

*Manual of*  
**Clinical  
Procedures  
in Dentistry**

*Edited by Nairn Wilson and Stephen Dunne*



**WILEY** Blackwell

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*Edited by*

*Nairn Wilson and Stephen Dunne*  
*King's College London Dental Institute (KCLDI)*

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## Preface

Dentistry is a complex healthcare science, oral health being of considerable importance to general health and wellbeing, let alone comfort and confidence in eating, tasting, swallowing, speaking, conveying a range of emotions through facial expressions, including smiling, and other forms of interpersonal interaction, notably kissing.

This manual provides guidance on procedures in primary dental care. In contrast to the countless, traditional books detailing the knowledge and science behind specific aspects of dentistry, this manual is a comprehensive, practical guide to the delivery of effective, state of the art oral healthcare – the ‘what, when and how’ of clinical practice.

It is acknowledged that desirable clinical outcomes in dentistry may typically be achieved in a number of different ways and, despite the efforts of generations of clinical academics and practitioners engaged in research, the evidence base to adopt one approach or technique over another remains limited in many situations. The approaches and techniques advocated in this manual reflect current thinking and teaching by the exceptionally large, highly qualified team of clinicians, past and present, who, by virtue of their expertise, are collectively responsible for King’s College London Dental Institute (KCLDI) – the largest dental clinical academic centre in Europe, enjoying substantial national and international standing as an outstanding centre of clinical excellence. Indeed, KCLDI is one of the top five dental clinical academic centres in the world, irrespective of whatever measures and criteria are employed for such ranking.

Given the above, this manual is considered to be unique and, as a consequence, an important, new addition to existing dental literature; its style, scope and purpose are unparalleled. Furthermore, as elements of primary dental care underpin advanced and specialist clinical practice, it is considered that this manual should find application in every sector of dentistry – a ubiquitous manual which is intended to have a place in all clinical environments.

All those who have contributed to the production of this manual are to be thanked and congratulated. It has been a huge KCLDI team effort, backed up by an equally huge effort by the team at Wiley. It is impossible to put a figure on the number of expert and specialist ‘man hours’ invested in the production of this publication, which from the outset put quality, immediate clinical relevance, ease of use and, above all else, excellence in clinical care first and foremost. Nothing would give the entire team behind this manual more pleasure and professional satisfaction than knowledge that their individual and collective effort helps enhance patient care and promote trans-national harmonisation of teaching and training in the art and science of the clinical practice of dentistry.

Is this manual intended to be read and studied cover to cover? No! It has been designed to enable members of the dental team at all levels to dip into the wealth of guidance brought together under one title, according to individual needs and interests. That said, much may be learnt from systematically working through the manual, and this has been catered for in the order of contents, starting with the changing nature of the practice of dentistry and an overview of patterns and trends in oral and dental diseases, and culminating with guidance on audit and procedures for the management of patient concerns and complaints in everyday practice. Apologies to anybody who feels that insufficient weight and density of detail has been assigned to their area of practice; every effort has been made to present equitable, balanced, conflict-free guidance across the ever-increasing spectrum of the clinical practice of dentistry.

More than enough from the Editors. Time for you to get into the meat of the manual. Hopefully, the more you read, the more you will value the manual, and share the view that every member of the dental team should have access to a copy.

*Nairn Wilson and Stephen Dunne*





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## 1

## The Changing Nature of the Practice of Dentistry

Nairn Wilson

This introductory chapter gives an overview of the changing nature of the practice of dentistry, highlighting current and anticipated future issues and challenges.

### Big Picture

Dentistry is a fast developing biomedical healthcare science which should be viewed as an integral element of mainstream healthcare – oral health having been recognised to be important to general health and wellbeing. Moving on from the long-established, experienced-based, mechanistic approach to treating different forms of oral and dental pain, discomfort and disease, dentistry is evolving into a patient-centred, evidence-based, preventatively orientated, minimum intervention system of care to establish and maintain oral health – a health-rather than a disease-management service. This, however, only holds true for dentistry in forward-looking, typically well-developed countries of the world. In other countries, where there are provisions for oral healthcare, dentistry may be found to be caught, to different degrees, in a twentieth century time warp, with treatment focusing on pain relief, often by means of traditional, interventive restorative procedures and the extraction of teeth, with or without prosthetic replacement. Elsewhere in our diverse, unequal world, billions of people have no, or at best very limited access to any form of dental care.

This chapter, in common with the rest of the manual, considers arrangements, procedures and techniques for patient-centred, evidence-based, preventatively orientated approaches to oral healthcare provision – best practice.

### Oral and Dental Disease

The social determinants of oral and dental disease are largely universal: exposure to an unhealthy diet, tobacco use, excessive consumption of alcohol, and poor oral

hygiene all contribute to poor oral health. In addition, many adults do not help themselves limit their exposure to oral and dental disease, by, for example, indulging in the frequent consumption of sugar, forgetting to brush their teeth, not bothering with interdental cleaning, and only seeking dental care when in pain or experiencing a problem.

In most developed countries overall levels of dental disease, in particular amongst children, have shown improvements in recent years, but behind such encouraging statistics there tend to be widening health inequalities, with levels of oral and dental disease increasing amongst the children of the poorest members of society. At the other end of the age spectrum, there is increasing longevity, with many more teeth being retained into old age; however, oral health among older people is generally poor, with levels of xerostomia and advanced periodontal disease being a particular cause for concern. In adolescents and young adults pathological tooth wear is now relatively common, and oral mucosal disease, notably the incidence of oral cancer, is increasing. So, while much has been achieved through the application of advances in the prevention of oral and dental disease, much remains to be done, and new forms of disease such as peri-implantitis, albeit limited to those who have been fortunate enough to access implant dentistry, are generally considered to be a 'ticking time bomb'. Overall, it may be concluded that there continues to be widespread exposure to the determinants of oral and dental disease, the most prevalent forms of which – caries and periodontal disease – are opportunistic and given the chance will affect patients of all ages. Furthermore, as discussed in detail in Chapter 2, it may be concluded that oral and dental diseases continue to be a major public health problem, in large part because of the failure of individuals to practise the most basic of preventative measures.

In helping to address oral and dental disease issues, dental teams should seek to find ways, in the community in which they operate, to help reduce oral health

inequalities and increase public awareness of the importance of oral health and how it may be achieved and maintained. Such a service to society, if undertaken by all dental teams, would make an enormous difference to oral health in general.

## The Dental Team

Modern oral healthcare is best provided by a dental team. The day of the single-handed general dental practitioner, attempting to meet most, if not all of the many different dental needs of a diverse population of patients of all ages, is widely considered to be a thing of the past. For maximum efficiency and effectiveness, the dental team, led by one or more dentists and supported by a network of specialists in different, distinct branches of dentistry, should comprise:

- Oral health therapists, which may comprise (dental) therapists with skills and expertise in oral hygiene, or therapists together with dental hygienists.
- Dental nurses, trained together with other members of the dental team, with roles and responsibilities, over and above chairside participation in the provision of treatment, ranging from the recording of simple intraoral radiographic images to the application of preventive measures (e.g. fluoride varnishes) and oral health education. Dental nurses in modern practice environments must have well-developed skills in running, or at least overseeing, state of the art decontamination and sterilisation procedures.
- Dental technologists, including clinical dental technologists, to work with the chairside team in the provision of indirect restorations, removable prostheses and other appliances. Increasingly, dental technologists are critical to developments in digital dentistry, including, for example, the production of restorations from digital images and CAD CAM (computer assisted design–computer assisted milling). It is anticipated that dental technologists of the future may have as many information technology (IT) skills as traditional manual skills.
- Practice managers with wide-ranging roles and responsibilities to ensure the safe, efficient running of the practice or dental health centre. Practice managers' skills and expertise may usefully include, by way of example, business development and marketing, practice accounting, consumables logistics and the management of human resources within the practice or centre.
- Dental receptionists as the patient's first and most common point of contact with the dental team. In this role, receptionists require excellent human relationship

and communication skills, together with skills in diary management, aimed at the best use of the time and skills of the various members of the dental team. Dental receptionists, in addition to requiring good telephone and face to face communication skills, are extending their roles to include multimedia communications with patients. Receptionists may also play crucial roles in patient satisfaction surveys and the initial response to concerns and complaints.

As leaders of dental teams, dentists, amongst the many other challenges they face, must develop the necessary leadership skills during their formative years in clinical practice. Leadership courses are anticipated to become an important element of postgraduate dental education.

## The Practice Environment

With the further demise of 'old-style', single-handed dental practices, in favour of multisurgery practices, if not dental health centres, the practice environment will continue to change. General dental practitioners of the future, more often than not with advanced skills and knowledge in some aspect of dentistry, may increasingly find themselves working in the same environment as specialists, as part of a 'full service' dental team. The facilities to support dental teams of different sizes and composition will grow in sophistication to take advantage of anticipated advances in dental technologies, some of which may be transformational, and possible changes in the scope of dentistry to facilitate the shared care of patients with other healthcare professionals. Innovations in IT, ergonomically enhanced ways of working, new devices and different forms of instrumentation, novel presentations of materials and growing patient expectations are some of the many factors which will individually and collectively shape and fashion the practice environment of the future. Above all else, the practice environment, apart from being welcoming and comfortable for patients and a good work environment for the dental team, must become an increasingly safe place for both patients and all those involved in their care.

## Regulation

It is hoped that the clinical practice of dentistry will come to be regulated by modern, 'right touch' regulation, based on the following qualities:

- *Proportionate*: Regulatory intervention only when necessary, with measured, cost-effective remedies appropriate to the risk posed.

- *Consistent*: Interrelated rules and standards implemented fairly.
- *Targeted*: Focused arrangements fit for purpose.
- *Transparent*: Open, simple, user-friendly regulation.
- *Accountable*: Subject to, and satisfying public scrutiny.
- *Agility*: Forward-looking and evolving to meet changing needs.

Good regulation should first and foremost protect the public, but with measures which support and encourage the profession to comply with the relevant code of conduct.

The main elements (pillars) of codes of conduct relevant to the practice of dentistry are anticipated to remain:

- Patient respect and autonomy.
- Do no harm (non-maleficence).
- Act in the best interest of the patient – ‘do good’ (beneficence).
- Honesty and truthfulness (veracity).

In essence, treat others the way you would wish to be treated.

Developments in regulation will sooner or later include revalidation (recertification) including requirements for lifelong learning (continuing professional development, CPD) and possibly some form of self-assessment and peer review or appraisal. Transformational innovations in dental technologies may bring about the need for top-up training, or new arrangements for dental specialties, possibly including the demise or merger of existing specialties and the introduction of new specialties. To remain fit for purpose, the regulation of dentistry must change with changes in, amongst other factors, clinical practice, the regulation of other healthcare professionals, the dental workforce, relevant technologies and the needs and expectations of patients and the public.

The day of self-regulation, once considered to be a defining characteristic of a profession, may have passed, in favour of ‘lay dominated’ regulation, but this should not disadvantage or cause concern to the vast majority of regulated dental healthcare professionals who practise ethically, satisfy expectations of ‘24/7’ professional behaviour, and always put the interests of their patients first and foremost.

## Scope of Practice

With the growing body of evidence that oral health is important to general health and wellbeing, the challenge of many more older, dentate patients with increasingly complex medical and dental histories, the ever increasing sophistication of existing techniques, innovations in, for example, regenerative techniques and salivary diagnosis,

trends towards the shared care of patients, and new evolving expectations of treatment, the scope of dentistry will need to be updated and modernised. With anticipated expansion in the scope of dentistry, it is considered unlikely that dentists can continue to graduate and remain competent in the many different, diverse procedures involved in the provision of comprehensive primary dental care. As a consequence, dentistry may have to look to adopting a medical model of skill mix, with a range of primary care procedures being delegated to team members. With such developments, dentists will, in all probability, become as much oral physicians as dental surgeons.

## Patient-Centred Care

Gone are the days of ‘just do as you think best’ or, worse, clinical paternalism: ‘I have decided that that you should have...’. To practise patient-centred care, the patient must be involved in treatment decision-making. To achieve this, the patient must understand the problem, the need for treatment, and the ‘pros’ and ‘cons’ of the various treatment options. This can be time consuming, in particular when a patient presented with complex treatment needs. However, such patient involvement is considered central to obtaining informed consent, prior to commencing any programme of care.

In providing patient-centred care there may be conflicts between practising clinical excellence and complying with the wishes of the patient. For example, clinical excellence may only be achieved in a case by providing surgery and reconstruction, but the patient, who is not experiencing any pain or discomfort and is unconcerned by their compromised dental appearance, simply wishes to be monitored and given advice as to how best to prevent further deterioration of their condition. In such situations, detailed clinical records, which should be a matter of routine, will be a safeguard against possible future criticism of less than ideal care, let alone supervised neglect.

## Preventatively Orientated Care

Prevention is always better than cure. In dentistry, prevention, unlike vaccination against an infectious disease, does not impart immunity; it merely reduces susceptibility and the risk of disease – primary and recurrent.

The guidance available on the prevention of dental disease tends to be supported by a substantial body of evidence, a notable exception being tooth wear. Indeed, preventive dentistry may be considered to be the most evidence-based aspect of clinical practice.



The application of best preventive practice in the provision of treatment is what constitutes preventatively oriented care. This is in sharp contrast to treatment which leaves a patient more susceptible to disease. For example, if an early occlusal lesion of caries were to be managed by means of fissure sealing, or a preventive resin restoration, this would be best practice, both in terms of preservation of tooth tissues and preventatively orientated care. In contrast, if the lesion were to be managed by means of aggressive restoratively orientated care, resulting in weakening of the remaining tooth tissues and a restoration susceptible to secondary caries, overall the benefits to the patient may quickly be outweighed by the negative consequences.

### Minimum Intervention

Very often, the easy option in dentistry is to extract a tooth, resort to a full coverage crown, or extirpate a troublesome pulp. Much more challenging, skilful and professionally rewarding, let alone beneficial for the patient, is to identify and successfully apply the least interventive, yet effective means to resolve presenting problems and establish and subsequently maintain oral health. Once lost or removed, tooth and associated soft tissues are lost for life, certainly until such times that major, anticipated advances in regenerative dentistry can be translated into clinical practice. Furthermore, the loss of tooth tissues leaves remaining tooth tissues substantially weakened and possibly more susceptible to disease. As a general rule, the less interventive the care, the more beneficial treatment is to the patient, both immediately and in the longer term, assuming the care is effective and the patient maintains good oral health. It is encouraging that increasing attention is being paid to the long-term consequences of interventive forms of treatment, recognising that the only 'permanent' restorations and prostheses are the ones patients die with, and that 'replacement dentistry' invariably results in the further loss of irreplaceable tissues. Minimum intervention dentistry is a key feature of care aimed at achieving 'teeth for life'. All that said, there are circumstances where interventive forms of treatment are indicated, if not necessary to achieve a satisfactory clinical outcome. Under such circumstances, all possible efforts should be made to limit the immediate and longer-term iatrogenic effects of the care.

### Patient Empowerment

Based on the premise that the maintenance of oral health is the responsibility of the patient, rather than the dental team, which is the 'occasional visitor' in the patient's mouth, patients need to be educated and charged with

undertaking all the measures necessary to prevent new disease. Identifying these measures and styling education to best meet the needs of the patient may best be achieved through risk assessment. Success in patient empowerment often involves behavioural interventions, aimed at behavioural change. As with most behavioural changes, such as smoking cessation and weight loss, the tipping point in oral health maintenance is patient acceptance: acceptance that they must look after the teeth they wish to retain, hopefully for life – only clean the teeth and gums you want to keep! 'Teeth for life' may also be viewed as partnership working between the patient and the dental team, with the patient assuming responsibility for the control of risk factors and day to day measures, and the dental team monitoring and, where necessary, prescribing and explaining changes to the agreed oral health regimen – in effect an oral health 'contract', which is amended from time to time by mutual agreement.

### Pain and Anxiety

Regrettably, fear of pain and anxiety remain barriers to many individuals seeking and reaping the benefits of dental care. Developments in the fields of pain control and anxiety management (anxiolysis) have been remarkable, with dentistry being at the forefront of certain elements of relevant research and innovation. Although certain dental procedures may not be pleasant, they should be pain free, with a minimum of discomfort. For anxious patients, various forms of anxiety management, up to and including conscious sedation, should be available to facilitate acceptance of care. In many cases, anxiety and fear of pain associated with dental procedures stem from a traumatic episode, often early in life, highlighting the value and benefits of effective prevention in early childhood. Reaching out to and engaging anxious patients can be one of the most demanding challenges in addressing unmet treatment needs in a community. Success in such endeavours not only transforms the dental prognosis for those who become regular dental attenders, but can give a sense of huge professional fulfilment.

### Funding

Where third party funding of oral healthcare exists, it tends to be under ever increasing budgetary pressure, with the available funding tending to be directed to care of the most vulnerable members of society, individuals with special needs and severe forms of disease, and to addressing ever expanding health inequalities – poor oral health and disease tending to increase in low-income families in many countries. Funding through insurance schemes and private contract should, as a consequence, be set to

increase with increasing interest in dental attractiveness and appreciation of the importance of oral health to general health and wellbeing, in particular amongst the 'worried well' with disposable income. For many practices the shift from the bulk of income coming from third party funding to insurance and private contract arrangements may be transformational – running a business rather than providing a service. Whatever the future arrangements for funding, there will be an expectation of value for money, with value being judged more by the health enjoyed rather than the number of procedures undertaken.

## Continuous Quality Improvement

As in most, if not all aspects of modern life there is an expectation that there is always opportunity to enhance quality, if for no other reason as a consequence of new advances in knowledge, understanding and technologies. Dentistry is no exception. Setting aside savings through the dental industry responding to demands for 'faster, quicker, easier and cheaper' materials and devices, efficiency gains and effectiveness may be achieved through audit, critical self-assessment by the dental team, and constructive feedback from patients. In addition, good management of patient complaints and concerns, including bottoming out causation, can help identify ways to do things better. For patients who tend to have several months, if not a year or more between encounters with the dental team, the cumulative effect of many small, quality enhancing changes can be immediately apparent, helping them 'bond' with the practice as a 'go ahead' enterprise.

## Ethics versus Cosmetics

Growing interest and the new value being placed in dental attractiveness plays a large part in dentistry moving away from the service to the business model.

## Further Reading

Department of Health (UK) and British Association for the Study of Community Dentistry (2014) Delivering better oral health: an evidence-based toolkit for prevention, 3rd edn. [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/367563/DBOHv32014OCTMainDocument\\_3.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/367563/DBOHv32014OCTMainDocument_3.pdf) (accessed 27th June, 2017).

In particular, growth in the demand for cosmetic procedures (as distinct to aesthetic treatments to address a need) is increasing the 'business element' of dentistry. In providing cosmetic enhancements to a patient's smile, the dental team must strike the correct balance between meeting the demands of the patient, maintaining professional standards and acting ethically, despite powerful financial incentives to just seize the opportunity. Professionalism – the set of values, behaviours and relationships that underpins the trust the public has in the dental team – must not be sacrificed by unethical approaches to the provision of cosmetic dentistry. There is no justification for any breach of the professional code of conduct in providing enhancements to dental attractiveness, albeit that certain cosmetic procedures which a dental team may provide may not be considered to constitute the practice of dentistry.

## The Unexpected

Futurology is far from being an exact science. In particular, expectations of what the future may hold cannot take account of the unexpected. In dentistry, the unexpected may take many different forms, for example, some new form of disease, a ground-breaking development in regenerative dentistry or dental biomaterials science, or new evidence which questions the value of some long established approach to patient care. Dealing with the unexpected in the provision of dental care can draw heavily on the knowledge and understanding of the dental team, and may involve the adoption of new procedures and mastering new competences. Any long established practitioner will confirm that clinical practice has undergone profound, unexpected change in their professional career. There is no reason to believe that things will be different for future generations of practitioners. This, it is suggested, adds to the appeal and challenge of a career in dentistry.

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## 2

## An Overview of Patterns and Trends in Oral and Dental Diseases

Jenny Gallagher

### Introduction

What do people from different parts of the world have in common (Figure 2.1)? They will almost all suffer from one or more oral diseases at some stage in their lives, diseases that are largely preventable. As a result they will require oral and dental care. Some will be fortunate and receive high-quality dental care in a timely manner; others will not, continuing to suffer either from the symptoms of disease or at the hands of non-qualified personnel in its treatment. As dental professionals, we should do everything possible to improve oral health and to ensure equitable access to oral healthcare for everyone in the world. Getting to grips with patterns and trends in oral health can assist us with this challenge and help us think through our roles and responsibilities. Even in high-income countries with well-developed dental services many adults suffer from urgent conditions and the impact of disease.

#### Oral Diseases

- 1) Sixty to ninety per cent of schoolchildren and nearly 100% of adults worldwide have dental caries
- 2) Severe periodontal disease, which may result in tooth loss, is found in 15–20% of middle-aged (35–44 years) adults
- 3) About 30% of people aged 65–74 have no natural teeth
- 4) Oral disease in children and adults is higher among poor and disadvantaged population groups

Data from WHO, 2012a.

### Why Is It Important to Examine Population Oral Health?

Why should clinicians who are largely concerned about the health of individuals be concerned with the health of populations? And the global population at that? Why not skip this chapter to discover more about the business of dentistry given that as dental professionals we are largely trained to identify and treat disease? Can I suggest a few reasons to explore these issues in more detail?

First, we are health professionals and therefore have a professional responsibility to be advocates for oral health and the patients whom we serve. Many think of dentistry as a business and, taking that approach, any business needs to understand the market, which for dentistry includes the population whom we serve, their health trends and the determinants of health. This will equip us better in our overarching goal to improve oral health – the ultimate business of dentistry.

Second, they can act as a mirror to our professional action. As dentists we become absorbed in minutiae; trained to consider details, we often fail to stand back and look at the big picture. Once in a while it is helpful to do so. One example which had a particular impact on me was the story of an epidemiologist who visited the same schools in England at regular intervals to undertake surveys of dental caries in 12-year-old schoolchildren during the period when oral health was improving. The team identified that caries prevalence (numbers of Decayed, Missing and Filled Teeth = DMFT) was not reducing in one school and they explored why this was the case. It came down to the fact that the local dentist was using an outmoded treatment approach and the profile of fillings in primary molars, the 'F' component, was



**Figure 2.1** Global connections. Source: <https://commons.wikimedia.org/wiki/File:GDJ-World-Flags-Globe.svg>. Public Domain.

excessive. Once one first permanent molar became — carious, there was the assumption that all would do so. After discussions with that dental practice, the pattern of treatment changed and, interestingly, so did the epidemiology statistics for that school. So this reminds us that monitoring trends in oral health has wide implications including informing the practice of appropriate dental care in support of oral health.

Third, global mobility means that clinicians are increasingly faced with new patient groups from different parts of the world. Furthermore, clinicians themselves may take the opportunity to work in different countries during their professional careers. Data on oral health are available from many countries across the globe and within countries. Even within the UK there is significant variation between different geographic areas. An understanding of population health information helps us to better understand the risk factors amongst different communities and their impact on oral health. For example Chinese populations have a higher prevalence of nasopharyngeal cancer (Yu and Yuan, 2002; Donaldson et al., 2012) and Bangladeshis have a higher rate of oral cancer (Efroymson et al., 2001; Donaldson et al., 2012), associated with viruses and cultural health behaviours respectively.

Fourth, and finally, consideration of trends in oral health and the determinants of health should therefore empower us to challenge environmental factors in culture, society and politics in support of health and inform our provision and planning of oral and dental care to

individuals. This is the best way to promote health and address inequalities. Given the importance of promoting health and preventing disease, this chapter therefore links closely with Chapter 7 on prevention of oral diseases.

This chapter will provide you with an overview of global oral health patterns and trends and consider the public health implications for us as health professionals wherever we practise. As an introduction to considering trends and patterns in oral health, it is important to start first with the demography or composition of the global population.

## The Global Population

It is staggering to consider how the world is changing in our lifetime. The global population has doubled in the past 50 years and will continue to expand exponentially. Between 2011 and 2050, the world population is expected to increase by 2.3 billion, from 7.0 to 9.3 billion (United Nations, 2011). Websites such as <http://www.worldlifeexpectancy.com/world-population-pyramid> show how the age-based population pyramid changes over time from a traditional pyramid with a large base towards a more rectilinear shape.

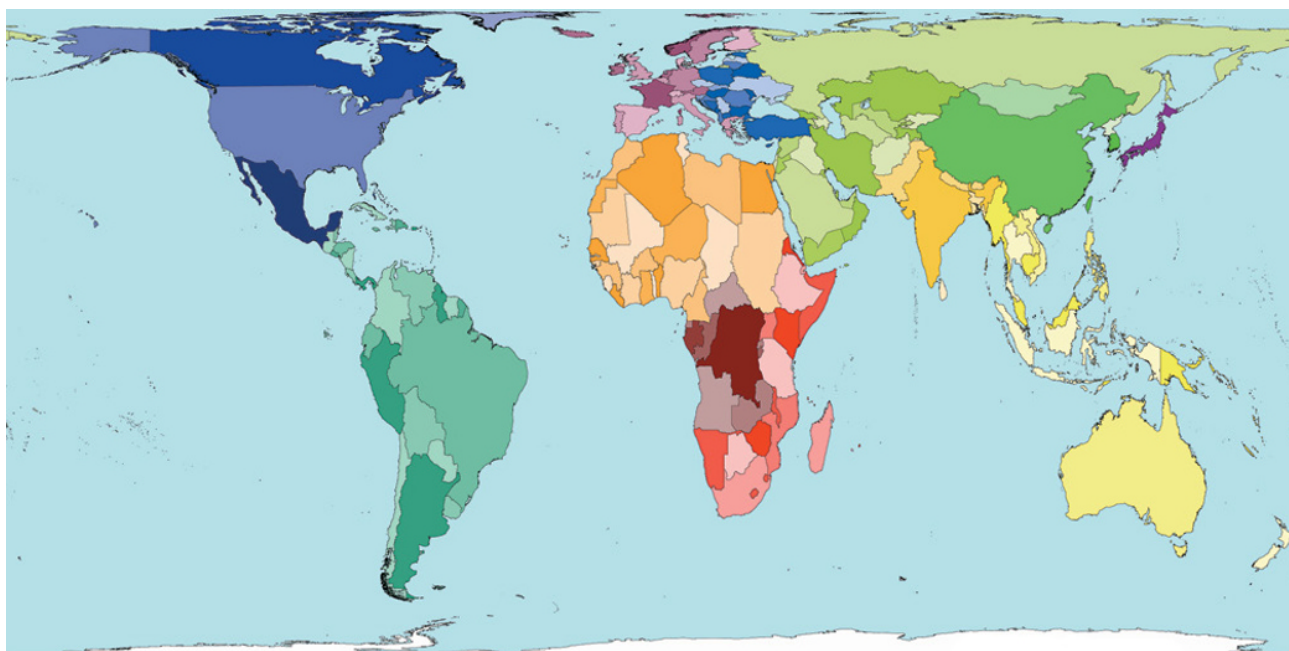
We each view the world map from our physical perspective — usually our country is centre stage— but also in relation to land mass (Figure 2.2); however, the global population is not evenly distributed, as demonstrated by Figure 2.3 which cleverly adapts the land mass to represent population size, providing us with a startling view of the world.

In more developed regions of the world, the majority of the population live in cities whilst in less developed regions the majority live in rural populations; however, this is predicted to change as outlined below.

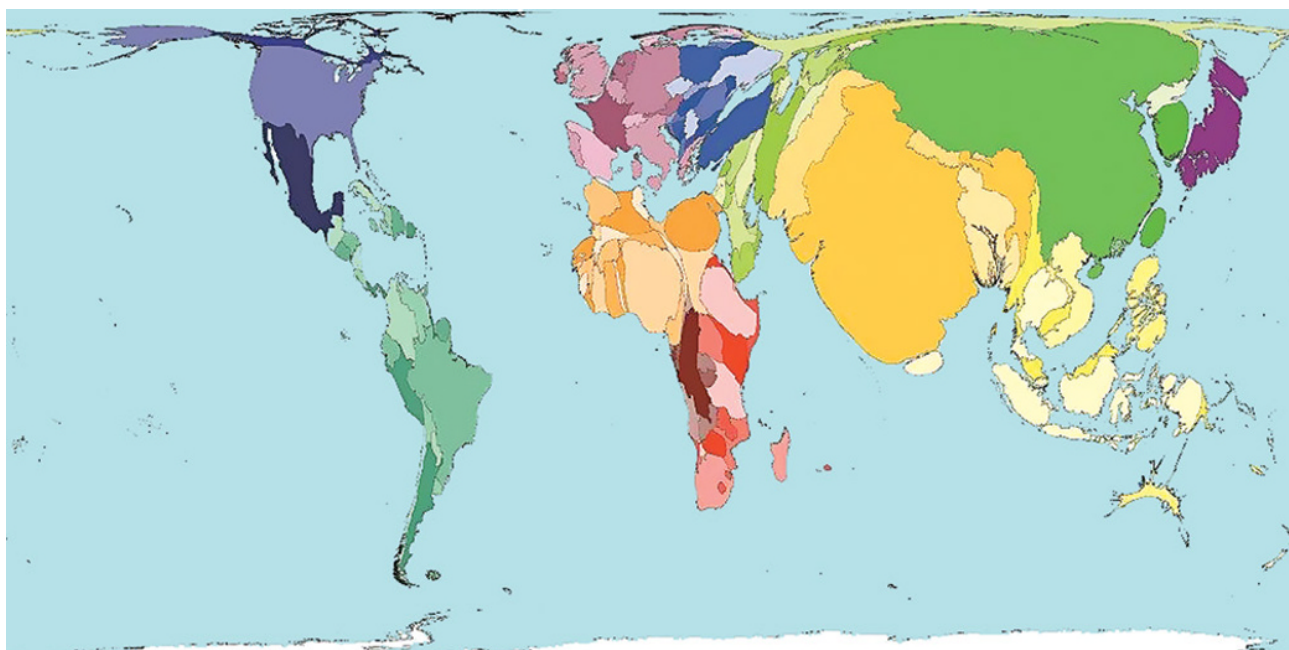
The population living in urban areas is projected to increase by 2.6 billion, rising from 3.6 billion in 2011 to 6.3 billion by 2050 (United Nations, 2011). The United Nations (UN) also suggest that the rural population is projected to decrease from 3.1 to 2.9 billion over the same time period. Therefore, the urban areas of the world are expected to absorb all the anticipated population growth over the next four decades while at the same time drawing in some of the rural population. There are currently 23 megacities (>10 million) and by 2025 this is expected to increase to 37. By 2025, the population living in megacities is expected to reach almost 8% of the overall world population; one in 13 people globally will then reside in a megacity (United Nations, 2011).

According to UN reports, most of the predicted growth will be absorbed by developing countries (United





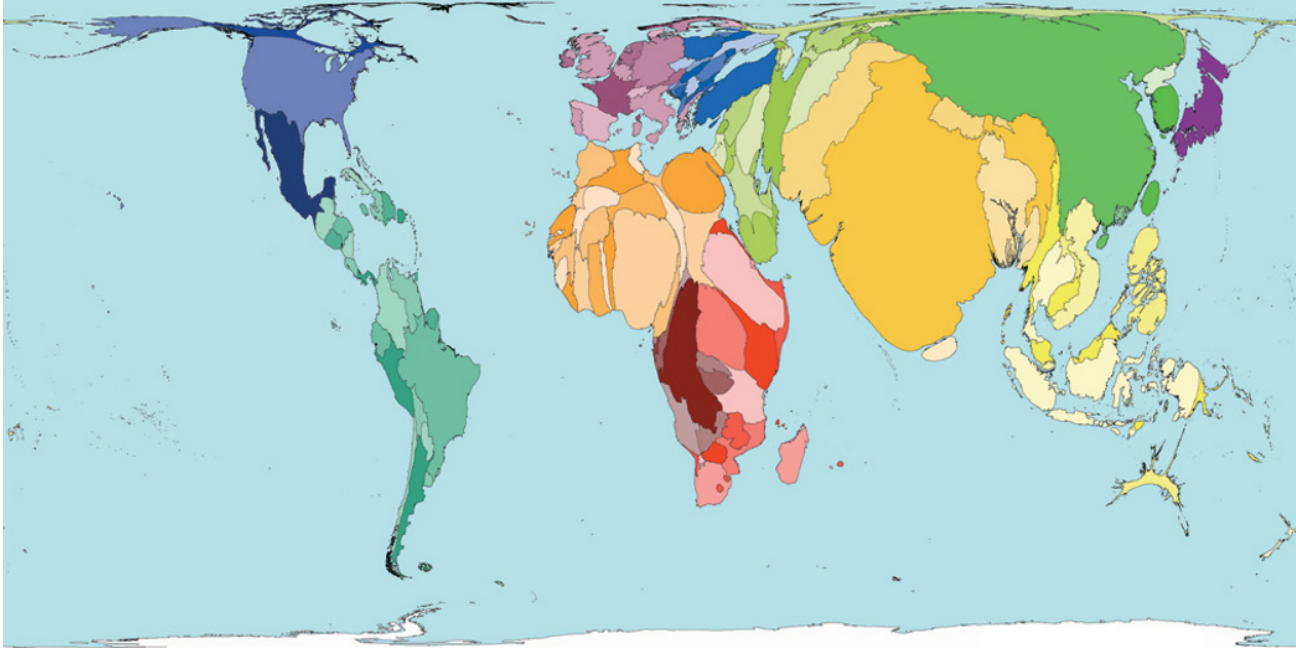
**Figure 2.2** Global perspective: land area. *Source:* <http://www.worldmapper.org/display.php?selected=1>. © Copyright Worldmapper.org / Sasi Group (University of Sheffield) and Mark Newman (University of Michigan).



**Figure 2.3** Global perspective: total population (population cartogram). *Source:* <http://www.worldmapper.org/display.php?selected=1>. © Copyright Worldmapper.org / Sasi Group (University of Sheffield) and Mark Newman (University of Michigan).

Nations, 2011). Whereas between 2011 and 2050 the population of the more developed regions will remain largely unchanged at 1.3 billion inhabitants, the population of the less developed regions is projected to rise from 5.7 billion in 2011 to 8 billion in 2050. At the same time, the population of the least developed countries is

projected to more than double from 851 million inhabitants in 2011 to over 1.7 billion in 2050. Consequently, by 2050, 90% of the world's population is expected to live in the less developed regions, including 18.6% in the least developed countries, whereas only 14% will live in the more developed regions (Figure 2.4).



**Figure 2.4** Global population prediction: 2050. Source: <http://www.worldmapper.org/display.php?selected=2>. © Copyright Sasi Group (University of Sheffield) and Mark Newman (University of Michigan).

To properly interpret the significance of health trends it is really important to consider the size and distribution of the population within our geographical sphere of work. Relatively low levels of disease in a large population may represent a much bigger challenge than high levels of disease in a small population, particularly because many larger countries tend to be less affluent at present and have less well developed health promotion and treatment services.

## Oral Health

A recent definition from the World Dental Federation (FDI) highlights that ‘oral health is multifaceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow, and convey a range of emotions through facial expressions with confidence and without pain, discomfort, and disease of the craniofacial complex’ (Glick et al., 2016).

Poor oral health can limit the ability to eat, speak and socialise. Oral diseases are largely preventable and yet remain common in most societies across the lifespan (WHO, 2012a). Within any community, there is great diversity of oral health by age, gender, geography and socio-economic status, as well as changes over time. Diseases and conditions that threaten oral health may be considered a ‘silent epidemic’ affecting our most vulnerable citizens in society (Benzian, Monse and Helderma, 2011).

## Oral Health Needs

This chapter focuses on oral health needs globally as well as some local examples, particularly from the UK. ‘Need’ is a concept that requires some ‘unpacking’. Bradshaw’s taxonomy provides a simple overview of the concept of ‘need’ (Bradshaw, 1972) and has remained an important concept in health and social care over recent decades (Cookson, Sainsbury and Glendinning, 2013). Bradshaw described different types of need as normative, expressed and perceived, as outlined in Table 2.1.

Oral health needs, as considered from the clinician’s perspective, or that of an epidemiologist, are termed ‘normative’ need. In public health circles, when we describe oral health and oral health trends we generally use epidemiological data that report the clinical epidemiologist’s perspective on need. Examples include the wealth of data collected in national decennial surveys (The Information Centre for Health and Social Care, 2011a), or by the public health service in England (Public Health England, 2014). In more recent years we have begun to place more emphasis on perceived oral health with the development of special questionnaire instruments to measure the impact on health and wellbeing for which there is a raft of measures such as the Oral Health Impact Profile (Slade and Spencer, 1994). Expressed oral health needs tend to be measured as the level of uptake of dental care, i.e. the use of dental services. None of these measures alone provides a perfect overview of oral health, but

**Table 2.1** Bradshaw's taxonomy of need.

Type of need	Definition	Example of how this need is measured
<b>Normative need</b>	Need that is defined by experts. Normative needs are not absolute and there may be different standards laid down by different experts.	Epidemiological surveys
<b>Felt need</b>	Need perceived by an individual. Felt needs may be limited by individual perceptions and knowledge of services.	Quality of life indicators
<b>Expressed need or Demanded need</b>	Felt needs turned into action. Help seeking.	Uptake of dental care (emergency and routine)
<b>Comparative need</b>	Individuals (or populations) with similar characteristics to those receiving help.	Comparison between areas and populations

Adapted from Bradshaw, 1972.

together they contribute a population profile that can assist in setting targets for improvement. Comparative need is the difference between two populations. In addition to the above, 'unmet need' is the difference between perceived and expressed need.

At an individual patient level, the same applies. Patients may perceive a need and complain of pain and express their need by attending for dental care, whilst others may suffer pain or discomfort without expressing their need (unmet need). When we as clinicians identify the presence of dental caries following clinical and/or radiological examination, this is evidence of 'normative need', which may or may not relate to perceived need.

As with individual patient care, it is important to understand the needs of the population, their help-seeking behaviour and how they are changing over time.

## Chapter Aims

Having set the scene by examining the importance of understanding our population and their health needs, the aims of this chapter are as follows: first, to outline very briefly how oral health is measured, and provide examples of oral health surveys; second, to describe key trends and patterns in oral diseases and conditions; third, to highlight inequalities in health and wellbeing; and fourth, to explore the implications of these oral health trends for policy makers and clinicians.

## Surveys of Oral Health – Epidemiology

Epidemiology can help to answer some important questions. What are the trends and patterns of oral health? What sections of society are most affected? What are the risk factors for the disease or condition? This includes

social, physical, behavioural and genetic factors. Epidemiology is the study of disease or condition (*logos*) upon (*epi*) a population (*demos*) and has been defined by Mausner, Kramer and Bahn (1985) as 'the orderly study of diseases and other conditions in human populations where the group rather than the individual is the unit of interest'.

Unlike many aspects of general health, oral disease and morbidity can be measured directly. However, this is an expensive process as it generally involves using dentists, and support staff who have been trained and calibrated, to undertake epidemiological surveys. Epidemiologists first need to be trained to measure dental disease according to set criteria so that when we consider trends over time or compare one survey finding with another we can be reasonably confident that we are comparing like with like. Epidemiological surveys of oral health generally involve dental examinations of a representative or random sample of the population. Most of our data come from cross-sectional surveys and thus reflect the prevalence of a disease or condition. Cross-sectional studies give us a snapshot in time, and trends over time may be inferred from regular cross-sectional studies in the population. Longitudinal studies are particularly important to look at changes over time but are much more difficult and expensive to conduct given population mobility. They can, however, provide rich data on the incidence rate of a disease, i.e. the number of new cases per population at risk in a given time period. A good example of a current longitudinal study which is providing the global dental community with important and interesting findings is the Dunedin study in New Zealand, where the birth cohort of 1972–73 has been followed up regularly over the decades (Dunedin Health and Multidisciplinary Research and Development Unit, 2014). Great effort is made to follow up as many people as possible, even those who have left the country. The findings are reviewed at key points in this chapter.



Some studies will combine an epidemiological survey or normative needs assessment with a questionnaire survey to explore perceived needs, thereby providing a better overview of the population's oral health. Where resources permit, this may be undertaken in conjunction with questionnaire surveys which examine perceived oral health and wellbeing, the impact of oral disease and health behaviours. The latter include diet, oral hygiene, tobacco, alcohol, fluoride use and dental attendance.

A wide range of oral diseases is measured by means of epidemiological surveys including those listed in Table 2.2. From the data collected, other dimensions of oral health may be reported such as edentulousness, having 'excellent' oral health or a 'functional dentition', as explored in later sections of this chapter. Other conditions such as cancers tend to be measured through health services data, both from registries (all cancer data have to be shared with the national cancer registry) and routine activity data where diagnoses are part of the data set.

As one would expect, the most commonly measured diseases are the most prevalent: dental caries and periodontal diseases. The World Health Organization (WHO) global oral health database is currently held by Malmo University, <http://www.mah.se/CAPP/>, and the periodontal database in Japan, on behalf of WHO/FDI, <http://www.dent.niigata-u.ac.jp/prevent/periodo/contents.html>. They provide a very useful, but sadly sometimes outdated, source of information, either because national surveys have not been undertaken, or not reported to the WHO. Additionally the FDI is launching a new oral health observatory app on which it is possible to look at available data by country: <https://www.fdiworlddental.org>

National statistics on oral health need to be treated with caution because they are not all collected at the same time and may not be fully representative of their country, depending on whether they come from a national survey involving a random sample of the population or a local survey of a particular area. They may

**Table 2.2** Data sources on the prevalence of oral diseases and conditions.

Epidemiological surveys	Health services registry and activity data
Dental caries	Cancers (oral, oropharyngeal, etc.)
Periodontal diseases	Cleft lip and/or palate
Tooth wear	Noma
Fluorosis	HIV/AIDS
Trauma to teeth	
Orthodontic need	
Other, e.g. soft tissue abnormalities	

include data on age ranges rather than one specific age. Whatever data are presented, we recognise that even within one country patterns of oral health will vary greatly, so even where data are representative of the national picture, they are average values and will not reflect the variation within society. Therefore clinicians may find themselves practising in areas where disease levels are higher or lower than the national average.

The incidence and prevalence of other serious conditions such as oral cancer are measured in high-income countries, such as the UK, by means of data from cancer registries, and supplemented by information from health services. Similarly, there is also registration of cleft lip and palate and HIV/AIDS which require formal reporting, thus providing robust information at local and national levels. In low-income countries the incidence may be estimated based on hospital activity and registries in the urban areas only. Hence, many of these diseases and conditions are likely to be under-reported and the incidence and prevalence likely to be much greater than the statistics suggest. For example, information on oral cancer in India only exists for patients who attend urban hospitals, whilst many attend only rural hospitals, or none. Global data must therefore be interpreted in light of data quality as outlined in subsequent sections.

## Challenges of Measuring Oral Diseases and Conditions

### Ethics

Epidemiology is generally undertaken for population rather than direct individual benefit. People are encouraged to take part for the good of society. Thus, it is important that the data from epidemiological surveys or questionnaire surveys are used to inform the planning of oral health services including health promotion. A further ethical consideration is that individuals taking part in epidemiological examinations should have the opportunity to have any serious oral health needs addressed appropriately; thus, all survey protocols should outline how someone with an acute or serious lesion will be facilitated to access care in a timely manner.

### Sampling

Population studies are rarely conducted as they are expensive and generally not necessary; instead a representative sample is selected. Sampling of populations is informed by science but requires practical consideration of which sections of the population may be measured and where. There is always consideration of keeping costs to a minimum whilst ensuring that the sample is large enough to be

representative but selected in a random manner. Hence, the majority of what is known about common oral diseases and conditions comes from cross-sectional studies involving a random sample of the population. It is always worth checking if nationally available data come from a national or a local sample randomly selected or merely a convenience sample; and also whether there have been power calculations to check if the sample size is sufficient. This will provide an indication of its representativeness. Birth cohort studies involve following up a specific section of the population, e.g. the birth cohort of 1972–73 in Dunedin, New Zealand (Dunedin Health and Multidisciplinary Research and Development Unit, 2014), or the Avon Longitudinal Study of Parents and Children (ALSPAC, 2014), both of which are population-based, prospective cohort studies, with an important oral health component.

### Indices

Table 2.3 shows the most common indices of oral health used in surveys, of which dmft/DMFT is the most frequently used. Dental caries has been measured by epidemiologists and clinicians counting the number of decayed [dt or DT], missing [mt or MT] and filled [ft or FT] teeth. This provides a composite score or number of affected teeth. This index was first described by Klein and colleagues in 1938 and adapted by the World Health Organization in 1986. It has been universally used in dentistry and advocated by the WHO in their 'Survey Methods' (WHO, 2013a).

Lower case 'dmft' denotes the primary dentition and upper case the permanent dentition; dmft/DMFT numerically expresses caries prevalence and is obtained by calculating the number of affected teeth at 'tooth' or 'surface' level. If the data relate to tooth surfaces, then they are reported as dmfs or DMFS and teeth dmft or DMFT. In countries where caries prevalence is high, the simple measure of dmft/DMFT is sufficient. The index does have a number of limitations in that caries is cumulative and therefore it is less helpful in adults than in children, particularly when teeth have been extracted.

Indices for measuring dental caries are undergoing further development: where caries levels are lower, there is increasing emphasis on developing more sophisticated dental indices to measure the depth and extent of dental caries, and to link the index to clinical care. Where disease levels are low and careful planning of both preventative and treatment services is required, it is important to begin to explore the use of more sophisticated clinical indices. An increasingly used index in clinical care is ICDAS, which may also be used as an epidemiological tool. ICDAS is the International Caries Detection and Assessment System (ICDAS Foundation, 2014), which is a 'system for detection and classification of caries

in dental education, clinical practice, dental research, and dental public health'.

Historically, the majority of surveys of oral health worldwide have been conducted in schoolchildren for the following reasons. First, because most children attend school, they are the easiest section of the population to identify and access. Second, given that oral disease is one of the most prevalent conditions in children, it is important to measure in childhood, before (5 or 6 years) and after (12 or 14/15 years) they develop their permanent dentition. Third, it is important to inform action such as oral health promotion and plan healthcare so that children are given the best start in life with healthy lifestyle and free from disease. This is particularly important because much oral disease is cumulative and patterns of oral health are established at an early age. However, as all countries have an ageing population it becomes increasingly important to understand and reflect on how best to address the various sub-groups, giving increasing importance to the oral health needs of the older population (Petersen and Yamamoto, 2005). Cohort studies in high-income countries are now suggesting that older people are a caries-active group, experiencing new disease at a rate which is at least as great as that of adolescents (Thomson, 2004).

### Training and Calibration

Much effort goes into planning an oral health survey. It is important to develop a clear written protocol for the study and ensure that all those administering a survey are trained in the criteria for diagnosing and recording diseases and conditions. Once staff have been trained then they need to be calibrated against a 'gold standard', to assess how accurately they use the survey criteria. Epidemiologists need to be reliable both internally and externally. Their findings should correlate with the 'gold standard', thus confirming that they are externally reliable. Internal consistency is demonstrated by re-examining a sub-sample of subjects (usually 10%), and comparing the scores to determine their level of consistency.

### Surveys of Health and Wellbeing

Increasingly, information on the perceived needs of populations' oral health and wellbeing is being collected. This involves using quality of life surveys, often as part of a general or oral health survey. One of the most popular indices is the Oral Health Impact Profile; the main measure has 49 items (Slade and Spencer, 1994), and the short-form OHIP-14 has 14 (Slade, 1997). It is one of the most common measures used in national surveys (Nuttall et al., 2006; The Information Centre for Health and Social Care, 2011b).

**Table 2.3** Epidemiological indices by disease and condition.

Diseases and conditions	Index name (abbreviation)	Reference		
		Authors	Year	
<b>Dental caries</b>	deft/defs: primary dentition (usually younger children) d – decayed e – tooth indicated for extraction f – filled t – teeth <i>or</i> s – surfaces of the teeth	Gruebbel	1944	
	dmft/dmfs: primary dentition d – decayed m– missing f – filled t – teeth <i>or</i> s – surfaces of the teeth	H. Klein, C.E. Palmer, and J.W. Knutson Modified by WHO	1938 1986	
	DMFT/DMFS: permanent dentition D – decayed M– missing F – filled T – teeth <i>or</i> S – surfaces of the teeth	H. Klein, C.E. Palmer, and J.W. Knutson Modified by WHO	1938 1986	
	Root caries index	R.V. Ratz	1979	
	Significant caries index	D. Bratthall	2000	
	Care index = FT/DMFT%	n/a	n/a	
	The International Caries Detection and Assessment System, or ICDAS, is a simple, logical, evidence-based system for detection and classification of caries in dental education, clinical practice, dental research, and dental public health <a href="https://www.icdas.org/">https://www.icdas.org/</a>	Ismail et al.	2007	
	<b>Periodontal diseases</b>	Periodontal index	A.L. Russell	1956
		Gingival index (GI)	J. Silness and H. Loe	1963
		Plaque index (PI)	H. Loe and J. Silness	1964
Community Periodontal Index of Treatment Needs (CPITN)		World Health Organization (WHO) and Fédération Dentaire Internationale (FDI)	1978	
<b>Orthodontic conditions</b>	IOTN – Index of Orthodontic Treatment Need	P.H. Brook and W.C. Shaw	1989	
	PAR Index – Peer Assessment Rating	S. Richmond et al.	1992	
	ICON – Index of Complexity, Outcome and Need	C. Daniels and S. Richmond	2000	
<b>Tooth wear</b>	Eccles index for dental erosion of non-industrial origin	J.D. Eccles	1979	
	TWI – tooth wear index	B.G. Smith and J.K Knight	1984	
	Lussi's index for erosion	A. Lussi	1996	

Table 2.3 (Continued)

Diseases and conditions	Index name (abbreviation)	Reference	
		Authors	Year
Fluorosis	O'Sullivan index	E.A. O'Sullivan	2000
	Simplified TWI (tooth wear index)	P.F. Bardsley, S. Taylor and A. Milosevic	2004
	Basic erosive wear examination (BEWE). <a href="http://elearningerosion.com/en/elearning_erosion/scientific-background/erosion-diagnosis/basic-erosive.html">http://elearningerosion.com/en/elearning_erosion/scientific-background/erosion-diagnosis/basic-erosive.html</a>	Bartlett et al.	2008
	Dean's index	H.T. Dean	1934
	TF Index – Thylstrup and Fejerskov's index for fluorosis	A. Thylstrup and O. Fejerskov	1978
	Horowitz et al. index of fluorosis	H.S.Horowitz, W.S. Driscoll, R.J. Meyers, S.B. Heifetz, and A. Kingman	1984
Dental trauma	Trauma index: developed during Child Dental Health Survey in the UK	M. O'Brien	1993

### How Are Data Used?

Epidemiological and quality of life data may be used in the planning of oral health services and preventive programmes. One of the most dramatic uses of epidemiology in the last century was the study of fluoride in water by Trendley Dean, who in his '21 cities study' identified the optimal level of fluoride in water to reduce dental caries whilst minimising the level of fluorosis and therefore bring great benefit to oral health; a good example of public health initiatives (Murray et al., 2003).

Evidence of poor oral health, obtained through population surveys, can stimulate action on tooth brushing and application of fluoride varnish in schools, together with action to improve the uptake of dental care, as with the Childsmile programme in Scotland (NHS Scotland, 2014). However, in many countries without state funded dental services there is not always such obvious use of information for planning dental care because of the way dentistry is organised and delivered – largely as a business. However, as outlined in the introduction, the use of epidemiology and health service data to demonstrate unmet need can be extremely helpful when considering where to invest existing time and resources and perhaps gain additional resources to address problems.

### How Does Epidemiology Differ from Screening?

Sometimes there is confusion between screening for oral disease and epidemiology – often because the two have historically been combined for schoolchildren. Screening has been defined as 'A public health service in which members of a defined population, who do not necessarily perceive they are at risk of, or are already affected by a disease or its complications, are asked a question or offered a test, to identify those individuals who are more likely to be helped than harmed by further tests or treatment to reduce the risk of a disease or its complications' (UK National Screening Committee, 2014). Essentially epidemiology is primarily conducted for the benefit of the population, and screening for the benefit of the individual. People testing positive at screening are sent for an examination and further investigations.

In dentistry, oral screening for dental caries or cancer generally involves a visual examination to determine if there is possible disease, which means it is easy to get epidemiology and screening confused.

### Global Oral Health

The World Health Organization (WHO), working closely with the World Dental Federation (Fédération Dentaire Internationale, or FDI), plays an important role

in monitoring oral health. This involves producing a manual, *Oral Health Surveys – Basic Methods*, which is now in its fifth edition (WHO, 2013a). This guidance, which includes advice on pathfinder surveys, is available online via WHO publications. The WHO manual has encouraged countries to conduct standardised oral health surveys that are comparable internationally. It facilitates development of procedures for management and analysis of data based on the use of information technology. The findings of national surveys are lodged in the Global Oral Health Data Bank, which is an important component of the Country/Area Profile Programme information system.

Because there may be so much difference in oral health within a population, it is important to ensure that there are robust data on key age groups to enable comparison over time and across countries. The key age groups as advised by the WHO (2013a) are:

- 5 years: dental caries in primary teeth (or later if children start school at 6 or 7 years).
- 12 years: dental caries in secondary teeth.
- 15 years: dental caries in secondary teeth.
- 35–44 and 65–74 years for dental caries in permanent teeth and periodontal disease.
- 65 years and over: edentulousness.

Pathfinder survey methods outlined by the WHO (2013b) are designed to assist those beginning epidemiological work in a given country and to assist in planning the provision of oral healthcare or further survey work and thus provide a practical, economic survey sampling method. A pathfinder survey is a stratified cluster sampling technique of key age groups. The sites are usually based on administrative districts and include the most important population sub-groups likely to have different disease levels. For example, a sample design for a national pathfinder survey for each ‘index age’ as shown in Box 2.1 may include 300 per group.

#### Box 2.1 Sampling for national pathfinder survey by index age and location as advised by WHO (2013b).

##### Urban:

- 4 sites in the capital city or metropolitan area ( $4 \times 25 = 100$ )
- 2 sites in each of 2 large towns ( $2 \times 2 \times 25 = 100$ )

##### Rural:

- 1 site in each of 4 villages in different regions ( $4 \times 25 = 100$ )

##### Total for one index age or age group:

- 12 sites  $\times$  25 subjects = 300

Data from WHO, 2013b.

At the time of writing there are 196 countries in the world. Countries are encouraged to report their epidemiological findings centrally. The WHO oral health databank contains information on the oral health of many countries for certain diseases and the key age groups. The most common data held relate to dental caries in 12-year-olds. Data on 12-year-olds are available for over 90% of countries worldwide, <http://www.mah.se/CAPP/>. There are some data on periodontal diseases in adults, <http://www.dent.niigata-u.ac.jp/prevent/periodontal/contents.html>, and oral cancer data are available through Cancer Today at <http://gco.iarc.fr/today/home>

## What Do We Learn from Countries with Surveys of Oral Health?

The following sections will examine oral health using a series of markers relating to the common oral conditions as well as perceived oral health. Each section will examine global information on the size of the problem, as well as reviewing risk factors and interesting facts. Each section will conclude with consideration of the relevant global targets for oral health which should be formulated at country level (Hobdell et al., 2003a) to reflect the local disease levels rather than having the same targets for all. Finally, each section explores the challenges for those of us who seek to promote oral health.

The most basic of marker of oral health, and the easiest to measure, is whether people have retained any natural teeth; this will be considered first.

## Edentulousness

Becoming edentate is the ultimate marker of dental morbidity and has significant implications for general health and wellbeing. Interestingly, as surveys of adults are less common than those of children, there are limited data on edentulousness worldwide.

### Size of the Problem

The CAPP (WHO/FDI) database has information on adults of 65 years and over (CAPP, 2014a). Looking across global oral health data, it is clear that relatively few countries ( $n = 56$ ) have conducted surveys of adults in older age groups and that data that are available cover several decades, thus the findings are not directly comparable. Furthermore, there is little indication of the extent to which the data are representative of the population as a whole. Nonetheless, there are some interesting findings and the variation in reported levels



of edentulousness is marked across continents and countries. Looking at the countries listed – and absent – Europe has more data (57% of the listed countries are European) (CAPP, 2014b) and higher levels of edentulousness, whereas Africa (CAPP, 2014c) has much less data coverage.

Although the global picture on edentulousness must be viewed with caution, total tooth loss appears to be common in high-income countries with a western diet and many dentists (Figure 2.5). The USA is a notable exception where edentulousness is low; this may be related to widespread water fluoridation which has benefits for all age groups in the population.

### Trends in Edentulousness

Countries which have a wealth of epidemiological data on edentulousness over time present an interesting story. They suggest that levels of edentulousness, which were highest in the latter part of the twentieth century, are falling. For example in the UK, edentulousness has fallen from 29% to 6% in just three decades (1978–2009); however, many people who lost all their teeth are still alive and so we see high levels of edentulousness in older people (Kelly et al., 2000). Who removed all their teeth? For the majority this involved professional intervention by dentists. Within the UK, the odds of being edentate have been shown to be almost nine times higher for those adults with no qualification and four times higher for those with qualifications below degree level. Being from the north of Great Britain was also a factor that had an effect, with the odds of having no teeth rising as distance from the south of England increased (Treasure et al., 2001).

Trend analysis in the USA highlights that is also now a rare condition in high-income households, and it has contracted geographically to states with disproportionately high poverty. Thus, with the passing of generations born in the mid-twentieth century, ‘the rate of decline in edentulism is projected to slow, reaching 2.6% (95% prediction limits: 2.1%, 3.1%) by 2050’ (Slade et al., 2014). Slade et al. suggest that the continuing decline will be offset only partially by population growth and population ageing such that the predicted number of edentulous people in 2050 (8.6 million; 95% prediction limits: 6.8 million, 10.3 million) will be 30% lower than the 12.2 million edentulous people in 2010 (Slade et al., 2014).

Looking back, it is clear that some of the dental profession were practising within the focal infection paradigm and were of the view that all pain and sepsis could be avoided by the removal of all teeth. This occurred without thought of the pain and discomfort and social embarrassment associated with long-term denture wearing. This view was also accepted by the local population. For

example within certain regions of the UK, most notably the north of England (Treasure et al., 2001; Steele et al., 2000), where edentulousness is highest, women were provided with a dental clearance and complete dentures for their twenty-first birthday present or as a wedding present from parents – just in case the husband-to-be could not afford to provide for his wife!

### Risk Factors for Edentulousness

The main risk factors for edentulousness appear to be extensive disease, particularly dental caries, and demography (age, educational and social status), together with professional practice and population norms regarding appropriate dental care. Surveys around the world suggest that periodontal diseases are less often a cause of total tooth loss than one might expect.

The philosophy or paradigm in which dentists are practising and available facilities will contribute to the care available, together with patient behaviour in seeking regular care or preferring to attending later in the disease process when they are ‘in trouble’.

### Interesting Facts Regarding Edentulousness

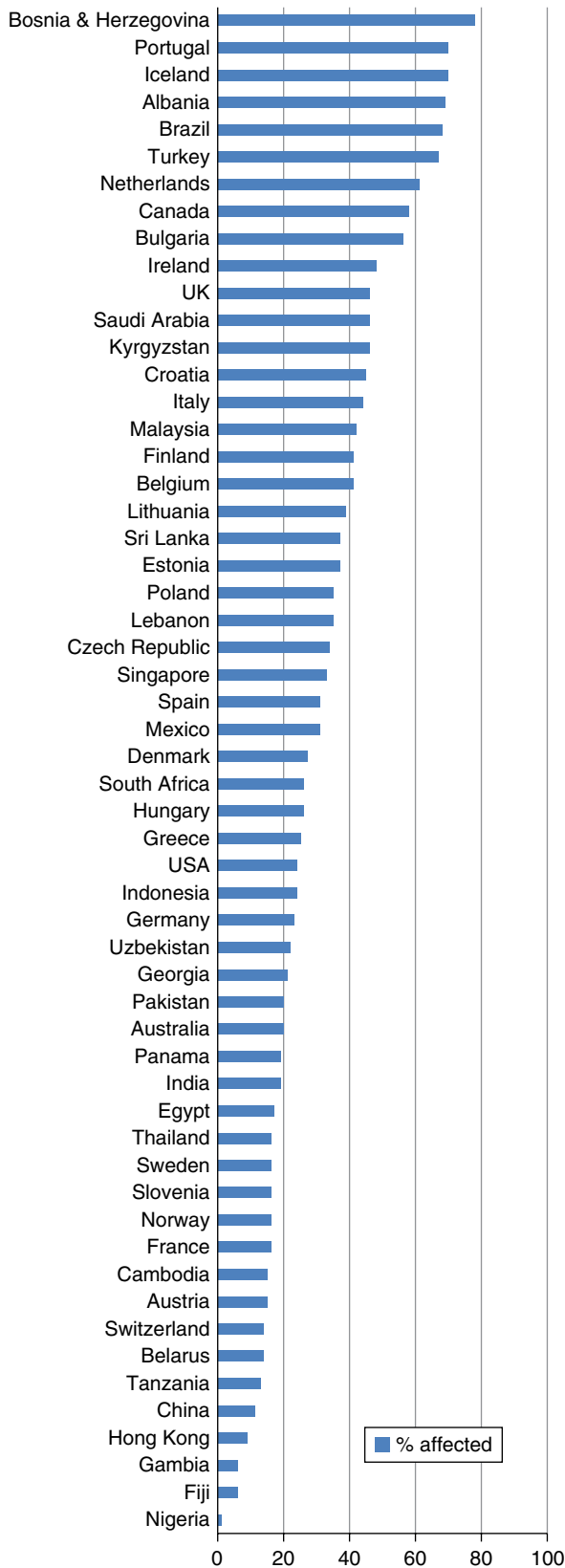
- There is national level evidence in Great Britain from older people’s national diet and nutrition survey that maintaining a natural and functional dentition (defined as having more than 20 teeth into old age) plays an important role in having a healthy diet rich in fruits and vegetables, a satisfactory nutritional status, and an acceptable body mass index (BMI) (Marcenes et al., 2003).
- Edentulous adults are less likely to attend dental services as they do not perceive a need for dental care (Kelly et al., 2000).

### Global Targets

Suggested goals for oral health relating to edentulousness are outlined in Box 2.2.

### Meeting the Challenge – So What Do We Do?

As oral health improves (The Information Centre for Health and Social Care, 2011c), edentulousness is increasingly not a useful marker of oral health, thus other markers of health are being tested such as having positive attributes, e.g. ‘functional dentition’ or ‘excellent oral health’ (The Information Centre for Health and Social Care, 2011c), or negative markers, e.g. ‘PUFA’, or ‘high complexity’. All of these markers recognise improvements in oral health and that adults will retain some or all of their natural teeth into older age and probably for life.



**Figure 2.5** Edentulousness in adults aged 65 years and over. Adapted from CAPP. Oral Health Country Area Profile Project, 2014a.

**Box 2.2 Global targets: edentulousness.**

- To reduce the number and proportion of edentulous adults
- To increase the average number of natural teeth present in adults
- To reduce inequalities in edentulousness

Adapted from Hobdell et al., 2003a.

Where information on edentulousness is collected, given the ageing global population, it is important to ensure that data are collected and reported by age band including older people aged 65 years and over so that there is greater understanding of those in need. The data from high-income countries such as the UK (The Information Centre for Health and Social Care, 2011c) suggest that edentulous adults are increasingly old, therefore special domiciliary denture services may be required for older and more vulnerable house-bound people.

Reflecting on history, it is really important that we as a profession think about the paradigm underpinning our patient care, moving away from a merely restorative and surgical approach to ensure that dental caries is managed preventatively and conservatively (Baelum et al., 2007; Fejerskov et al., 2013).

**Functional Dentition**

It is important that adults retain the ability to eat, speak and socialise throughout life. There is evidence that having 20 or more natural teeth enables dentate individuals to eat what they want in comfort, without the need for partial dentures; this is known as having a ‘functional dentition’ (Gotfredson and Walls, 2007). Within the UK, 21 or more teeth, or two thirds of the permanent dentition, is used as the marker for having a ‘functional dentition’, with patients having a ‘shortened dental arch’. In 2009, 86% of dentate adults across England, Wales and Northern Ireland were reported as having a functional dentition (21 or more natural teeth). Furthermore, whilst almost all young adults had a functional dentition, this reduced with age.

**Interesting Facts about Functional Dentition**

There is national level evidence from a national diet and nutrition survey that maintaining a natural and functional dentition, which is defined as having 20 or more teeth into old age, plays an important role in having a healthy diet rich in fruits and vegetables, a satisfactory nutritional status, and an acceptable body mass index (BMI) (Marcenes et al., 2003).

**Box 2.3 Global targets: tooth functional dentitions.**

- Increasing the number and proportion of adults with functional dentitions (i.e. either  $\geq 20$  or  $\geq 21$  or more natural teeth)

Adapted from Hobdell et al., 2003a.

**Global Targets**

Suggested targets in relation to achieving a functional dentition are outlined in Box 2.3.

**Meeting the Challenge**

Retaining a functional dentition, ideally with opposing pairs of teeth, must as far as possible become a long-term goal of patients and clinicians, at least where there are resources to do so.

**Excellent Oral Health**

The UK Adult Dental Health Survey 2009 instituted a category of 'excellent' oral health for the first time, defined by five features (The Information Centre for Health and Social Care, 2011c):

- Number of teeth – 21 or more natural teeth.
- Number of sound and untreated natural teeth – 18 or more.
- Decay – no decay at any site.
- No periodontal loss of attachment (LOA)  $>4$  mm.
- No bleeding or calculus.

Overall, 10% of the adult population were reported as having excellent oral health, ranging from 23% of 16 to 24-year-olds through to only 5% of adults in the 45 to 54-year-old age group (The Information Centre for Health and Social Care, 2011c); only 1% of those aged over 55 years were recorded as having excellent oral health. As with improvements in functional dentitions, this marked transition could be associated with access to fluoride whereby older adults, who did not have access to fluoride when their adult dentition was emerging, did not have as much protection against dental caries. Adults aged 45 years and below will have benefitted from fluoride in products such as toothpaste and/or water in retaining their natural dentition, together with changes in caries management (Baelum et al., 2007; Fejerskov et al., 2013). Despite decades of improvements in oral health, it is still salutary to realise just how few adults have good oral health.

**Global Targets for Oral Health**

There are no global targets relating to excellent oral health. However, this is something that should actively be considered by clinicians and patients, from childhood onwards, as oral diseases, particularly dental caries, are cumulative.

**Meeting the Challenge**

Patients' expectations are rising, particularly in high-income countries and amongst socially affluent individuals (Clow, Fischer and O'Bryan, 1995). Retaining excellent oral health into adult life is clearly possible as highlighted above, but maintaining this state through adult life and into older age increasingly becomes a challenge for individuals in relation to their self-care and wider psychosocial and environmental conditions.

Clinicians should be encouraging those with good oral health to maintain excellent oral health. It is notable amongst children and young people that more lesions will arise in the section of the population who appear to be disease free, i.e. 'low risk', than in those who are 'high risk' (Batchelor and Sheiham, 2002, 2006). However, wider environmental influences can support or detract from oral health so not everything is as much under the control of individuals as we would like to think. Our behaviours are heavily influenced by environmental, cultural and social norms.

**Urgent Conditions**

The last UK Adult Dental Health survey reported on 'urgent' conditions using an index called PUFA (Box 2.4). This index was first used in the Philippines amongst schoolchildren to report the clinical consequences of untreated dental caries (Benzian et al., 2011a; Monse et al., 2011). It was designed to provide additional information to inform healthcare planning. PUFA (pulp, ulceration, fistula, abscess) provides a measure of badly diseased and broken down teeth which have been attacked by dental decay and are causing significant problems in need of early attention. It is now advocated for use by the FDI as a tool that can help to stress the importance of tackling dental caries to planners (Benzian et al., 2011b). It is interesting to note that in the UK, where there have been massive improvements in oral health, some 7% of dentate adults (adults with teeth) had one or more conditions. A PUFA score of one or more was more common in men than women, adults from lower social groups than more affluent, amongst adults who reported brushing less than once a day than amongst those who brushed once or twice, and amongst smokers rather than



**Box 2.4 PUFA index criteria.**

**P** – pulp involvement is recorded when the opening of the pulp chamber is visible or when the coronal tooth structures have been destroyed by the carious process and only roots/root fragments are left

**U** – ulceration due to trauma is recorded when sharp edges of a dislocated tooth with pulp involvement or root fragments have caused traumatic ulceration of the surrounding soft tissues, e.g. tongue or buccal mucosa

**F** – fistula is scored when a pus-releasing sinus tract related to a tooth with pulp involvement is present

**A** – abscess is scored when a pus-containing swelling related to a tooth with pulp involvement is present

Source: Monse et al., 2011; Health and Social Care Information Centre, 2011c.

**Box 2.5 Global targets: pain.**

- Reduction in episodes of pain of oral and craniofacial origin
- A reduction in inequalities in relation to pain of oral and craniofacial origin

Adapted from Hobdell et al., 2003a.

non-smokers. These findings contrast with the Philippines where over half (56%) of 12-year-olds had PUFA lesions (Monse et al., 2011). The evidence from UK adults is that having a PUFA score was very strongly associated with perceived poor oral health (The Information Centre for Health and Social Care, 2011b; Monse et al., 2011).

Suggested targets proposed in relation to acute conditions can best be related to pain as presented in Box 2.5, since many oral and dental conditions involve pain.

**Meeting the Challenge**

Even in countries where there are established dental services and state subsidies to support care for low-income families, there is still a section of the population that attends only when in trouble and even then delays dental attendance for as long as possible (The Information Centre for Health and Social Care, 2011d). This impacts on disease levels and the restorability of lesions. It is important to address this because retaining a functional dentition must as far as possible become a long-term target of patients and clinicians, at least where there are resources to do so.

**Complexity**

In order to make sense of the data on adult oral health and the implications of the burden of disease for maintenance and care, the researchers involved in the latest UK

**Box 2.6 Complexity indicators.**

- In the top quintile for restored surfaces (based on all dentate adults; 32+ surfaces restored)
- In the top quintile for crowns (based on all dentate adults; 3 or more)
- Having any denture, bridge or implant
- Having one or more sextant with pocketing of 6 mm or more or loss of attachment of 9 mm or more
- Having any active decay of crown or root
- In the top quintile for active decay
- PUFA score greater than zero or an unrestorable tooth (pulp, ulceration, fistula, abscess)
- Reporting at least one of the Oral Health Impact (OHIP-14) problems as having been experienced very or fairly often over the last 12 months

Source: Health and Social Care Information Centre, 2011c.

adult dental health survey have helpfully created a complexity score (The Information Centre for Health and Social Care, 2011e). There are eight possible indicators of how adults with a combination of issues may lead to a degree of complexity in management. The index includes the factors listed in Box 2.6.

In the UK, one third of adults had no complexity and 45% had only one or two items whereas 19% per cent had three or more and 8% of adults had four or more indicators of complexity (The Information Centre for Health and Social Care, 2011e). The difference was quite marked by age with only 6% of adults in the 16–24 age category having three or more impacts, compared with 32% of those aged 65–74. Extreme complexity was apparent in 0.65% of the UK adult population, which would account for over a quarter of a million adults. This measure is particularly important because in high-income countries with established dental services there is a growing number of adults aged 50 years and over with large fillings and crowns, which now require significant maintenance and frequently require complex treatment (Watt et al., 2013).

**Oral Health Related Quality of Life**

The most common measure of oral health related quality of life is the shortened form of the Oral Health Impact Profile (OHIP-14). The purpose of using this index is to provide a comprehensive measure of self-reported dysfunction, discomfort and disability arising from oral conditions. The original Oral Health Impact Profile (OHIP), a 49-item questionnaire instrument, was devised by Slade and Spencer (1994), to assess individuals' oral health related quality of life. It was based on Locker's

adaptation of the WHO's classification of impairments, disabilities and handicaps (Locker, 1998). Each of the seven dimensions of impact in the original scale was assessed from questions on the type of problems experienced (a total of 49 questions). The shortened version (OHIP-14) was later developed based on a subset of two questions for each of the seven dimensions, making 14 in total (Slade, 1997).

There is widespread support for this measure as being a valid global self-reported oral health measure (Thomson et al., 2012), providing a useful adjunct or alternative to clinical surveys. This measure has been used in both the UK child and adult dental health surveys as a measure of perceived oral health (Nuttall et al., 2006; White et al., 2012).

Amongst children, oral health impacts are common. One or more oral health impacts during the previous 12-month period has been reported in 22% of 5-year-olds, 26% of 8-year-olds, 34% of 12-year-olds and 28% of 15-year-olds (Nuttall et al., 2006).

Amongst UK adults (excluding Scotland), 39% of adults experienced one or more of the problems included in OHIP-14 occasionally or more often in the previous 12 months (The Information Centre for Health and Social Care, 2011b). Thirty per cent of adults had experienced physical pain, and 19% had experienced psychological discomfort (The Information Centre for Health and Social Care, 2011b). There was a clear socio-economic gradient in the adult population with those from lower social groups reporting more problems. There was no difference between dentate and edentate adults. Overall the impact reduced from the previous survey in 1998 in parallel with general improvements in oral health as dental caries experience reduces in the population (The Information Centre for Health and Social Care, 2011b).

### Global Targets for Oral Health Related Quality of life

Suggested targets for oral-health-related quality of life are listed in Box 2.7.

### Meeting the Challenge

Just as in clinical encounters it is important to understand patients' perceptions of their oral health, so it is with quality of life measures. These measures are of increasing importance in measuring oral health as part of wider surveys of health and wellbeing when a clinical dental examination is not possible. To consider the parallel situation in the care of individuals, it is equally important in clinical care that the patient's perception is taken into account to ensure that their oral health needs are met and their quality of life is enhanced.

#### Box 2.7 Global targets: oral health related quality of life.

- A reduction in episodes of pain of oral and craniofacial origin
- A reduction in the number of days absent from school, employment and work resulting from pain of oral and craniofacial origin
- A reduction in the numbers of people experiencing difficulties in chewing, swallowing, socialising and speaking/communicating because of a problem with their teeth or mouth

Adapted from Hobdell et al., 2003b.

## Dental Caries (Tooth Decay)

### Size of the Problem

Dental caries is the most prevalent chronic condition in the world and a global health problem (Beaglehole et al., 2009). Caries affects the majority of the world's population at some time in their lives despite being a preventable disease (WHO, 2012a). Decay arises when dietary sugars and oral bacteria in the oral biofilm are present on a tooth surface over time (Selwitz, Ismail and Pitts, 2007); the consequences are pain, suffering, dental care (which for many in the world is inaccessible and/or unaffordable) and potentially tooth loss.

Worldwide a staggering 60–90% of school children and nearly 100% of adults have experienced dental caries (WHO, 2012a). This disease causes much pain and suffering as well as days lost from school and work. Analysis of the global burden of disease (GBD) showed that untreated caries in permanent teeth was the most prevalent condition evaluated for the entire GBD 2010 Study (global prevalence of 35% for all ages combined) (Marcenes et al., 2013). In addition, untreated caries in deciduous teeth was the tenth most prevalent condition, affecting 9% of the global population (Marcenes et al., 2013).

Twelve years of age has been determined as the global indicator age group for international comparisons and surveillance of dental caries. It was selected as it is a pivotal point in the permanent dentition and a time when most children can be surveyed through schools. Most countries of the world have surveyed the oral health of their 12-year-olds (n=189 in 2011) (Table 2.4). The global weighted mean DMFT value for 12-year-olds in 2011 was 1.67 (WHO, 2012b).

The data in the WHO global oral health databank, whilst hopefully being the most recent available for the country, may or may not be representative of the average levels of oral health. First, not all countries have the

**Table 2.4** Mean levels of dental caries by WHO region and globally, 2004 and 2015.

WHO region	DMFT in 12-year-olds	
	2004	2015
African	1.15	1.06
Americas	2.76	2.08
Eastern Mediterranean	1.58	1.64
European	2.57	1.81
South East Asia	1.12	2.97
Western Pacific	1.48	1.05
Global	<b>1.61</b>	<b>1.67</b>

Data from CAPP <http://www.mah.se/CAPP/Country-Oral-Health-Profiles/According-to-Alphabetical/Global-DMFT-for-12-year-olds-2011/>

resources, human and financial, available to conduct a national survey of oral health. Second, not all surveys are conducted at the same time. Third, not all will have used the same criteria for diagnosing caries. All these issues make comparisons difficult. Fourth, and finally, increasing emphasis on obtaining positive consent from parents for their child's participation in a survey means that some children will be excluded, and there is some evidence that amongst younger children they will be those from socially deprived backgrounds who are more likely to suffer from dental caries.

### Trends over Time

Globally, the data suggest that overall caries prevalence in 12-year olds has fallen from 1980 when the global average was 2.43 (Leclercq et al., 1987) to 1.67 in 2011 (Natarajan, 2011). Most high-income countries have shown great improvements in oral health. For example Switzerland has achieved a reduction from 8.1 DMFT in 1964 to 0.8 in 2009 amongst 12-year-olds in the Canton of Zurich (CAPP, 2014b). Dental caries within Europe appears to be highest in eastern countries such as Croatia and Serbia (CAPP, 2014b).

Globally, some of the poorest countries, particularly in the African region, appear to be stable, possibly due to a failure to continue epidemiological surveys, whereas certain middle income countries have rising levels of dental caries. The American region has the highest mean levels of decay with Central and South American countries most affected (CAPP, 2014d).

The management of dental caries is one of the public health success stories of the twentieth century with the discovery of fluoride as a preventive measure against the effects of sugars in the diet (Centers for Disease Control

and Prevention, 2013). Tooth decay has moved from being a national epidemic amongst children in many high-income countries such as the USA and the UK to being a disease of poverty and of older age. Although vulnerable groups bear a disproportionate amount of disease (US Surgeon General, 2000), the global data show that most individuals will experience dental caries at some stage in their lifetime. A representative survey of children aged 11–12 years in the Philippines, a country which has some of the highest caries levels in the south east Asian region, showed a significant association between caries and body mass index (BMI), and particularly between odontogenic infections and 'below normal' BMI (Benzian et al., 2011a).

### Risk Factors for Dental Caries

Risk factors for dental caries include social factors – low income, low education, social deprivation – and behavioural factors including a diet high in sugar, lack of optimal fluoride on a regular basis and poor plaque removal. Diet is the main behavioural risk factor and is common to many other non-communicable diseases, including obesity, metabolic syndrome and cardiovascular diseases.

### Interesting Facts about Dental Caries

- Sheiham and Sabbah (2010), suggest 'universal patterns of caries, in terms of prevalence, incidence, frequency distribution and rates of progression, in permanent teeth that can be applied when planning dental care' as follows:
  - Caries levels follow trend lines, therefore knowing the caries level at one age can be used to predict the levels at later ages in that cohort by looking at the trend line for that cohort.
  - The distribution of dental caries of a population exhibits the following characteristics: as the mean DMFT increases, the percentage of caries-free individuals falls and the caries distribution widens.
  - There is a specific mathematical relationship between the mean DMFT and mean DMFS.
  - There is a hierarchy of caries susceptibility by tooth type and sites on teeth; for a given DMFT or DMFS, there is a specific intraoral pattern of caries by tooth type.
  - Changes in mean DMFT scores for individuals and groups are not linear, but 'stepped'; there are groupings of teeth and tooth sites that may have similar 'resistance' to caries.
  - As the mean DMFT declines, the post eruptive time for initiation of caries increases and the progression rate of caries through enamel decreases.

- In most high-income countries dental caries is associated with social deprivation (Harris et al., 2004; Pitts and Harker, 2004).
- Dental caries in early childhood has been shown to be associated with maternal patterns of caries (Pitts and Harker, 2004).
- In managing dental caries, it is important to note that more new caries lesions develop in children who were previously 'caries free' (Batchelor and Sheiham 2002, 2006) hence challenging the adoption of a high-risk strategy for prevention.
- There is some evidence that stress has been shown to be associated with early childhood caries (Boyce et al., 2010). This convergence of psychosocial infectious and stress-related biological processes appears to be implicated in the production of greater cariogenic bacterial growth and in the conferral of an increased physical vulnerability of the developing dentition (Boyce et al., 2010).
- Older people become more susceptible to dental caries, including root caries in later life (Thomson, 2004).
- Older people in care homes have higher levels of dental caries than their counterparts in the community when matched for age and sex (Steele et al., 1998).
- Good social relations are important in older age. A study amongst dentate older people who lived in community settings surveyed as part of the Kungsholmen Elders Oral Health Study (KEOHS) in Sweden suggests that social relations are related to the oral health status of old-old individuals. It was found that those who lived alone or who became alone during the 7 years prior to the dental examination had greater odds of having coronal caries than those who continually lived with others, and that those who were continuously dissatisfied with the frequency of their social contacts were more likely to have root caries than those who reported a sustained satisfaction with the frequency of their social contacts (Avlund et al., 2003).
- Dental caries continues as a disease of adulthood, remaining important beyond childhood and adolescence, and rates of dental caries over time remain relatively constant (Broadbent et al., 2013).

### Meeting the Challenge – So What Do We Do?

It is very important to avoid a simplistic approach to understanding dental caries. As dental professionals we should be aware of the wider psychosocial and environmental influences on oral health as well as the biological factors, which together produce both modifiable and non-modifiable risk factors. Our approach to caries management must move away from merely a

#### Box 2.8 Global targets: dental caries.

- Increasing the proportion of caries-free children at key ages: particularly 5/6 and 12 years
- Reduction in average caries experience levels in key age groups
- Decreasing inequalities in dental caries experience
- Reducing risk factors for dental caries, e.g. sugar consumption and ensuring optimal fluoride

Adapted from Hobdell et al., 2003a.

simplistic behavioural approach to working on the wider determinants of health in tandem with modifiable risk factors. Thus actions should include:

- Support action against sugar to address the level of sugar consumption in society.
- Support community interventions such as healthy school initiatives.
- Lead action in support of fluoride availability through water, toothpastes, varnish, etc.
- Ensure careful assessment of caries prevalence and consider using ICDAS as a tool which also reflects caries management.
- Assess caries risk factors during patient care and support individuals in reducing their caries risk.

Suggested targets are listed in Box 2.8.

## Periodontal Diseases

Periodontal diseases are highly prevalent and can affect up to 90% of the world's population (Pihlstrom, Michalowicz and Johnson, 2005). Hughes estimates that periodontal diseases have increased significantly over the past decade and are becoming 'the new caries' as the challenge for our dental professions (Hughes, 2014). Evidence from Dunedin suggests that 'periodontitis commences relatively early in adulthood, and its progression accelerates with age, particularly among smokers' (Thomson et al., 2013). The term 'periodontal diseases' covers a wide range of conditions which have been categorised by Armitage (1999) as follows:

- Gingival diseases: plaque (gingivitis) or non-plaque induced.
- Chronic periodontitis: the most common form of periodontitis resulting in attachment loss and tooth loss for much of the world's population.
- Aggressive periodontitis: patients are otherwise healthy, show progressive destruction and there is a familial aggregation of this condition.



- Periodontitis as a manifestation of systemic disease.
- Necrotising periodontal diseases.
- Abscesses of the periodontium.
- Periodontitis associated with endodontic lesions.
- Developmental or acquired deformities and conditions.

Gingivitis, which is the mildest form of periodontal disease, and reversible, is caused by the dental biofilm that accumulates on teeth adjacent to the gingivae but does not affect the underlying structures, although it may do so in time. In contrast, periodontal diseases result in the loss of connective tissue and bone support and are a cause of tooth loss in adults (Pihlstrom, Michalowicz and Johnson, 2005).

There have been a range of indices developed to measure aspects of periodontal diseases including: bleeding, pocket depth, attachment loss, tooth mobility, presence and severity of dental plaque (Table 2.3). None of the indices used to date on their own has widespread support and the variety of indices used, and the lack of consistency in scoring indices mean that detailed comparisons are not meaningful.

Partial mouth recordings are generally used in epidemiological surveys; however, this approach tends to lead to an underestimation of disease, an important point when epidemiological findings are reviewed. A database of periodontal epidemiology is held as part of the Country Area Profile Project (CAPP) (2014e). What is striking about the database is that much of the data are not contemporary. Whatever the reasons, it could reflect the fact that there is less emphasis on collecting oral health data or that surveys which are being undertaken are not representative of the country, or that data being collected are just not being reported to the WHO. It is important, therefore, that efforts are made to ensure that this resource for international surveillance is regularly kept up to date.

### Size of the Problem

Gingivitis is the most common periodontal condition, affecting four out of five adults worldwide (Pihlstrom, Michalowicz and Johnson, 2005). It is increasingly evident that severe periodontal disease occurs in a few teeth of a subsection of the population which generally ranges from 5% to 20% of the 34 to 44-year-old population (WHO, 2012); within the UK it is considered to be 10–15%. Severe forms are found only in a portion of the adult population who show abnormal susceptibility (Genco and Borgnakke, 2000).

The GBD study ranked severe periodontal disease as the sixth most prevalent condition worldwide in 2010 (Vos et al., 2012; Marcenes et al., 2013). Three case definitions of severe periodontitis were used in the

GBD study, depending on which one was used in the publication:

- Community Periodontal Index score of 4 mm
- clinical attachment loss of more than 6 mm, or
- gingival pocket depth of more than 5 mm.

Disability adjusted life years (DALYs) due to severe periodontitis increased since 1990 and this was considered to be due to population growth and ageing (Murray et al., 2012).

National surveys such as those undertaken within the UK provide an in-depth overview and evidence of trends (The Information Centre for Health and Social Care, 2011a, 2011f). Periodontal disease was measured by bleeding on probing, calculus and pocketing in each sextant. In adults aged 55 and over, attachment loss (LOA) was also recorded. The overall findings provide a pattern of disease within a high-income country where the majority of the population are regular or occasional dental attenders of dental care (The Information Centre for Health and Social Care, 2011a, 2011f):

- Only 17% of dentate adults had very healthy periodontal tissues and no evidence of bleeding, calculus, pocketing of 4 mm or more or loss of periodontal attachment of 4 mm or more anywhere in their mouth.
- The majority of dentate adults had some periodontal disease, albeit generally at a low or moderate level.
- Gingival bleeding on probing was present in 54% of adults.
- 45% of dentate adults had LOA of 4 mm or more and this increased with age.
- 37% of dentate adults had pocketing of 4mm-5.5 mm which is considered 'mild'.
- 8% had pocketing of 6 mm or more present and just 1% had 9 mm or more.
- LOA is an indication of damage over a lifetime and takes into account gum recession. In dentate adults over 55 years of age, 66% had a LOA of 4 mm or more, 21% 6 mm or more, and 4% over 9 mm.
- Periodontal health was positively associated with reported regular dental attendance and regular tooth brushing (twice per day or more).
- Periodontal health was negatively associated with smoking.
- Females generally had better periodontal health than males.
- A social gradient was apparent only in moderate and severe periodontitis.

Further in-depth analysis revealed that periodontal disease was associated with quality of life independent of socio-demographic characteristics and other conditions present in the mouth (Bernabé and Marcenes, 2010).

The 2003 UK Child Dental Health Survey revealed that just over half (52%) of 15-year-olds had some evidence of inflammation and 63% had plaque present (White and Lader, 2004). Only data on gingival health, plaque and calculus were collected. The findings suggested that gingivitis, plaque and calculus levels were generally higher than 10 years previously and there was some evidence of variation associated with social variables.

Moving from considering the findings of cross-sectional studies over time to a longitudinal study, the Dunedin study in New Zealand revealed that:

- Periodontitis commences relatively early in adulthood, and its progression accelerates with age, particularly among smokers (Thomson et al., 2007).
- Current and long-term smoking in young adults is detrimental to periodontal health, but smoking cessation may be associated with a relatively rapid improvement in the periodontium (Thomson et al., 2007).
- Site-specific periodontal attachment loss due to dental caries or restorative events occurs in adults in their third and fourth decades of life (Thomson et al., 2013).

### Risk Factors for Periodontal Disease

Plaque is a risk factor for periodontal diseases, as are tobacco, systemic infections, stress, genetic disorders and localised factors which predispose to the accumulation of plaque (Petersen and Ogawa, 2012). Localised factors include calculus, malaligned teeth, partial dentures and overhanging fillings.

Smoking is one of the most significant risk factors associated with the development of gum disease. Additionally, smoking can lower the chances for successful treatment. Hormonal changes in girls/women can make gums more sensitive and make it easier for gingivitis to develop. Diabetes involves higher risk for developing infections, including gum disease. Diseases such as cancer or AIDS and their treatments can also negatively affect the health of gums.

Some people are more prone to severe gum disease than others and appear to have a genetic susceptibility. The association between periodontal and systemic diseases – an increasingly important aspect of research – is well recognised (Petersen and Ogawa, 2005; Kinane and Bouchard, 2008; Petersen and Ogawa, 2012). Additionally, medications can increase risks, either directly by leading to abnormal overgrowth of the gum tissue or indirectly through reduced salivary flow.

Research which suggests that socio-economic status variables alone account for approximately 50% of the

differences in the prevalence of periodontitis at 35–44 years of age is noteworthy and places in perspective efforts to improve individual health by changing behaviour and lifestyle as the sole focus of preventive strategies (Hobdell et al., 2003b).

There is evidence from the Dunedin longitudinal study that localised periodontal disease can be associated with restorative dentistry. For example, where a caries/restorative event had occurred on an inter-proximal tooth surface before age 26, attachment loss at the corresponding periodontal site was approximately twice as likely to be  $\geq 3$  mm than if the adjacent tooth surface had remained sound (Broadbent et al., 2006). This was also the case where a caries/restorative event had occurred subsequent to age 26 (Broadbent et al., 2006).

### Interesting Facts about Periodontal Disease

A consensus document highlights the evidence from epidemiological research of the *association* between periodontal diseases and other conditions such as cardiovascular diseases; however, there is to date no compelling evidence that preventive periodontal care or therapeutic intervention will influence general health (Kinane and Bouchard, 2008).

### Meeting the Challenge – So What Do We Do?

*Measurement:* the WHO has been working on new approaches to measure periodontal diseases. The current data are relatively weak and there needs to be robust discussion as to whether periodontal disease is a sufficiently severe oral health problem to warrant greater time and investment in its measurement and, above all, prevention of periodontal diseases (Petersen and Ogawa, 2005). Given the cost of treating periodontal disease, there are arguments for doing so. Longitudinal studies will be important in contributing to a greater understanding of who goes on to develop periodontal disease, the associations with other systemic diseases and the underlying pathogenesis, together with mechanisms for intervention.

*Dental clinicians:* it is important for dental practitioners to ensure that a thorough oral examination has been undertaken, including a periodontal charting. Patients must be made aware of their periodontal condition early in the process and assisted with its management (Public Health England et al., 2017).

### Global Targets for Oral Health: Periodontal Diseases

Suggested targets are listed in Box 2.9.

**Box 2.9 Global targets: periodontal diseases.**

- Reducing the average number of teeth lost to periodontal diseases amongst adults
- Reducing the prevalence of necrotising forms of periodontal diseases
- Reducing the prevalence of periodontitis disease in adults and children with healthy gums
- Reducing risk factors for periodontal diseases, e.g. smoking and poor oral hygiene

Adapted from Hobdell et al., 2003a.

## Tooth Wear

Tooth wear or tooth surface loss (TSL) is the loss of tooth tissue that is not related to dental caries. It involves one or more of the following: attrition, abrasion, erosion and abfraction (Bartlett and Dugmore, 2008). It is increasingly perceived as an oral health problem, particularly when pathological. It is a natural feature of ageing and involves the loss of hard tissue by physical (e.g. eroded by toothbrush and abrasive paste), chemical (e.g. acidic from diet and gastric reflux) and mechanical (e.g. grinding contact between opposing arches of teeth) means or often a combination of all three. The prevalence of tooth wear is difficult to estimate because of the range of indices or methods of measuring the disease, some of which are best used in clinical or epidemiological studies and others which may be used in laboratory research. (Bardsley, 2008). Dental erosion appears to be a growing problem in a number of countries, associated with the ingestion of beverages containing acid. Bartlett, Phillips and Smith (1999) suggest that tooth wear has received more emphasis in European countries than North America and that erosion appears to be the most common of the above aetiological factors.

Evidence from the UK, where information on tooth wear is collected in cross-sectional national surveys, reveals the following. In UK (excluding Scotland) adults, the prevalence of tooth wear extending into dentine was high, with over 77% of dentate adults showing some tooth wear in their anterior teeth (The Information Centre for Health and Social Care, 2011f). Overall, 15% showed moderate and only 2% severe wear. Almost half (44%) of dentate 75 to 84-year-olds had moderate tooth wear; however even in this age group only 6% had severe wear (The Information Centre for Health and Social Care, 2011f). When tooth wear occurs in younger adults it is a potential threat to their retaining their natural teeth; however, in older adults, who are much less likely to lose their teeth from tooth decay, it is a feature of

ageing. Moderate or severe wear in young adults is therefore of greater clinical concern and needs to be detected early and managed. Examination of trends over time in England did not reveal evidence that tooth wear in older people was higher than in the previous survey in 1998 (White et al., 2010).

It was possible to examine trends in tooth wear in England between 1998 and 2009. The greatest increase in moderate wear between the 1998 and 2009 surveys was in young adults aged less than 45 years. Adults who cleaned less than twice a day had more wear than those who cleaned twice a day or more. There was an association with other health behaviours: adults who attended a dentist less often (5 or more years since their last dental visit) were more likely to have evidence of tooth wear (White et al., 2011).

In UK children, the last national survey in 2003 revealed the following, with TSL being more common on the lingual than the buccal surfaces of incisors (Chadwick and Pendry, 2004):

- In 5-year-olds, 20% had evidence of TSL on the buccal surface of primary upper incisors and 2% had TSL involving dentine or pulp.
- TSL of lingual surface primary upper incisors was present in 53% of children; in 22% of children this involved dentine or pulp on the lingual/incisor surfaces.
- In the permanent incisor teeth of 15-year-olds, 14% showed evidence of TSL on the buccal surface and 33% on the lingual surfaces.
- TSL on the occlusal surface of first permanent molars rose with age so that at 15 years 2% had TSL affecting the occlusal surface; 4% of the total had dentine involvement. Lower molars were more likely to be affected than uppers.

Following systematic review of the prevalence of tooth wear in children and adolescents, Kreulen et al. (2010) reported that prevalence of wear involving dentine ranged from 0 to 82% for deciduous teeth in children up to 7 years; regression analysis showed age and wear to be significantly related. The results of this systematic review indicate that the prevalence of tooth wear leading to dentine exposure in deciduous teeth increases with age (Kreulen et al., 2010). Most of the studies in the permanent dentition showed low levels of dentine exposure, with only a few reporting high prevalence (range 0–54%); increase in wear of permanent teeth with age in adolescents up to 18 years old was not substantiated (Kreulen et al., 2010).

### Risk Factors

The aetiology of dental erosion includes intrinsic sources of acid (gastro-oesophageal reflux) and extrinsic sources

such as consumption of demineralising acidic foods and drinks.

### Meeting the Challenge – So What Do We Do?

Some tooth wear is a natural feature of ageing. Once there are signs of pathological tooth wear in relation to age, it is necessary to identify the risks and address them to avoid more severe wear occurring. The implications of tooth wear for an individual can be devastating, leading to sensitivity and possible loss of teeth. The importance of regular dental visits is that tooth wear can be detected early in the process and the risks managed to minimise further tooth loss.

### Interesting Facts about Tooth Surface Loss

Normal wear is age-dependent; however, pathological wear does not appear to be (Bartlett and Dugmore, 2008). There is some evidence to suggest that tooth wear may be managed by preventative measures such as fissure sealant application to affected surfaces (Bartlett et al., 2011).

### Global Targets for Oral Health

None exist because tooth wear is not a recognised public health problem.

## Orthognathic Abnormalities

Within the UK there has been seminal work to look at orthodontic need in children and young people (Brook and Shaw, 1989). There are two components to the index: a normative component whereby the examining dentist determines the need, and an aesthetic component whereby the patient is graded in relation to 10 photographs in relation to their 'attractiveness'. In the UK, this assessment of oral health was a component of the 1993 and 2003 national child dental health surveys.

### Size of the Problem

The UK oral health surveys provide a helpful overview as they suggest that 35% of 12-year-olds have a great, or very great, orthodontic need for treatment, with similar levels of need between boys and girls (Chestnutt et al., 2006). At age 15 years, 21% still had an identified need; however, the level of need was greater in boys (24%) compared with girls (19%). More of the 15-year-olds were receiving treatment (31%). Around one third (32%) overall had had some experience of orthodontics. There was no difference in the level of need by social class; however, at 15 years of age inequalities were apparent.

Those 15-year-olds from schools with evidence of deprivation were less likely to be receiving care (10% compared with 15%) and more likely to have an identified need (24% compared with 20%).

In the USA, there is evidence that, of children under 12 years of age, 17.2% had a definite orthodontic need, with clear differences by age, sex, social class and ethnic group (Christopherson, Briskie and Inglehart, 2009). While the provider-assessed treatment need was higher for white children than for black children, black children were less happy with their smiles than white children, and wanted braces more than white children (Christopherson, Briskie and Inglehart, 2009).

A survey of 12-year-olds in India provided very different findings. It suggested that the level of great or very great orthodontic need as determined by WHO criteria was very low at around 5% (Singh et al., 2011).

### Risk Factors for Orthodontic Need

The majority of orthodontic need is genetically determined. In essence, both dummy and thumb sucking are associated with increased orthodontic need, the former associated with an increased risk of developing a posterior cross bite.

### Interesting Facts about Orthognathic Abnormalities

There is some evidence that the level of orthodontic need appears to vary by ethnic group (Proffit et al., 1998; Singh et al., 2011).

There is evidence that young people who have received, or are receiving, orthodontic treatment report having fewer impacts on daily living associated with their occlusion and thus a better quality of life (Bernabe et al., 2008).

The occlusal and psychosocial outcomes from orthodontics funded through Medicaid and private care in the UK were comparable, despite worse malocclusions in the young people treated through Medicaid at baseline (King et al., 2012).

### Global Targets for Oral Health

A suggested target is listed in Box 2.10.

#### Box 2.10 Global targets: orthodontics.

- To increase detection and management of severe orthodontic malocclusions
- To reduce inequalities in access to care

Adapted from Hobdell et al., 2003a.