

# Chapter 3

## Oral Health Over the Life Course

Anja Heilmann, Georgios Tsakos, and Richard G. Watt

### Introduction

Oral health is an integral and core component of overall health and well-being. The main oral diseases include dental caries (tooth decay), periodontal disease (gum disease) and oral cancers, all of which are common chronic conditions that affect a considerable proportion of both the child and adult populations across the world. Oral diseases have been somewhat neglected by policy makers and politicians, and considered as a marginal health issue. However, at a recent United Nations summit on the prevention of non-communicable diseases, oral conditions were highlighted as a major global public health priority (UN 2011).

Dental caries and periodontal diseases are both highly prevalent chronic conditions. Caries can affect individuals across the life course from early childhood to old age. It is often stated that caries is the most common chronic disease in childhood. In the US, it is estimated that caries is five times as common as asthma and seven times as common as allergic rhinitis (Benjamin 2010). Caries is a cumulative condition, and prevalence increases with age. The recent Global Burden of Disease (GBD) 2010 Study found that untreated caries of the permanent dentition was the most prevalent condition worldwide, affecting 35 % of the global population (Marcenes et al. 2013). Periodontal disease largely affects adults and older people. Although most adults have some gingival inflammation (bleeding gums), approximately 11 % of the global adult population have severe progressive periodontal disease, which can ultimately lead to premature tooth loss (Marcenes et al. 2013). Rates of oral cancer, a debilitating and potentially fatal condition, are steadily increasing across

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A. Heilmann (✉) • G. Tsakos • R.G. Watt

Department of Epidemiology and Public Health, University College London, London, UK  
e-mail: [anja.heilmann@ucl.ac.uk](mailto:anja.heilmann@ucl.ac.uk); [g.tsakos@ucl.ac.uk](mailto:g.tsakos@ucl.ac.uk); [r.watt@ucl.ac.uk](mailto:r.watt@ucl.ac.uk)

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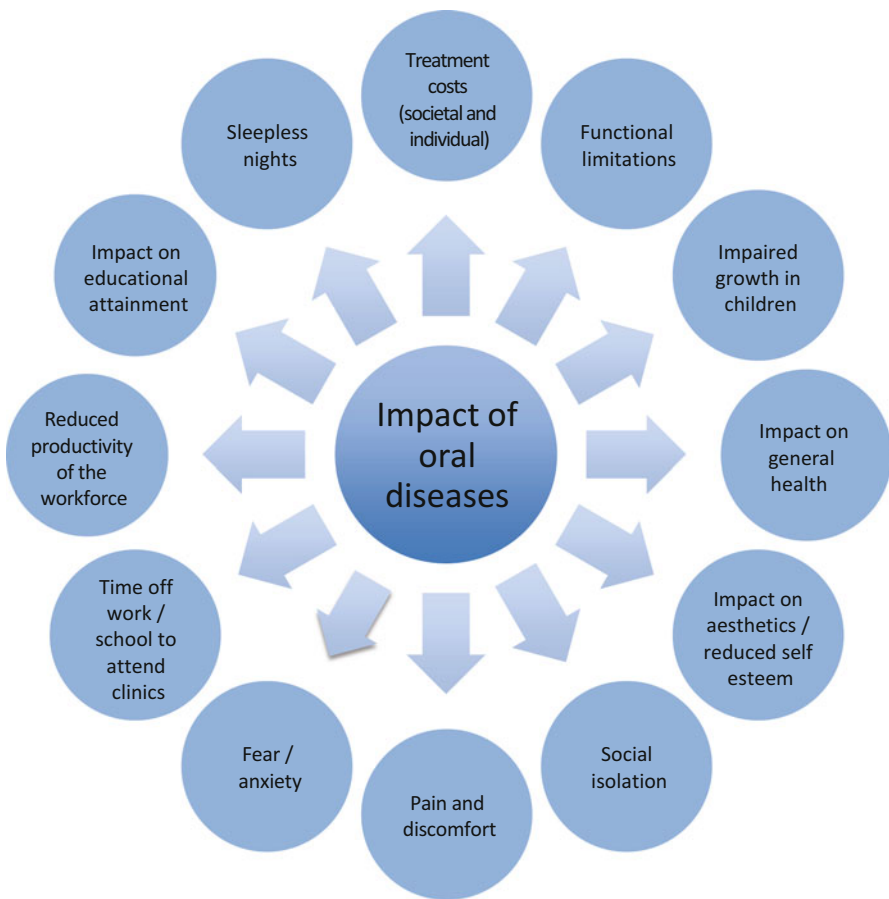
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Europe. In the UK, 6,500 people are diagnosed each year with oral cancer, which is similar to the number of women affected by cervical cancer (Cancer Research UK 2012).

Despite being very common, oral diseases are largely preventable. However, oral diseases are socially patterned, with disadvantaged and lower income groups disproportionately affected (Hobdell et al. 2003). Indeed, consistent stepwise social gradients exist for both clinical and subjective oral health outcomes, at all points across the life course (Sheiham et al. 2011).

As well as being very common, oral diseases have a significant negative impact on quality of life and well being (Fig. 3.1). The recent global burden of disease study highlighted that oral diseases accounted for 15 million disability adjusted life years globally (Marcenes et al. 2013). In preschool children, caries in the primary dentition (baby teeth) is often left untreated, causing severe pain, discomfort and



**Fig. 3.1** Impact of oral diseases (Adapted from Daly et al. 2013)

infection (both acute and chronic). The resulting eating and sleep disruption can adversely affect children's ability to concentrate in school, ultimately compromising their educational performance (Sheiham 2006). Moreover, severe dental caries has been shown to negatively impact on a child's growth and development (Duijster et al. 2013; Sheiham 2006). Amongst adults and older people, tooth loss caused by dental caries or periodontal disease can severely restrict dietary intakes, particularly of fresh fruits and vegetables (Tsakos et al. 2010). Further, there is evidence for direct links between oral health and general health. Systematic reviews concluded that poor oral hygiene and periodontal disease are risk factors for pneumonia, and possibly also for chronic obstructive pulmonary disease (Azarpazhooh and Leake 2006; Sjögren et al. 2008), and that periodontal disease adversely affects diabetes outcomes (Borgnakke et al. 2013).

The treatment of caries is costly and time consuming. In the UK, the multiple extraction of carious teeth is the main reason for administering general anesthesia among young children, a costly and traumatic experience. In addition to the negative effect on the individual and their family, oral diseases also impose a major economic burden in terms of the costs to the health care system of providing dental treatment. WHO (2003) has estimated that dental care accounts for between 5 and 10 % of total healthcare expenditure and that dental caries is the fourth most expensive disease to treat. In addition to the direct costs of dental treatment, indirect costs are also very high. In the US, it is estimated that 2.4 million days of work were lost due to attendance at dental services for the treatment of oral diseases (Beaglehole et al. 2009).

From a clinical perspective, oral diseases are caused by poor oral hygiene, diets high in added sugars, lack of fluoride, tobacco use and excess alcohol consumption. It is increasingly recognised that oral diseases share common behavioural risks with the other main non-communicable conditions (Sheiham and Watt 2000; Watt and Sheiham 2012). For example, high sugars consumption is the main cause of dental caries, but is also linked with overweight and obesity (WHO 2003). However from a public health perspective, it is fundamentally important to acknowledge that behaviours are socially patterned and therefore shared health behaviours are enmeshed and determined by their broader social, environmental and political context. Health related behaviours alone do not account for patterns of oral diseases in the population. A broader social determinants framework which includes biological, behavioural, psychosocial, economic, environmental and political factors is now recognised as an appropriate approach to explore the aetiology of chronic diseases, including oral conditions and patterns of health inequalities (Marmot and Bell 2011).

As will be outlined in this chapter, oral diseases are ideal for the application of life course epidemiological research (Nicolau et al. 2007b). They are cumulative and chronic in nature, relatively common across the population and can be measured with good accuracy. In addition, they share common social determinants with other chronic non-communicable conditions, and indeed are a suitable early marker for exposure to risk factors across the life course.

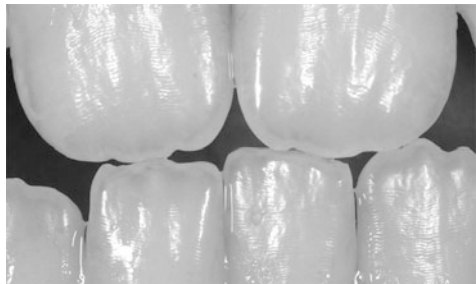
## Oral Health Over the Life Course: Evidence from Empirical Studies

Over the past decade, the number of published oral health studies adopting a life course perspective has been steadily increasing. Main lines of enquiry relate to critical period and accumulation of risk models, and include outcome measures such as developmental defects of enamel, levels of caries and periodontal disease, tooth loss and oral health-related quality of life (OHRQoL). Some studies have examined the interrelationships between oral and general health, such as the associations between caries experience and child growth. The following sections provide an overview of the most important findings on oral health over the life course so far.

### *Developmental Defects of Enamel*

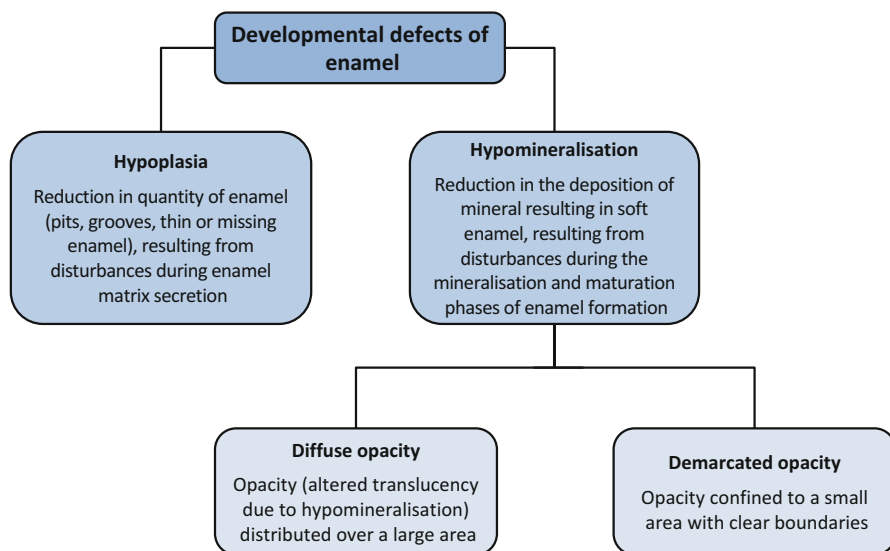
Dental enamel is the hardest tissue of the body. Its formation (amelogenesis) takes place over a time window starting prenatally and spanning the first years of life up to age 11, with specific timings depending on tooth type (Reid and Dean 2006). Enamel is formed incrementally and cyclically during tooth development. Similar to the rings of a tree, the periodical activity of enamel-secreting cells results in fine lines, the so-called Striae of Retzius, which can be seen on the enamel surface as grooves called perikymata (Figs. 3.2 and 3.3). In accordance with a critical

**Fig. 3.2** Visible perikymata on the surface of dental enamel (Image courtesy of Dr Ali Golkari, Shiraz University of Medical Sciences, Iran)



**Fig. 3.3** Rings of a tree (Note: This is a Wikimedia image released unconditionally into the public domain, no copyright: <http://en.wikipedia.org/wiki/File:Tree.ring.arp.jpg>)





**Fig. 3.4** Types of developmental defects of enamel (Adapted from Seow 2013)

period model, disturbances occurring during the development of dental enamel may result in visible and immutable defects. The microstructure of enamel therefore provides a fascinating record not only of the timing of tooth development, but also of any disturbances due to early life experiences. These features of enamel are used also in anthropological and evolutionary research (Dean 2006; Humphrey et al. 2008). Dental hard tissues can also provide important information on exposure to environmental pollution. For example, recent advances make it possible to assess lead levels accumulated over the first few years of life from exfoliated primary teeth.

The aetiology and implications of developmental defects of enamel (DDE) have been reviewed by Seow (2013). An overview of the classification of enamel defects is shown in Fig. 3.4. Enamel defects due to disturbances during the secretion phase result in enamel hypoplasia, a reduction in the quantity of enamel. Insults during the mineralisation and maturation phases manifest as enamel hypomineralisation, which becomes visible in the form of diffuse or demarcated opacities.

Enamel defects are caused by a range of factors including genetic conditions (Table 3.1). Of interest from a life course perspective are especially those influences that are acquired rather than hereditary. These include early malnutrition, metabolic disturbances, infections, exposure to chemicals or drugs and trauma, or combinations of these. Systemic factors will affect several teeth at the same time, depending on their developmental stage, while defects involving only single teeth point towards localised trauma such as from orotracheal intubation in preterm children. It is possible to deduce the timing of the insult from the type of defect, i.e. hypoplasia

**Table 3.1** Main causes for developmental defects of enamel (Seow 2013)

Main causes	Examples
Genetic	Amelogenesis imperfecta
Malnutrition	Protein-energy malnutrition (PEM), Vitamin D deficiency (rickets)
Metabolic disturbances	Chronic renal and liver disease, coeliac disease, hypocalcaemia
Infections	Respiratory infections, chickenpox, rubella, measles, mumps, influenza, cytomegalovirus, meningococcal infection, congenital syphilis
Exposure to chemicals or drugs	Dental fluorosis, tetracyclines, lead, cytotoxic drugs
Localised trauma	Orotracheal intubation in preterm children, trauma to deciduous tooth affecting enamel development of permanent tooth

or hypomineralisation, and from its location on the tooth surface (Seow 1997, 2013).

Enamel defects have been frequently linked to low birth weight, an association that has been recently examined in a systematic review of 23 studies. The review concluded that there is currently good evidence for a relationship between very low birth weight and enamel opacities, and between preterm birth and enamel hypoplasia in primary teeth (baby teeth), while for permanent teeth the evidence was deemed inconclusive (Jacobsen et al. 2014). The main pathway is probably via mineral deficiencies resulting from the systemic conditions that are associated with low birth weight, such as malnutrition, gastrointestinal and renal disorders and severe infections (Seow 2013). Maternal risk factors related to low birth weight, such as smoking, have also been implicated in the aetiology of enamel defects (Needleman et al. 1992). Given that the risk of low birth weight is associated with socio-economic disadvantage (Kramer et al. 2000), it would be expected that the prevalence of enamel defects is socially graded. However, the question of a social gradient in relation to developmental defects of enamel has not been conclusively addressed in the literature.

The most important consequence of enamel defects is an increased susceptibility to dental caries, but aesthetic concerns and tooth sensitivity can also be considerable, and clinical management especially of children can be difficult and costly (Seow 2013). Thus, developmental defects of enamel may be viewed as one link in a chain of risk model, where early life stressors lead to enamel defects, which in turn are associated with a higher risk of dental caries. For the primary dentition, the particular pathway between early malnutrition and dental caries has been reviewed and generally supported, however high quality evidence from longitudinal studies is still needed (Psoter et al. 2005).

## ***Early Life Conditions and Adult Oral Health***

Most of the oral health research that explicitly made reference to a life course approach has examined childhood socio-economic characteristics in relation to adolescent or adult oral health. The paucity of prospective cohort studies that contain clinical data on oral health means that much of the longitudinal evidence currently available stems from only three birth cohort studies: the Newcastle Thousand Families 1947 birth cohort in England, the Dunedin Multidisciplinary Health and Development Study in New Zealand, whose members were born in 1972–1973, and the 1982 and 1993 Pelotas birth cohorts in Brazil. An alternative approach taken by a number of studies is the use of information collected retrospectively.

### **Childhood Socio-economic Background and Adult Levels of Disease**

Three studies have analysed data from the Newcastle Thousand Families cohort to assess the relationships between childhood socio-economic status (SES) and tooth retention, as well as oral health-related quality of life, at 50 years of age (Mason et al. 2006; Pearce et al. 2004, 2009). Pearce et al. (2004) examined a sample of 337 participants to establish the relative importance of risk factors operating in childhood and adulthood for tooth retention at age 50. In this study, most of the variance in the number of retained teeth was explained by adult factors, namely socio-economic status, smoking and alcohol consumption. Childhood SES was predictive of tooth retention in middle age only among women, and this relationship was no longer statistically significant after adjustment for adult SES. In contrast, in the same sample oral health-related quality of life was associated with childhood SES only among men, and again the relationship was fully mediated by adult SES (Mason et al. 2006). For both men and women, the number of retained teeth to middle age was related to oral health-related quality of life.

These findings are in contrast to research that investigated the associations between childhood SES and levels of caries and periodontal disease at age 26 in the aforementioned Dunedin Study from New Zealand (Poulton et al. 2002; Thomson et al. 2004). Both studies in this younger cohort found that childhood SES contributed to adult levels of disease, after adjusting for adult SES. A study based on the Survey of Health, Ageing, and Retirement in Europe (SHARE), which used data from 13 European countries, reported that childhood financial hardship was an independent predictor of functional limitation (reduced chewing ability) at age 50 (Listl et al. 2014). Further, Nicolau et al. (2007a) reported an independent association between low paternal education in childhood and periodontal disease in adulthood among a small sample of women in Brazil.

The role of parental education as a measure of childhood socio-economic background was examined also in a study by Bernabé et al. (2011), who analysed data from 7,112 adult participants in the Finnish Health 2000 Survey. This study explicitly tested critical period and accumulation of risk models in relation to oral

health. Outcome measures were edentulousness (total tooth loss), perceived oral health, dental caries and periodontal disease, measured in adulthood (the mean age of the sample was 53 years). Parental education was measured retrospectively, and models adjusted for participants' own level of education attained. The results supported all three life course models: both parental and own education contributed independently to adult oral health, with the exception of periodontal disease which was associated with own education only. Further, the study found a graded relationship between the level of cumulative exposure to low education and the four markers of oral health, in that oral health was poorest among those who were exposed to socio-economic disadvantage in both childhood and adulthood, followed by those who were exposed to disadvantage at only one time point, while those who were never in the low education group had the most favourable outcomes.

In the Dunedin Study, researchers also found evidence for intergenerational effects: adult caries experience at age 32 was related to maternal oral health measured at age 5 (Shearer et al. 2011). The relationship was graded across the categories of maternal self-rated oral health, with the highest caries risk found among those whose mothers had rated their oral health as poor or were edentulous, after adjusting for childhood SES and plaque trajectories. These findings are supported by results from a large cross-sectional study among more than 6,000 mother and child pairs in Quebec, Canada (Bedos et al. 2005). The Canadian data showed that caries experience among 5–9 year old children was associated with maternal edentulousness, independent of family socio-economic status, age, gender and children's oral health related behaviours such as toothbrushing, eating sugary snacks and dental visits. It is however likely that the behavioural variables adjusted for were too crude to fully explain the behavioural pathway, especially in relation to the role of dietary sugars. Similarly, parental dental status at age 10 was related to adult oral health among three different birth cohorts (born 1929–1938, 1939–1948 and 1959–1960) in Norway (Holst and Schuller 2012). To further corroborate intergenerational effects, a small study from the US among a low-income Hispanic cohort found that mothers' levels of cariogenic bacteria in their saliva were related to levels of caries experienced by their children (Chaffee et al. 2014). The authors suggest that the association is likely to be due to shared environmental factors, as well as direct maternal-to-child transfer of bacteria.

### **Impact of Social Mobility on Oral Health Outcomes**

From accumulation of risk models it follows that health outcomes should be influenced by a reduction or increase in risk via upward or downward social mobility. Such social trajectories models have been investigated also in relation to oral health, however the findings so far have been somewhat mixed.

A study on the Newcastle Thousand Families cohort used information on social class at age 25, retrospectively collected at age 50, to test associations between



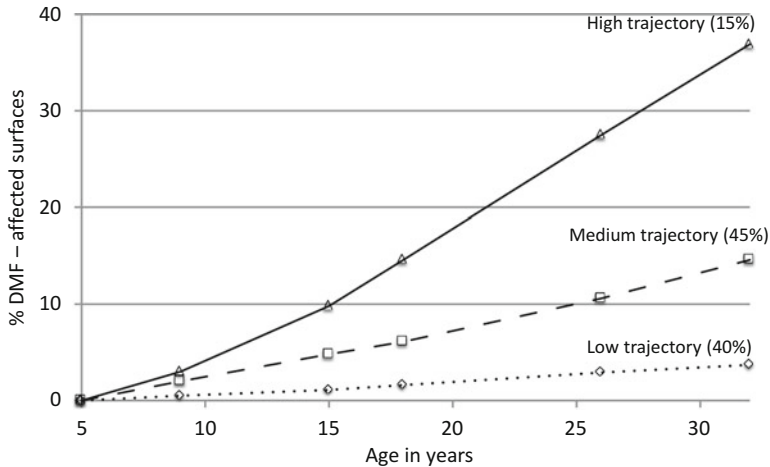
markers of oral health and upward and downward social mobility (Pearce et al. 2009). Four socio-economic mobility trajectories were constructed (stable manual, stable non-manual, upward and downward). Retaining a functional dentition to age 50 was associated with social mobility among women only. Women in the stable non-manual group were most likely and women in the stable manual group were least likely to retain a functional dentition to age 50. Between ages 25 and 50, a gradient was apparent: no difference was observed between women in the stable non-manual and upwardly mobile groups, who were most likely to retain a functional dentition, followed by the downwardly mobile and then the stable manual groups. No associations were found between social mobility trajectories and oral health-related quality of life.

Evidence that social mobility influences oral health outcomes also came from the aforementioned study by Bernabé et al. (2011), who tested a social trajectories model using information on parental education at age seven and participants' own level of education in adulthood. The authors found that oral health among study participants became progressively worse across the following social trajectories and in that order: persistently high (high parental and high own education), upwardly mobile (low parental and high own education), downwardly mobile (high parental and low own education) and persistently low education.

However, analyses of the younger 1982 Pelotas birth cohort regarding the social trajectories model produced mixed findings. Family income trajectories between birth and age 15 were only partly associated with caries experience: adolescents who had been always poor had more decay and more unmet treatment need than those who had been never poor, but no differences were observed in these regards between upward or downward mobility and being always poor (Peres et al. 2007), suggesting that the experience of poverty, even if only at one stage in early life, was associated with poorer dental health. In a later study the same sample was followed up to age 24 years, thus including data from three time points (birth, age 15 and age 24) (Peres et al. 2011). This study reported a dose–response relationship between the cumulative exposure to poverty and the number of unsound teeth, supporting the accumulation of risk model. Participants who were socially mobile had better oral health than those who were poor at all three time points. No difference was observed between upward and downward social mobility, possibly because the observed time spans were too short for potential differences to play out.

### **Trajectories of Oral Disease**

The team of researchers working on the Dunedin Multidisciplinary Health and Development Study have analysed trajectories of caries and dental plaque from childhood to young adulthood (ages 5–32), as well as periodontal disease between ages 26 and 38. The study follows all children born in 1 year (1972–1973) in the town of Dunedin, New Zealand. The initial sample comprised about 1,000 children, and the study achieved very good retention rates at later sweeps.



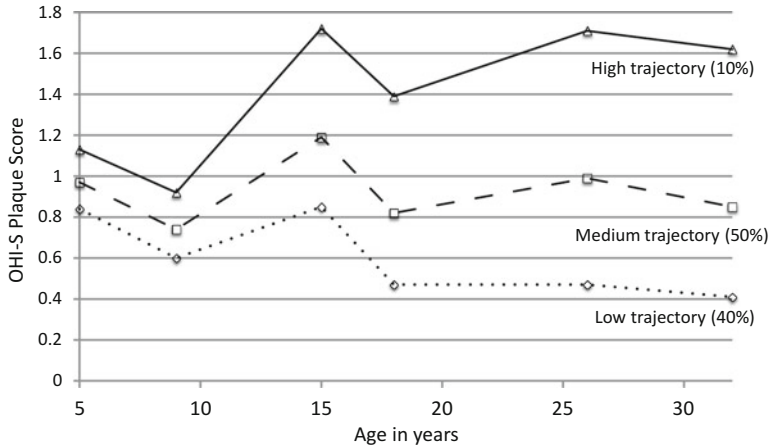
**Fig. 3.5** Mean percentage of at-risk tooth surfaces affected by caries over time. Caries levels were measured at ages 5, 9, 15, 18, 26 and 32 (Reproduced from Broadbent et al. 2008)

### Dental Caries

The progression of caries across the life course follows distinct patterns and trajectories, meaning that caries levels measured at one age predict caries levels at later ages. Broadbent et al. (2008) identified three distinct trajectories for the rate of increase in the percentage of caries-affected tooth surfaces in the permanent dentition, measured via the DMFS index (Decayed, Missing and Filled Surfaces) up to age 32. Of 955 participants who provided data at three or more time points, 40 % were in the low trajectory group, 45 % in the medium trajectory group and 15 % were classified as being in the high trajectory group. Interestingly, each of these trajectories was fairly linear, suggesting constant caries rates over time (Fig. 3.5). The authors concluded that although it is often assumed, there are no periods of markedly increased or decreased risk, and that therefore caries-preventive measures need to include all ages. However, longer follow-ups are needed to establish whether this is true also beyond the age of 32. The study was important in terms of describing caries progression patterns, but did not investigate which childhood and later life factors were associated with these different trajectories. Other research has consistently shown that caries in the primary dentition is a precursor of caries in permanent teeth (Sheiham and Sabbah 2010). The prevalence and severity of caries in the primary dentition are strongly related to individual as well as contextual socio-economic factors such as family income and maternal education (Hallett and O'Rourke 2003), as well as area deprivation (Locker 2000).

### Dental Plaque

A separate study on the Dunedin sample investigated plaque levels over the same time period, as well as associations with caries, periodontal disease and tooth loss



**Fig. 3.6** Plaque trajectories by age. The graph shows the mean plaque levels for each trajectory group at ages 5, 9, 15, 18, 26 and 32 (Data source: Broadbent et al. 2011)

(Broadbent et al. 2011). Again, three trajectories were identified, with distributions that were strikingly similar to those found earlier for dental caries. Of 911 study participants, 40 % had plaque levels that were low and decreasing with age, 50 % had medium levels that were stable, and about 10 % had levels of plaque that were high and increasing (Fig. 3.6). Those in the high plaque group were more likely to be male, to have grown up in a family with a low socio-economic status, to have attained a lower level of education as adults, to be smokers and to be episodic rather than routine dental visitors. Allowing for the influence of childhood SES, sex, dental visiting patterns and smoking, plaque trajectories were strongly associated with caries experience, tooth loss and periodontal disease. The risk of periodontal disease was especially high among those who were smokers and had high levels of plaque at the same time.

### Periodontal Disease

The most recent publication on disease trajectories coming from the Dunedin Study examined the prevalence and extent of periodontal disease through the ages 26, 32 and 38 (Thomson et al. 2013). The authors describe the following four trajectories for periodontal disease: very low (55.2 % of the sample), low (31.5 %), moderately increasing (10.7 %) and markedly increasing (2.5 %). Notable findings were a strong association between membership in the two “increasing” trajectories and long-term smoking, as well as a strong link between membership in the “markedly increasing” trajectory and low adult SES. The increase in periodontal disease was greater between ages 32 and 38 than it was between ages 26 and 32, which is to be expected as most periodontal disease occurs at later ages. The authors caution

that the analysis had some limitations in relation to the quality of the data, but more importantly, given that periodontal disease mainly affects older adults it is necessary that the characterisation of the trajectories is corroborated by following the sample over a longer time period.

Taken together, these findings are in line with accumulation of risk models including the clustering of risk factors, and suggest that early life circumstances as well as oral health-related behaviours at later ages are important in influencing long-term patterns of oral disease.

### ***Pathways Between Childhood Socio-economic Conditions and Adult Oral Health***

The evidence presented in the previous sections suggests that childhood social conditions affect later adult oral health regardless of the socio-economic position that a person achieves later in life. But what are the pathways linking early circumstances and later oral health? The following sections describe some important findings in relation to potential mechanisms.

#### **Early Malnutrition and Dental Caries**

Early material disadvantage may result in malnutrition, a condition that is associated with deficiencies in protein, energy and micronutrients (Schroeder 2001). The links between early childhood malnutrition and dental caries have been discussed in a review by Psoter et al. (2005), who suggest two main mechanisms: via enamel hypoplasia and hypomineralisation (see also section “[Developmental Defects of Enamel](#)”), and via changes in salivary function, which include salivary flow, composition and buffering capacity.

An indirect marker of childhood malnutrition is stunted growth or height for age. The 1993 Pelotas birth cohort provided some longitudinal evidence for an independent relationship between height for age deficit at 12 months of age and higher caries levels at ages 6 and 12 years, after controlling for family SES (Peres et al. 2005, 2009). Similarly, in another Brazilian study taller adolescents had lower levels of caries experience in a sample of schoolchildren aged 15 (Freire et al. 2008).

#### **Psychosocial Pathways and Oral Health-Related Behaviours**

The link between childhood socio-economic status and adult health behaviours has been highlighted more than a decade ago in the highly influential work by Lynch et al. (1997). It is today widely accepted that social conditions in childhood influence educational attainment and adult life chances, and thereby shape peoples’

psychological outlooks, such as their views about their futures and their feelings of control over their lives. Negative psychosocial dispositions, i.e. stronger beliefs in the influence of chance on health, and less thinking about the future are in turn related to health-compromising behaviours (Wardle and Steptoe 2003).

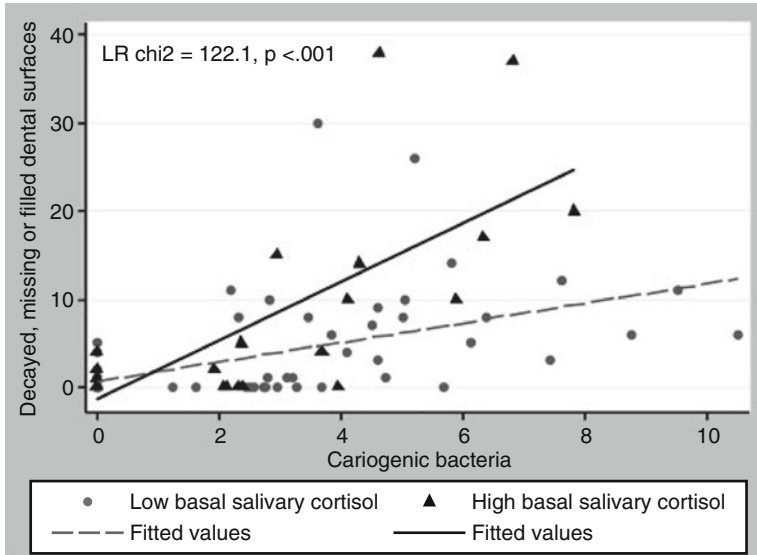
A psychosocial construct that is linked to people's sense of control and optimism is 'sense of coherence'. Sense of coherence is usually described as consisting of the three components comprehensibility, manageability, and meaningfulness in relation to one's internal and external environments (Antonovsky 1987). The role of sense of coherence in the relationship between parental education and adult oral health-related behaviours was investigated by Bernabé et al. (2009) in the Finnish Health 2000 Survey. The analysis revealed that parental education was indirectly associated with adult oral health-related behaviours, measured via a latent construct that included dental attendance, toothbrushing frequency, sugar intake frequency and daily smoking. The association was mainly mediated by adult socio-economic status measured via education and income, but to a lesser extent also by adult sense of coherence.

Support for psychosocial pathways comes also from two Brazilian studies which linked adverse family relationships, that is, high levels of paternal punishment and discipline, to the experience of traumatic dental injuries among adolescents (Nicolau et al. 2003), and also to periodontal disease among adult women (Nicolau et al. 2007a). Another study from Australia found that the recollection of a supportive parental rearing style was associated with more positive adult psychosocial attributes such as sense of control and satisfaction with life, which in turn was related to better subjective oral health (Sanders and Spencer 2005). But, all the studies mentioned here were cross-sectional and may have suffered from recall bias.

The biological mechanisms through which psychosocial adversity is translated into ill health have been investigated in a series of studies that examined the relationships between family financial stressors, oral cariogenic bacteria, salivary cortisol and dental caries among preschool children in the USA (Boyce et al. 2010). The researchers showed that dental caries was related to the number of cariogenic bacteria in the mouth, but there was a significant interaction: the association between caries levels and the number of cariogenic bacteria was stronger in children with high basal salivary cortisol secretion, which in turn was related to low family socio-economic position (Fig. 3.7). A possible explanation is that higher cortisol levels might affect immune competence and thus lower the defence against oral bacteria. This work provides evidence of a biological pathway that links higher levels of psychosocial stress with higher levels of caries in children.

### **Access to Dental Care**

Data from the New Zealand Dunedin Study provided rare longitudinal evidence for the association between long-term dental visiting patterns and oral health (Thomson et al. 2010). The study followed participants between ages 15 and 32. After adjusting for SES and oral hygiene, those who were routine dental attenders, i.e. usually

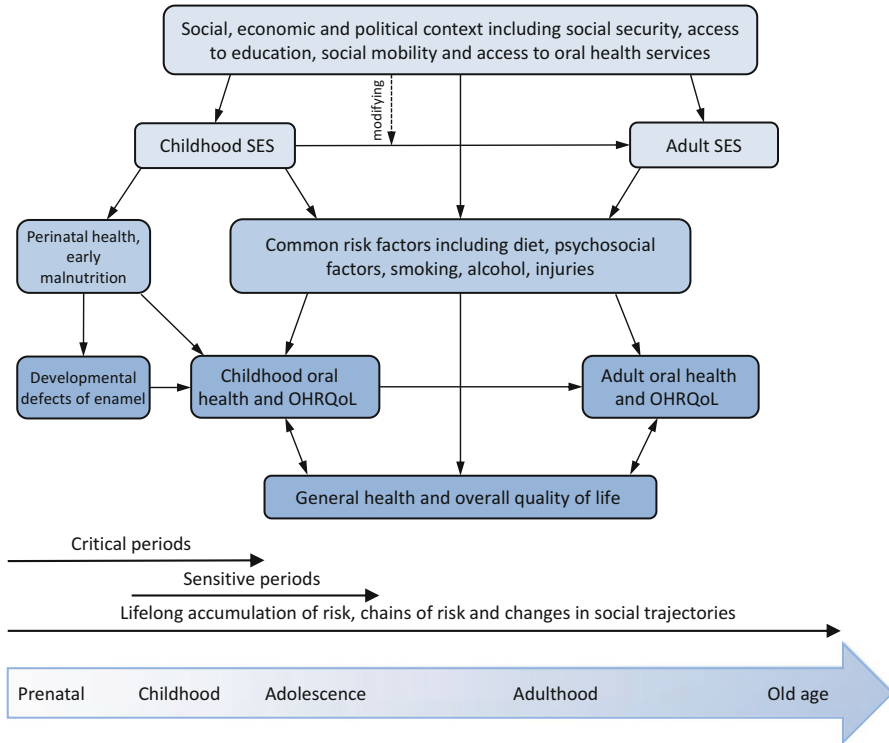


**Fig. 3.7** Cariogenic bacteria and tooth decay, by level of cortisol secretion (Boyce et al. 2010)

visited the dentist for a check-up as opposed to visiting only when having a problem, had better oral health at any given age, and this effect was stronger the longer routine attendance was maintained. An association between retrospectively collected data on regular dental attendance since childhood and chewing ability at age 50 years was also reported in the study by Listl et al. (2014), based on the analysis of data from 13 European countries. These findings suggest that the relationship between routine dental visiting and better oral health is not merely due to a “healthy user” effect, but is indeed causal.

### A Life Course Framework for Oral Health

The reviewed research has clearly shown that life course epidemiological models are very much applicable to oral diseases. Accumulation of risk including chains of risk, critical and sensitive period as well as social trajectories models are supported in the literature. Studying oral health from a life course perspective has provided insights into the importance of early life experiences, as well as lifelong trajectories of oral conditions. As is the case for general health, the underlying wider determinants of oral health are social. We therefore propose a theoretical framework for oral health that combines a life course perspective with the well-established models of the social determinants of oral diseases and their influence on the common risk factors that are shared between general and oral health (Fig. 3.8).



**Fig. 3.8** A life course framework for oral health

The model emphasises the importance of socio-economic variables in childhood and adulthood such as education and income, which are influenced by economic, political and social factors at the societal level. This includes the degree to which childhood SES predicts adult SES, in other words the level of social mobility within a country, as well as national policies and provisions in relation to education, social security, public health and healthcare. One of the pathways through which early disadvantage might translate into poorer oral health is via developmental defects of enamel. The formation of dental enamel takes place within a specific time window, which for the primary dentition and some permanent teeth starts already in the womb. It has been shown that in line with a critical period model, stressors or disturbances during the development of enamel may result in irreversible defects, thus becoming embedded in the physical structure of the teeth (Seow 2013). Enamel defects that result in increased susceptibility to dental caries may be seen as part of a chain of risk (Psoter et al. 2005).

Another pathway is via the common risk factors that are known to affect oral as well as general health. In childhood, the main risk factors are a diet that is high in sugars, poor oral hygiene, and psychosocial stress, but also first experiences with tobacco and alcohol. Traumatic dental injuries are also socially patterned. Further,

childhood and adolescence are sensitive periods, when foundations are laid for educational and occupational life chances, and when health-related behaviours are learned. For example, the research on trajectories of dental plaque discussed in the section on “[Childhood Socio-economic Background and Adult Levels of Disease](#)” suggests that hygiene habits adopted in childhood track through adolescence into adulthood (Broadbent et al. 2011). Our model further states that childhood oral health is predictive of adult oral health, in part because parental social position influences children’s own life chances and destinations in terms of education and income, while adult social position is again strongly related to the common risk factors for oral diseases. In addition, early psychosocial factors may affect susceptibility to disease through biological mechanisms such as allostatic load. Further, childhood oral health directly influences oral health in later life, due to the colonisation of the oral cavity with oral bacteria and due to the irreversibility of damage to dental hard tissue and tooth loss. However, changes in social trajectories might still lead to changes in disease trajectories, although more evidence is needed to elucidate when such changes might have the greatest impact, how big they would need to be and how they might affect oral health. Finally, the model acknowledges the interrelationships between oral and general health, and the impact of both on a person’s quality of life.

## **Policy Implications**

The emerging evidence on the determinants of oral diseases from life course epidemiological studies has profound implications for future health and social policy. It is increasingly recognised that traditional preventive approaches which rely on clinical interventions and simplistic educational support are ineffective, costly and most likely increase oral health inequalities across the population (Watt 2005). Life course studies help to conceptualise how the social determinants of health influence oral health outcomes and in particular provide compelling evidence of the importance of early life factors.

Future oral health improvement strategies need to focus on addressing the shared underlying social determinants of chronic conditions, including oral diseases. Multi-strategy public health approaches are required which aim to create a supportive health promoting social environment conducive to good oral health and greater equity. Such an approach requires effective multi-sectoral working across a range of sectors, not just within the health care system. A particular priority is focusing on early life interventions to ensure that young children and families are given the best possible start in life. Public health interventions to promote health and well-being in early life need to utilise a range of complementary strategies including healthy public policy, creating supportive environments, strengthening community action, developing personal skills and ensuring evidence based support is provided by health and social care professionals. Although of fundamental importance, evidence on caries trajectories from adolescence to later adulthood highlight that



getting a good start in life alone is not sufficient. Ongoing public health actions are also needed to protect and support good oral health across the life course. For example, oral health improvement strategies focusing on older people are needed to tackle high levels of disease amongst this group, and may also have important intergenerational effects.

Further research is needed to explore how oral health conditions such as enamel defects may be used as indicators of early life adverse exposures detrimental to health. Also, caries levels in preschool children are an accurate and relatively simple marker of social deprivation. Such approaches may help in targeting support to more vulnerable populations with particular needs.

## Summary

Most of the research on oral health from a life course perspective has focused on the associations between childhood socio-economic circumstances and adult oral health. There is good evidence that early childhood is a sensitive period, influencing lifelong oral health trajectories. While the research suggests that the socio-economic conditions under which children grow up cast a long shadow on adult levels of oral disease, there is some evidence that these influences are amenable to change, however this area of research warrants further investigation.

Poor oral health is a marker of socio-economic disadvantage, and is strongly linked to general health. More research needs to be done to further our understanding of the interrelationships between oral and general health, and how they play out over the life course. A source of information that so far remains underused are developmental defects of enamel, which can provide a unique record of early life experiences.

While the prospective cohort study is the most desirable design to study life course influences on oral health, longitudinal studies that include clinical oral health data are very rare. So far, the available evidence rests mainly on three relatively small cohorts from England, New Zealand and Brazil. Reasons for this lack of data are likely to include costs, as the collection of clinical oral health outcomes by qualified dentists is expensive. Respondent burden might be another consideration. An alternative would be to use validated measures of self-reported outcomes such as self-rated oral health and oral health-related quality of life, which have been shown to correspond well with objective measures of disease (Pattussi et al. 2007). Unfortunately it is also quite likely that oral health is still seen as a low priority health outcome. We hope to have succeeded in highlighting the potential and importance of collecting high quality oral health data within cohort studies with large, nationally representative samples.

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