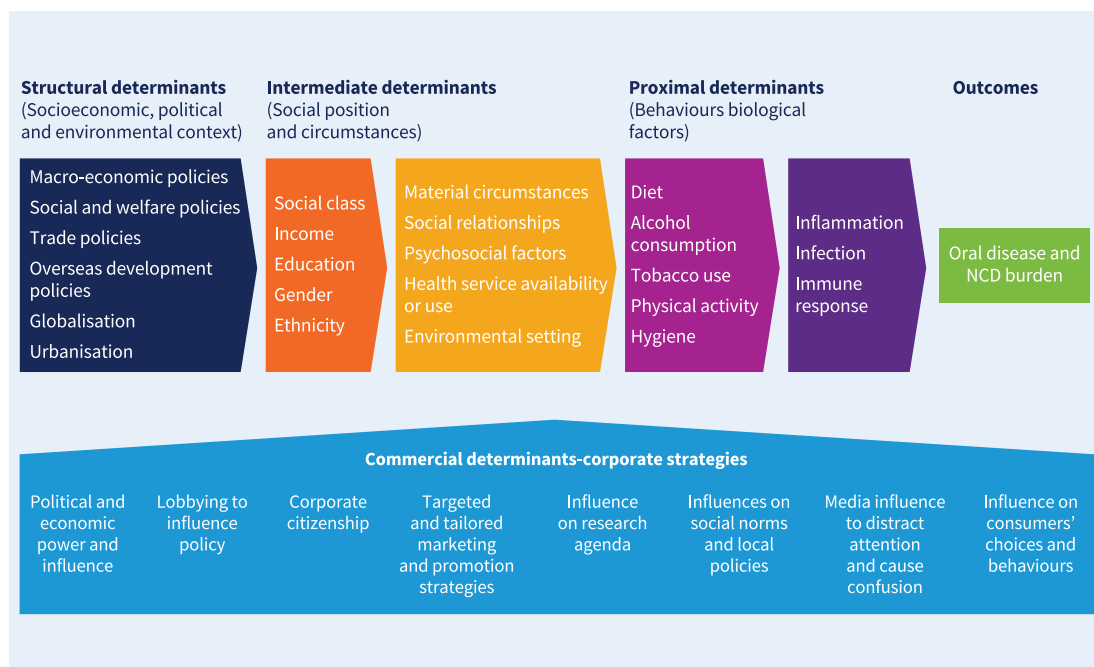
## 1.2 Common determinants and risk factors of oral diseases

Oral diseases share determinants and risk factors with other NCDs. The WHO Commission on Social Determinants of Health drew attention to the importance of the wider socioeconomic, political and environmental drivers of health: the circumstances in which people are born, grow, live, work and age (10). These circumstances largely determine the behaviours that people adopt and the opportunities and choices available to them. This framework has been modified to incorporate the underlying causes of oral diseases, the shared risk factors between oral conditions and other NCDs, and the commercial determinants of oral health (11, 12).

### 1.2.1 Social and political determinants of oral health

The underlying causes of oral health inequalities are often complex and related to country-specific historical, economic, cultural, social or political factors. The conditions in which people are born, grow, live, work and age and the structural drivers of those conditions – the inequitable distribution of power, money and resources in society – are the underlying social determinants of oral health inequalities (13–15). More recently, aspects of discrimination among racial and ethnic groups or indigenous minority populations have gained attention as symptoms of inequality in power and agency influencing health and oral health (16, 17). The conditions and choices available to individuals and their families are therefore largely determined by their social circumstances – the conditions of daily life (Fig. 8; modified from Peres et al, 2019) (88).

**Fig. 8 Social and commercial determinants of oral diseases**



### 1.2.2 Commercial determinants of oral health

Commercial determinants of health are the corporate-sector activities that affect people's health positively or negatively. Corporations, often with transnational or global reach, are promoting products that are detrimental to population health, particularly in the areas of NCDs and oral health. The global tobacco and alcohol industries are prime examples that increasingly target emerging economies in low- and middle-income countries or particularly vulnerable population groups (18, 19).

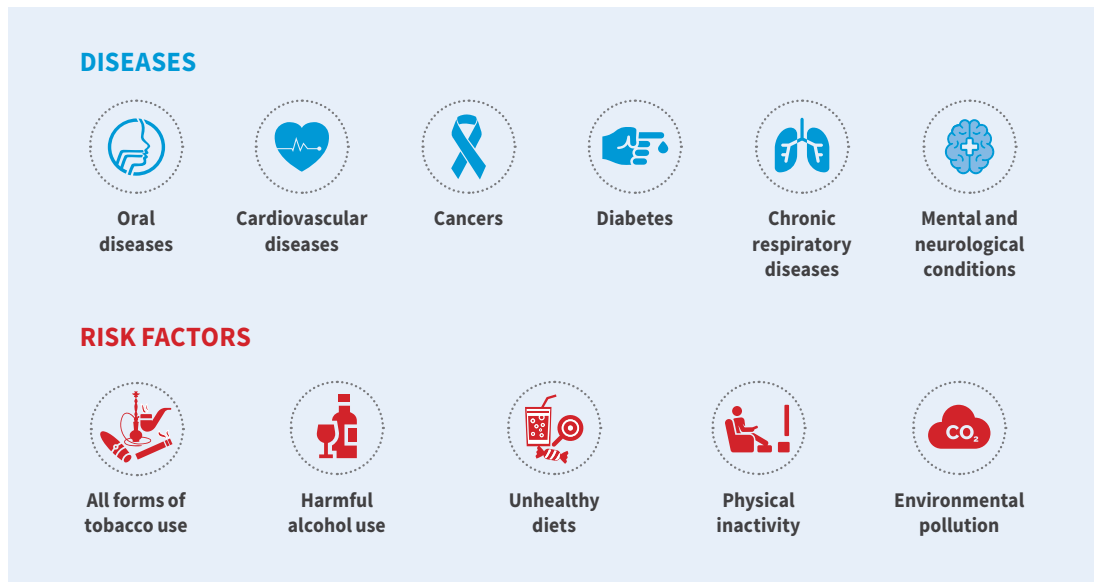
Global food and drinks industries, including those producing foods high in sugar and sugar-sweetened beverages (SSBs), use similar strategies and are lobbying governments and public opinion to delay, modify or hinder public policies that protect public health, such as controls on advertising to children, the introduction of health taxes, or limiting the retail size of SSBs. These industries are also keen on engaging with public health, education and other sectors to give themselves a socially responsible image including for example sponsorship of school activities and sporting events. Some are also engaging with health and oral health research and professional organizations, thereby potentially biasing science and public communication. With sophisticated marketing, promotion and sales approaches these industries seek to influence consumer behaviour and create an environment where their products are universally available, affordable, accessible and appealing – a powerful and potent threat to population oral health. The role of sugar consumption, tobacco use and alcohol use as risk factors of oral disease render oral health sector particularly susceptible to such detrimental commercial influences (20, 21).

The role and impact of global and local corporations related to unhealthy commodities should be distinguished from those that are related to the production and marketing of products for personal oral hygiene and self-care. The widespread commercial promotion of fluoride toothpaste and other personal oral hygiene products has an overall positive impact on oral health by expanding access to and daily use of these products, even though pricing and other factors also contribute to inequalities in affordability. When the complex product portfolio of large holding companies or global corporations includes products with positive and negative health benefits, public-private cooperation and support becomes challenging.

### 1.2.3 The common risk factor approach

The common risk factor approach recognizes that noncommunicable diseases and conditions, including oral diseases, share a set of key modifiable risk factors (11). For example, tobacco use is a major risk factor for a range of conditions, such as cardiovascular diseases, respiratory diseases and many cancers, but also for severe periodontal disease and lip and oral cavity cancer. The common risk factor approach is the basis for linking action on oral disease prevention with the wider NCD agenda. This can be seen most notably in relation to the integrated action on improving poor diets, tackling tobacco use and reducing harmful alcohol consumption.

**Fig. 9 Common risk factors for NCDs and oral health**



#### 1.2.4 Common risk factors of public health importance

High sugar intake, all forms of tobacco and harmful alcohol use are major public health challenges for a wide range of NCDs. They are also the key modifiable risk factors for oral diseases (more specific risk factor aspects for selected oral diseases are addressed in Section 2).

Sugar consumption is the main cause of dental caries, showing a clear dose–effect relationship. The evidence for the role of sugar in the aetiology of dental caries played a crucial role in the WHO Sugars Guideline recommending less than 10% of daily total energy intake from free sugars as well as the conditional recommendation to reduce intake even further to 5% of total energy (22, 23). The consumption of *free sugars*, defined as “all monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates” is increasingly recognized as a public health concern (24). Sugar is cheap and almost universally available across the globe. In high- and middle-income countries, sugar consumption far exceeds WHO recommendations, and in many low-income countries, consumption is steadily rising. More recently, the very high level of free sugars found in commercial foods for infants and young children has become a cause for concern, resulting in the promulgation of numerous guidelines from WHO (21).

Despite overall reductions, 22.3% of the global population were estimated to use some forms of tobacco (2020). Among populations aged 15 years and older, the proportion of men using tobacco amounted to 36.7% while that of women equaled to 7.8%. The prevalence rate of current tobacco use for males was more than four times the rate for females. The age-specific rates peak at age group 45–54 for men

and 55–64 for women (25). Cancers, heart disease, stroke, chronic lung diseases and many other NCDs, including oral diseases, are caused by tobacco use. The burden of tobacco use disproportionately falls on the poor and disadvantaged and is therefore a major cause of health inequality. All forms of tobacco use are major risk factors for lip and oral cavity cancer (see Section 2.4) (26). More than 350 million people globally are estimated to use smokeless tobacco, a cultural habit that is particularly popular in South Asia and some Pacific Island countries (27). Tobacco use remains one of the leading global causes of preventable deaths and is associated with more than 8 million death in 2019 (28).

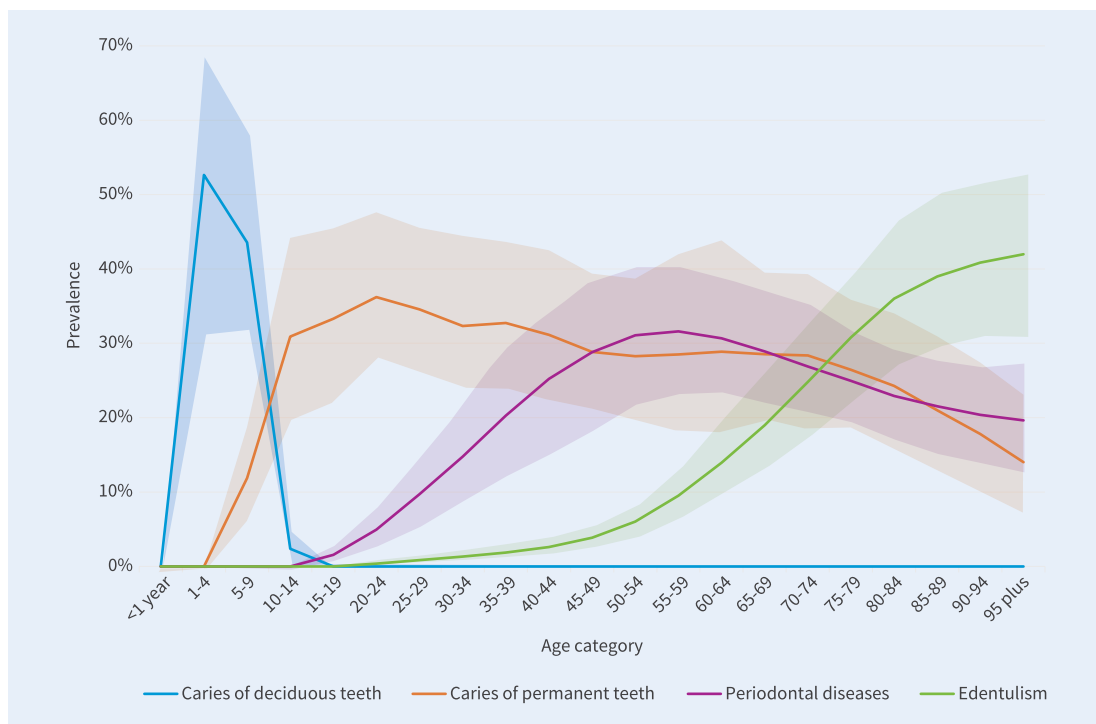
An estimated 1.3 billion people aged over 15 years consume alcohol at harmful levels (above non-drinker equivalence, 2020), with the highest rates found across Europe, the Americas and the Western Pacific region (29, 30). In 2019, total alcohol per capita consumption was 5.8 litres of pure alcohol, with higher consumption among men with 9.2 compared to women with 2.5 litres (31). The harmful use of alcohol is a causal factor in more than 200 disease and injury conditions, including injuries, digestive diseases, cardiovascular diseases and many other NCDs as well as oral diseases, mainly lip and oral cavity cancer (see Section 2.4) (32). Moreover, harmful alcohol consumption is associated with a variety of family, social, and economic problems and mental and behavioural disorders. Globally, the harmful use of alcohol causes an estimated 3 million deaths per year, representing 5.3% of all deaths. Of the global burden of disease and injury, 5.1% is attributable to alcohol, as measured in DALYs.



### 1.3 Individual and population impacts of oral diseases along the life course

Oral diseases affect individuals and populations across the entire life course (see Fig. 10) (33, 34). The main oral diseases impair different age groups in specific ways (6). Deciduous teeth are prone to caries as soon as they erupt, with a peak of prevalence around the age of 6. Similarly, prevalence of caries in permanent teeth typically shows steep increases after eruption and reaches the highest levels in late adolescence and early adulthood before remaining stable for the rest of the lifetime. Severe periodontal disease is a disease of middle age, reaching highest prevalence rates around 60 years. Edentulism (total tooth loss) steadily increases with a peak in older age groups.

**Fig. 10 Prevalence rates of four major oral diseases over the life course**



Note. Data are from GBD 2019 (4).

All oral diseases are chronic, progressive and cumulative in nature. Toothache, which accompanies many of the major oral diseases, is a common individual experience and is consistently rated among the most intense of pains. Combined with a high prevalence, impacts from oral diseases are often experienced on a repeated basis, resulting in physical, social and mental consequences. This includes impacts on self-confidence and self-esteem, often leading to reduced social interaction, isolation or even stigmatization. Severe untreated oral diseases may negatively affect employment opportunities and reduce productivity (see Fig.11).

Negative impacts from untreated caries are common among children and adolescents, frequently causing acute infection, dental pain and discomfort (35). Untreated caries affect a child's ability to eat, speak, learn and sleep. Severe untreated caries in children affect nutrition, growth and weight gain. Toothache can also affect school attendance, leading to poorer educational performance (36, 37). In many high-income countries, the extraction of carious teeth under general anaesthesia is the main reason for hospitalization of young children. All of these negative impacts of oral diseases disproportionately affect people from more disadvantaged backgrounds (38).

### Case study 1. Promoting oral health as essential to healthy ageing (Japan)

In 1987, a survey in Japan found that people at age 80 had only about five natural teeth on average, causing malnutrition and poor health in the elderly. Two years later, based on new data on oral functionality, Japan's Ministry of Health and Welfare and Japan Dental Association launched the 8020 Campaign (39). The goal was to ensure that people still had 20 of their teeth at age of 80 so that they could maintain nutritional and social well-being. The campaign adopted a lifelong approach to preventing tooth loss by engaging multiple sectors and carrying out initiatives that targeted all generations.

At 93 years old, Sakuji Yanadori from Niigata City, Japan, still has 30 natural teeth, dispelling the myth that "losing teeth is a normal part of getting older." His explanation for his healthy mouth does not reveal any secrets. He practices good oral hygiene, does not miss his regular dental visits and avoids sugar.

Maintaining natural teeth with adequate functionality allows Yanadori to enjoy well-balanced meals that he shares with his family. His diet consists of a variety of meat, fish and vegetables that helps him keep his body in optimum condition, allowing him to remain socially connected as well. Today, Yanadori can still



be found playing piano or the game Go at the local community club.

A national survey in 2016 showed that the 8020 Campaign had been successful in reaching its goals, with half of the 80-year-old population maintaining more than 20 of their natural teeth. The campaign continues to adopt a holistic approach to oral health, ensuring that the future elderly population has sufficient teeth and oral function to maintain good health and quality of life (40).

Poor oral health among older people can negatively affect daily activities and thereby contribute to overall frailty. Oral diseases result in specific challenges related to pain, impaired chewing and eating ability, or even nutritional deficiencies. Frail older people living in long-term care facilities often have especially high oral health needs that may complicate existing comorbidities. As longevity increases,

quality of life matters even more, and oral health is among the major health aspects related to improved quality of life (41, 42). It is therefore important for oral health care services and professionals to provide appropriate services for the needs of older populations. The UN declared the “Decade of Healthy Ageing (2021–2030).” The accompanying action plan recognizes that oral health is a key indicator of overall health in older age (43).

**Fig. 11 Selected impacts of oral diseases**



### 1.3.1 Relation between oral health and general health

Oral health is integral part of general health, sharing common causal pathways and affecting each other in a bi-directional fashion. In recent decades, many studies have assessed the potential link between poor oral health and a range of chronic diseases (44). The strongest and most consistent evidence has shown an association between severe periodontal disease and diabetes mellitus; clinical interventions to treat severe periodontal disease have shown improvements in diabetes status (45, 46). Evidence also exists of an association between severe periodontal disease and cardiovascular disease and, to a lesser extent, cerebrovascular disease and chronic obstructive pulmonary disease (47–49). In addition to severe periodontal disease, associations have been found of caries and tooth loss with other conditions such as cognitive decline, certain cancers and pneumonia. These associations are underpinned by shared biological (infection, inflammation, microbiome and immune responses), behavioural and wider social risk factors. It is important, however, to recognize that the nature of associations between poor oral health and other chronic diseases is not necessarily causal and is often weak compared to other key risk factors. More high-quality research is needed to understand fully the potential shared pathways between oral diseases, poor oral health and other general diseases and conditions, the coexistence of multiple health conditions, as well as the impact of oral health interventions on general health (50).

## 1.4 Global inequalities in the burden of oral diseases

The burden of oral diseases is not uniformly distributed across populations. Instead, all oral diseases are socially patterned and show strong social gradients, disproportionately affecting the most vulnerable and disadvantaged population groups within and across societies, and over the life course. People who are on low incomes, people living with disabilities, older people living alone or in care homes, people who are refugees, in prison or living in remote and rural communities, children and people from minority and/or other socially marginalized groups generally carry a higher burden, similar to other NCDs. These differences in oral health status are not inevitable and do not occur by chance; inequities are caused by a complex array of interconnecting factors, many of which are largely beyond individuals' direct control.

*Oral health inequalities* are defined as differences in oral health status that are avoidable and deemed to be unfair, unacceptable and unjust. Addressing oral health inequalities is a matter of social justice, ethical public health policy and professional practice.

Different types of oral health inequalities exist. It is important to distinguish inequalities in oral health status from inequalities in access and use of oral health services. Both aspects are important but are caused by different factors and therefore require different policy solutions.

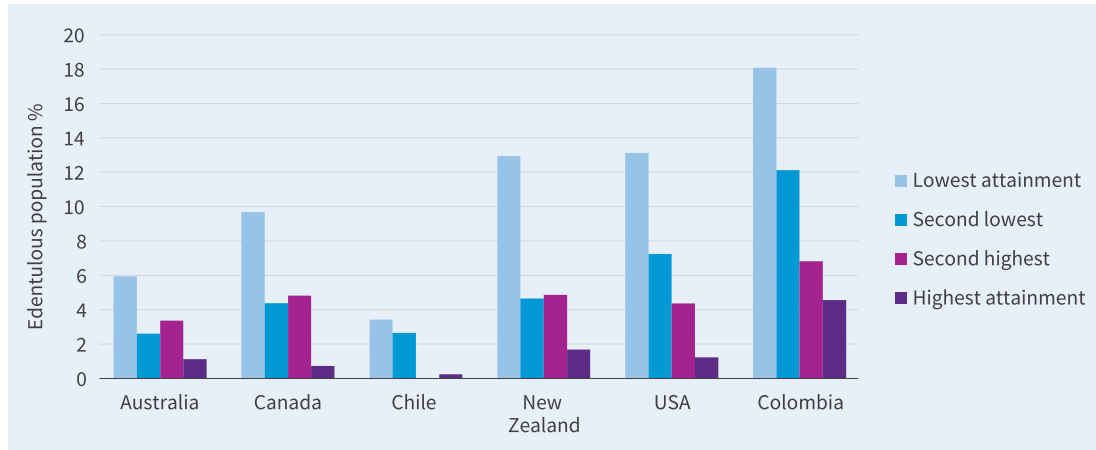
Many studies from high-, middle- and low-income countries have shown the direct and proportional association between different measures of socioeconomic status (income, education and social class) and the prevalence and severity of oral diseases across the life course, from early childhood to older age. The association between socioeconomic status and oral diseases is not limited to the differences between the rich and the poor in society. As is the case with most chronic diseases, oral diseases are socially patterned across the entire social spectrum in a consistent stepwise fashion – the social gradient in oral health. This has important policy implications because a traditional approach of targeting only high-risk groups fails to address the social gradient in oral health.

Inequalities in oral health status also exist across different population groups. Across the life course, oral diseases and conditions disproportionately affect the poor and vulnerable members of societies, often including those who are on low incomes, people living with disabilities, older people living alone or in care homes, people who are refugees, in prison or living in remote and rural communities, and people from minority and/or other socially marginalized groups.

The burden of severe tooth loss and edentulism provides a stark example of significant inequalities in oral health status (see Fig. 12) (51–53). Those with lower socioeconomic status, with lower education levels or who are affected by other disadvantages have on average fewer teeth than population groups with higher socioeconomic and educational indicators. The resulting impacts on speaking, eating, social interaction and self-esteem can be significant and further contribute to disadvantage and inequality. The negative aesthetic and social impacts of visibly missing teeth greatly reduce prospects of finding a job (54).



**Fig. 12 Comparison of edentulism by educational attainment in different populations (in percentage of edentulous population)**



Note. Data for Australia, Canada, Chile, New Zealand and the United States are for adults aged 25+ years; education categories: lowest, secondary, postsecondary and university (from Elani et al., 2017). Data for Colombia are for adults aged 45+ years; education categories: primary or less, secondary, technical and university (from Guarnizo-Herreño et al., 2018) (51, 52).

## 1.5 Inequalities in access to oral health services

Access to oral health services is highly variable both within and among countries. Oral health care is largely a demand-led service rather than the result of a rigorous planning process and therefore can be poorly aligned with the oral health needs of the local population. In many situations, the classic inverse care law applies: provision of oral health services is inversely related to the oral health needs of the population (57). Across the world, oral health care is predominantly provided by private practitioners. Both, private and public oral health care services, often only cover a small proportion of the population (see Section 3.1). Inequalities in dental attendance also exist throughout the life course (58). In high- and middle-income countries, oral health services are often poorly distributed or inaccessible to vulnerable or disadvantaged groups in society. In stark contrast, there is often an overconcentration of oral health services in affluent urban neighbourhoods where disease levels are generally lower than in poorer, underserved areas. In many low-income countries, the situation is far worse. In these settings, oral health professionals tend to be concentrated largely in urban areas, inaccessible to much of the population who live in rural locations. In these circumstances, people often spend considerable time and cost for travel to seek professional oral health care (12).



## Case study 2.

### The challenge of oral health care for people living with disabilities (France)

Philippe Aubert, 42 years old from France, lives with athetotic cerebral palsy (CP). This condition, characterized by involuntary movements, is present from birth and affects muscle function. The uncontrolled movements prevent Aubert from walking, talking or using his arms.

“Due to pronounced bruxism (habitual teeth grinding), I had almost ground down all my teeth. I had serious difficulties in chewing and eating,” Aubert explains, referring to his dental problems caused by the symptoms of cerebral palsy (55). “My teeth were a real problem for a long time, considering all the difficulties I went through to get them treated.” Aubert explains that dental appointments had been very challenging since childhood because medical staff had little knowledge of his special needs and the dental equipment and settings were inappropriate.

“I can testify that, as far as the experience of disabled people in dental offices is concerned, many simple details including the texture of the seats, transfer to the dental chair, the light, the noise of the dental drill, and even the typical smell of a dental clinic could easily trigger spasticity, anxiety or other symptoms for a patient with CP,” Aubert says.

Some experiences during Aubert’s dental visits made him feel unsafe and more reluctant to go to another appointment. “Once I almost choked on a dental x-ray film that was put in my mouth and nearly destroyed the dental chair on which I was being examined, because of the involuntary movements triggered by the procedure,” he explains.

Aubert strongly believes that the most important aspect of successful treatment of people with special needs is the attitude and skill of the health care team. “Lack of knowledge and training of medical and dental personnel regarding different types of disabilities needs to be addressed,” he says, highlighting the need for organized and effective training of medical personnel.



“I am well aware of the practical challenges of listening to the individual needs of disabled patients, but a reliable and respectful relationship is required for the care of these patients and can only be established by taking time to hear them out and understand their needs,” says Aubert, calling for a caring approach to build a trusting relationship with each patient.

After years of hospital visits, which usually ended in tooth extraction, Aubert found help through a non-profit organization, Handident (<https://www.handident.com/>), where he was warmly welcomed and treated for his dental problems. “I had to go to the extreme of full mouth rehabilitation so that I could claim, and finally appreciate, my mouth and teeth,” Aubert says with gratitude to the dentists who treated him with kindness. He refers to them as the people who changed his life.

After publishing his book *Rage to exist*, Aubert became a public figure with a mission to highlight the experience of people with disabilities (56). His words are “spoken” via a speech synthesizer that is controlled by his gaze, but his emotions are clearly conveyed by his smile.

“I have not spoken since birth! My mouth and teeth helped me to eat, not to communicate. Today, my mouth plays an essential role in my communication and my aesthetic,” says Aubert referring to his bright smile as a real asset that has become part of his identity.

### Case study 3. Reforming access to oral health care to address disparities (United States)

In February 2007, 12-year-old Deamonte Driver died in Maryland after complications from an avoidable dental infection. “Twelve-year-old Deamonte Driver died of a toothache Sunday. A routine, \$80 tooth extraction might have saved him. If his mother had been insured. If his family had not lost its Medicaid. If Medicaid dentists weren’t so hard to find. If his mother hadn’t been focused on getting a dentist for his brother, who had six rotted teeth,” wrote Mary Otto on the Metro page of the Washington Post on 28 February 2007 (59).

Deamonte’s death brought to light the long-standing issue of access to oral health care for Maryland’s poor children. Reports at that time showed that 71% of children on Medicaid in Maryland (ages 0–20) had received no dental services during the previous year, and more than 11 000 of these children had not seen a dentist in 4 years. As a result, more than 30% of Maryland’s elementary school children had untreated caries. Because of poor Medicaid reimbursement rates, only 12% of Maryland dentists were full participants in the program.

Otto’s article in the Washington Post sparked global media attention, which then led to a collaboration among oral health advocates, civil society organizations, policy-makers and legislators to prioritize the oral health agenda.

“The oral health reforms first is about a tragedy of a child that rants and improvements to oral health surveillance and infrastructure statewide. As a result of numerous oral health policy reforms and initiatives, utilization rates of oral health care increased as did the number of dentists participating in the state Medicaid programme, making Maryland a role model for other states (60).



“The story of Deamonte Driver continues to be told, not just in Maryland but around the country. It has become part of an ongoing movement to improve access to oral health services to Americans of all ages who might otherwise go without care,” Otto says. She highlights the difficulties that economically disadvantaged people are facing and the need to integrate oral health into overall health care in her book *Teeth* (2017) (61).

Since Deamonte’s death, access to dental services for all has been identified as an important component of comprehensive health care for children. In 2009, the reauthorization of the Children’s Health Insurance Program (CHIP) required states to provide dental coverage to enrolled children and gave states the option to provide dental benefits to certain children who did not qualify for full CHIP coverage. In 2010, the health reform bill known as the Affordable Care Act required that starting in 2014, all insurance plans to be offered through new health insurance exchanges had to include oral health care for children and prohibited insurers from charging out-of-pocket expenses for preventive paediatric oral health services (62).

## 1.6 Global expenditures and economic impact of oral diseases

Expenditures for oral health care are highly unequal globally as well as across regions and countries. With a generally high burden of untreated oral disease for all populations and countries, the differences in spending indicate great differences in availability of and priority for oral health care. However, the level of national expenditures is not necessarily correlated to better or worse oral health status. In addition, there are significant challenges in availability, scope, quality and comparability of economic data at national, regional and international levels (63–65).

### 1.6.1 The cost of oral health care

The total direct expenditure for oral diseases among 194 countries amounted to US\$ 387 billion or a global average of about US\$ 50 per capita in 2019. This represents about 4.8% of global direct health expenditures. At the same time, productivity losses from oral diseases were estimated at about US\$ 42 per capita, totalling to around US\$ 323 billion globally (66).

#### Box 5. Health expenditure definitions

Direct dental expenditure includes public and private treatment costs for oral health care (without the costs of care for lip and oral cavity cancer). Such costs comprise workforce, facility and service costs covered by public and private financial sources, including patient out-of-pocket expenditures. Travel costs are excluded. Data detailing the share of prevention or specific interventions as part of direct dental expenditures are not available (63, 67).

Productivity losses are calculated using the methodology of the WHO Commission on Macroeconomics and Health whereby GDP per capita values are multiplied by oral-disease-specific estimates of DALYs (68). Further details are provided in Section A.2.

The inequalities of oral health expenditures are striking, and differences among countries are very notable. The average per capita expenditure in low-income countries is US\$ 0.52, whereas high-income countries spend an average of US\$ 260 per capita – 500 times more. The ratio of total amounts spent on oral health care is even worse: all low-income countries together spend 800 times less than all high-income countries together (see Figs. 13 and 14). The single highest total amount is spent in the United States with US\$ 134 billion, followed by China with US\$ 61 billion; both combined represent a 51% share of all direct costs globally.

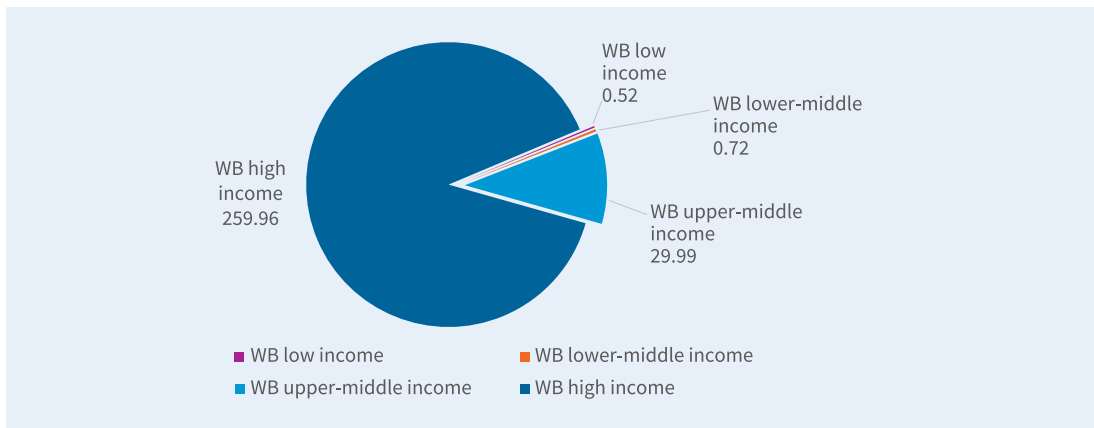
The pattern of unequal spending among the countries reveals four major groups (Fig. 15):

- Group 1:
  - 99 countries (about half of WHO Member States) spend very little on oral health care
  - 50 countries (about one quarter of countries, among them 34 from the WHO African Region) spend less than US\$ 1 per person per year.
  - 50 countries (about one quarter of countries) spend between US\$ 1 and US\$ 10 per person per year.
- Group 2:
  - 49 countries (about one quarter of WHO Member States) spend between US\$ 11 and US\$ 50 per person per year.

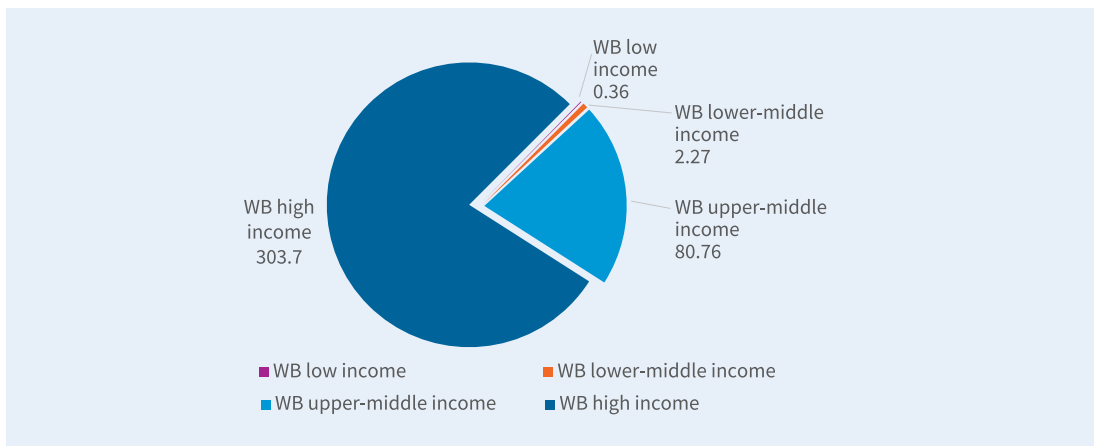
- Group 3:
  - 31 countries (16% of WHO Member States) spend between US\$ 51 and US\$ 300 per person per year.
- Group 4:
  - 12 countries (6% of countries) spend more than US\$ 300 per person per year.

The combined direct dental expenditures of the 13 highest-spending countries equal about US\$ 340 billion. This is an 88% share of the global direct expenditure, yet these countries only represent 22.5% (2.5 billion people) of the world’s population. People in these highest-spending countries benefit from an average of US\$ 136 per capita annual expenditure. The remaining 13% of global direct expenditure (US\$ 47 billion) is shared among 181 countries with 5.3 billion people; their average per capita annual expenditure is 15 times lower, reaching only US\$ 9 per capita each year (66).

**Fig. 13 Per capita direct dental expenditure in US\$ per WB country income group (2019)**



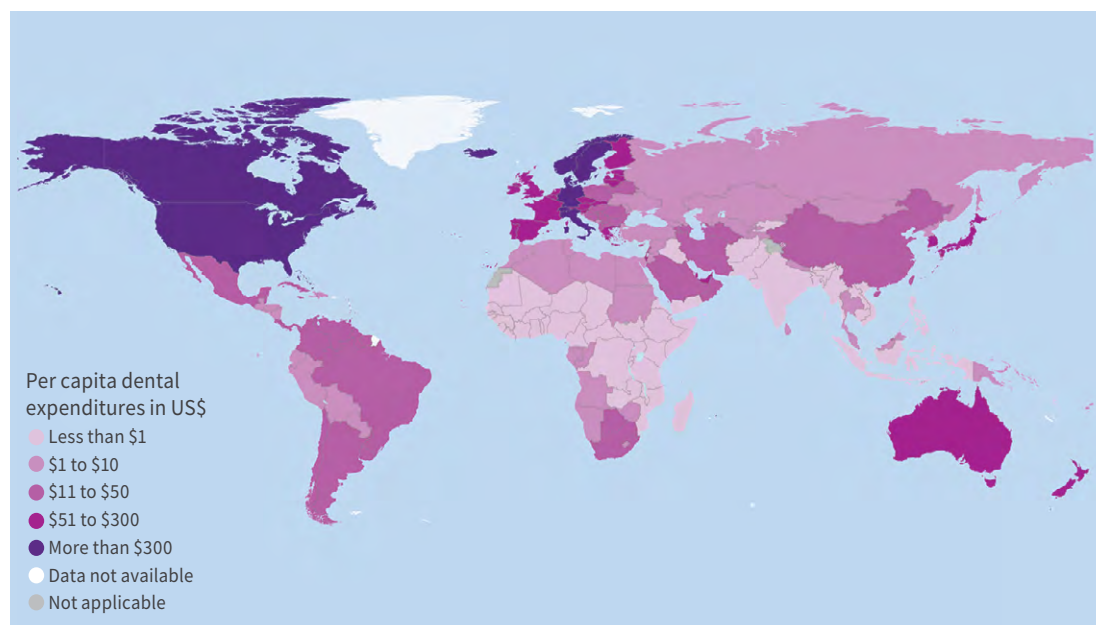
**Fig. 14 Total direct dental expenditure in US\$ per WB country income group (2019)**



In terms of WHO regions, the lowest total and per capita direct expenditure was reported from the South-East Asian Region, with a total expenditure of US\$ 0.76 billion and US\$ 0.52 per capita expenditure. The Region of the Americas shows the highest amounts, with US\$ 157 billion total and US\$ 155 per capita annual expenditure.

Out-of-pocket costs can be major barriers to accessing oral health care. With private practitioners predominantly providing services, which often are only partially or not at all covered by government programmes and/or insurance, patients accessing oral health services must either pay the entire cost of care or need to cover substantial copayments. Paying for necessary oral health care is one of the leading reasons for catastrophic health expenditures, resulting in an increased risk of impoverishment and economic hardship (69, 70). A survey by the WHO European Region Office (2019) showed that among all households with catastrophic health expenditures, dental expenditures ranked third after medicines and inpatient care (71). The same survey reported that access to general health care is much more equitable than access to oral health care. On average, out-of-pocket expenditure for oral health care within the 28 countries of the European Union was more than 60% of the treatment costs, and in some Member States, it was close to 100% due to complete exclusion of oral health care from health coverage.

**Fig. 15 Per capita dental expenditures in US\$ per country (2019)**



Data Source: Jevdjevic & Listl 2022. Economic impacts of oral diseases in 2019. Map Production: WHO NCD/MND unit. Map Creation Date: 30 August 2022. Note: N = 194 countries.

# 2

## The burden of the main oral diseases



## 2.1 Dental caries

### 2.1.1 The burden of untreated dental caries

More than one third of the world's population lives with untreated dental caries. The disease, also known as tooth decay or simply cavities, is the most widespread NCD and a major public health problem for populations and governments worldwide. Untreated dental caries in permanent teeth is the most prevalent condition among all diseases, affecting more than 2 billion people worldwide. In deciduous teeth, untreated caries is the single most common chronic childhood disease, affecting 514 million children worldwide (4, 6, 72).

#### Box 6. What is dental caries and how is it measured?

Dental caries is defined as a gradual loss and breakdown (decay) of tooth hard tissues (enamel and dentine) that results when free sugars contained in food or drink are converted by bacteria into acids that destroy the tooth over time. Free sugars are all sugars added to foods by the manufacturer, cook or consumer, plus sugars that are naturally present in honey, syrups and fruit juices (22, 73). Caries can lead to cavities, which are permanently damaged areas in the hard surface of the teeth ("holes" or "cavities") (74).

Dental caries can be measured like all diseases with prevalence and incidence. In addition, WHO recommended the use of the DMFT index, which reports cumulative caries experience over time (75).

Other indicators and caries assessment systems exist, and new indicator frameworks are now being considered. The GBD project uses its standard metrics, such as estimated prevalence, case numbers and DALYs, in the context of dental caries (72, 76).

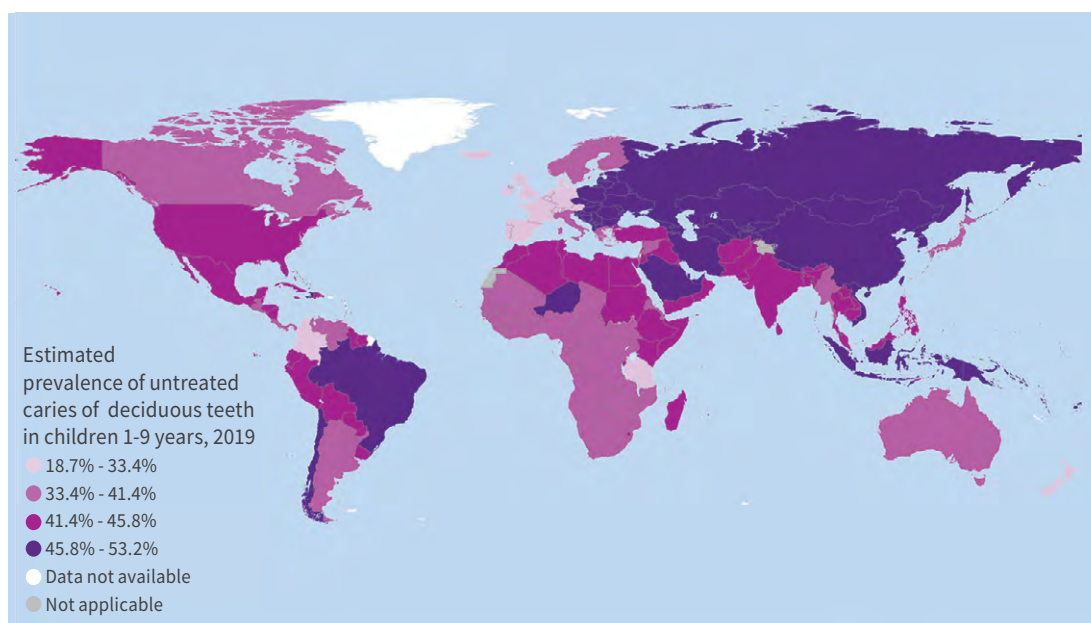
Dental caries affects all age groups, starting with the eruption of the first teeth (deciduous teeth/primary dentition) and increasing in prevalence until late adulthood, then remaining at high levels until older age. The onset of the disease in children younger than 6 years is early childhood caries, which at times progresses quickly to complete destruction of the primary dentition. Children with early childhood caries have a much higher risk of continued disease burden in their later life (77–79).

### 2.1.2 Prevalence and case numbers of untreated caries of deciduous teeth

The estimated global average prevalence of caries of deciduous teeth is 43%, and 134 of 194 (69% of countries) WHO Member States have prevalence figures of more than 40% (see Fig. 16).

Prevalence ranges from 46% in upper-middle-income countries to 38% in high-income countries. Case numbers are highest in lower-middle-income countries (244 million cases) and lowest in high-income countries (45 million cases; see Table 2 and Fig. 17). Overall, more than three quarters of cases of untreated caries in deciduous teeth are found in middle-income countries where health systems and resources to address the burden are often inadequate.



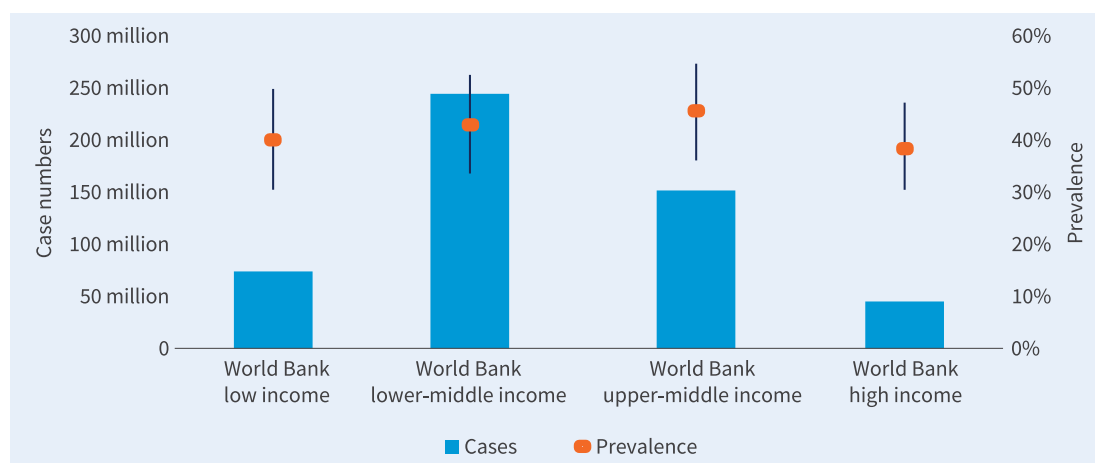
**Fig. 16. Estimated prevalence of dental caries of deciduous teeth per country**

Data source: Global Burden of Disease Collaborative Network. GBD 2019. Seattle: IHME; 2020. Map Production: WHO NCD/MND unit. Map Creation Date: 30 August 2022. Note. N = 194 countries; data are for children aged 1–9 years, both sexes, from GBD 2019 (4).

**Table 2. Estimated prevalence and cases of caries of deciduous teeth in 2019 and the percentage change from 1990 to 2019 per WB country income group**

WB income group	Prevalence (2019)	Cases (2019)	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)
Low income	40.00%	73 733 740	-3.31%	87.49%
Lower-middle Income	42.92%	244 114 139	-2.51%	17.37%
Upper-middle Income	45.61%	151 481 711	-1.84%	-21.22%
High income	38.30%	44 907 180	-3.88%	-11.94%
Global	42.71%	513 829 451	-3.33%	5.56%

Note. Data are for children aged 1–9 years, both sexes, from GBD 2019 and UN DESA 2019 (4, 7).

**Fig. 17 Estimated cases and prevalence of caries of deciduous teeth per WB country income group**

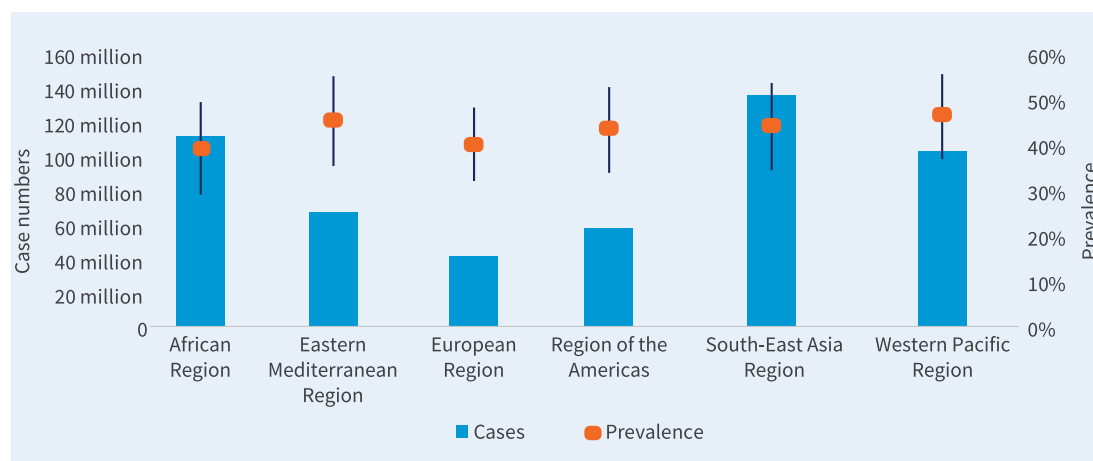
Note. Data are for children aged 1–9 years, both sexes, from GBD 2019 (4).

Among WHO regions, the highest prevalence is estimated for the Western Pacific Region (46%) and the lowest for the African Region (39%). Case numbers are highest in the South-East Asia Region, with an estimated 135 million cases, and lowest in the European Region, with an estimated 41 million cases (see Table 3 and Fig. 18).

**Table 3. Estimated prevalence and case numbers of caries of deciduous teeth in 2019 and their percentage change from 1990 to 2019 per WHO region**

WHO region	Prevalence (2019)	Cases (2019)	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)
African Region	38.61%	111 024 979	-3.40%	87.19%
Eastern Mediterranean Region	45.10%	66 378 695	0.60%	44.35%
European Region	39.64%	40 853 621	-7.22%	-22.10%
Region of the Americas	43.21%	57 459 634	-2.21%	-2.29%
South-East Asia Region	43.77%	135 260 519	-1.96%	-3.25%
Western Pacific Region	46.20%	102 138 618	-0.20%	-22.75%
Global	42.71%	513 829 451	-3.33%	5.56%

Note. Data are for children aged 1–9 years, both sexes, from GBD 2019 and UN DESA 2019 (4, 7).

**Fig. 18. Estimated cases and prevalence of caries of deciduous teeth per WHO region**

Note. Data are for children aged 1–9 years, both sexes, from GBD 2019 (4).

### 2.1.3 Caries of deciduous teeth – trends 1990–2019

Between 1990 and 2019, the global average prevalence of caries of deciduous teeth decreased slightly by 3% (with the largest decreases in high-income countries). Estimated global average case numbers increased by 6%. However, this figure masks significant increases in case numbers, with an increase (87%) that almost doubled in low-income countries as well as a 17% increase in lower-middle-income countries. Case numbers decreased by 21% in upper-middle-income countries and by 12% in high-income countries (see Table 2).

A decrease in estimated prevalence is reported for all WHO regions (with the largest decrease in the European Region at 7%), yet the other decreases are modest. Only the Eastern Mediterranean Region showed a slight increase in prevalence. Estimated changes in case numbers with the highest increases were reported for the African Region (87%) and the Eastern Mediterranean Region (44%), while all other regions showed decreases (with the largest decrease in the Western Pacific Region at 23%; see Table 3).

### 2.1.4 Prevalence and case numbers of caries of permanent teeth

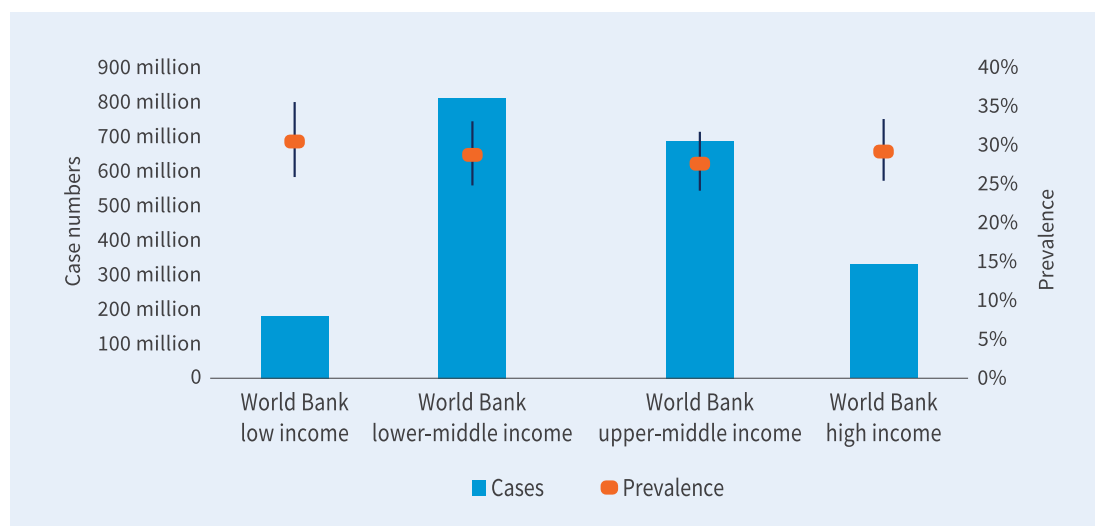
The estimated global average prevalence of caries of permanent teeth is 29%, and case numbers reach more than 2 billion cases. Prevalence differences between country income groups are minor. The highest case numbers are estimated for lower-middle-income countries (816 million) and upper-middle income countries (690 million). Middle-income countries thus report 75% of cases of untreated caries in permanent teeth (see Table 4 and Figs. 19 and 20).

**Table 4. Estimated prevalence and cases of caries of permanent teeth in 2019 and the percentage change of prevalence, cases and population from 1990 to 2019 per WB country income group**

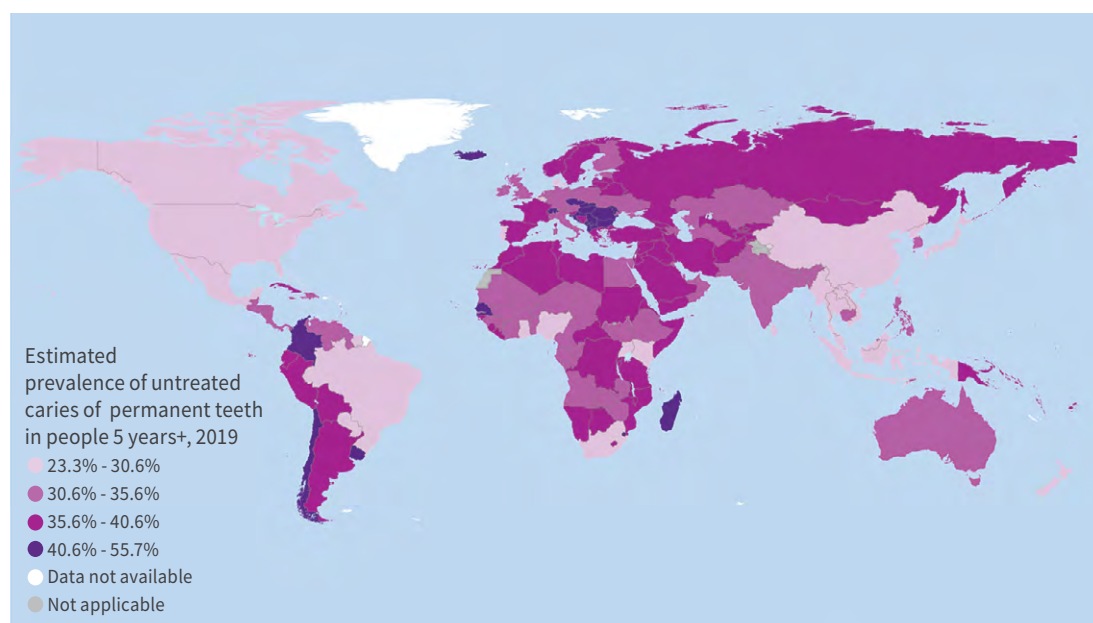
WB income group	Prevalence (2019)	Cases (2019)	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)	Percentage change population (1990–2019) <sup>a</sup>
Low income	30.61%	180 950 660	-0.43%	120.55%	117.98%
Lower-middle income	28.89%	815 650 762	-0.69%	73.57%	63.25%
Upper-middle income	27.75%	689 898 365	-4.15%	26.23%	27.97%
High income	29.30%	331 635 645	-4.64%	16.66%	20.63%
Global	28.70%	2 019 706 083	-2.59%	46.07%	44.79%

Note. Data are for ages greater than 5 years, both sexes, from GBD 2019 and UN DESA 2019 (4, 7).

<sup>a</sup> Population numbers are for total population across all age groups.

**Fig. 19. Estimated cases and prevalence of caries of permanent teeth per WB income group**

Note. Data are for ages greater than 5 years, both sexes, from GBD 2019 (4).

**Fig. 20. Estimated prevalence of caries of permanent teeth per country**

Data source: Global Burden of Disease Collaborative Network. GBD 2019. Seattle: IHME; 2020. Map Production: WHO NCD/MND unit. Map Creation Date: 30 August 2022. Note. N = 194 countries; data are age standardized, for ages greater than 5 years, both sexes, from GBD 2019 (4).

**Table 5. Estimated prevalence and cases of caries of permanent teeth in 2019 and the percentage change of prevalence, cases and population from 1990 to 2019 per WHO region**

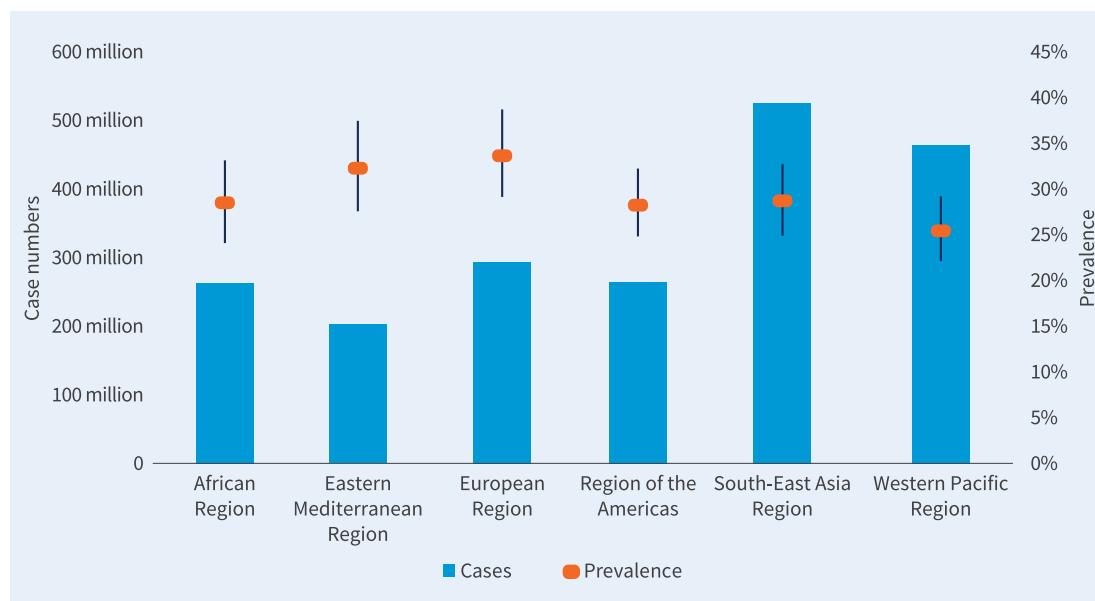
WHO region	Prevalence (2019)	Cases (2019)	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)	Percentage change population (1990–2019) <sup>a</sup>
African Region	28.50%	262 650 114	-1.66%	119.94%	114.98%
Eastern Mediterranean Region	32.25%	202 193 940	-0.27%	102.94%	93.08%
European Region	33.63%	293 866 294	-3.91%	6.09%	9.94%
Region of the Americas	28.24%	264 462 149	-0.05%	46.35%	40.70%
South-East Asia Region	28.69%	525 752 700	0.67%	65.26%	52.38%
Western Pacific Region	25.41%	463 936 789	-6.50%	20.37%	24.96%
Global	28.70%	2 019 706 083	-2.59%	46.07%	44.79%

Note. Data are for ages greater than 5 years, both sexes, from GBD 2019 and UN DESA 2019 (4, 7).

<sup>a</sup> Population numbers are for total population across all age groups.

Estimated prevalence for WHO regions range from 25% (Western Pacific Region) to 34% (European Region). Case numbers are highest in the South-East Asia Region (526 million) and Western Pacific Region (464 million; see Table 5 and Fig. 21).

**Fig. 21. Estimated cases and prevalence of caries of permanent teeth per WHO region**



Note. Data are for ages greater than 5 years, both sexes, from GBD 2019 (4).

### 2.1.5 Caries of permanent teeth – trends 1990–2019

Over almost a 30-year period, the number of cases increased by about 640 million cases, despite a slight decrease in prevalence (-2.6%). This significant increase in caries burden is mainly driven by the rise in case numbers due to the population growth in low- and lower-middle-income countries, where prevalence increases of 121% and 74% respectively were reported (see Table 4).

The WHO African Region showed the highest increases (120%), followed by the Eastern Mediterranean Region with 103%. The lowest increase was estimated for the European Region with a 6% increase. Between 1990 and 2019, prevalence was estimated to remain stable or decrease slightly in all WHO regions, with the strongest decrease in the Western Pacific Region (-6%; see Table 5).

### 2.1.6 Risk factors, determinants and impacts of dental caries

Dental caries is a multifactorial disease, and its development is linked to a complex web of individual, family and community-related factors that include the social and physical environment, behaviour and health services as well as commercial determinants, all acting over the life-course time (80, 81).

However, the consumption of free sugars in food and beverages is the most important risk factor for dental caries and is one of the common risks for NCDs. High sugar consumption is directly related to higher caries activity, and restricting intake of sugars decreases incidence and severity of dental caries. In addition, self-care and personal oral hygiene practices can significantly reduce the development and slow down the progression of caries. This is the rationale for recommending to brush teeth twice daily with a fluoride toothpaste to reduce the risk of caries in all age groups.

Untreated caries has many negative impacts in different phases of life. Repeated episodes of pain as well as chewing and sleeping difficulties reduce quality of life and productivity. Caries is a major cause of productivity losses at work, leads to missed educational opportunities and contributes to poor academic performance in school. Severe untreated caries with systemic inflammatory reactions from pulp infections is also a contributing factor to underweight and stunting in children (36, 82–87).

## 2.2 Severe periodontal disease

### 2.2.1 Global burden of severe periodontal disease

Severe periodontal disease (see Box 7 for definition) is widespread, with a global prevalence of about 19% in people aged greater than 15 years, representing more than 1 billion cases worldwide. Prevalence across country income groups is similar, yet case numbers are highest in lower-middle-income countries (437 million) and lowest in low-income countries (80 million; see Fig. 22 and Table 6). Prevalence of severe periodontal disease starts in late adolescence, peaks around 55 years of age and remains high until old age. Men and women are almost equally affected (88, 89). Fig. 23 provides an overview of prevalence per country.

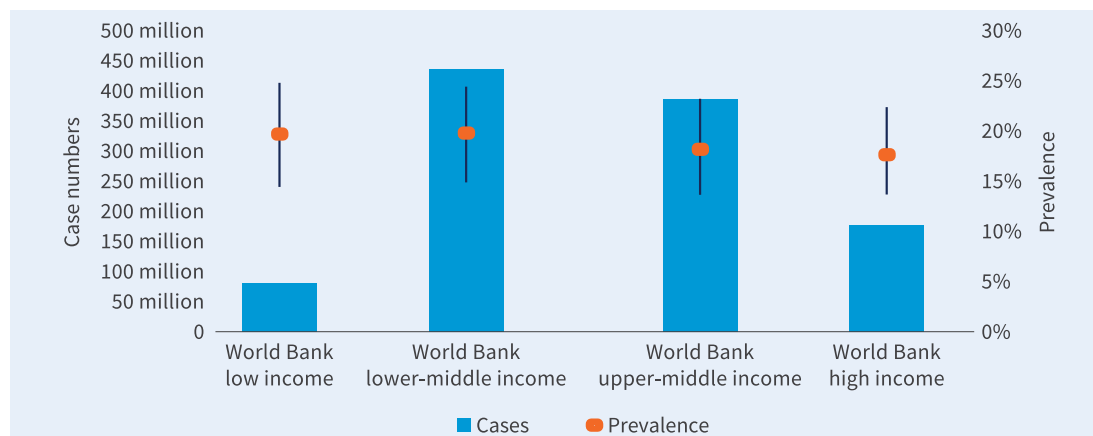


### Box 7. What is severe periodontal disease?

Periodontal disease is a chronic inflammation of the soft and hard tissues that support and anchor the teeth. Periodontal diseases include gingivitis (gum disease), a superficial and reversible inflammation of the gum resulting in swelling and bleeding. In the presence of other accelerating factors, such as tobacco use, systemic diseases or a compromised

immune response, gingivitis may develop into periodontitis, thereby affecting the deeper gum tissues and bone. The loss of attachment (“pocket”) eventually leads to increased mobility and tooth loss. Only severe periodontal disease, defined as the presence of a pocket of more than 6 mm depth, is a condition of public health concern (4, 89).

Fig. 22. Estimated cases and prevalence of severe periodontal disease per WB country income group



Note. Data are age standardized, for ages greater than 15 years, both sexes, from GBD 2019 (4).

Table 6. Estimated prevalence and cases of severe periodontal disease in 2019 and the percentage change of prevalence, cases and population from 1990 to 2019 per World Bank income group

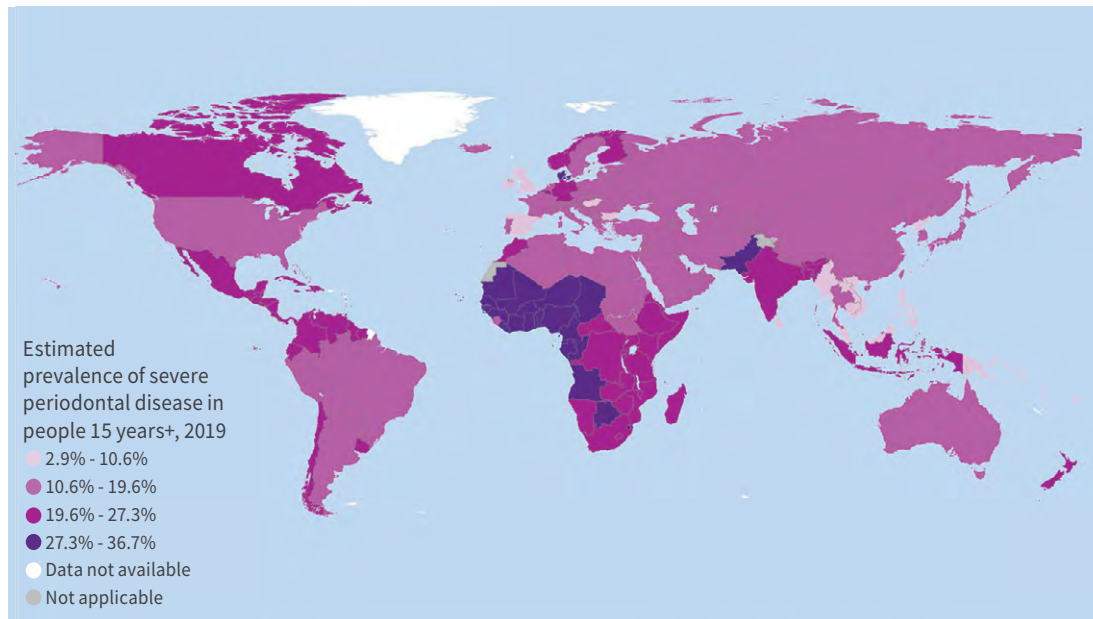
WB income group	Prevalence (2019)	Cases (2019)	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)	Percentage change population (1990–2019) <sup>a</sup>
Low income	19.71%	80 008 079	0.73%	129.75%	117.98%
Lower-middle income	19.80%	436 697 336	17.24%	124.66%	63.25%
Upper-middle income	18.19%	386 443 138	34.98%	96.83%	27.97%
High income	17.65%	176 251 937	18.71%	51.43%	20.63%
Global	18.82%	1 079 927 025	23.96%	99.18%	44.79%

Note. Data are age standardized, for ages greater than 15 years, both sexes, from GBD 2019 and UN DESA 2019 (4, 7).

<sup>a</sup> Population numbers are for total population across all age groups.



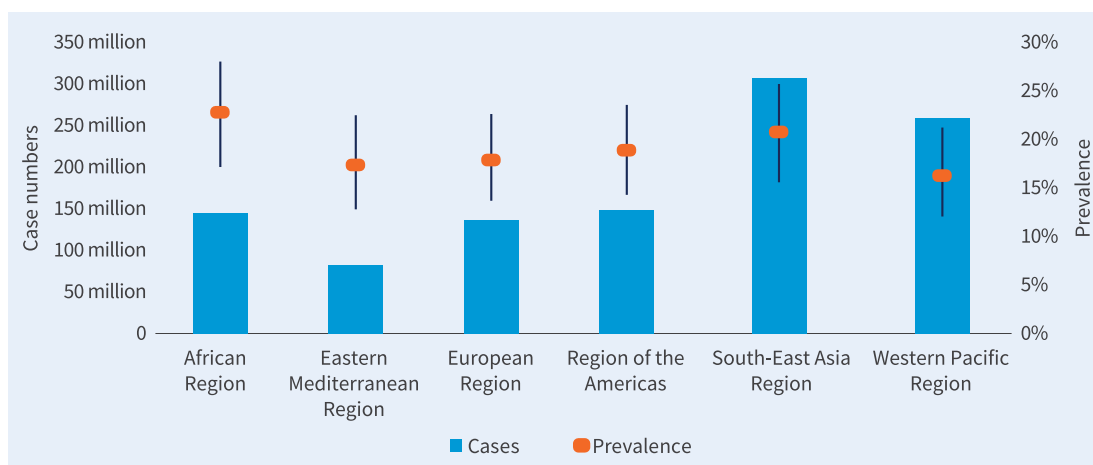
**Fig. 23. Estimated prevalence of severe periodontal disease per country**



Data source: Global Burden of Disease Collaborative Network. GBD 2019. Seattle: IHME; 2020. Map Production: WHO NCD/MND unit. Map Creation Date: 30 August 2022. Note. N = 194 countries; data are age standardized, for ages greater than 15 years, both sexes, from GBD 2019 (4).

Among the WHO regions, prevalence ranges in a narrow band between 16% (Western Pacific Region) and 23% (African Region), while the case numbers reflect the demographic share of the respective regions, with the South-East Asia Region and Western Pacific Region showing the highest case numbers and the Eastern Mediterranean Region showing the lowest (see Fig. 24 and Table 7).

**Fig. 24. Estimated cases and prevalence of severe periodontal disease per WHO region**



Note. Data are age standardized, for ages greater than 15 years, both sexes, from GBD 2019 (4).

**Table 7. Estimated prevalence and cases of severe periodontal disease in 2019 and the percentage change of prevalence, cases and population from 1990 to 2019 per WHO region**

WHO region	Prevalence (2019)	Cases (2019)	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)	Percentage change population (1990–2019) <sup>a</sup>
African Region	22.80%	144 745 633	2.47%	136.93%	114.98%
Eastern Mediterranean Region	17.37%	82 864 263	10.42%	149.44%	93.08%
European Region	17.89%	136 209 156	16.13%	34.14%	9.94%
Region of the Americas	18.89%	148 617 765	19.74%	89.37%	40.70%
South-East Asia Region	20.77%	306 964 138	22.66%	125.95%	52.38%
Western Pacific Region	16.28%	258 963 653	39.19%	97.51%	24.96%
Global	18.82%	1 079 927 025	23.96%	99.18%	44.79%

Note. Data are age standardized, for ages greater than 15 years, both sexes, from GBD 2019 and UN DESA 2019.

<sup>a</sup> Population numbers are for total population across all age groups.

## 2.2.2 Trends in disease burden 1990–2019

Prevalence and case numbers of severe periodontal disease increased significantly between 1990 and 2019. Estimated case numbers increased by almost 540 million, while estimated prevalence increased by 24%. Upper-middle-income countries showed the highest increase in prevalence (35%); the group of low-income countries was estimated to have almost no change in prevalence. Case numbers, however, increased the most in this country group (130%), as opposed to high-income countries with the smallest increase in case numbers (51%; see Table 6).

Among the WHO regions, the Western Pacific Region had the highest increase in prevalence between 1990 and 2019, while the highest increase in case numbers was estimated for the Eastern Mediterranean Region (see Table 7).

Prevalence of severe periodontitis increases with age (see Fig. 10). With the global demographic changes characterized by larger ageing populations and increasing longevity, an even higher global burden of severe periodontal disease may be expected in the future.

## 2.2.3 Severe periodontal disease, inequalities and general health

As for other NCDs, there are significant inequalities among population groups resulting from differences in exposure to risk factors and wider determinants of health. A greater disease burden is found in populations with lower socioeconomic status, income or education as well as among those living in rural areas. The consequences of severe periodontal disease for people affected include difficulties with eating or speaking, particularly when teeth are loose or already lost. Social interaction, general well-being and quality of life may also be significantly impaired.

Poor oral hygiene is a major behavioural risk factor for periodontal disease, together with common NCD risk factors such as tobacco use (90).

Severe periodontal disease is closely interlinked with major NCDs; particularly an association with unmanaged type 2 diabetes is well documented. Good periodontal health improves glycaemic control; deterioration of periodontal health may be an early indicator of poorly managed diabetes (44, 91).

## 2.3 Edentulism

### 2.3.1 The global burden of severe tooth loss and edentulism

A person is said to suffer from severe tooth loss when fewer than nine teeth are remaining in the mouth, which includes complete toothlessness, or edentulism (4, 92). Losing teeth is generally the end point of a lifelong history of oral disease, mainly advanced dental caries and severe periodontal disease, but can also be due to trauma and other causes, all possibly leading to tooth extraction. It can also be a consequence of weak oral health care services in resource-poor settings where restorative and prosthetic care are either not generally available or unaffordable (88).

Losing teeth is often seen as an inevitable result of ageing and is socially accepted in many cultures. However, losing teeth and living with reduced or absent dentition can be psychologically traumatic, socially damaging and functionally limiting to the individual affected. Balanced nutrition may become difficult, especially when partial or full dentures to replace missing teeth are not accessible or affordable (54).



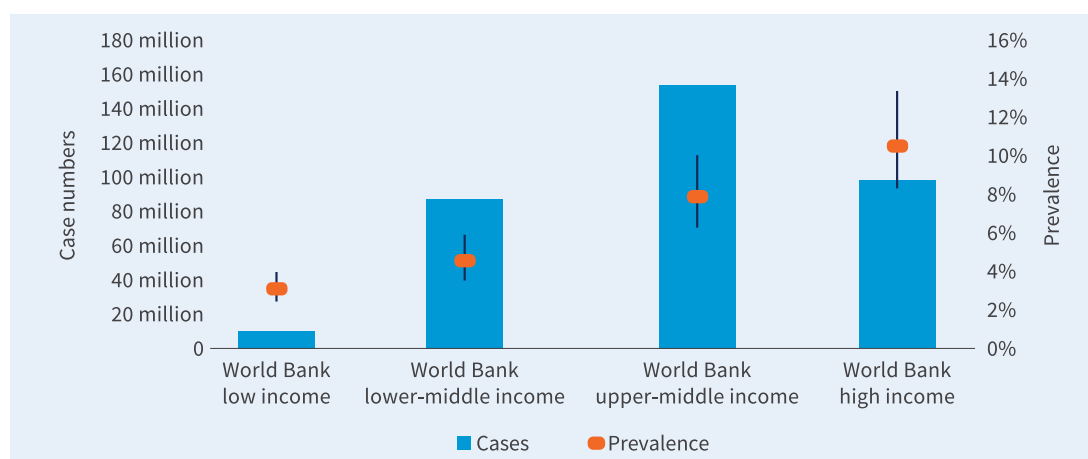
The estimated global average prevalence of complete tooth loss is almost 7%, with more than 350 million cases worldwide (see Table 8). The lowest prevalence is estimated for low-income countries (3%), followed by lower-middle-income countries (4.5%) and upper-middle-income countries (8%). The highest prevalence rates of 10.5% are estimated for high-income countries, as well as highest case numbers with 98 million cases (see Fig. 25). The European Region has the highest prevalence among the 6 WHO regions and, together with the Western Pacific Region, also has the highest numbers of cases (see Table 9 and Fig. 26). The African Region has the lowest prevalence and case numbers.

**Table 8. Estimated prevalence and cases of edentulism in 2019 and the percentage change of prevalence, cases and population from 1990 to 2019 per WB country income group**

WB income group	Prevalence (2019)	Cases (2019)	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)
Low income	3.10%	10 221 945	-4.35%	118.01%
Lower-middle income	4.56%	87 256 962	2.56%	103.26%
Upper-middle income	7.89%	153 803 699	30.41%	105.66%
High income	10.52%	98 065 451	5.63%	39.02%
Global	6.82%	350 060 709	8.02%	81.12%

Note. Data are age standardized, for ages greater than 20 years, both sexes, from GBD 2019 and UN DESA 2019

**Fig. 25. Estimated cases and prevalence of edentulism per WB country income group**



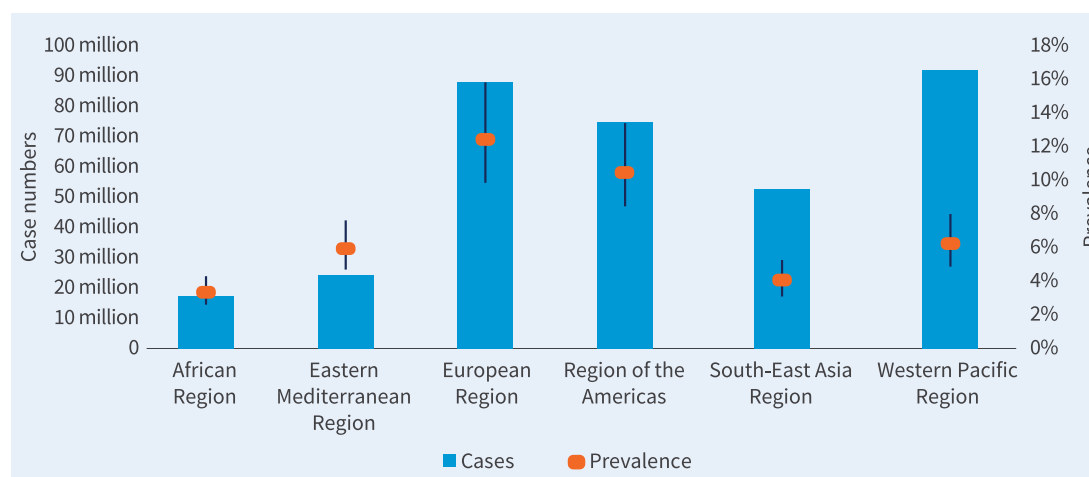
Note. Data are age standardized, for ages greater than 20 years, both sexes, from GBD 2019 (4).

**Table 9. Estimated prevalence and case numbers of edentulism in 2019 and the percentage change of prevalence, cases and population from 1990 to 2019 per WHO region**

WHO Region	Prevalence (2019)	Cases (2019)	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)
African Region	3.34%	17 369 660	-11.75%	105.84%
Eastern Mediterranean Region	5.93%	24 454 031	-2.75%	130.89%
European Region	12.42%	88 199 746	8.95%	30.01%
Region of the Americas	10.54%	74 843 184	14.51%	88.25%
South-East Asia Region	4.06%	52 687 418	16.39%	123.36%
Western Pacific Region	6.24%	91 909 753	39.15%	114.86%
Global	6.82%	350 060 709	8.02%	81.12%

Note. Data are age standardized, for ages greater than 20 years, both sexes, from GBD 2019 and UN DESA 2019.

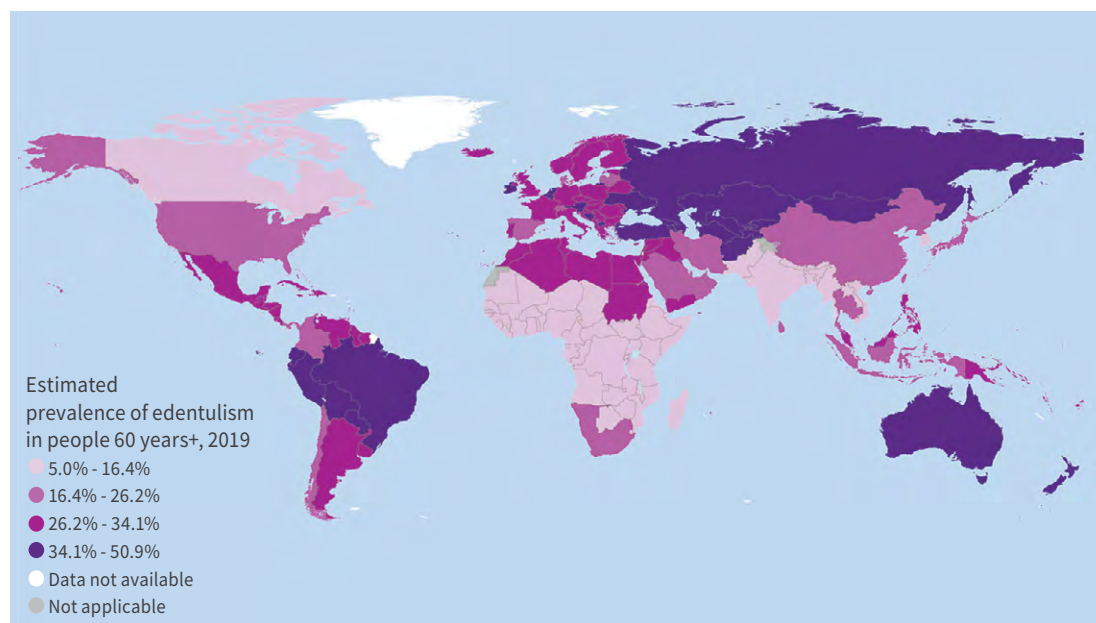
**Fig. 26. Estimated cases and prevalence of edentulism per WHO region**



Note. Data are age-standardized, for ages greater than 20 years, both sexes, from GBD 2019 (4).

For people older than 60 years the global average prevalence of edentulism is much higher, estimated at 22.7% – almost one in four persons older than 60 have no teeth left. Rates vary across country income groups, with low-income countries showing the lowest rate (11.7%) and high-income countries reporting the highest rate (25.4%). Among the WHO regions, the highest rate is estimated for the European Region (31.3%) and the lowest for the African Region (12.1%; see Fig. 27).

The burden of DALYs due to tooth loss is estimated at more than 9.5 million (GBD combines severe tooth loss and edentulism to calculate DALYs).

**Fig. 27. Estimated prevalence of edentulism**

Data source: Global Burden of Disease Collaborative Network. GBD 2019. Seattle: IHME; 2020. Map Production: WHO NCD/MND unit. Map Creation Date: 30 August 2022. Note.  $N = 194$  countries; data are for ages greater than 60 years, both sexes, from GBD 2019 (4).

### 2.3.2 Trends in disease burden 1990–2019

The global average prevalence of edentulism increased by 8% and the estimated global case numbers rose by 81% between 1990 and 2019, representing an additional 157 million cases (see Table 8). During this time span, only low-income countries saw a modest decrease in prevalence (-4%), while all other country income groups had increases, which were highest in upper-middle-income countries (30%). Case numbers more than doubled in all country income groups, except in high-income countries, where case numbers increased by 39%.

Among the WHO regions, the African Region had the largest decrease in prevalence (-12%), followed by the Eastern Mediterranean Region (-3%; see Table 9). Prevalence increased in all other WHO regions, with the most growth in the Western Pacific Region (39%). Case numbers more than doubled in all WHO regions, except for the European Region (30% increase) and the Region of the Americas (88% increase). The trends measured in DALYs follow similar patterns, with a global increase of 80% from 1990 to 2019.



## 2.4 Oral cancer

### 2.4.1 Global and regional burden of lip and oral cavity cancer

Oral cancers are a disease group with high mortality and morbidity. The IARC Global Cancer Observatory (GLOBOCAN) estimated 377 713 new cases and 177 757 deaths from lip and oral cavity cancers worldwide in 2020 (93, 94). The number of estimated incident cases of lip and oral cavity cancers ranked 16th among all cancers (for both sexes); combined with cases of oropharyngeal cancers, the rank increased to the 13th most common cancer worldwide. The global incidence rate for men (13.1 per 100 000) is more than 2.5 times higher than for women (5 per 100 000). Mortality rates for men are more than double compared to women (see Figs. 28 and 29). Lip and oral cavity cancer is the 11th most common cancer for men (all ages), with a share of 3.5% of all cancers.

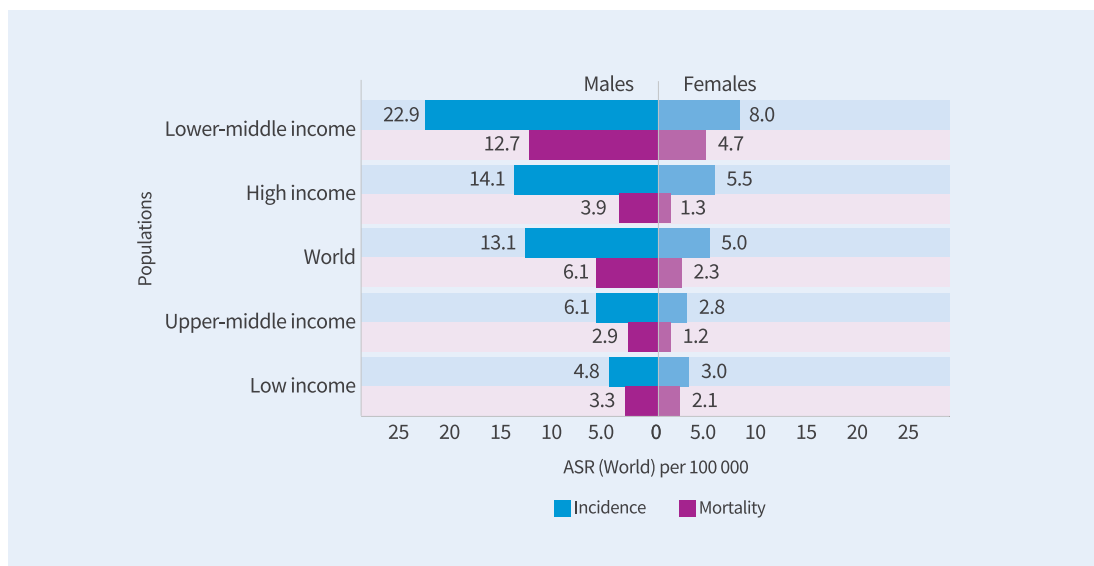


#### Box 8. Definition of oral cancer

The umbrella term oral cancer includes malignant neoplasms, predominantly squamous cell carcinomas occurring in the mucosa of the lips and oral cavity (tongue, upper and lower gums, floor of the mouth, palate and other parts of the mouth), corresponding to the International Classification of Diseases (ICD-10) codes C00–C06. The IARC groups lip and oral cancers together under the generally used term oral cancer, yet they are cancers with distinct epidemiological and clinical profiles (93, 95). Due to increasing incidence of cancers of the tonsils and other parts of the oropharynx (ICD-10 C09 and C10) linked to human papillomavirus (HPV) infections, they are now also recognized as global public health problems under the term oropharyngeal cancer. This report uses oral cancer for lip and oral cavity cancer, unless otherwise stated.

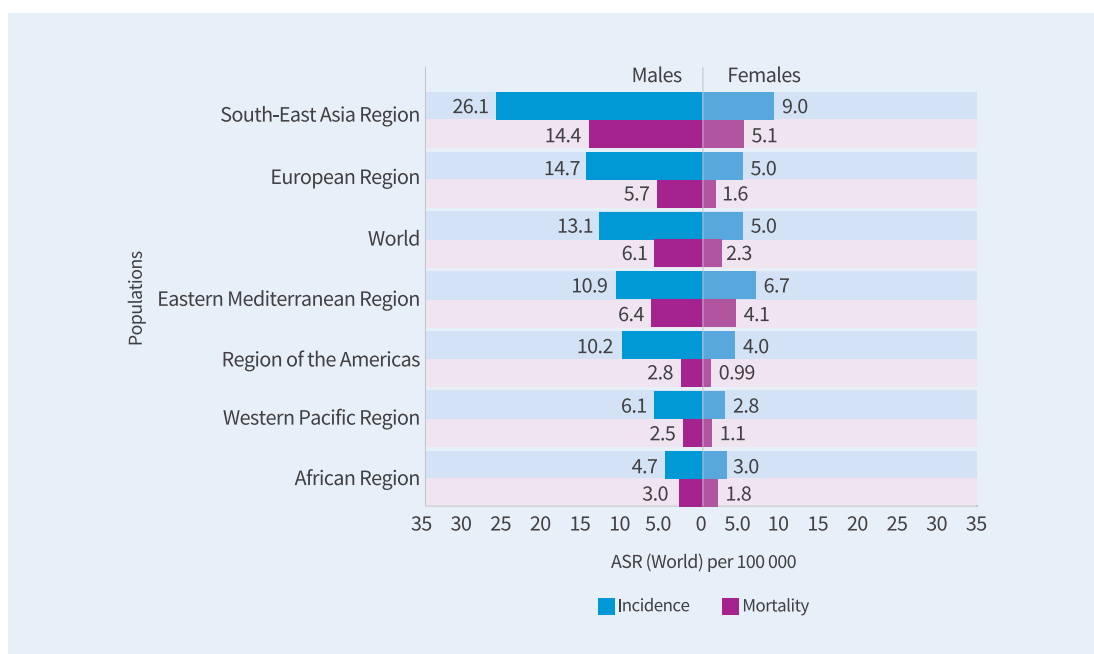
Prevalence of oral cancer differs significantly by regions, countries and population groups (see Fig. 30). Middle- and high-income countries carried almost the entire burden in terms of case numbers in 2020, with estimates for lower-middle-income and high-income countries encompassing more than three quarters of global estimated cases (5). The WHO South-East Asia Region shows the highest incidence and mortality of all WHO regions, with rates almost double the global average (see Figs. 29, 30 and 31). Oral cancers are the most common cancer for males in the region, with men aged 25–39 accounting for more than one quarter of all cancer cases. Overall, inequalities are significant with people with low income, socio-economic status or other disadvantage being more frequently affected. Treatment availability, outcomes and survival rates are generally better in high-income countries (96, 97).

**Fig. 28. Incidence and mortality rates of lip and oral cavity cancer per WB country income group**



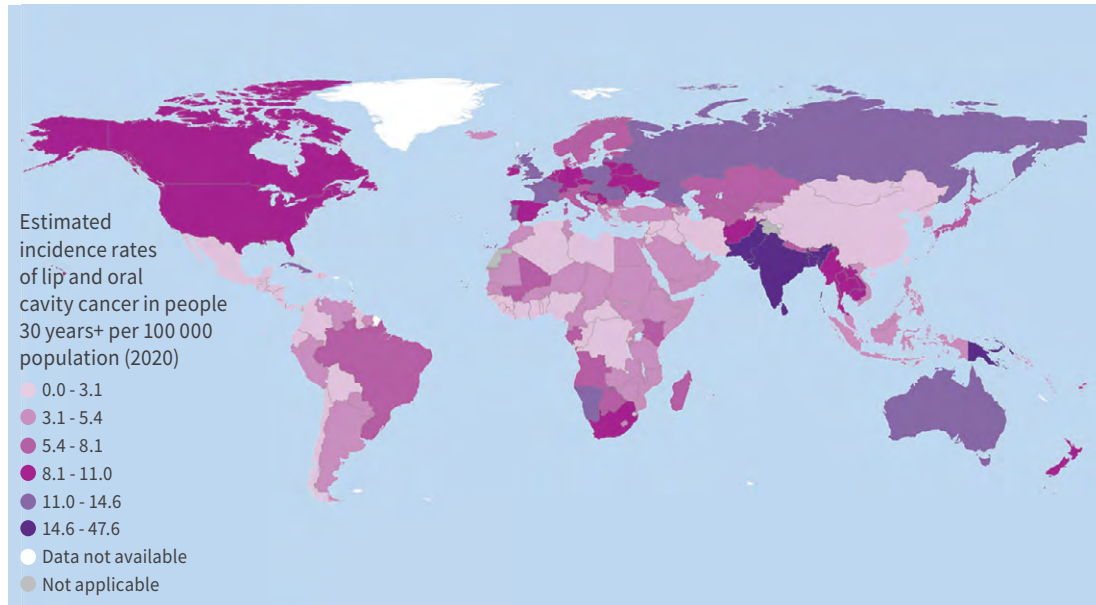
Note. Data are age-standardized, for ages greater than 30 years, from GLOBOCAN 2020 (5).

**Fig. 29. Incidence and mortality rates of lip and oral cavity cancer per WHO region**

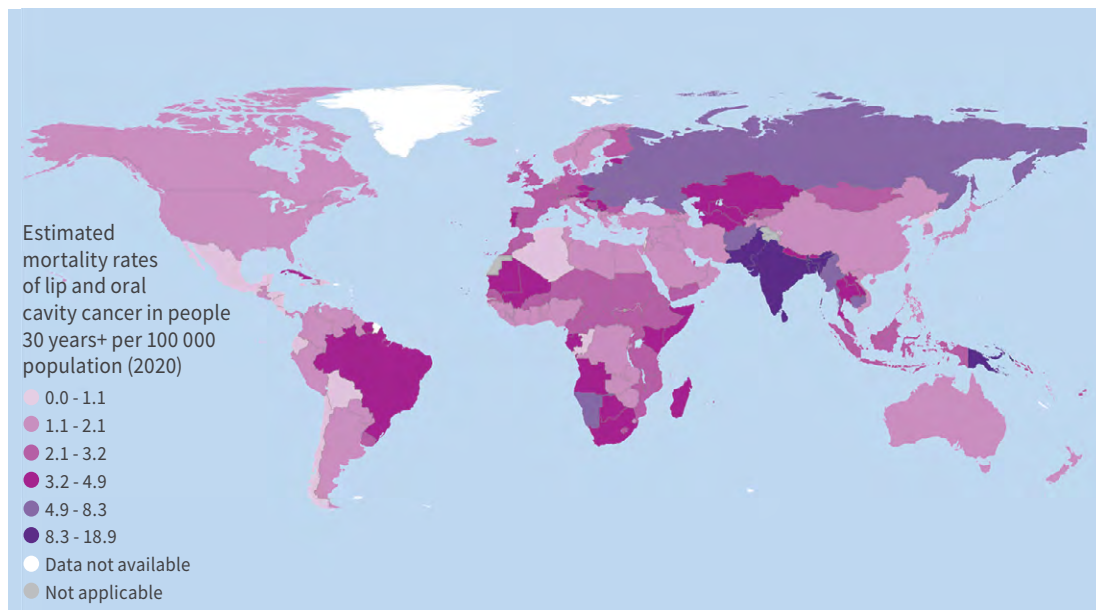


Note. Data are age-standardized, for ages greater than 30 years, from GLOBOCAN 2020 (5).



**Fig. 30. Estimated incidence rates of lip and oral cavity cancer**

Data source: Ferlay et al. Global Cancer Observatory: Cancer Today. International Agency for Research on Cancer: Lyon, France; 2020. Map Production: WHO NCD/MND unit. Map Creation Date: 30 August 2022. Note. N = 176 countries; data are age-standardized, for ages 30–85 years, both sexes, from GLOBOCAN 2020 (5).

**Fig. 31. Estimated mortality rates of lip and oral cavity cancer**

Data source: Ferlay et al. Global Cancer Observatory: Cancer Today. International Agency for Research on Cancer: Lyon, France; 2020. Map Production: WHO NCD/MND unit. Map Creation Date: 30 August 2022. Note. N = 176 countries; data are age-standardized, for ages 30–85 years, both sexes, from GLOBOCAN 2020 (5).

The 136 000 new cases and 75 000 deaths occurring in India alone account for 36% of all new cases and 42% of deaths from oral cancers worldwide. The South-East Asia Region has a 52% share of deaths from oral cancer (97).

Variations of oral cancer are also observed relative to location. The tongue is the most common site of oral cavity cancers in Europe, the United States and Japan, whereas the buccal and lip mucosa are more common cancer locations in some regions of Asia. These regional variations in the incidence of oral cavity cancer subsites relate to the distribution of the main risk factors (such as tobacco and alcohol use in Western countries and betel quid and tobacco chewing in South and Southeast Asia).

### 2.4.2 Oral cancer – trends over time

Observed trends in incidence and mortality of oral cancers vary according to geographical location, age group and sex. Differences largely follow changes in tobacco consumption, thereby reflecting the stage and degree of the tobacco epidemic of the respective region. Overall, there is a long-term downward trend in the incidence of oral cancers among men, while it is increasing or stable among women in countries where the tobacco epidemics reached their peak some time ago. By contrast, and not unexpectedly, oral cancers have increased in countries with rising tobacco use.

### 2.4.3 Specific risk factors of oral cancer

The main risk factors for lip, oral cavity and oropharyngeal cancers are tobacco use, alcohol consumption and betel quid use, which act independently or in combination (see Section 1.2.4). Other risk factors with lower impact include diet and socioeconomic position (98–100).

Lip and oral cavity cancers are the third most common cancer related to tobacco use, and about one quarter of oral cancer cases are related to harmful alcohol consumption. Both risk factors combined substantially increase the risk of oral cavity cancers.

The group of Human Papilloma Viruses (HPV) is a well-recognized cause of about 4.5% of all cancers worldwide. HPV types 16 and 18 are now the most common cause of oropharyngeal cancers (base of the tongue, tonsils and back of the throat). Increases in cases have been reported in many countries where previously low incidence rates were seen, particularly among young male white adults. With rising prevalence of HPV infection in specific age cohorts, the incidence of oropharyngeal cancer in men surpassed the incidence of cervical cancer in women in the United Kingdom in 2016. Survival rates of HPV-positive oropharyngeal cancers are better compared to patients with HPV-negative cancers. In many countries, public health agencies advocate for gender-neutral HPV vaccination as a populationwide primary prevention strategy to reduce incidence of HPV-associated cancers in both males and females (101–103).

Specific risk factors for lip and oral cavity cancers are smokeless tobacco (chewing and snuff) and betel quid (paan), substances that have long been established as strong carcinogens (104). Chewing betel quid without tobacco is estimated to increase the risk of oral cavity cancer 2.5-fold; in combination with tobacco the risk increases 7.74-fold, with a cumulative effect over the life course (105). More research is needed to assess the impact of e-cigarettes and vaping nicotine products on oral cancer.

### Box 9. Betel quid: a dangerous yet popular carcinogen

Betel quid chewing with tobacco is one of the most common forms of smokeless tobacco and is used by approximately 600 million individuals worldwide, with a higher prevalence in South and South-East Asia and the Pacific islands. The effect of betel quid chewing is a general stimulation, similar to the effects of tobacco or caffeine (110).

Betel quid is a mixture of areca nut (nut of a palm tree, *Areca catechu*), slaked lime (calcium hydroxide) and betel leaf (leaf of the piper betel vine), and it can have tobacco (mainly in South-Central Asia) or not (in East Asia and Melanesia). All of the ingredients are wrapped inside the betel leaf and made into a bunch commonly known as a “quid,” which is then chewed. It stains teeth and tissues dark red and is spit out after chewing for a few hours.

### Box 10. IARC handbook Vol. 19 - on oral cancer prevention

The IARC handbooks of cancer prevention provide comprehensive reviews and consensus evaluations of interventions and strategies that aim to reduce cancer incidence or mortality at the population level. The process involves a working group of international, interdisciplinary experts who review the literature and assess the body of evidence.

The volume 19 of the IARC handbook covers the topic of oral cancer prevention, both primary and secondary prevention. In terms of primary prevention, the handbook evaluates the effectiveness of quitting exposure to the known risk factors for oral cancer – tobacco smoking, alcohol consumption, and chewing of products (including betel quid) that contain smokeless tobacco, areca nut, or both – in reducing oral cancer incidence and mortality. In the subsequent section, the handbook assesses the impact of interventions aimed at quitting the use of smokeless tobacco and areca nut products; the impact of policies pertinent to smokeless tobacco and areca nut control is also assessed. In terms of secondary prevention, the effectiveness of screening by clinical oral examination is evaluated. The handbook also covers other related topics, such as the global burden of oral cancer and potentially malignant disorders, their natural history, risk factors for oral cancer, the prevalence of smokeless tobacco and areca nut chewing in the different WHO regions, screening methods and technologies as well

as screening programmes and the determinants of participation in screening.

Publication of the IARC handbook on oral cancer prevention, volume 19, is scheduled for the end of 2022. This handbook will help policy-makers develop evidence-based interventions or recommendations to reduce oral cancer risk at the population level. See <https://publications.iarc.fr/Book-And-Report-Series/iarc-Handbooks-Of-Cancer-Prevention>.



#### Case Study 4. Two betel nut consumers and their battles with oral cancer (India)

Oral cancer contributes to about 30% of cancer cases in India, with more than 130 000 new cases diagnosed in 2020, according to the Global Cancer Observatory (5). This represents two thirds of registered cancer cases of the National Cancer Registry Programme (106). In 2021, it was reported that nearly one out of every four adults in India consumes betel nut, of which around 10% is mixed with tobacco (107). The large number of users of betel nut, a known carcinogen and risk factor for oral cancer, presents a huge public health challenge for the country.

Shashank Wani, a 31-year-old teashop owner from Jabalpur, was diagnosed with Stage 2 oral cancer in 2021. He started using betel nut products when he was a senior at secondary school and continued consuming four to five packs a day, occasionally mixed with smokeless tobacco, until he learned that the ulcer in his mouth, which had not been healing, was oral cancer.

“I started this habit after taking over our family teashop when my father passed away. We ate betel nuts when chatting to pass time with my friends at the shop,” Wani says, pointing out the lack of awareness about the harmful effects of betel nut. “Teenagers need to be informed and educated about the consequences and should not fall into the trap of addiction. Only then the future generations could be safe,” he adds. As chewing betel nut is a socially acceptable habit in most parts of India, community leaders show indifference towards it. Further, betel nut or its products can be easily found and purchased in small shops.

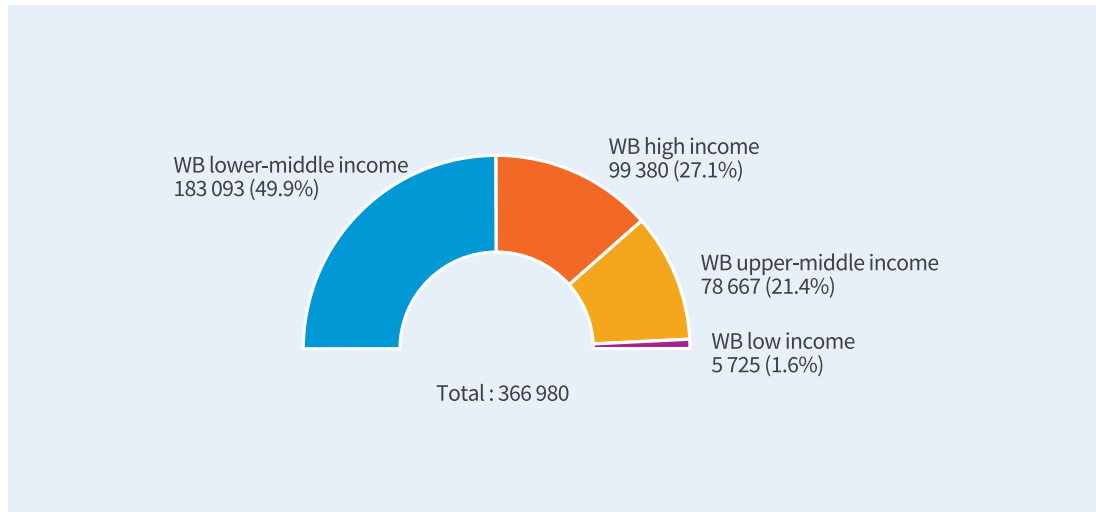
Wani feels lucky that the cancer was diagnosed at an early stage and his surgeries were successful. He has a 1-year-old daughter. “I had to stay strong and fight the cancer for her sake. Thank God that I am alive and healthy today. I have been granted a second life, which I intend to live to the fullest with my family and friends,” he says, feeling grateful to all those who cared for him during the stressful time of his illness.



Betel nuts are also widely consumed by people who work long hours as they are believed to help improve mood and concentration. Rahul Wankhede, a 35-year-old engineer in computer science from Indiranagar, started eating betel nuts in his twenties when he worked in the army. Other soldiers who were habitually taking betel nuts to reduce stress and exhaustion introduced them to Wankhede. Three years ago, he was diagnosed with oral submucous fibrosis (OSMF), an abnormal collagen deposition in the oral cavity (108, 109). After being informed by the medical team about the disease’s debilitating outcomes, such as restriction in the mouth opening and formation of a malignant tumour, Wankhede started getting treatment and stayed away from betel nuts for a while.

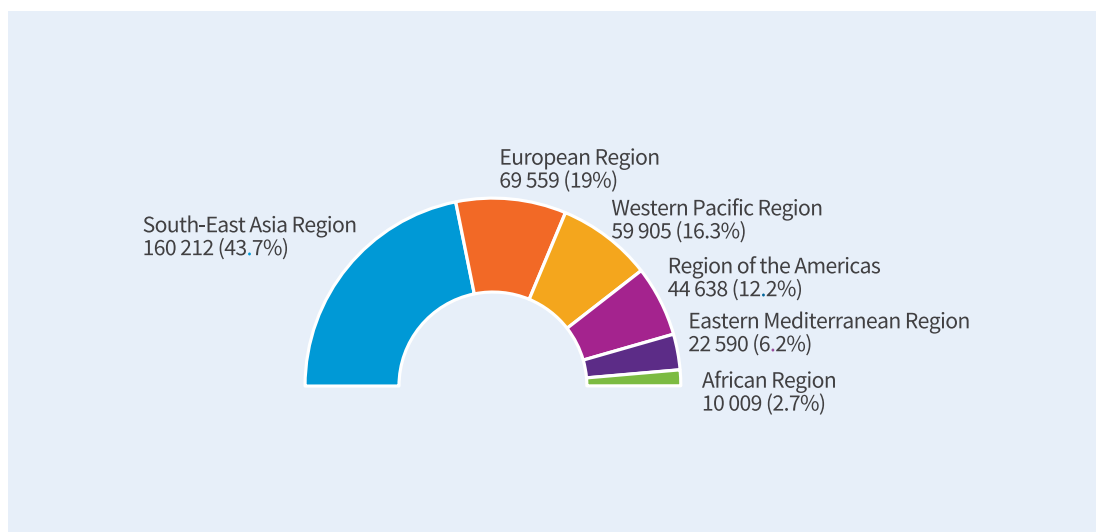
“Unfortunately, after some time I went back to eating betel nuts again to cope with the consistent stress,” Wankhede explains. His OSMF later worsened, forming blisters and ulcers and causing him difficulty with opening his mouth. A biopsy taken from one of the tongue ulcers that did not respond to treatment showed that he had oral cancer. Despite having a radical surgery, during which part of his tongue was removed and replaced with some muscles from his arm, as well as his ongoing radiotherapy, Wankhede is hopeful to be in remission and looking forward to life beyond cancer.

**Fig. 32. Estimated numbers of new cases and percentage share of total cases of lip and oral cavity cancer per WB country income group (2020)**



Note. Data are for all ages, both sexes, from GLOBOCAN 2020 (5).

**Fig. 33. Estimated numbers of new cases and percentage share of total cases of lip and oral cavity cancer per WHO region (2020)**



Note. Data are for all ages, both sexes, from GLOBOCAN 2020 (5).

## 2.5 Other oral conditions of public health relevance

In addition to the four main oral diseases, other diseases and conditions of the mouth have a significant impact on the health and well-being of populations. These include congenital malformations, noma and traumatic dental injury.

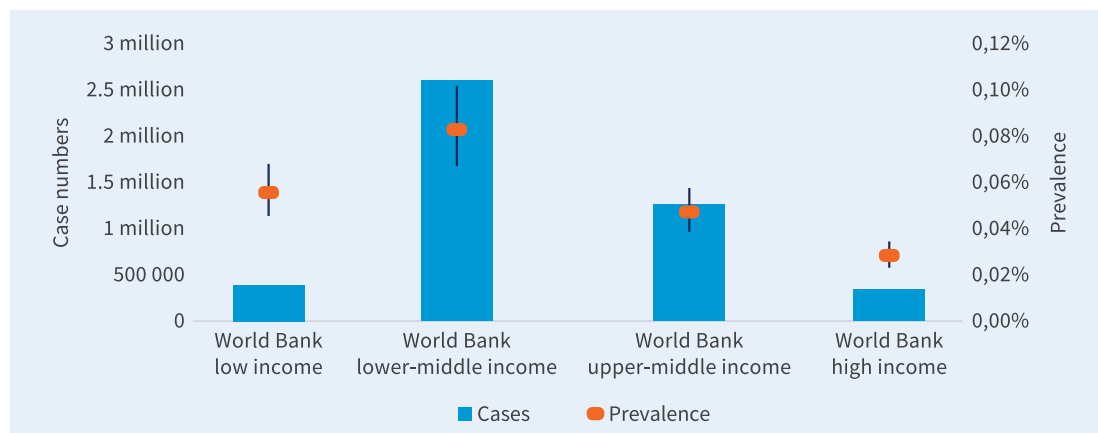
### 2.5.1 Congenital malformations

Orofacial clefts are among the most common human congenital malformations (OFCs) and the predominant congenital malformations of the face and mouth. They include cleft lip and/or cleft palate in different combinations. OFCs occur either alone (70%) or as part of a syndrome, affecting approximately 1 in 1000-1500 newborns worldwide, though with varying rates across ethnic groups and geographical areas.

Accurate surveillance data on the global burden of OFCs are still a challenge, despite improvements in recent years. The GBD project uses an advanced modelling approach to develop estimates for all countries worldwide, but a lack of international agreement on underlying assumptions, definitions and other aspects likely results in an underestimation of case numbers and mortality rates (4, 111-114).

GBD 2019 estimates the global number of undifferentiated OFC cases at about 4.6 million cases; more than 90% of cases occur in low- and middle-income countries. The global DALYs amount to almost 530 000. The highest case numbers are estimated for lower-middle-income countries (2.6 million) and the lowest case numbers for high-income countries (340 000). Prevalence rates range between 0.03% and 0.08% (see Fig. 34 and Table 10) and showed a minimal global decrease of 2.4% between 1990 and 2019. However, case numbers globally increased by 41% during the same period, with numbers more than doubling in low-income countries (107% increase). Similar patterns are estimated for DALYs.

**Fig. 34. Estimated cases and prevalence of OFCs by WB Income group**



Note. Data are from GBD 2019 (4).

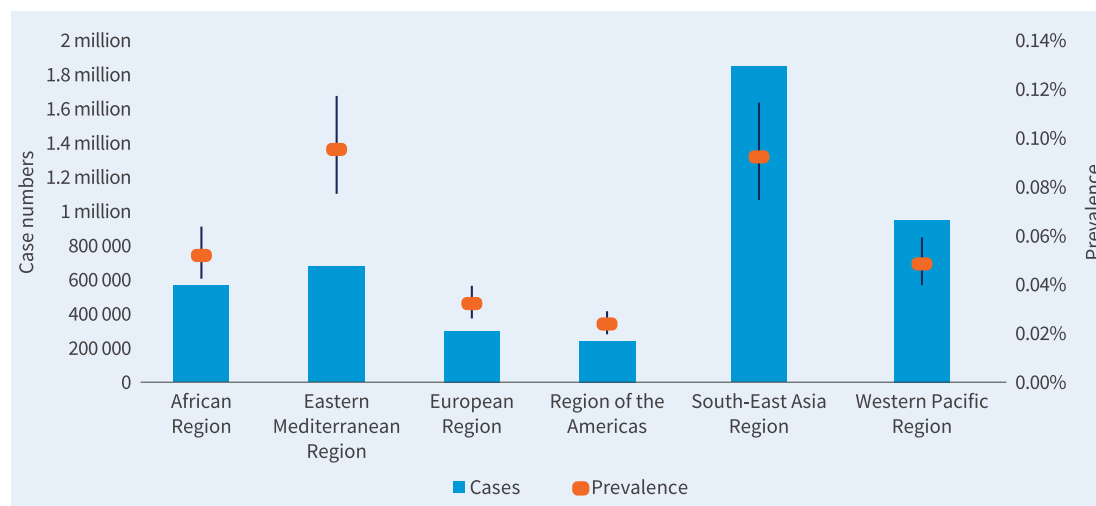
**Table 10. Estimated prevalence, case numbers and DALYs of OFCs and their percentage changes from 1990 to 2019 per WB Income group**

WB income group	Prevalence	Cases	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)	DALYs rate per 100 000 pop	DALYs	Percentage change DALYs rate (1990–2019)	Percentage change DALYs (1990–2019)
Lower income	0.06%	389 797	-3.36%	106.62%	0.00016	108 775	-3.04%	26.62%
Lower-middle income	0.08%	2 603 451	-5.12%	57.17%	0.00009	284 213	-5.31%	-33.30%
Upper-middle income	0.05%	1 259 459	-12.65%	10.20%	0.00004	111 284	-13.26%	-82.55%
High income	0.03%	338 915	4.74%	25.79%	0.00002	21 832	3.78%	-13.25%
Global	0.06%	4 603 372	-2.40%	41.16%	0.00007	528 116	-2.83%	-56.37%

Note. Data are for all countries, all ages, both sexes, from GBD 2019 (4).

The WHO Southeast Asia region is most affected with the highest case numbers (1 850 000 cases/prevalence 0.09%). The lowest case numbers and prevalence are estimated for the Region of the Americas (240 000 cases/prevalence 0.02%). Case numbers more than doubled in the WHO African region between 1990 and 2019 (see Fig. 35 and Table 11).

**Fig. 35. Estimated cases and prevalence of OFCs by WHO region**



Note. Note. Data are from GBD 2019 (4).

**Table 11. Estimated prevalence, case numbers and DALYs of OFCs and their percentage changes from 1990 to 2019 per WHO region**

WHO region	Prevalence	Cases	Percentage change prevalence (1990–2019)	Percentage change cases (1990–2019)	DALYs rate per 100 000 pop	DALYs	Percentage change DALYs rate (1990–2019)	Percentage change DALYs (1990–2019)
African Region	0.05%	566 944	-5.05%	104.94%	0.00013	137 831	-5.05%	104.94%
Eastern Mediterranean Region	0.10%	678 784	-3.90%	84.38%	0.00010	74 571	-3.90%	84.38%
European Region	0.03%	299 700	-0.70%	7.49%	0.00002	21 872	-0.70%	7.49%
Region of the Americas	0.02%	241 357	-5.60%	33.22%	0.00002	24 552	-5.60%	33.22%
South-East Asia Region	0.09%	1 847 699	-4.14%	47.76%	0.00009	181 183	-4.14%	47.76%
Western Pacific Region	0.05%	948 756	-14.53%	5.71%	0.00004	85 866	-14.53%	5.71%
Global	0.06%	4 603 372	-2.40%	41.16%	0.00007	528 116	-2.40%	41.16%

Note. Data are for all countries, all ages, both sexes, from GBD 2019 (4).



Although genetic predisposition is the leading factor for congenital anomalies, other modifiable risk factors, such as nutrition deficits and smoking during pregnancy, also play a role. This underlines the importance of antenatal care and support for pregnant women (115).

OFCs have considerable negative impact on individuals and communities, including stigma, impairment of function, need for extended complex treatments, impacts on social interaction and self-esteem, and reduced quality of life.

Diagnosis and treatment of OFCs present a significant challenge to public health, particularly in lower-middle-income countries where availability, access and affordability of complex, multidisciplinary care are limited and complications from untreated OFCs may result in high rates of infant mortality. Cleft surgery is on the list of cost-effective essential surgery services recommended by WHO and the WB (116, 117).



### 2.5.2 Noma

Noma is a serious gangrenous disease of the mouth and the face, often starting as a sore on the gums inside the mouth. Initial lesions then develop into a rapidly progressing acute necrotizing gingivitis, destroying the soft tissues and further expanding to the hard tissues and skin of the face. Without early treatment, noma is fatal in about 90% of cases. Noma mostly affects children between the ages of 2 and 6 living in extreme poverty and suffering from malnutrition, infectious diseases and poor oral and general hygiene or with weakened immune systems. Surviving children, adolescents and adults are often seriously disfigured, suffering from complex functional impacts that affect eating, drinking and speaking. Social interaction is often severely affected because of these limitations and the social stigma resulting from disfigurement (118, 119).

Noma occurs predominantly in an area of sub-Saharan Africa stretching from Mauritania to Ethiopia – the so-called noma belt. Sporadic cases are also reported from other world regions. In 1998, WHO estimated an annual incidence of more than 140 000 cases worldwide (120). Recent epidemiological data are not available due to lacking surveillance systems and high mortality at early ages combined with stigma, so that affected children are hidden by their families (121). In addition, awareness and capacity to recognize the first signs of noma are low among health workers and the general population.

A WHO-commissioned systematic review highlighted a lack of high-quality, comprehensive research studies as well as substantial gaps in knowledge with respect to understanding the aetiology, pathogenesis, preventative and treatment efficacy, distribution and burden of noma (122).

Prevention measures include childhood vaccination for infectious diseases, appropriate nutrition including breastfeeding and improvements in water and sanitation as well as environmental, personal and oral hygiene. Equally important is education of parents and health care workers about early symptoms so that appropriate care can be provided in a timely manner. Treatment includes antibiotics, nutrition supplementation and rehydration therapy as well as hygiene improvements. Advanced cases require repeated complex reconstructive surgery and rehabilitation, which are often unavailable in the countries most affected.

Noma is a marker of absolute poverty. In 2012, the UN Human Rights Council acknowledged noma to be a violation of basic child rights and made a comprehensive set of recommendations, in line with the strategies of the WHO Regional Office for Africa Noma Control Programme (see Box 11) (123). The disease is part of the priority actions of the WHO Regional Office for Africa's Regional Oral Health Strategy 2016–2025 and other WHO AFRO oral health guidance documents (124). Moreover, in World Health Assembly resolution WHA74/R5, Member States requested that WHO include noma in the planned review process to consider the classification of additional diseases as part of the road map for neglected tropical diseases 2021–2030. This would give noma renewed international attention, access to new research capacities, additional options for resource mobilization and stronger engagement with efforts to eliminate absolute poverty as part of the Sustainable Development Goals (SDGs) (125–127).

### Case Study 5. Supporting survivors of noma (Nigeria)

Mulikat Okanlawon, now around 37 years old, had noma when she was 6 years of age. Her wounds were treated in a local hospital and she survived noma's acute stage but suffered severe facial disfiguration. Her cheekbone and the adjacent teeth and muscles were completely destroyed, making it very difficult for her to eat and speak normally.

Okanlawon faced years of stigma and isolation because of her disfigurement. "My own siblings wouldn't interact with me," she explains. "The children would look at me and run away. The teachers would explain to them what had happened to me and why my face looked like the way it was. Some would understand and become friends but some would never try," she adds.

Okanlawon was referred for the necessary surgery as a teenager, after a doctor noticed her by chance on the street. Understanding quickly that her disfigurement was caused by noma, the physician met with her father and recommended that she seeks specialist care at the Sokoto Hospital in northern Nigeria.

Sokoto Hospital adopts a people-centred holistic approach to noma cases. In addition to surgery, services include nutrition counselling, engagement with patients' families and support for survivors to help them reintegrate into society. Physiotherapy is integral to full recovery of noma survivors. "Noma is a disease that could be debilitating but noma survivors can always come out of it, grow back into the community and live their life like other people," confirms says Victor Oluwalomola, a physiotherapist at Sokoto Hospital

After seven surgeries, Okanlawon finally started feeling like she could integrate into society again. Since then, she has been offered a job at the hospital where she was treated and has been



working closely with noma patients, dedicating herself to supporting them because of her experience. In 2014, with the encouragement of Dr Semiyu Adetunji Adeniyi, one of Okanlawon's surgeons at Sokoto Hospital, and his wife, she went back to school and studied health information management while continuing to work at the hospital.

"These studies really helped her," explains Adeniyi. "She couldn't really mix with others before but after the surgery she was able to go to school and participate. At the end, she was successful. That really helped her to also feel that there is a better opportunity for her than just waiting for people to give her their sympathy," he adds.

Okanlawon now hopes to start a noma foundation. "I'm in touch with Mr Fidel Strub, the president of the Noma-Aid Foundation in Switzerland, who is also a survivor, and I would like to coordinate with him on starting up an 'International Noma Patient Foundation' to continue fighting this disease," she says. Her dream is to set up this foundation to reach other noma patients, advocates, and affected families and communities and to support prevention of the condition and treatment in its early stages, eventually eliminating it globally.

**Box 11. The Regional Noma Control Programme in the WHO African Region**

The WHO Regional Office for Africa established the Regional Noma Control Programme in 2001. As part of the programme, the Regional Office for Africa has supported 10 noma priority countries\* to develop and implement national noma-control activities, financially supported since 2013 by the German NGO Hilfsaktion Noma e.V. These national programmes focus on strengthening and developing the capacities of health workers, social actors and

communities to prevent, detect early and manage cases of noma. Improved awareness of the disease among populations helps to remove stigma and enhances the reintegration of noma survivors and their families into society. Integration of noma into existing health surveillance systems improves data availability and accessibility and strengthens leadership of ministries of health through improved inter- and multisectoral collaboration.

\*Benin, Burkina Faso, Cote d'Ivoire, Democratic Republic of Congo, Guinea Bissau, Mali, Niger, Nigeria, Senegal and Togo





### 2.5.3 Traumatic dental injury

Traumatic dental injury is a widespread yet often overlooked condition, defined as an impact injury to the teeth and/or other hard and soft tissues inside or around the mouth and oral cavity. In the absence of surveillance data, it has been estimated that around 1 billion people are affected, with a prevalence for children aged up to 12 years of around 20%. Front teeth are most likely to be affected, resulting in significant impacts on function and aesthetics. The severity ranges from simple cracks or chipping of the enamel to complex fractures of the crown or even adjacent jawbone, exposing the pulp and requiring complex and expensive rehabilitation (128, 129).

Traumatic dental injury is often part of wider orofacial trauma and a frequent consequence of interpersonal violence, road traffic injuries and unsafe domestic, workplace or recreational environments leading to accidents. It can also be a first sign of domestic violence and child abuse (see Box 1). In March 2022, a revision of the International Classification of Diseases (ICD) was published, that now includes more detailed codes on dental trauma, allowing for better data collection and surveillance (130).

Prevention of traumatic dental injury is an example of action on the wider determinants of oral health. Health and safety regulations, safety measures in schools, playgrounds and sports facilities, and improvements in road traffic safety are among the possible interventions to reduce the incidence of traumatic dental injuries.

# 3

## Challenges and opportunities towards oral health for all



Oral diseases are largely preventable or require only simple interventions if diagnosed and addressed at early stages. Many countries have established effective policies and successful programmes to reduce the prevalence and severity of oral diseases. Yet from a global perspective, much more needs to be done, positive action needs to be accelerated, and innovative solutions need to be evaluated and implemented at scale so that the vision of UHC for oral health becomes a realistic goal. This includes a renewed focus on integrating oral health care with primary health care (PHC), including prevention and oral health promotion in settings outside specialist oral health facilities.

Some of the challenges – but also opportunities – in preventing and controlling oral diseases are related to the design and organization of (oral) health care systems, including oral health workforce models, individuals' capability for effective self-care and access to and affordability of fluorides for oral health as well as data, surveillance and research issues that limit availability of basic information on oral health and disease (12, 131, 132). In addition, persisting challenges of public health relevance require urgent and effective reactions.

### 3.1 Health service and models of oral health care

Oral health care interventions, technologies and outcomes have seen significant advances and improvements. Clinical oral health care procedures now effectively alleviate pain, discomfort and infection caused by oral diseases, and they help to restore patients' oral function and aesthetics, thereby improving their psychosocial well-being and health. However, there are major limitations and challenges related to coverage, accessibility, availability, appropriateness and affordability of oral health care across the globe, despite the commitment to patient-centred care by oral health professionals. The problems are often due to system-level failures in the model and provision of oral health services.

For many populations and communities, there is a mismatch between their oral health needs and the availability, location, appropriateness and affordability of oral health services. In most countries, private practitioners predominantly provide oral health care services; only a few countries have strong public oral health care services. Oral health services are largely demand led, often poorly planned by public institutions and influenced by entrepreneurial choices inherent to private practice. This leads to oral health services that are not always adequately aligned with the oral health needs of populations and lack integration within available general PHC models. Affluent urban areas of many high- and middle-income countries often see an oversupply of dentists, while in low-income countries and rural or remote areas facilities and resources for oral health care are much weaker so that people must often travel great distances to reach an appropriate oral health care service.

Apart from challenges in access and availability, the affordability of oral health services is a major issue for low-income and disadvantaged populations. The generally high out-of-pocket expenditures for oral health services can have a catastrophic economic impact on the individuals and families affected (69). More generally, the unabatedly high burden of oral diseases across populations as well as the unfair and avoidable inequalities in oral health status across the globe result from the current model of oral health care, including insufficient access to prevention and protection from health risks (12).

Moreover, for a variety of historical, professional and political reasons, a treatment-focused, surgical and interventionist approach dominates the practice of dentistry. This treatment model largely relies on the use of expensive high-tech equipment and materials. Such an approach is not suitable for all countries or population groups, and in many resource-poor settings, it is entirely unrealistic because of workforce limitations, costly or unavailable functioning infrastructure, and lack of supplies or limited capacity for servicing arrangements. Yet, oral diseases are largely preventable or require only minimally restorative interventions if diagnosed and treated at early stages. The primary focus of oral health professionals' activities should therefore be on delivering evidence-based preventive care and minimally invasive interventions, supporting patients in effective self-care practices and acting as advocates for policies to promote population oral health.

The isolation of dentistry from the mainstream health system is another key challenge brought to light by the COVID-19 pandemic. This separate approach to oral health care is an almost universal characteristic worldwide and is the result of historical and professional factors. Because independent private practitioners deliver a significant proportion of oral health care outside of the public health system, public health policy-makers and politicians often consider dentistry to be a marginal issue of low priority. Where oral health services are more integrated into the public health system, it is far easier to work across professional boundaries to deliver more holistic care as well as for patients to access and afford primary oral health care.

Financing systems ideally should support the delivery of high-quality, patient-centred oral health care and adequately reimburse oral health staff for their activities. Many countries rely on fee-for-service systems that carry a higher risk of incentivizing intervention and invasive treatment rather than promoting prevention (133, 134). Financial protection through expanded private and public insurance policies and programmes, including coverage of oral health services, is one of the cornerstones of UHC.

Very limited planning has been undertaken concerning the number, distribution and type of oral health personnel required to meet the oral health needs of populations (135). Many countries have relied on training more and more dentists rather than on developing a broader range of oral health professionals, such as dental assistants, hygienists and therapists. In some countries, this has resulted in systems that do not promote a wider team approach to oral health care, which then affects the provision of public primary oral health care. In contrast, some countries have long-standing and successful traditions of using a wider oral health team within the context of PHC. Promoting an integrated team approach to the delivery of oral health care is thus a priority for planning, professional regulations, education and training. Such an approach is likely to be more cost-effective and can deliver high-quality, appropriate care as part of PHC and UHC (136).

Despite the existence of the evidence-based medicine movement for the last 30 years, the adoption of this approach in dentistry is still lagging. Although a significant body of scientific evidence has been gathered on the effectiveness (or the lack thereof) of many routinely provided elements of oral health care, incorporating this evidence into education and training as well as the daily practice of millions of oral health professionals remains a challenge.

**Box 12. Results from the 2021 Global WHO surveys assessing country capacity for oral health**

Two periodic WHO-led global surveys are assessing health system capacities related to NCDs and UHC benefit packages, and both include information on oral health system capacities. The survey formats cover simple oral health information and will also inform the future Global Monitoring Framework for Oral Health.

The national capacity for NCD prevention and control is assessed through a global survey every 2 years that involves all Member States: the NCD Country Capacity Survey (CCS). The survey allows countries and WHO to monitor progress and achievements in expanding capacity to respond to the epidemic of NCDs, including oral diseases. Questions related to health system capacity to manage oral diseases include whether there is a dedicated person for oral health at the Ministry of Health, an oral health policy, a tax on SSBs and several others.

The latest available information from the 2021 NCD CCS survey provides data from all 194 WHO Member States. About two thirds of countries reported having a dedicated person in charge of oral health (134 of 194), but about 55% of countries did not have a specific policy related to oral health (106 of 194). Forty-five percent had a tax on SSBs in place (94 of 194). Almost all countries reported having screening for early detection

of oral diseases, urgent treatment and basic restorative procedures available, although information on the scope of coverage and type of financial protection for patients was not collected.

Another source of oral health system information is WHO's global survey on health technology assessment (HTA) and health benefit packages. The survey, first conducted in 2015, is undertaken every 5 years and aims to assess the status of health technology country health benefit packages for UHC, with detailed information about health benefit package characteristics and contents.

The oral-health-related results of the NCD CCS 2021 (all countries) and the results of the last Global HTA and health benefit packages survey 2020–2021 (115 countries) are included in the online country oral health profiles.

For more information on the WHO NCD CCS see <https://www.who.int/teams/ncds/surveillance/monitoring-capacity/ncdcss>

For more information on the WHO HTA and health benefit packages survey see <https://www.who.int/teams/health-systems-governance-and-financing/economic-analysis/health-technology-assessment-and-benefit-package-design/survey-homepage>

### 3.2 Global oral health workforce

The promotion of oral health and clinical management of oral diseases require an oral health workforce equipped with the appropriate skills, knowledge, attitudes and competencies as well as the ability to integrate these in their performance of tasks. Different oral health care professions with complementary roles ideally work together as a team to achieve universal coverage for oral health care, fully integrated and aligned with the principles of PHC and in collaboration with health and community care teams.

In reality, however, oral health care is often characterized by major limitations, stark inequalities and health system challenges: low workforce numbers in many regions and countries, predominance of private provision models and underresourced public services, inadequate task sharing and skills mix within a wider team, limited or no access for rural, remote or disadvantaged populations, and lack of financial protection and coverage for oral health care (135, 137, 138). Moreover, management and planning roles within health care systems require combined oral health and public health expertise, which are often insufficient.



### Box 13. Who is part of the oral health workforce?

A range of clinical personnel are involved in oral health care. Dentists are defined by the International Labour Organization (ILO) as those who “diagnose and treat diseases, injuries and malformations of the teeth, gums and related oral structures. They restore normal oral function using a broad range of treatments, such as surgery and other specialist techniques, and advise on oral health (139).” The scope of practice, competencies and training requirements of other personnel who deliver oral health care vary considerably across the globe. WHO’s National Health Workforce Accounts (NHWA)

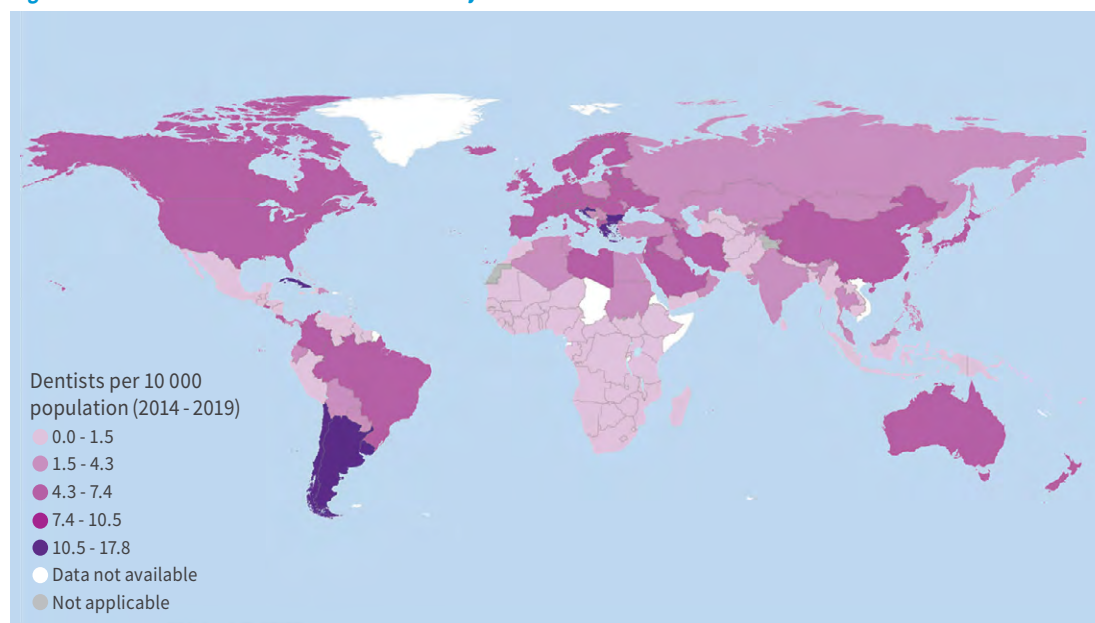
define clinical dental auxiliaries as “dental assistants and therapists,” which include dental therapists, dental hygienists, dental nurses and dental assistants. In addition, nonclinical technical personnel are involved with producing dentures, crowns, bridges, orthodontic appliances and other oral appliances. The WHO NHWA categorize these as “dental prosthetists/technicians.”

This report uses the latest available workforce data obtained from the WHO NHWA Data Platform for the period 2000–2019 (for head-count numbers) and 2014–2019 (for professional-to-population ratios) (140).

The total oral health workforce is estimated to amount to nearly 4 million globally (3 984 325), comprising about 2.5 million (2 465 296) dentists, 1.2 million (1 242 053) “dental assistants and therapists” and nearly 300 000 (276 976) “prosthetists/technicians”. The global average density for dentists is 3.28 dentists per 10 000 population, for “dental assistants and therapists” is 1.88 per 10 000 population and for “prosthetists/technicians” is 0.57 per 10 000 population (using the latest available data from 2014–2019). As some of the data are not recent, are unavailable for all countries and do not include dental aides/surgery assistants, the actual total figure for the global oral health workforce is likely to be an underestimation. On the other hand, some of the reported numbers may also include nonpracticing professionals.

Stark differences are evident in the distribution of the oral health workforce across the globe (see Fig. 36), with sub-Saharan Africa and parts of Southeast Asia reporting the lowest absolute numbers and professional-to-population ratios.



**Fig. 36. Workforce for oral health – dentist density**

Data source: The National Health Workforce Accounts (NHWA) data platform, WHO; 2020. Map Production: WHO NCD/MND unit. Map Creation Date: 30 August 2022. Note. Per 10 000 population, N= 184 countries, from the latest available data (2014–2019).

**Table 12. Global oral health workforce by WB country income group**

Income status	Dentists			Dental Assistants/Therapists			Dental Prosthetists/Technicians			Global oral health workforce per 10 000
	Number	Per 10 000	Countries reporting/total	Number	Per 10 000	Countries reporting/total	Number	Per 10 000	Countries reporting/total	
High income	820 046	6.85	60/60	550 250	11.61	31/60	171 993	3.48	30/60	11.35
Upper-middle income	1 168 468	4.04	52/54	124 141	1.60	27/54	21 387	0.36	26/54	4.77
Lower-middle income	441 466	1.57	46/49	36 570	0.16	31/49	14 931	0.06	27/49	1.47
Low income	35 244	0.57	25/29	1 932	0.08	12/29	894	0.04	12/29	0.58
Global	2 465 224	3.28	183/192	712 893	1.88	101/192	209 205	0.57	95/192	4.54

Note: Data are based on the NHWA data platform as of 26 August 2020, reporting the latest available data between 2014 and 2019 (exceptions: the Philippines data are from 2020; Cook Islands and Niue were excluded from the analysis due to missing categorization according to WB income groups); population data used to compute density values are from UN DESA 2019 (7).

High-income countries have a dentist–population ratio of 6.85 : 10 000 while low-income countries report a dentist–population ratio of only 0.57 : 10 000 – more than 12 times lower (see Table 12). Only 1.4% of the total number of dentists work in low-income countries while more than 80% of all dentists worldwide work in either high- or upper-middle-income countries. The picture is even more unequal for “dental assistants and therapists”; the “dental assistant and therapist”–population ratio is 11.61 : 10 000 in high-income countries and only 0.08 : 10 000 in low-income countries – 145 times lower. Only 0.3% of all “dental assistants and therapists” worldwide work in low-income countries; more than 77% work in high-income countries. Similarly, 82% of “prosthodontists/technicians” work in high-income countries (with a “prosthodontist/technician”–population ratio of 3.48 : 10 000) while low-income countries have only 0.4% of the global “prosthodontist/technician” workforce (with a “prosthodontist/technician”–population ratio of 0.04 : 10 000).

### Case Study 6. Delivering oral health care to rural communities (Burkina Faso)

Ensuring access to high quality oral health care in rural areas is a challenge for many countries. One approach to meeting this need is to reconsider traditional workforce boundaries that typically define professions involved in the delivery of oral health care.

Pascal Zoungrana worked as a community health nurse during the 1990s in a remote health care centre in Sérékéni, Burkina Faso, where he saw firsthand the burden of oral diseases and encountered many challenges in providing his local community with sufficient oral health care. “During the consultations, I saw many cases of dental caries and periodontal disease and noticed how little the community knew about oral hygiene,” Zoungrana says.

Although he was able to deliver partial care for some oral health problems, Zoungrana referred many of the patients to a medical centre in Orodara, just over 30 kilometres from the village, to be treated in an equipped dental clinic by trained oral health personnel. “Many patients would simply refuse to go and see the specialist, instead stay and self-medicate which would leave them with more complications,” he says. Zoungrana tried to address the oral health needs within his community by organizing regular visits from a dental nurse, with an appointment schedule for the patients.

Driven to better address the unmet demand for oral health care in his community, Zoungrana studied for two



years at the National School of Public Health in Orodara to become a specialist dental nurse. He was one of six nurses to participate in a programme training nurses to deliver oral health services in primary care settings, like the one available in his village.

“Primary health care workers trained in oral health play a key role on increasing the quality of life for the population suffering from dental infection and pain, including for the children who often miss school for the same reasons. They also help reducing unnecessary patient referrals to large university or regional hospitals,” says Zoungrana.

Since 2004, Zoungrana has been working within the Ministry of Health in Burkina Faso to support the implementation of national oral health strategies to fight against serious oral diseases like noma. He is keen to improve early detection and prevention of oral diseases as well as their timely management, by increasing the education and training of primary care practitioners who are able to meet the demands from vulnerable populations in rural and remote areas.

Inequalities in the availability of the oral health workforce are also obvious when comparing WHO regions. Only 1.4% of all dentists work in the African Region, with a dentist–population ratio of 0.33 : 10 000 – 17 times less than the Region of the Americas, which has the highest dentist–population ratio (5.67 : 10 000; see Table 13). Almost two thirds of all “dental assistants and therapists” work in the European Region and the Region of the Americas; only about 4% work in the African Region. The European Region has the highest ratio of “dental assistants and therapists” to population (12.10 : 10 000), more than 86 times higher than the South-East Asia Region with a ratio of just 0.14 : 10 000. The European Region is also home to almost half of all “prosthetists/technicians” with a “prosthetist/technician”–population ratio of 4.04 : 10 000, more than 100 times higher than the “prosthetist/technician”–population ratio in the South-East Asia Region, which has the lowest ratio of 0.04 : 10 000.

**Table 13. Global oral health workforce by WHO region**

WHO region	Dentists			Dental Assistants/ Therapists			Dental Prosthetists/ Technicians			Global oral health workforce per 10 000
	Number	Per 10 000	Countries reporting/ total	Number	Per 10 000	Countries reporting/ total	Number	Per 10 000	Countries reporting/ total	
Region of the Americas	572 328	5.67	34/35	144 155	4.32	16/35	9 158	0.70	9/35	5.33
European Region	524 454	5.64	53/53	296 986	12.10	22/53	100 049	4.04	24/53	10.72
Western Pacific Region	830 812	4.55	24/27	210 793	5.42	20/27	73 628	2.05	16/27	5.40
Eastern Mediterranean Region	174 491	2.50	20/21	6 450	0.21	5/21	7 393	0.34	6/21	4.27
South-East Asia Region	327 678	1.64	11/11	23 836	0.14	8/11	7 145	0.04	10/11	1.72
African Region	35 467	0.33	42/47	30 681	0.40	31/47	11 833	0.16	31/47	0.73
Global	2 465 230	3.28	184/194	712 901	1.88	102/194	209 206	0.57	96/194	4.69

*Note.* Data are based on the NHA data platform as of 26 August 2020, reporting the latest available data between 2014 and 2019 (exception: the Philippines data are from 2020); population data used to compute density values are from UN DESA 2019 (7).

### 3.3 Fluorides for oral health

Together with reducing sugars consumption, dental caries can be effectively reduced or prevented by ensuring optimal fluoride delivery for the population. Since the early beginnings more than 70 years ago, the different application forms of fluorides for oral health have been extensively studied: self-applied fluorides (in toothpaste and mouth rinses), professionally applied forms (varnish and gel) and



community-based programmes (in water, salt or milk). There is a body of scientific evidence on the safety, efficacy, cost-effectiveness and population-wide feasibility of different fluoride vehicles. Fluoride toothpaste and water fluoridation are among the population-level fluoridation interventions with the strongest evidence. Various WHO publications, resolutions and policies promote the use of fluorides in different settings and provide technical guidance. The effects of fluorides are largely topical, and negative side effects (fluorosis) only occur if fluoride is ingested in excess during the formation of teeth (141). The regular use of fluoride at recommended low levels is safe and effective, and it plays an important role in preventing caries and improving the oral health of vulnerable population groups (142).

### 3.3.1 Fluoride toothpaste

Brushing teeth with fluoride toothpaste twice-daily is a simple, effective way of topical fluoride delivery. WHO and other public health agencies recommend a fluoride concentration in toothpaste of between 1 000 ppm and 1 500 ppm (143, 144). Fluoride toothpaste is easy to use and widely available; however, the cost of toothpaste can be a barrier to its usage (145, 146). Young children are advised to use smaller amounts of toothpaste together with supervision while toothbrushing to prevent swallowing of toothpaste and ensure proper spitting after brushing.

When considering fluoride toothpaste as an essential health product, its quality, availability and affordability become a matter of public health interest (see Boxes 1 and 14). International Organization for Standardization (ISO) norms define minimum standards for content declaration and consumer labelling, though industry compliance is voluntary unless enforced by national authorities (147). The fluoride content of certain toothpastes may decrease over time as the product ages, or it may be too low to start with so that there is no protective effect (148–150).

#### **Box 14. Affordability of essential medicines: the case of fluoride toothpaste in 78 countries**

Affordability of fluoride toothpaste has been identified as a barrier for widespread use, particularly for people and families at the lower end of the income scale. A recent WHO-led study in collaboration with the University of York, Radboud University and New York University's WHO Collaborating Center assessed affordability in 78 countries using the WHO/Health Action International methodology developed to study affordability of medicines.

The results show that fluoride toothpaste is a highly affordable commodity in high-income countries,

relatively affordable in middle-income countries and highly unaffordable in low-income countries. A person living on the reference income of the lowest-paid unskilled government worker in a high-income country would have to work about 4.5 hours to purchase an annual supply of fluoride toothpaste. A person in the same income category living in a low-income country, however, needs to work an average of 3.6 days to buy the same amount of toothpaste. For most low-income countries surveyed, the required expense was beyond the threshold of catastrophic expenditure.



The WHO Director-General's report on oral health recommends “promoting legislation to increase the affordability and accessibility of high-quality fluoride toothpaste and advocating for its recognition as an essential health product (151).” Recent inclusion of fluoride toothpaste in the WHO model list of essential medicines for adults and children (EML/c; see Box 16) provides a unique and pertinent opportunity to address the affordability of fluoride toothpaste (where available, information on affordability of fluoride toothpaste is also provided in the country oral health profiles in Section A.1.).

The effects of fluoride toothpaste depend on compliance with the recommendation of twice-daily toothbrushing. Self-reported toothbrushing practice is generally high due to reporting bias, although the limited data available show huge variations among countries and populations. The WHO Global School-based Student Health Survey (GSHS), conducted in collaboration with the US Centers for Disease Control and Prevention, analysed data from 75 low- and middle-income countries. The survey revealed that 35–94% of 12-15-year-olds say they brush their teeth between one and three times a day, while 2% to almost 38% indicated not brushing their teeth at all (152).

### Case Study 7. Making good oral health part of the daily school routine (Philippines)

“The Philippines are amongst the countries with the highest prevalence of dental caries in children. Toothache, infections, dental impairment, impacted nutritional intake, and school absenteeism are some of the consequences. With the available resources to address oral diseases, a curative approach was neither realistic nor ethically appropriate,” states Dr Maria Corazon Dumlao, Chief of the Health Division of the Health and Nutrition Centre at the Philippine Department of Education, recalling the situation back in 2008. At that time, only regular preventive interventions in key institutionalized settings, such as schools, were identified as realistic to address the silent epidemic of dental caries in the Philippines.

The Regional Fit for School Programme, initiated by the Philippine Department of Education, the German Development Cooperation and the German Federal Ministry of Economic Cooperation and Development facilitated the integration of daily group toothbrushing with fluoride toothpaste as part of the Essential Health Care Programme, along with other school health and water, sanitation and hygiene interventions (153).



Supervised by teachers or older students, this approach of simple, effective interventions not only allows schools to manage toothbrushing efficiently for a large number of students, but also ensures that basic hygiene and exposure to fluoride are accessible on a daily basis for students, irrespective of their socioeconomic background. Toothpaste and toothbrushes are financed by the Department of Education, and agreements were made with a local manufacturer to simplify bulk procurement of affordable, high-quality fluoride toothpaste. Research showed that, depending on implementation quality, daily group toothbrushing with fluoride toothpaste prevented up to 38% of new caries lesions and reduced days of absence (154, 155).

“The integration of oral health into a broader approach to establish healthy learning environments is a great success. Water, sanitation and hygiene (WASH) in schools and other common, yet preventable child diseases are pressing problems in many countries, and effective collaboration between health, education and local governments can have a big impact,” adds Dr Noel Vallesteros, Chief Dental Officer at the Philippine Department of Health.

Fourteen years later, the Regional Fit for School Programme reaches an estimated 30 million children in the Philippines, Cambodia, Indonesia and Lao People’s Democratic Republic.

Measures to promote the production, marketing and sustained use of fluoride toothpaste need to be taken to counter observed trends of increasing market share of nonfluoridated toothpaste in some countries. Product quality and the sale of counterfeit products should be controlled regularly. In addition, issues related to plastic and microplastic pollution, waste management and other environmental aspects related to the production, use and disposal of oral hygiene products need to be addressed.

#### **Box 15. Self-care and maintaining oral health**

Self-care is defined as autonomous action to preserve or improve health. Self-care is a fundamental aspect of well-being that helps individuals gain greater control over their health. Oral diseases are largely preventable; therefore, adopting sustained self-care practices is a key aspect of maintaining good oral health. Empowering individuals and communities to make better oral health choices can significantly improve oral health over the life course (142).

The recommendation for twice-daily toothbrushing with a fluoride toothpaste is a key personal hygiene behaviour that is part of daily grooming habits. Such health-promoting habits should be encouraged in education and workplace settings as well as within families and other community settings (35). Schools, preschools and kindergartens have a particularly important role in developing positive behaviours, as highlighted in various WHO publications, including the new WHO/UNESCO global standards for health-promoting schools (124, 156, 157).

### **3.3.2 Water fluoridation**

Adjusting the level of fluoride in drinking water is a safe, cost-effective public health measure for the prevention of caries. This includes adding fluoride in areas where the natural fluoride levels of drinking water are too low as well as eliminating fluoride from drinking water in areas where natural fluoride concentrations are too high. As a population-based health strategy, water fluoridation does not discriminate by social class and provides universal health benefit to all groups within a community, thereby reducing inequalities. The estimated reduction rates for caries range between 25% and around 60% depending on the study, location and population (158, 159).

WHO and other public health agencies recommend that appropriate fluoride levels range between 0.5 mg/l and 1.0 mg/l of water, depending on average water consumption and climate as well as the population’s exposure to other sources of fluorides (that is, from certain foods) (141, 160). Using water fluoridation may be technically limited due to lack of access to piped water systems, thereby

often restricted to urban and peri-urban areas. Cultural and political acceptance of adjusting fluoride levels in drinking water may also be an important factor in public health decision-making. Depending on geographical location, the natural concentrations of fluoride in water can be elevated (such as in parts of China, India and the United States, and along the East African Rift Valley) (161, 162). Excessive fluoride concentrations elevate the risk of severe dental and skeletal fluorosis. In such areas, measures for defluoridation of water need to be taken (141, 159).

#### **Box 16. Fluoride-containing products on the WHO model list of essential medicines**

Recognizing the essential role of fluorides in caries prevention, the WHO EML/c has included sodium fluoride as a generic substance since 1979. In 2021, the WHO Expert Committee agreed to establish a category for dental medicines comprising more specific medicines and products, such as fluoride toothpaste, silver diamine fluoride (SDF) and glass-ionomer

cement (163, 164). Governments are encouraged to improve availability, affordability and quality of these fluoride products, particularly for vulnerable and disadvantaged groups, through appropriate regulations and legislation (such as tax reductions/exemptions, inclusion in government procurement among other measures) (165).

## 3.4 Oral health information and research challenges

### 3.4.1 Surveillance, monitoring and evaluation

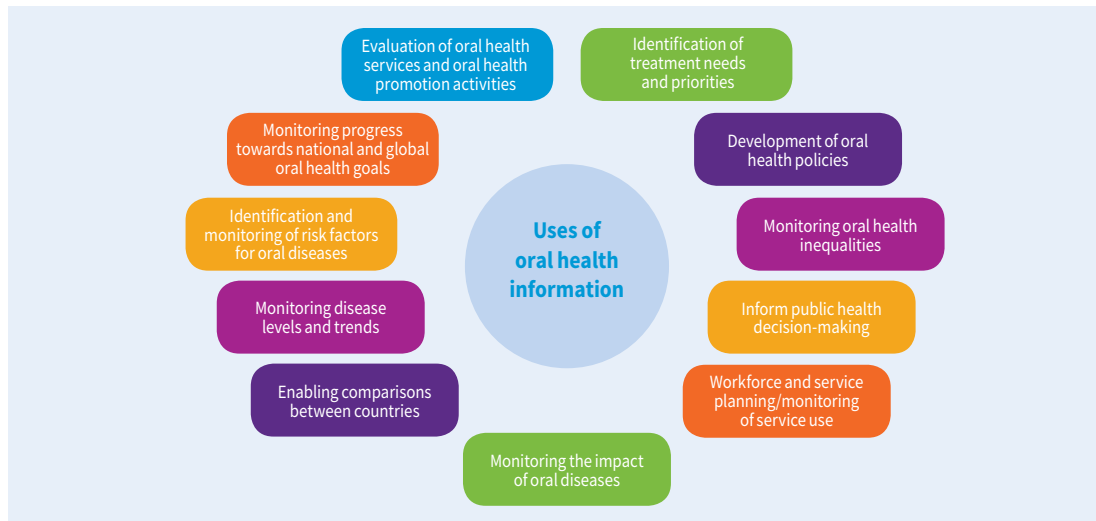
The 2021 World Health Assembly resolution on oral health (WHA74.5) urges Member States “to facilitate the development and implementation of effective surveillance and monitoring systems (2).” Surveillance is the systematic and ongoing collection, collation and analysis of data and the timely dissemination of this information to facilitate action.

Public health surveillance guides the development of oral health policy and strategies based on information about the incidence and severity of disease, health services costs, and preventability and feasibility of prevention and control. When this information is routinely collected, stored, reported and analysed, public oral health policies are much more likely to be tailored, effective and relevant to the population.

The GBD study has given visibility to the extent and global importance of oral diseases. The study has also highlighted the need for improved and systematic reporting of oral health data. High-quality data are needed to monitor disease levels and trends, the impact of oral diseases, treatment needs and priorities. Workforce and service planning as well as service evaluation rely on data availability. Data are a prerequisite for the development and evaluation of strategies to promote oral health to track progress towards national and global oral health goals as well as integration of oral health into UHC and to enable between-country comparisons. Oral health inequalities are a major concern globally. Addressing and monitoring them require data on the structural and commercial determinants of oral health that are relevant to the context of each country. Evidence-based oral health policies require an understanding of the risk factors for poor oral health and the determinants of oral health inequalities (see Fig. 37).



Fig. 37. Uses of oral health information



The neglect of oral diseases is reflected in significant data gaps: fewer than a third of all countries have oral health surveillance data on their populations. Oral health data are rarely included in existing health surveys, or only to a very limited extent. The costs of conducting dedicated, regular national oral health surveys are high and often prohibitive for countries. It is therefore important to include oral health in existing and emerging national health surveillance and monitoring systems, particularly as part of ongoing NCD surveillance.

Standardized and validated indicators facilitate the integration of oral health within existing survey tools. Many of the oral health indicators commonly used were developed by specialists for research purposes and are often difficult for policy-makers to interpret and translate into public health policy. Pertinent innovative indicators, which also allow tracking of process and implementation quality, would facilitate the integration of oral health issues into existing surveillance systems and health surveys, thereby strengthening decision-making.

WHO provides countries with several standardized survey tools for children and adults that offer opportunities for further integrating oral health into health information systems. The GSHS, which is primarily conducted among students aged 13–17 years in low- and middle-income countries, collects data on health behaviours and protective factors (166). The 2021 version of the GSHS includes three oral health questions in its core hygiene module. An expanded oral health module with a more detailed set of questions is available that countries may add to the core questionnaire. A new Child Health Measurement Survey (CHMS) for the surveillance of health behaviours in schoolchildren aged 5–10 years is currently under development. Also relevant to oral health is the Global School Health Policies and Practices Survey (G-SHPPS), which collects school-level data on national school health policies and practices (167). For adults aged 18–69 years, the Stepwise Approach to NCD Risk Factor Surveillance (STEPS) offers periodic data collection of key NCD risk factors designed for low- and middle-income countries (168). An optional oral health module is available and should be upgraded and included as part of the core questions to encourage more widespread implementation by countries.

Apart from gathering individual-level data, performance indicators for oral health services, such as availability, accessibility, quality of services and out-of-pocket expenditures, should be collected at regional and national levels. At the national level, the development and implementation of a national oral health strategy or action plan and progress towards integrating essential oral health care into a UHC benefit package should be monitored. The WHO-led NCD CCS includes some questions related to oral health system capacity, but more detailed data on health service delivery will be required to comprehensively monitor progress towards integrating oral health services into UHC globally. Existing systems of information gathering in the context of district health surveys, national health accounts, health facility-based surveys and other appropriate surveillance tools with indicators and metrics related to oral health and oral health services are needed to address the current data gaps.

### 3.4.2 Oral health research

High-quality oral health research is fundamentally important for filling crucial knowledge gaps, improving quality of oral health care and ultimately promoting better oral health for individuals and populations. Oral health research has made significant advances over recent decades in our understanding of the aetiology, disease processes, treatment and management of oral diseases. The global health research community has the potential to inform the further development of evidence-based clinical practice, support the reform of oral health care systems and drive the development of more effective oral health policies and strategies.

Oral health research activities and resources are, however, unequally distributed, with high-income countries dominating the global oral health research agenda. In contrast, the number of research centres, funding sources and active researchers in low- and middle-income countries is relatively low, resulting in a comparably small research output. There is a strong research focus on high-income countries, high-tech solutions, basic and materials science, and clinical care.

In many parts of the world oral health research as a low priority and public funding is limited. Nonprofit organizations, foundations and the private sector also provide research funding. Transparency on funding sources as well as systematic and comprehensive conflict-of-interest policies and guidelines are important to limit the influence of vested commercial interests and to safeguard independent, unbiased research in the best interest of public health (169, 170).

The increasing specialization of oral health research has led to isolation from the mainstream public health research community and has often resulted in a disconnect from population oral health needs. Future global oral health research agendas should be oriented more towards public health programmes and population-based interventions. Oral health research needs to focus more on addressing the global burden of oral diseases and better responding to the population's oral health needs (171–173). This should include research on learning health systems, implementation sciences, workforce models, digital technologies, health economics and the public health aspects of oral diseases and conditions. Other research priorities include developing mercury-free dental restorative materials, identifying and overcoming access barriers in oral health care, addressing oral health inequalities, promoting oral health in key settings like schools, promoting environmentally sustainable practices and identifying cost-effective interventions through economic analysis. Translation and implementation of research findings into practice are equally important and should include the development of regionally specific, evidence-informed guidelines for prevention and clinical care. Oral health researchers have an important

role in supporting the development and evaluation of population oral health policies and evaluating and applying the evidence generated by new public health interventions. This will be particularly critical in accelerating progress towards implementing the WHO Global Strategy on Oral Health.

### 3.5 Issues of public health relevance in oral health care

Delivery of oral health care services and the practice of dentistry face several challenges from developments that affect current and future approaches, yet all of them are also opportunities for reform and improvement.

One particular challenge is the phase down in the use of dental amalgam as a filling material in line with the Minamata Convention on Mercury. This will require a major change in the routine delivery of care. Eliminating the use of mercury-containing products improves environmental sustainability together with other measures to safeguard natural planetary resources.

The COVID-19 pandemic has challenged oral health care services and led to a major disruption of services in most countries. Aspects of pandemic preparedness and resilience of oral health care services need to be addressed so that continuation of essential oral health care is ensured without increased risks of infection for patients and providers. Moreover, growing public health threats from antimicrobial and antibiotic resistance, combined with challenges in infection prevention and control (IPC), require continued and heightened attention in oral health care.

Lastly, mobile and remote technologies using smartphones and other digital approaches are expanding the scope of and approaches to health promotion and aspects of oral health care while challenging patient-provider relations and data protection.

#### 3.5.1 The Minamata Convention on Mercury

Mercury pollution is a significant global issue affecting human and environmental health. Consequently, the WHO recognizes mercury as one of 10 chemicals of public health concern, and no safe level of mercury has been established. Mercury is highly toxic to human health and is associated with a wide range of serious health conditions. In response to the growing problem of mercury environmental pollution, the Minamata Convention on Mercury, negotiated in 2013, came into force on 16 August 2017 and has since been adopted by 137 countries (as of July 2022). The global treaty aims to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. Mercury pollution is harmful to the environment, and mercury poisoning can cause long-term and sometimes permanent neurological damage in humans. The convention seeks to control, restrict and eliminate the use of mercury across a broad range of industries and products.

Dental amalgam is a common filling material for treating dental caries and has existed for more than 175 years. Dental amalgam has several favourable characteristics that supported its widespread use in the past, such as ease of placement, material strength, longevity and cost-effectiveness (174). Dental amalgam consists of approximately 50% mercury and is formed by the amalgamation of liquid (elemental) mercury and a mixture of metal alloys.

Mercury pollution may occur during the amalgam life cycle from production, supply, cavity placement, removal of fillings and disposal. It has been reported that dentistry uses between 270 and 340 metric tonnes of mercury annually, with approximately 100 tonnes entering the waste system. Cremation and burial processes are also associated with mercury release from dental amalgam (175).

Article 4 of the Minamata Convention addresses mercury-added products, including dental amalgam. Annex A, Part II of the Convention outlines the provision that, to phase down the use of dental amalgam, a Party to the Convention shall implement two or more of nine measures (see Box 17), considering the Party's domestic circumstances and relevant international guidance.

### Box 17. Minamata Convention on Mercury measures to phase down the use of dental amalgam

“Measures to be taken by a Party to phase down the use of dental amalgam shall take into account the Party's domestic circumstances and relevant international guidance and shall include two or more of the measures from the following list:

- (i) Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration;
- (ii) Setting national objectives aiming at minimizing its use;
- (iii) Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration;
- (iv) Promoting research and development of quality mercury-free materials for dental restoration;
- (v) Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices;
- (vi) Discouraging insurance policies and programmes that favour dental amalgam use over mercury-free dental restoration;

(vii) Encouraging insurance policies and programmes that favour the use of quality alternatives to dental amalgam for dental restoration;

(viii) Restricting the use of dental amalgam to its encapsulated form;

(ix) Promoting the use of best environmental practices in dental facilities to reduce releases of mercury and mercury compounds to water and land.

In addition, Parties shall:

(i) Exclude or not allow, by taking measures as appropriate, the use of mercury in bulk form by dental practitioners;

(ii) Exclude or not allow, by taking measures as appropriate, or recommend against the use of dental amalgam for the dental treatment of deciduous teeth, of patients under 15 years and of pregnant and breastfeeding women, except when considered necessary by the dental practitioner based on the needs of the patient.

Source. The Minamata Convention on Mercury text, Annex A, Part II. (176) and UNEP/MC/COP.4/CRP.16 (177)

Central to the phase down of dental amalgam are efforts to strengthen oral disease prevention and oral health promotion, representing an important shift from the traditional restorative dental model. A renewed global focus on disease prevention would be a fundamental step towards better oral health, thereby reducing the need for restorative oral health care and fillings (178). WHO provides information on mercury-free products and minimally-invasive interventions to prevent and treat dental caries (165). Stakeholders, in particular governmental agencies and professional associations, have an important role to establish national plans to accelerate and monitor progress in phasing down the use of dental amalgam by 2030 (179, 180).

### 3.5.2 Sustainability and oral health care

A confluence of global problems is putting the health of the planet in danger. The effects of industrialization, population growth and intensive agriculture are damaging the environment, biodiversity and natural resources; climate change, pollution, deforestation and depletion of natural resources are environmental issues that threaten the conditions under which we live, work and flourish. Sustainability considers the broader social, environmental and economic impact of products, processes and actions. The practice of dentistry relies heavily on energy, materials and wider resources associated with significant environmental burden. It is important for the oral health care sector to identify key areas of wider environmental impacts and move towards more sustainable practices (181–183).

A report commissioned by Public Health England on UK National Health Service dental services highlighted three key areas within dentistry contributing to carbon pollution: patient and staff travel (64.5%), procurement (19%) and energy use (15.3%). The oral health sector heavily relies on procuring a wide range of clinical and nonclinical products. Consequently, environmental pollution can occur at any stage of the product-procurement cycle. Energy is consumed through equipment use, water heating and building heating. Other areas of energy consumption include the use of air conditioning units, general electrical appliances and computers. In addition, the oral health sector uses a wide range of dental materials that are associated with environmental pollution, including dental amalgam, resin composite, gypsum and radiographic-processing solutions. Dental procedures also result in significant amounts of clinical and nonclinical waste, including single-use disposable materials and packaging materials.

Prevention of oral disease is a logical starting point to reduce the environmental burden of dentistry, reducing the need for invasive oral health care services and moving away from the traditional restorative cycle. Self-care, health promotion and addressing the broader determinants of health are important long-term aspects of this preventive paradigm. Successful prevention strategies can lead to reduced practice visits, favour minimal intervention techniques and minimize oral health care waste, helping to improve the environment.

Reducing waste is another key aspect of environmental health (184). Waste reduction can be achieved through more effective stock management, recycling or replacing disposable plastic materials with reusable alternatives. Oral health care waste must be correctly segregated to reduce unnecessary incineration and prevent toxic dental materials from entering landfill sites and the environment. Computer use, economical printing and online oral health care management systems can also reduce paper waste. Digital x-ray units provide an alternative solution to traditional radiographic film and manual processing machines, which use toxic materials like silver and lead. Interventions to reduce energy consumption can also be applied to the oral health care setting, thereby reducing associated carbon emissions (185). These measures include investments in green power, building insulation, solar panelling and alternative lighting. It is equally important to consider sustainability protocols associated with the manufacture and distribution of oral health care materials and goods to encourage sustainable practices within the wider oral health care industry (186).

Sustainability within the oral health care sector is a growing field that needs further research and development. Sustainable dentistry requires multilateral commitment from oral health professionals, manufacturers, governments and the public to promote a successful long-term environmental strategy

that also encompasses water, sanitation and hygiene in oral health care facilities. WHO has developed comprehensive guidance for climate-resilient and environmentally sustainable health care facilities, which are entirely applicable in oral health care contexts (187).

### 3.5.3 Pandemic preparedness and response

Oral health care services pose a particular infectious risk to providers and patients. Closeness between providers and patients, interventions in direct contact with saliva, blood and other body fluids, and procedures that generate aerosols are among the daily risks related to oral health care. Oral health care services have been particularly affected by the early waves of the COVID-19 pandemic. In many countries, services were severely disrupted or completely shut down as part of measures to address risks of infection and in situations of high community transmission. A global WHO pulse survey reported that oral health care services were among the most disrupted essential health services, with 60% of countries reporting partial and 17% reporting severe or complete disruption of oral health care services during the first phase of the pandemic in 2020 (188). Disruption rates were even higher in the WHO African Region where 90% of countries reported complete service closure (189). Dental education and well-being of oral health professionals have equally been negatively affected.

Guidance from WHO and other organizations highlighted the pivotal role of universal infection control, including appropriate personal protective equipment, surface disinfection and instrument sterilization, careful anamnestic triage, and spacing of appointments, together with many other measures (190–192).

Among the lessons from the COVID-19 pandemic is the realization that oral health care is part of essential health care and that oral health care workers are essential health care workers and should thus be entitled to comparable benefits. Almost 70% of countries have included urgent oral care as part of their national list of essential health services (188).



However, not all procedures of contemporary dentistry are essential, and procedures defined as “urgent” or “emergency” should be prioritized over elective interventions in situations of high community transmission (193). Improvements in preparedness for new pandemic challenges have been recommended, including but not limited to clearer governance of such public health emergencies; better coordination between governmental ministries, public health organizations and professional organizations; rapid dissemination, enforcement and regular updating of standard procedures and guidelines; and better provision of essential supplies and protective equipment. The pandemic has also accelerated the use of remote consultation and tele-dentistry concepts.

#### 3.5.4 Antimicrobial resistance and Infection Prevention and Control

Increasing rates of bacteria, viruses, fungi and parasites that have become resistant to drugs commonly used for treating such infections are a growing global public health concern. Antimicrobial resistance has been named one of the 10 most important global public health issues threatening humanity, recognizing the importance of effective medications to treat infections (194). For oral health care, antimicrobial resistance (AMR) is of relevance since antibiotics for bacterial infections are among the medicines most frequently prescribed by oral health professionals (195).

The main pathway for developing AMR is excessive, unnecessary or inappropriate use of antibiotics. In addition, their use in veterinary medicine and agriculture often results in environmental pollution and poses a risk to human health. Dental prescriptions of antibiotics are estimated to account for about 10% of all global antibiotic prescriptions, giving oral health professionals a significant role in mitigating AMR on a global scale. Despite comprehensive clinical guidelines and indications for antibiotic use in oral health care, several studies confirmed a lack of compliance and an overuse of antibiotics in dentistry (194, 196–198).

The WHO Global Action Plan on Antimicrobial Resistance as well as many oral health professional organizations and the FDI World Dental Federation provide guidance on addressing resistance, emphasizing the crucial role of knowledge and problem awareness; effective infection control, including sanitation, water and hygiene; and optimization of the use of antimicrobials and antibiotics. Governments are encouraged to strengthen their surveillance and research to support effective national antimicrobial resistance strategies, which ideally also include oral health care (195, 199, 200).

Infection prevention and control (IPC) in oral health care is a key pillar for providing a safe environment for patients and staff and is thereby linked to addressing antimicrobial resistance. Extensive guidance is available covering disinfection and sterilization of instruments and equipment, including surfaces; personal protective measures; hand hygiene; injection safety; and hygiene for the entire clinic setting (200, 201). The COVID-19 pandemic and other infectious disease outbreaks highlighted repeatedly the crucial importance of strict compliance and routine adherence to these measures. The management of and regulatory framework for IPC in oral health care as part of overall health care allow for effective control and enforcement of infection-control measures. IPC is a major activity in systematic efforts to strengthen health systems, along with ensuring basic water, sanitation and hygiene in health care facilities.

### 3.5.5 Digital technologies for oral health

Digital technologies provide new and innovative opportunities to improve oral health of communities using different information technologies, artificial intelligence, telemedicine and mobile health (mHealth). *mHealth* refers to the use of wireless and mobile technology to support health practices, providing numerous opportunities to deliver, access and share health information (202). It is estimated that 76% of the global population now has access to a mobile phone, although a digital divide is acknowledged among countries and population groups. With the move towards an increasingly digitized world, it is essential that the oral health sector consider the role digital technology can play in promoting oral health, reducing oral health inequalities and improving access to oral health care services while countering misinformation from unvetted online and other sources (203–206).

WHO and the International Telecommunication Union (ITU) joined forces and developed the Mobile Oral Health (mOralHealth) programme as part of the wider “Be Healthy Be Mobile” initiative. Designed as flexible components, the four modules of the mOralHealth programme on literacy, training, early detection and surveillance can be implemented individually or collectively, according to country-specific needs. Overall, the programme aims to contribute to achieving better oral health as part of the 2030 Sustainable Development Agenda, including UHC, as well as to tackle the burden of NCDs. The mOralHealth programme can be implemented as a standalone intervention to improve oral health, or it can be integrated into existing initiatives targeting other NCDs.

WHO published an implementation guide for mOralHealth, providing guidance for developing and implementing an mOralHealth programme to support respective target groups in preventing and controlling oral diseases, maintaining good oral health, and improving well-being and quality of life (207). It is intended to help policy- and decision-makers and implementers to establish a national or large-scale mOralHealth programme. The document describes how an mOralHealth programme can be used to complement existing initiatives and health system responses.

In the oral health sector, digital technology is primarily focused on clinical aspects of care, using technology like digital radiography, intraoral cameras or computer-aided design to diagnose, plan and treat oral diseases. Digital oral health should focus on promoting oral health and preventing oral illnesses and on reaching as many people as possible, especially the most fragile population groups. Deployment strategies should take into consideration accessibility and skills requirements to be usable by most of the population. In addition, digital technologies have the potential to improve early detection of oral pathologies, facilitate referral and access to oral healthcare professionals, optimize health care processes, prioritize treatments and support guidance for patients suffering from fatal pathologies such as noma and oral cancer.

The delivery of such approaches depends on a number of technological factors, including access to technological resources, reliable phone and internet networks, and the ability to navigate technology. Therefore, it is important that mOralHealth programmes do not widen oral health inequalities among vulnerable population groups but rather aim for inclusiveness of older adults, people with disabilities or other digitally challenged groups that may lack digital literacy skills or access to appropriate technology (208). Ethical considerations, privacy and data protection need to be addressed to ensure the safety of and trust in mOralHealth concepts. Digital tools offer an opportunity to improve healthy behaviour, lower risk factors common to noncommunicable diseases and contribute to reducing oral health inequalities.

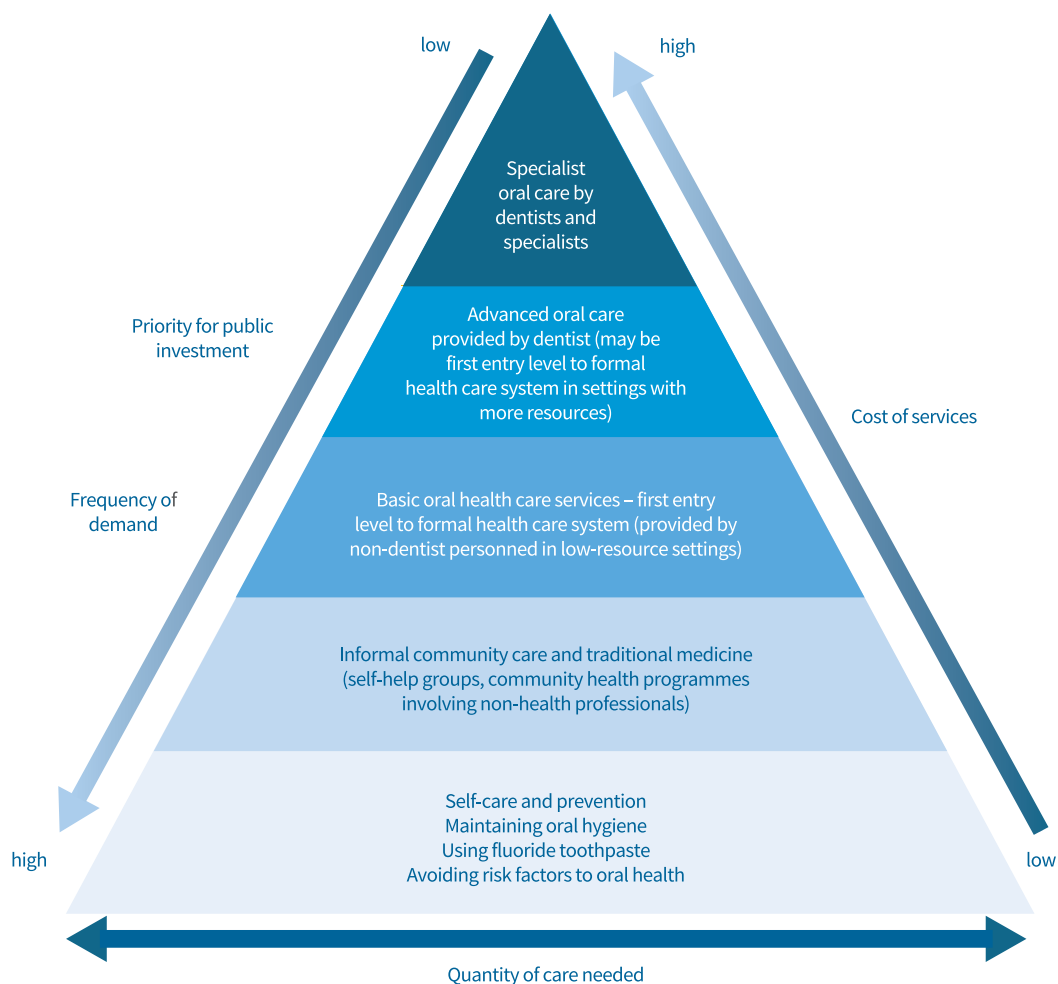


### 3.6 Reorientation on primary oral health care and UHC

Oral health care services include prevention of oral diseases, screening and diagnosis, service delivery and rehabilitation as well as continued monitoring and support for effective self-care (209, 210). The concept of primary oral health care remains the cornerstone of public services in most countries. Fig. 38 details five service and intervention levels of the primary oral health care pyramid: (1) fundamental prevention through self-care and management of risk factors; (2) community oral health programmes, such as water-fluoridation schemes; (3) essential oral health care as the entry level to the formal health care system (possibly provided by midlevel providers and trained nondental health care workers); (4) advanced oral care provided by a dentist; and (5) specialized oral health care for complex and advanced disease management (211). The principle of the pyramid is based on the notion that need and demand are highest at the lower levels and decrease at the higher levels. Cost of services shows an inverse relation: the most expensive care is provided at the top of the pyramid and the least expensive towards the bottom. Priority for public investment thus should focus on aspects that have higher needs and demand and lower costs.



**Fig. 38. Conceptual model of the primary oral health care pyramid**



Source. Adapted from The challenge of oral disease – a call for global action. Geneva: FDI World Dental Federation, 2015 (211).

The WHO conference on PHC in Astana, Kazakhstan, in 2018 concluded with renewed commitment towards PHC as the only realistic way to achieve the health-related targets of the 2030 SDGs and UHC (212, 213). Subsequent publications and resolutions of the World Health Assembly have expanded on this commitment and led to the development in 2020 of a new operational framework for *primary health care* by WHO and the United Nations Children’s Fund (UNICEF). In this framework, primary health care is defined as “a whole-of-society approach to health that aims to maximize the level and distribution of health and well-being through three components: (a) primary care and essential public health functions as the core of integrated health services; (b) multisectoral policy and action; and (c) empowered people and communities (214).” Aligning primary oral health care with this foundational concept will be an important stepping-stone towards integrating oral health into PHC.

### Case Study 8.

#### Oral health benefits and school oral health as part of UHC (Thailand)

Thailand has achieved UHC since 2002, thanks to three public health insurance schemes that together cover the entire population. Unlike in many other countries with UHC, the package of services available in Thailand includes an oral health benefits package, making oral health services accessible to the entire population (215, 216).

The components of the oral health benefits package differ across the three insurance schemes, each of them providing slightly different coverage. A wide range of oral health services, including prevention, curative care and rehabilitation services, are covered under the Universal Coverage Scheme for the general population, as well as for those insured under the Civil Servant Medical Benefit Scheme for civil servants and their dependents. Private-sector employees are covered by Social Health Insurance, which is limited to removable dentures and has an annual coverage ceiling for scaling, extraction, surgical removal of impacted teeth and restorations. Once the ceiling are exceeded, members have to pay the difference. All three programmes cover oral health promotion and prevention services, including pit and fissure sealants and fluoride applications.

Oral health promotion programmes for school-age children have been implemented for decades by the Ministry of Public Health, helping children to start good oral habits early (217). The programmes are now co-financed with oral health services being part of UHC and school environment improvements being supported by schools and local governments. Over the years, collaboration between the education and



health sectors has grown and has proven to be crucial in creating and maintaining school-based oral health programmes. Teachers, parents, communities and local health workers take combined responsibility to keep children's teeth healthy at home and school.

"The critical success factor of the school oral health programme is the participation of all sectors, including oral health self-care by students themselves, children's oral health care at home by parents, oral health education by schoolteachers, the healthy school lunch programme by the school chef, health care services by health and oral health personnel, a budget for health-promoting activities by local government, and a healthy environment surrounding the school (not selling candies and soft drinks) created by the whole community," says the director of a primary school in Angthong province. "Oral health personnel are not the key people at school oral health programmes," adds an oral health professional based in Nakhon Pathom province.

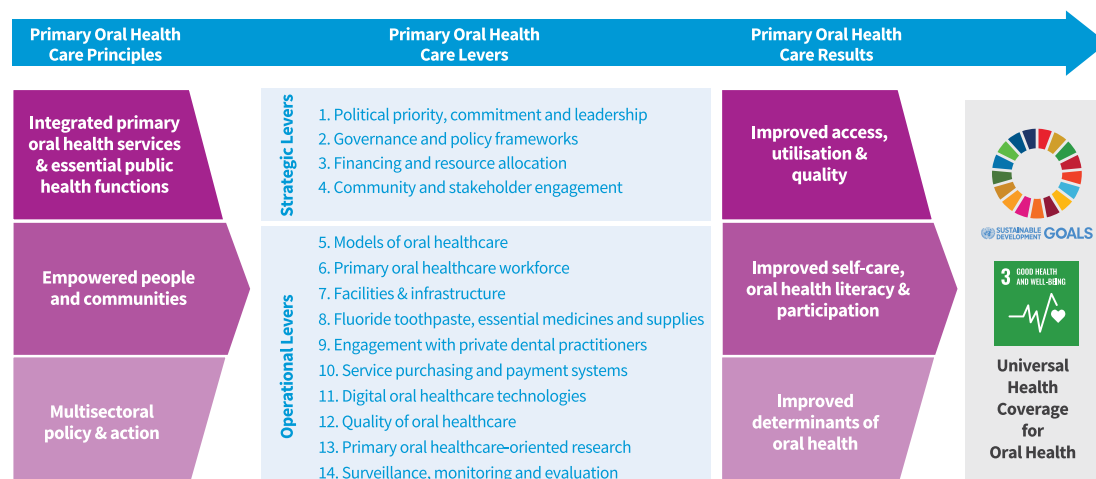
The education sector-led school-based oral health programme complements the UHC oral health benefits package driven by the health sector. Both together offer a multifaceted approach to ensuring oral health for all.

The operational framework presents a theory of change to guide countries on their journey towards PHC, building on the principles of PHC such as integration, focus on essential people-centred services, empowerment and multisectoral action. The framework introduces 14 levers that are helping to translate the global commitments into action. The measures for each lever are highly interrelated so that they support and enable one another. Ideally, they become an integral part of national health strategies and

are prioritized, adapted and sequenced so that overall progress along the three dimensions of UHC – coverage, quality, and financial protection – becomes realistic.

Fig. 39 outlines the elements of the new operational framework and applies them to a primary oral health care context.

**Fig. 39. The primary oral health care operational framework**



Source. Adapted from WHO, UNICEF (2020). Operational framework for primary health care: transforming vision into action. Geneva: World Health Organization (214).

The four core strategic levers are (1) political priority, commitment, and leadership; (2) governance and policy frameworks; (3) funding and resource allocation; and (4) engagement of communities and other stakeholders. These core strategic levers are fundamental to the 10 operational levers. The operational levers cover all relevant aspects required for appropriate integration of oral health care and PHC, including an innovative oral health workforce mix, care models oriented towards patient needs and appropriate technology responding to local resources, strengthening of essential infrastructure and using digital technologies, ensuring quality of care and outcomes, reorienting research, and surveillance, monitoring and evaluation as well as a focus on availability of essential medicines and supplies for oral health, including fluoride toothpaste.

In the context of advancing primary oral health care, the WHO Regional Office for Africa has developed a practical implementation manual for integrated promotion of oral health as part of addressing NCDs, highlighting the role of key settings in improving coverage of and access to essential primary oral health care and prevention (124).

The ultimate outcomes of such a reorientation towards primary oral health care and UHC will be improved access, utilization and service quality, better self-care, oral health literacy and participation in decision-making processes as well as progress towards improving key determinants of oral health.

# 4 A road map towards UHC for oral health



This report has highlighted that the status of global oral health is alarming in many ways. The estimated 45% of the world's population affected by one or several untreated oral diseases and conditions represents almost 3.5 billion people suffering from largely preventable pain, infection, impairment or other negative impacts. No other disease group affects humanity across the life cycle and across all countries in the way that oral diseases do. Over the last 30 years, 1 billion additional people were affected by oral diseases, more than the estimated population growth during the same period. Globally, there were an estimated 2.5 billion cases of dental caries of deciduous and permanent teeth, 1 billion cases of severe periodontal disease and 370 million cases of edentulism in 2019. More than 370 000 new cases of lip and oral cavity cancer are diagnosed and more than 170 000 people die from these cancers every year (according to 2020 data).

Challenges across all countries are related to persisting or even increasing inequalities, linked to exposure to risk factors like high sugar consumption and tobacco or alcohol use as well as to wider social, commercial and political determinants of oral health. Population coverage with essential preventive and clinical services shows large gaps, especially for vulnerable, disadvantaged, rural or poorer populations. Oral health systems emphasize dentist-centred workforce models and interventions requiring costly technologies over cost-effective preventive approaches (12).

Major opportunities offer avenues for reform and change to solve these challenges. These include continued momentum to address the global epidemic of NCDs and their shared risk factors as well as renewed attention to PHC and integrating essential oral health care as a strategy to achieve UHC. Other opportunities described in this report are related to the Minamata Convention to eliminate mercury, mOralHealth and digital oral health as well as strengthening of health systems in the context of the COVID-19 pandemic. The global agenda for the SDGs with its priority for UHC provides the key overarching direction.

The global burden of disease from untreated oral diseases and conditions, the continuing lack of coverage and affordability of essential oral health care for large segments of the world's population, and growing inequalities are all clear signs of the low public health priority given to oral health. A handful of countries recognized the need to address this situation and, under the leadership of Sri Lanka, decided in December 2019 to advocate for a World Health Assembly resolution on oral health. In May 2021, a historic resolution on oral health was adopted by the 74<sup>th</sup> World Health Assembly (2). The resolution calls for a paradigm shift in oral health policy planning from a conventional model of restorative dentistry towards a promotive and preventive model including innovative workforce solutions integrated into health systems at all levels, with the ultimate objective of reducing the environmental impact of health services worldwide and actively contributing to the achievement of UHC. The resolution also confirms that oral health should be fully embedded in the NCD agenda and that essential oral health care interventions should be included in UHC benefit packages.



The resolution, adopted with great country support, called for a comprehensive set of steps, including the following:

- the development of a Global Strategy for Oral Health by 2022;
- the addition of a Global Action Plan on Oral Health by 2023, accompanied by a global monitoring framework with indicators and targets, aligned with the global NCD monitoring with periodic reporting until 2031;
- the definition of Best Buys for Oral Health as part of Appendix 3 of the WHO *Global action plan for the prevention and control of noncommunicable diseases*;
- practical guidance and technical support in the context of the implementation of the Minamata Convention to eliminate mercury and the phasedown of dental amalgam as a filling material;
- the continued updating of technical guidance to ensure safe and uninterrupted dental services, including under circumstances of health emergencies; and
- the inclusion of noma in the 2023 review process to consider additional diseases within the road map for neglected tropical diseases 2021–2030.

Targeting a range of system levers to align primary oral health care with general PHC will support integration of oral health within the broader global NCD and UHC agendas (218–220). Momentum towards UHC for oral health has continued with the development of the Global Strategy on Oral Health and its adoption during the 75<sup>th</sup> World Health Assembly in May 2022. The vision of the strategy is “Universal Health Coverage for oral health for all individuals and communities by 2030, enabling them to enjoy the highest attainable state of oral health and contributing to healthy and productive lives. UHC means that all individuals and communities have access to essential, quality health services that respond to their needs and that they can use without suffering financial hardship. These services include oral health promotion and prevention, treatment and rehabilitation interventions related to oral diseases and conditions across the life course. In addition, upstream interventions are needed to strengthen the prevention of oral diseases and reduce oral health inequalities. Achieving the highest attainable standard of oral health is a fundamental right of every human being.” This report on the global status of oral health complements these tools and policies by providing foundational information and, as far as possible, baseline data in the context of monitoring progress towards universal coverage for oral health.

Recognition of oral diseases as global public health problems will continue to generate momentum and action by all stakeholders, guided by the principles and the six strategic objectives outlined in the Global Strategy on Oral Health. These include progress in oral health governance, oral health promotion and disease prevention, the oral health workforce, oral health services and PHC, oral health information systems and oral health research agendas (12). Progress in all of these areas will be possible only with the concerted and synergistic efforts of all stakeholders, including governments, the UN system, intergovernmental bodies, nonstate actors, NGOs, professional associations, youth and student organizations, patients’ groups, academia, research institutions and the private sector (172). With ambitious targets to be achieved by 2030, aligned with the priority for UHC through primary health care and the focus on noncommunicable diseases in the SDGs, there is hope that substantial progress will be made globally to close the gaps in oral health.



# 5

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