Inequalities in oral health in England

Contents

Foreword

Public Health England's mission is to protect and improve the nation's health and to address inequalities.

A value shared by colleagues in public health is that they want to 'make a difference' and in particular, they want to ensure that everyone in the population has an equal and fair opportunity to be healthy.

Where people live, their education, their employment, a suitable roof over their head, their friends, family and the networks they belong to all are important for health and wellbeing.

Tackling the causes of inequalities is not easy. "Action on the social determinants of health requires action across multiple arenas and domains and that requires commitment and know-how from a range of workforces outside health."[1]

Having a healthy mouth is not going to change everyone's life chances, but oral health is very important as it affects what we can eat, how we communicate and socialise, and our self-confidence. Poor oral health can result in missing school or work and even in dropping out of employment. Achieving good oral health as part of good overall health and wellbeing is therefore a vital aspect of helping people live well. A good smile is a good start in life!

The steps to improving oral health involve reducing the amount of sugar we consume, brushing our teeth and having access to the protective effects of fluoride. We also need equity of access to both preventive and treatment services for all. This will mean targeted support and bespoke solutions for some in society. There is an ethical and a legal duty for the public sector under the Equality Act 2010.

Targeted support for tooth brushing in early years settings and water fluoridation have most benefit in those with the worst oral health.

There are good examples in England of informed commissioning of services that understand the unique challenges of providing care for disadvantaged groups such as those experiencing homelessness.

This report draws on the extensive literature on socio-economic inequalities in oral health and describes inequality seen by geography, and experienced by disadvantaged groups and those with protected characteristics.

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[1] Marmot et al, Health Equity in England: The Marmot Review 10 Years On (2020)

Going back to our shared values, describing inequalities is not enough we want to make a difference. Findings from this report are already informing action to reduce inequalities in oral health involving the co-ordination and collaboration of multiple organisations.

Public Health England intends to publish a companion piece to this report, setting out in more detail what action is needed to address research and epidemiological gaps. Our ambition is that children from all backgrounds should expect to grow up free from tooth decay as part of having the best start in life, and that all adults should have a healthy mouth as part of living well.

"As long as poverty, injustice and gross inequality persist in our world,
none of us can truly rest"
Nelson Mandela
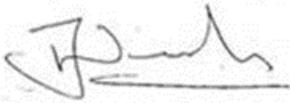
Professor John Newton   Dr Sandra White
Director of Health Improvment   National Lead for Dental Public Health

1. Purpose and scope of the document

Although there is a considerable amount of literature describing inequalities in oral health, there is value in summarising this large body of evidence in one document to inform equality impact assessments and the commissioning of health improvement and treatment services in England.

The objectives of this report are to:

1. describe oral health inequalities in England using epidemiological data, National Health Service for England (NHS) data and published literature
2. summarise evidence on interventions that reduce oral health inequalities from the published literature

The document reports on inequalities by socioeconomic position, geographic area, protected characteristics and vulnerable or 'seldom heard' groups. Table 1.1 summarises measures of different types of inequalities.

Table 1.1 Measures of different types of inequalities

Inequality type	Measures
Socioeconomic position	Education; income/wealth; occupation/social class; employment status; eligibility for free school meals; and area-based measures of deprivation (for example, Indices of Multiple Deprivation, Townsend Index, Carstairs Index, Jarman Under Privileged Area score)
Protected characteristics	Age; sex; ethnicity; disability; marriage and civil partnership; pregnancy and maternity; religion; sexual orientation; and gender reassignment
Vulnerable groups	Homeless; prisoners; travellers; people with longstanding medical conditions; refugees; looked-after children; and sex workers
Geography	Georgraphical locations

The document covers 9 different outcomes related to oral health:

1. dental caries (tooth decay)
2. odontogenic (tooth-related) infection for example, PUFA (pulp involvement, ulceration, fistula, abscess)
3. periodontal (gum) diseases
4. tooth loss
5. traumatic dental injuries
6. oral cancer
7. self-rated oral health

8. oral health related quality of life (including oral pain)
9. oral health related behaviours (fluorides, tooth brushing or oral hygiene, sugar intake and dental service use)

Chapter 3 describes oral health inequalities in England using epidemiological surveys and NHS data.

As available epidemiological surveys and NHS data do not report inequalities across all types and measures of inequalities, Chapter 4 summarises evidence on oral health inequalities in England and beyond, based on scoping and rapid reviews of the literature.

Chapter 5 outlines what could be done to tackle oral health inequalities and summarises evidence on community-level and service utilisation interventions to reduce oral health inequalities based on rapid reviews of the literature. Chapter 6 outlines next steps to follow this report.

2. The importance of addressing oral health inequalities

2.1 Introduction

This chapter outlines the importance of having good oral health and the financial costs of oral diseases. It defines oral health inequalities and summarises their causes andpresents the case for the importance of addressing oral health inequalities.

2.2 Importance of good oral health

"Oral health is multi-faceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex." (1).

Good oral health is essential for general health and wellbeing. For example, good oral health can support older people to stay independent for longer, or to recover from episodes of crisis or frailty.

On the other hand, poor oral health can have a negative impact throughout life and can cause pain and infection, leading to difficulties with eating, sleeping, socialising and well being. Amongst adults, it can result in time off work due to pain or for treatment. Children with poor oral health are likely to have time off school and their parents and carers are likely to have time off work to take them for treatment. Tooth decay is still the most common reason for hospital admissions in the 6 to 10 year old age group (2). In 2018 to 2019 there were 37,406 hospital procedures for extraction of carious teeth in children age 0 to 19 years old (2). This means that around 102 children a day, some just a year old, are having teeth removed in hospital. An average of 3 days are missed from school due to dental problems (3). Extraction of teeth with general anaesthetic is often a child's first introduction to dental care and can lead to fear and anxiety with lifetime consequences.

2.3 The financial cost of oral diseases

In England oral diseases place significant costs on society and the NHS for what are essentially preventable diseases. The NHS spent £3.6 billion on dental care in 2017 to 2018 in England (4). A similar amount is estimated to be spent on private sector dental care in the UK (4).

In 2015 to 2016 the cost of tooth extractions alone was approximately £50.5m among children aged 0 to 19 years in England (3), the majority of which were for tooth decay. This represented the biggest cost to the NHS for this age group across all areas of healthcare.

The cost to the NHS of health inequalities have been estimated to be £5.5 billion per year (5) and the NHS spend on those in the lowest income quintile has been estimated to be 25% higher than spend on those in the highest (6).

Evidence shows that prevention and early intervention are effective in improving or maintaining health and represent good value for money (7). Not only do well-chosen public health interventions implemented at a scale help to avoid poor health and reduce the growth in demand on the NHS, they can also reduce pressure on other public services and support economic growth. Figure 2.1 shows the positive impact preventative measures can have in terms of reducing NHS costs, social care costs, and wider economic costs, and preventing productivity losses.

Figure 2.1 The costs of poor health

Public Health England   Health**matters**

Making the case for prevention

Investing in prevention can protect individuals and their health, but also wider parts of the economy:

NHS costs

Social care costs

Productivity losses

Wider economic costs

e.g. hospital care and medical treatment

e.g. residential care

e.g. sickness absence

e.g. alcohol-related crime

2.4 Oral health inequalities

Good oral health is not enjoyed equally across the population in England (8, 9, 10). Oral health inequalities can be defined as differences in levels of oral health that are avoidable and deemed to be unfair, unacceptable and unjust (11, 12). They are not simply the differences in oral health status between the richest and poorest extremes in society. As is the case with general health, a consistent stepwise relationship exists across the entire social spectrum with oral health being worse at each point as one descends along the social hierarchy, a relationship known as the social gradient (13). However, the most marginalised and socially excluded groups in society such as homeless people, prisoners, people with disabilities and refugees experience extreme

oral health inequalities with very high levels of oral diseases, a perfect example of a 'cliff edge' of inequality (14). These inequalities are not merely academic issues as the universal nature of the social gradient and cliff edge of inequality has profound implications for policy measures to reduce oral health inequalities in society.

The impacts of poor oral health disproportionally affect the most vulnerable and socially disadvantaged individuals and groups in society. These differences in oral health across population groups do not occur by chance, nor are they inevitable. Oral diseases are largely preventable and therefore are avoidable. Reducing these oral health inequalities is a matter of social justice and ethical imperative.

The World Health Organization's Commission on Social Determinants of Health articulated an emphatic call for action on addressing health inequalities (15) and nationally, public bodies across the health sector have legal duties and responsibilities to address inequalities that are set out principally through 2 pieces of legislation:

- the Equality Act 2010 sets out the public sector Equality Duty
- the Health and Social Care Act 2012 sets out the Health Inequalities Duty

Details of these duties can be found in Appendix 1.

Figure 2.2 shows how health inequalities have been documented between population groups across at least 4 dimensions, namely socioeconomic position, protected characteristics, vulnerable groups and geography. It is important to note that these are overlapping dimensions with people often falling into various combinations of these categories.

Figure 2.2 Dimensions of inequalities

Socioeconomic position could be measured at an individual and area-based level. Different indicators are used to measure socioeconomic position, such as:

- education
- income or wealth
- occupation or social class
- employment status
- eligibility for free school meals
- area-based measures of deprivation (for example, Indices of Multiple Deprivation, Townsend Index, Carstairs Index, Jarman Under Privileged Area score)

Protected characteristics include age, disability (including mental illness), gender reassignment, marriage and civil partnership, pregnancy and maternity, race (including self-defined ethnicity), religion or belief, sex, and sexual orientation.

Vulnerable groups (disadvantaged groups) include, but are not limited to: homeless people, prisoners, travellers, people with longstanding medical conditions, refugees, looked-after children, and sex workers.

Appendix 2 provides definitions of the abovementioned types of inequalities.

2.5 Causes of oral health inequalities

Actions to address oral health inequalities need to be informed and guided by theoretical understanding of the underlying causes of health inequalities in society. Global health policy to reduce health inequalities has been heavily influenced by the World Health Organization's (WHO) seminal review which presented a comprehensive theoretical framework of the underlying political, economic and societal causes of health inequalities, the social determinants ('the conditions in which people are born, grow, live, work and age and the structural drivers of those conditions the inequitable distribution of power, money and resources) (15). The WHO framework has been modified to consider specifically the social determinants of oral health inequalities (16). The following summarises the upstream, midstream and downstream determinants or causes of oral health inequalities.

2.5.1 Upstream structural determinants – political, economic and environmental drivers of inequalities

The structural determinants are the overriding influences that ultimately create and determine the social and physical conditions of life and the opportunities and choices available to people. For example, the state of the economy and economic policy determines levels of economic growth, income levels and the distribution of wealth across society. Welfare, employment and education policies are all highly influential in determining resources and opportunities particularly for the most vulnerable groups in society. These structural factors are therefore the underlying drivers of oral health inequalities.

2.5.2 Midstream intermediary determinants – circumstances, vulnerabilities and risks

Largely driven by the structural factors, the intermediate determinants refer to an individuals' social position and the day-to-day circumstances and living conditions they experience. Social position includes such indicators as social class, income levels and educational status, all of which have a powerful influence on oral health. Material and social circumstances include access to resources, quality of housing and social relationships. Psychosocial factors encompass a wide range of influences such as self-esteem, anxiety and stress, social support and social capital, again all having either direct or indirect influences on oral health. Accessible, affordable and appropriate health services are also clearly an important determinant of oral health inequalities.

2.5.3 Downstream proximal determinants – behavioural and biological influences

The proximal determinants include oral health related behaviours such as diet, tobacco use, hygiene practices and alcohol use and the biological factors that are directly linked to oral diseases, namely inflammation, infection and immunity. These downstream factors are heavily influenced by the broader structural and intermediary determinants in society. For example, health behaviours such as smoking, sugar consumption and hygiene practices are all highly socially patterned (16).

Very recently the WHO framework has been further modified to consider the more specific factors that influence the oral health status of the most vulnerable population groups in society (17). Enabling (protective) and disabling (detrimental) factors have been included in this new framework to capture the experiences and influences of adverse life events, social isolation, stigma, discrimination, abuse and harassment.

Figure 2.3 gives a conceptual framework for the social determinants of oral health inequalities taking into account structural and intermediate determinants. It shows how wider socioeconomic and political contexts can impact on socioeconomic position, which in turn can impact on material and social circumstances, beahviours and biological factors, psychological factors and health services, and how these in turn lead to oral health inequalities and social gradient.

Figure 2.3 Conceptual framework for the social determinants of oral health inequalities

Structural Determinants

(Political and economic drivers)

Socio economic &

political context

Macro economic policies

Social & welfare policies

Political autonomy

Discrimination

Globalisation

Intermediary Determinants

(Circumstances & risk for oral disease)

Socioeconomic

Position

Social Class

Gender

Ethnicity

Occupation

Income

Material & social circumstances
Living and working conditions
Food security
Social capital
Behaviours & biological factors
Age, genetics
Inflammatory Processes
Infections
Psychological Factors
Stress
Perceived control
Social support
Health Services
Quality of care
Appropriate Access
Evidenced based preventative orientation

Oral health inequalities

And

Social gradient

Source: Watt, RG. Sheiham, A. (2012). Integrating the common risk factor approach into a social determinants framework. Community Dentistry and Oral Epidemiology 40, 289 to 296.

2.6 Summary

Good oral health is essential for good general health and wellbeing. Poor oral health can have a negative impact throughout life and can cause pain, infection and lead to difficulties with eating, sleeping, socialising and wellbeing. In England oral diseases place significant costs on society and the NHS for what are essentially preventable diseases. Good oral health is not enjoyed equally across the population in England. The impacts of poor oral health disproportionally affect the vulnerable and socially disadvantaged individuals and groups in society. Oral health inequalities can be defined as differences in levels of oral health that are avoidable and deemed to be unfair, unacceptable and unjust. There are upstream, midstream and downstream causes of oral health inequalities. Reducing oral health inequalities is a matter of social justice and ethical imperative. Public bodies across the health sector in England have legal duties and responsibilities to address inequalities.

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3. Oral health inequalities in England: what do epidemiological surveys and NHS data tell us?

3.1 Introduction

This chapter describes oral health inequalities using data from the decennial UK adult dental health survey and child dental health survey, the National Dental Epidemiology Programme (NDEP) and the National Cancer Registration and Analysis Service. Service data is from NHS England commissioning and activity statistics, NHS Dental Statistics, Hospital Episode Statistics, and Summary of the Dental Results from the GP Patient Survey. Data on population demographics was obtained from the Office for National Statistics website.

Details of these data sources are summarised in Appendix 3.

In England, the oral health of the adult and child populations have improved. For example, the proportion of dentate adults with one or more decayed teeth decreased from 56% in 1998 to 30% in 2009. Similarly, the proportion of adults with no natural teeth reduced from 37% in 1968 to 6% in 2009. The percentage of adults reporting at least one impact on their daily life due to their oral condition in the preceding 12 months reduced from 51% in 1998 to 39% in 2009. The proportion of 5 year old children in England with experience of obvious decay decreased from 31% in 2008 to 23% in 2019.

Despite this observed and welcomed improvement in oral health in England, unacceptable inequalities in oral health persist. How dental services are commissioned, contracted and organised can negatively or positively influence oral health inequalities.

Dental services in England are funded either privately or by NHS England. Although in some areas of the country private dental care makes up a significant proportion of the dental market, collated service data is not available so are out of the scope of this report. NHS activity data from primary care dental services is available from the Business Services Authority (BSA).

The availability of NHS dental services is largely based on provision prior to 2006 when dentists were able to set up a dental practice wherever they chose. Since 2006, NHS funded dental services at primary, secondary and tertiary care levels have been commissioned by the NHS and at the time of the contract change, perpetual contracts were made with existing NHS dental providers based on their historical service provision. This 'new contract' effectively capped spend on dental care by giving all NHS practices an annual sum based on a reference year. Another important change at that time was that patients were no longer registered with a dentist and now only have a formal relationship with a dentist whilst they are undergoing a course of treatment.

In an attempt to reduce inequalities in access to care, NHS dental services are free for some patients. These include those:

- who are under 18, or under 19 and in full-time education
- who are pregnant or have had a baby in the last 12 months
- being treated in an NHS hospital by a hospital dentist
- who are reciving Income Support, Income-related Employment and Support Allowance and Income-based Jobseeker's Allowance
- who are receiving Pension Credit Guarantee Credit
- who are recivieng Universal Credit (in certain circumstances)
- who hold a valid NHS tax credit exemption certificate, a valid HC2 certificate (for people on a low income) or a valid maternity exemption certificate

Although there is also an NHS Low Income scheme (HC3) for partial help with NHS charges, dental co-payments are most likely to affect those sections of the population who are 'just about managing', who are not exempt from payments but may struggle to budget for dental care.

3.2 Oral health inequalities by socioeconomic position

3.2.1 Oral health inequalities by individual-level socioeconomic position

3.2.1.1 Adult oral health data

The 2009 adult dental health survey showed that there was a social gradient across different oral health indicators (Table 3.1). Adults in routine and manual occupations had higher levels of dental caries, unrestorable (severe) dental caries, periodontal diseases (visible plaque, bleeding on probing and periodontal pocketing) and tooth loss than their counterparts in intermediate occupations. The latter in turn had higher levels of these oral diseases compared to their counterparts in managerial and professional occupations.

Adults in managerial and professional occupations were more likely to have excellent oral health and rate their dental health as good or very good than their counterparts in intermediate occupations. The latter in turn were more likely to have excellent oral health and rate their dental health as good or very good than their counterparts in manual occupations.

Table 3.1 Variations in adult oral health by individual-level socioeconomic position (in percentage, based on the UK adult dental health survey 2009)

Oral health indicators	Occupational class		
	Routine and manual (%)	Intermediate (%)	Managerial and professional (%)
Dental caries	37	31	26
Unrestorable dental caries	13	8	5
PUFA^	9	7	4
Periodontal condition+			
Visible plaque	72	68	59
Bleeding on probing	58	53	49
Pocketing (4+mm)	48	47	43
Tooth loss+	10	4	2
Excellent oral health^^	7	9	12
Self-rated oral health^^^	66	69	76
Oral health related quality of life			
Functional limitation*	18	13	8
Physical pain*	64	62	52
Psychological discomfort*	44	42	34
Physical disability*	19	16	10
Psychological disability*	36	28	22
Social disability*	16	14	10
Handicap*	13	10	8
At least one problem (OHIP 14)**	42	42	34
At least one oral impact (OIDP)***	35	32	31
Oral health related behaviours+			
Frequency of tooth brushing$	68	74	79

Oral health indicators	Occupational class		
	Routine and manual (%)	Intermediate (%)	Managerial and professional (%)
High Sugar intake$$	50	48	50
Dental service attendance			
Regular attendees	55	61	66
Only with trouble	34	28	22

[+] England-only figures
[^] PUFA: pulp involvement, ulceration, fistula, abscess
[^^] Excellent oral health included having 21 or more teeth, 18 or more sound and untreated teeth/roots, no active decay and being periodontally healthy with no calculus or bleeding
[^^^] Good and very good
[*] Occasionally, often or very often
[**] Based on the frequency of impacts on quality of life, as measured by the short version of the Oral Health Impact Profile (OHIP-14).
[***] Based on the severity of impacts on daily performance
[$] Twice a day or more
[$$] Having 6 or more intakes a week of puddings, cakes, biscuits, sweets, chocolate, pastries and fizzy drinks.

With respect to oral health-related quality of life, the percentage of adults reporting at least one impact due to their oral conditions in the preceding 12 months varied by individual-level socioeconomic position with more people from routine and manual occupations experiencing at least one oral impact occasionally, fairly often or very often compared to people from intermediate or managerial and professional occupations. Adults in routine and manual occupations were more likely to report impacts occasionally or more often across all types of reported problems. They were also more likely to report oral impacts on daily performance than adults from intermediate or managerial and professional occupations.

With regard to oral health behaviours, adults in managerial occupations were more likely to report brushing their teeth at least twice a day and attending the dentist on a regular basis than their counterparts in intermediate occupations. The latter in turn were more likely to report brushing their teeth at least twice a day and attending the dentist on a regular basis than their counterparts in manual occupations. There was no variation in high sugar intake by individual-level socioeconomic position.

3.2.1.2 Child oral health data

The 2013 child dental health survey showed that amongst children self-reported oral health problems and impacts varied by socioeconomic position. Children aged 12 and 15 years who were eligible for free school meals were more likely to report toothache in the past 3 months. Twelve-year olds who were eligible for free school meals were also more likely to report bleeding or swollen gums (21%) or a broken tooth (12%) in the previous 3 months than their counterparts who were not eligible for free school meals (14% and 7%). Similarly, fifteen year old children who were eligible for free school meals were more likely to report one or more oral

impacts (53%) in the previous 3 months than children who were not eligible for free school meals (43%). Twelve year old children who were eligible for free school meals were much more likely to report 2 or more oral impacts (40%) in the previous 3 months than 12 year old children who were not eligible for free school meals (27%).

Oral health behaviours in terms frequency of consumption of sugary drinks and toothbrushing varied by socioeconomic position. Both 12 and 15 year old children who were eligible for free school meals were at least twice as likely to report having sugary drinks at least 4 times a day compared to those not eligible for free school meals. Fifteen year old children eligible for free school meals were less likely to self-report brushing their teeth at least twice a day (71%) than 15 year olds who were not eligible for free school meals (82%).

3.2.1.3 NHS dental service data

The NHS data showed that between 2014 to 2015 and 2018 to 2019, while the total number of courses of treatment for paying adults and children has increased by 2.5% the total number of courses of treatment for non-paying adults has decreased by 4.2% (Figure 3.1).

Figure 3.1 Percentage of Courses of Treatment by patient type (2014 to 2019)

2014-15	Children	27.8
	Non-paying adult	20.9
	Paying adult	51.3
2015-16	Children	28.3
	Non-paying adult	19.6
	Paying adult	52.1
2016-17	Children	28.5
	Non-paying adult	18.6
	Paying adult	52.9
2017-18	Children	29.1
	Non-paying adult	17.4
	Paying adult	53.5
2018-19	Children	29.6
	Non-paying adult	16.7
	Paying adult	53.8

Proportion of courses of treatment 2018 to 2019 (%)

Source: NHS digital 2019

21
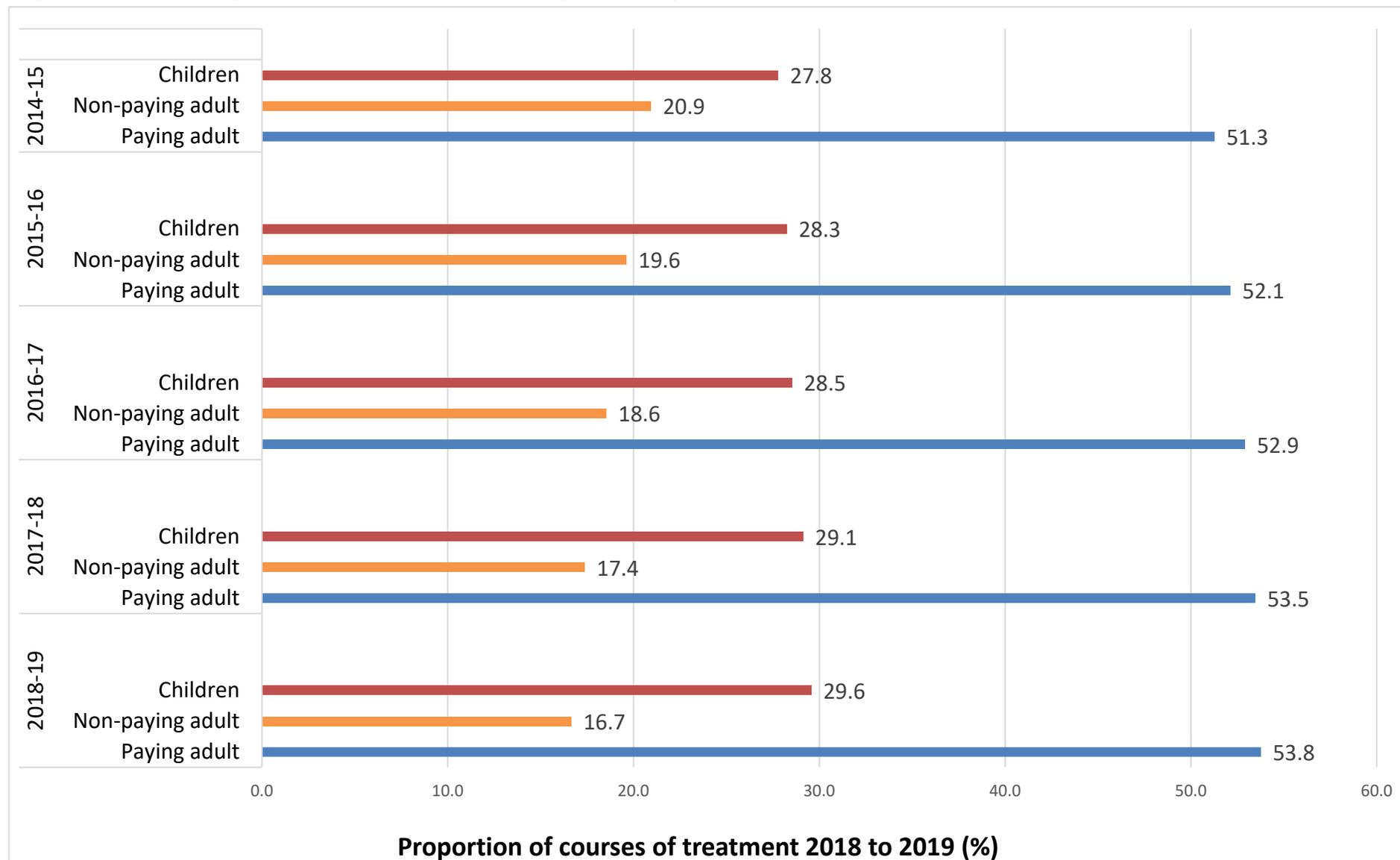
3.2.2 Oral health inequalities by area-level socioeconomic position

3.2.2.1 Adult oral health data

Variation in oral health diseases by area deprivation was not reported in the UK adult dental health survey 2009. Based on cancer registers, the incidence and mortality of oral cancer increased with deprivation.

3.2.2.2 Child oral health data

The 2013 NDEP showed that amongst children in England 19% of 3 year old children living in the 10% most deprived areas of the country and 6% of children living in the 10% least deprived areas had experienced dental caries. Deprivation explained 19% of the variation in prevalence and 25% of the variation in severity of dental caries.

The 2019 5 year old NDEP showed that 34% living in the 10% most deprived areas of the country and 14% living in the 10% least deprived areas had experienced dental caries. Deprivation explained 38% of the variation in prevalence of dental caries (Figure 3.2) and 42% of the variation in severity of dental caries.

Figure 3.2 Correlation between dental caries prevalence amongst 5 year olds and Index of Multiple Deprivation (IMD) 2019 by lower tier local authority, 2019
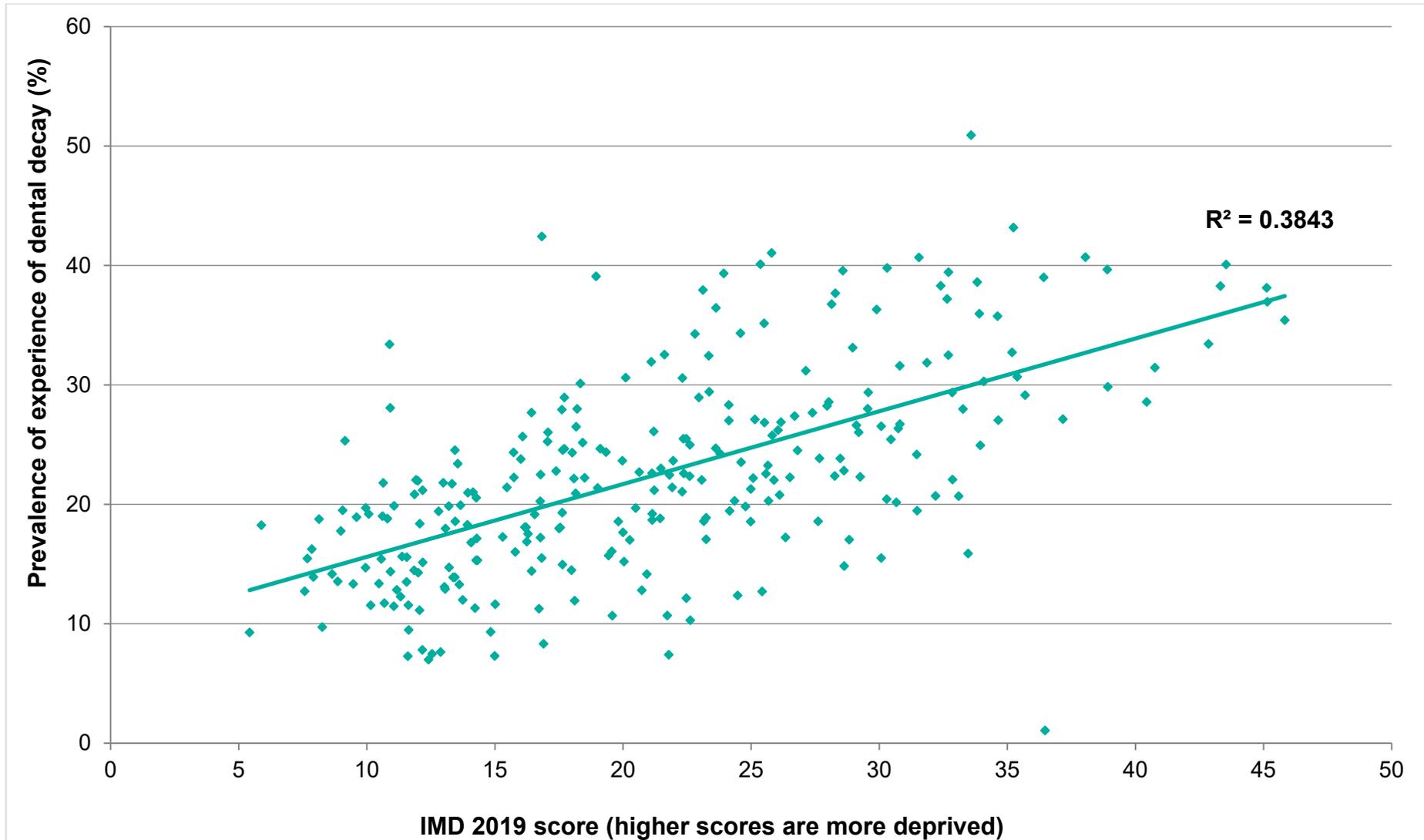
Source: PHE, 2020

Amongst 15 year old children, the prevalence of severe or extensive dental caries was 20% in those living in the most deprived 10% of areas and 8% for their counterparts living in the least deprived 10% of areas.

3.2.2.3 NHS dental service data

Hospital Episode Statistics data from 2018 to 2019 for children aged 0 to 19 reported a total of 37,406 extractions. The rate of extractions per 100,000 population varied between area-level socioeconomic groups. The highest rates are seen in the most deprived populations (Table 3.2) with the rate in the most deprived quintile over 3 times that of the least deprived quintile. Trend data show that while the overall extraction rate has decreased slightly between 2014 to 2015 and 2018 to 2019, the pattern with respect to deprivation has not changed and inequalities persist (Figure 3.3).

Table 3.2 Hospital extractions for children aged 0 to 19 by deprivation quintile 2018 to 2019

Index of Multiple Deprivation England Quintile	Carious tooth extractions	Quintile population	Tooth extraction rate per 100,000 population
1 (most deprived)	14,653	3,143,218	466.18
2	8,950	2,747,615	325.74
3	6,080	2,504,350	242.78
4	4,479	2,391,983	187.25
5 (least deprived)	3,244	2,454,121	132.19
England	37,406	13,241,287	282.50

Source: PHE 2020

Figure 3.3 Hospital extraction rate due to caries (0 to 19 year olds) by deprivation quintile between 2014 to 2015 and 2018 to 2019
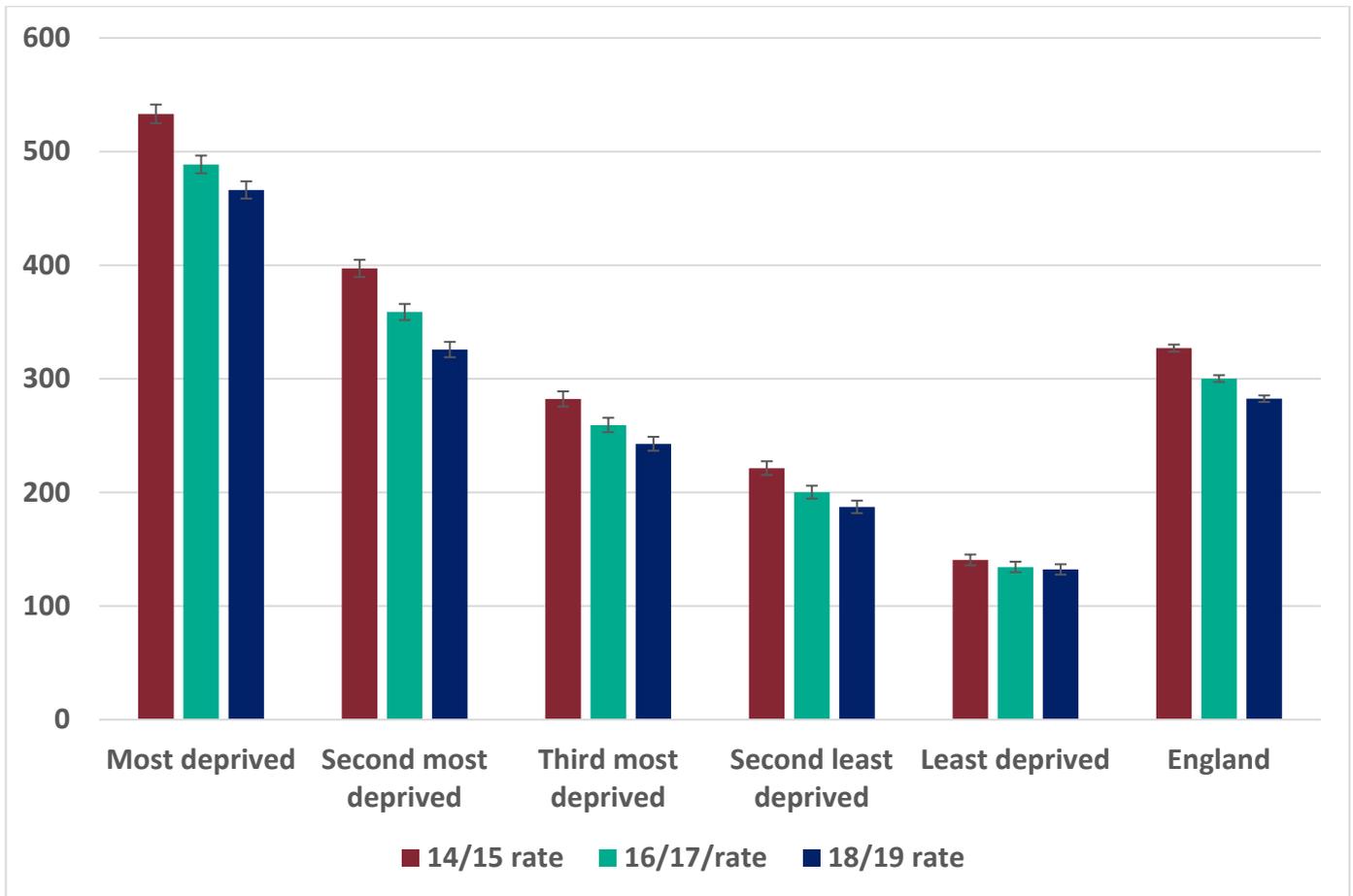
Source: PHE 2020

3.3 Oral health inequalities by geographical areas

3.3.1 Adult oral health data

Table 3.3 summarises geographic variations in the prevalence of oral health indicators amongst adults in England. The pattern of these variations was not consistent across all oral health indicators.

Table 3.3 Variations in adult oral health by geographical area (in percentage, based on the UK adult dental health survey 2009)

Oral health indicators	Geographic areas									
	North East	North West	Yorkshire & The Humber	East Midlands	West Midlands	East of England	London	South East Coast	South Central	South West
Dental Caries[+]	34	30	30	32	39	23	28	21	29	36
Unrestorable caries[+]	11	9	9	8	7	7	10	7	4	9
PUFA[+^]	9	9	4	6	7	5	7	4	5	10
Periodontal condition[+]										
Visible plaque	70	81	68	78	81	42	67	45	60	67
Bleeding on probing	61	51	62	60	61	32	49	52	64	57
Pocketing (4+mm)	43	43	42	44	53	32	46	49	39	59
Tooth loss[+]	8	7	7	6	9	4	4	5	2	6
Excellent Oral Health[+^^]	10	7	8	7	4	20	11	17	7	6

[+] England-only figures
[^] PUFA: pulp involvement, ulceration, fistula, abscess
[^^] Excellent oral health included having 21 or more teeth, 18 or more sound and untreated teeth/roots, no active decay and being periodontally healthy with no calculus or bleeding.

Table 3.3 (continued) Variations in adult oral health by geographical area (in percentage, based on the UK adult dental health survey 2009)

Oral health indicators	Geographic areas									
	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East Coast	South Central	South West
Self-rated oral health^^^	73	70	68	74	75	70	67	71	73	68
Oral health-related quality of life+										
Functional limitation*	12	12	10	17	10	12	14	14	11	16
Physical pain*	64	64	60	61	54	59	55	65	53	68
Psychological discomfort*	42	43	42	44	30	42	40	44	34	38
Physical disability*	13	16	12	18	12	17	18	17	15	16
Psychological disability*	33	30	29	34	26	29	28	30	22	27
Social disability*	9	16	14	16	13	12	10	14	8	14
Handicap*	9	12	10	15	9	11	10	14	8	9
At least one problem**	44	41	39	42	34	39	37	42	36	41
At least one oral impact***	35	32	33	36	25	34	36	39	31	34

+ England only figures   ^^^ Good and very good
* Occasionally, often or very often   ** Based on the frequency of impacts on quality of life
*** Based on the severity of impacts on daily performance.

Table 3.3 (continued) Variations in adult oral health by geographical area (in percentage, based on the UK adult dental health survey 2009)

Oral health indicators	Geographic areas									
	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East Coast	South Central	South West
Oral health related behaviours[+]										
Frequency of tooth brushing[$]	71	78	72	71	71	77	77	76	79	73
High Sugar intake[$$]	50	44	51	48	50	55	45	56	47	53
Dental service attendance[+]										
Regular attendees	65	63	62	63	64	62	44	62	69	66
Only with trouble	25	29	29	25	25	26	35	28	20	25

[+] England-only figures
[$] Twice a day or more
[$$] Having 6 or more intakes a week of puddings, cakes, biscuits, sweets, chocolate, pastries and fizzy drinks.

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Cancer registry data showed that regions in the North of England had a higher incidence than the country as a whole and regions in the South and East had a lower incidence (Figure 3.4).

**Figure 3.4 Standardised incidence of oral cancer (C00-C14 cancers) 2012 to 2016, England regions**
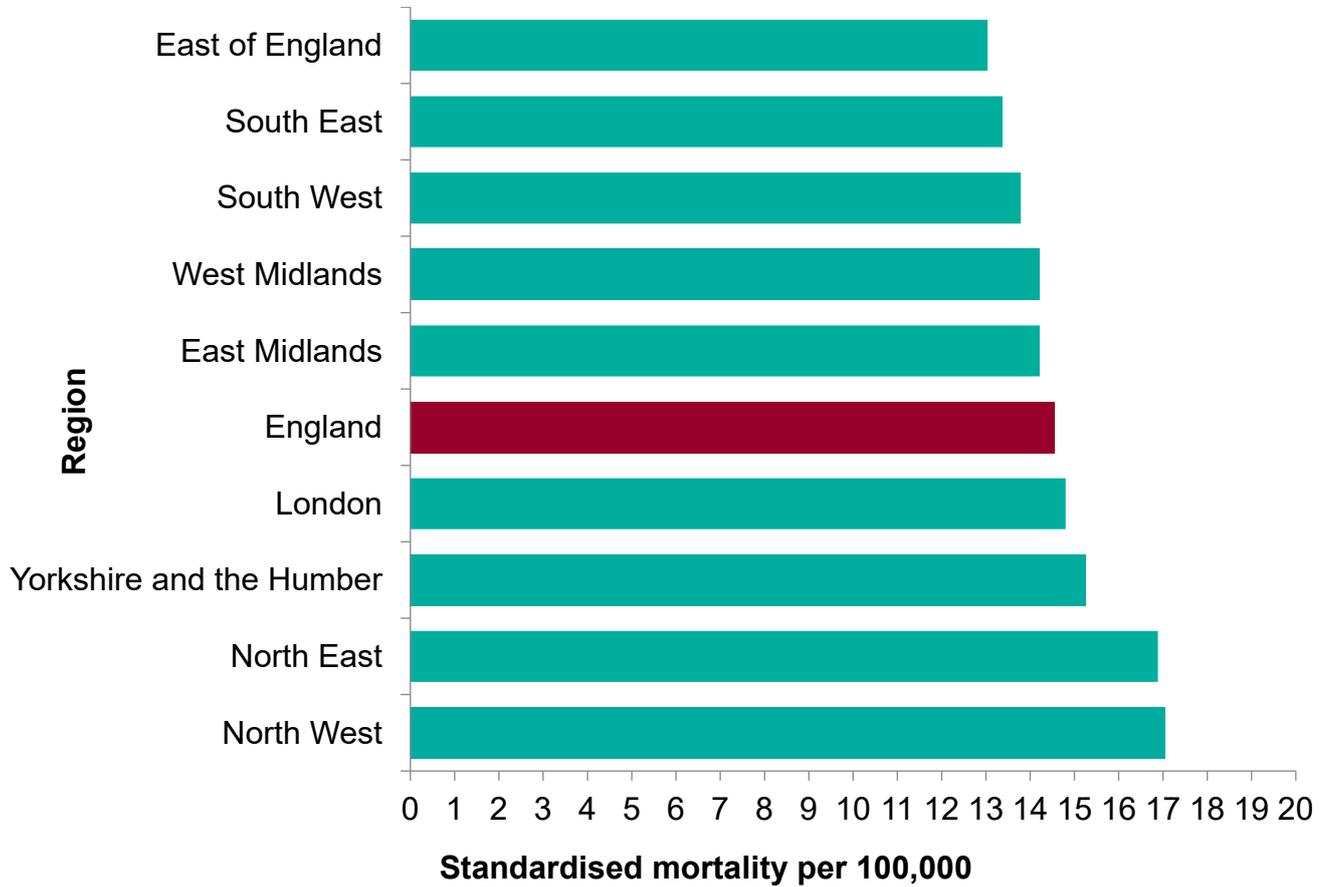
Source: PHE 2020

There was also considerable variation in incidence of oral cancer within English regions. The incidence in some lower tier and unitary local authorities was higher than in the country as a whole. These areas were mainly, but not exclusively, in the North of England and mostly urban (Figure 3.5).

Figure 3.5 Standardised incidence of oral cancer (C00-C14 cancers) 2012 to 2016 by lower tier and unitary local authorities in England
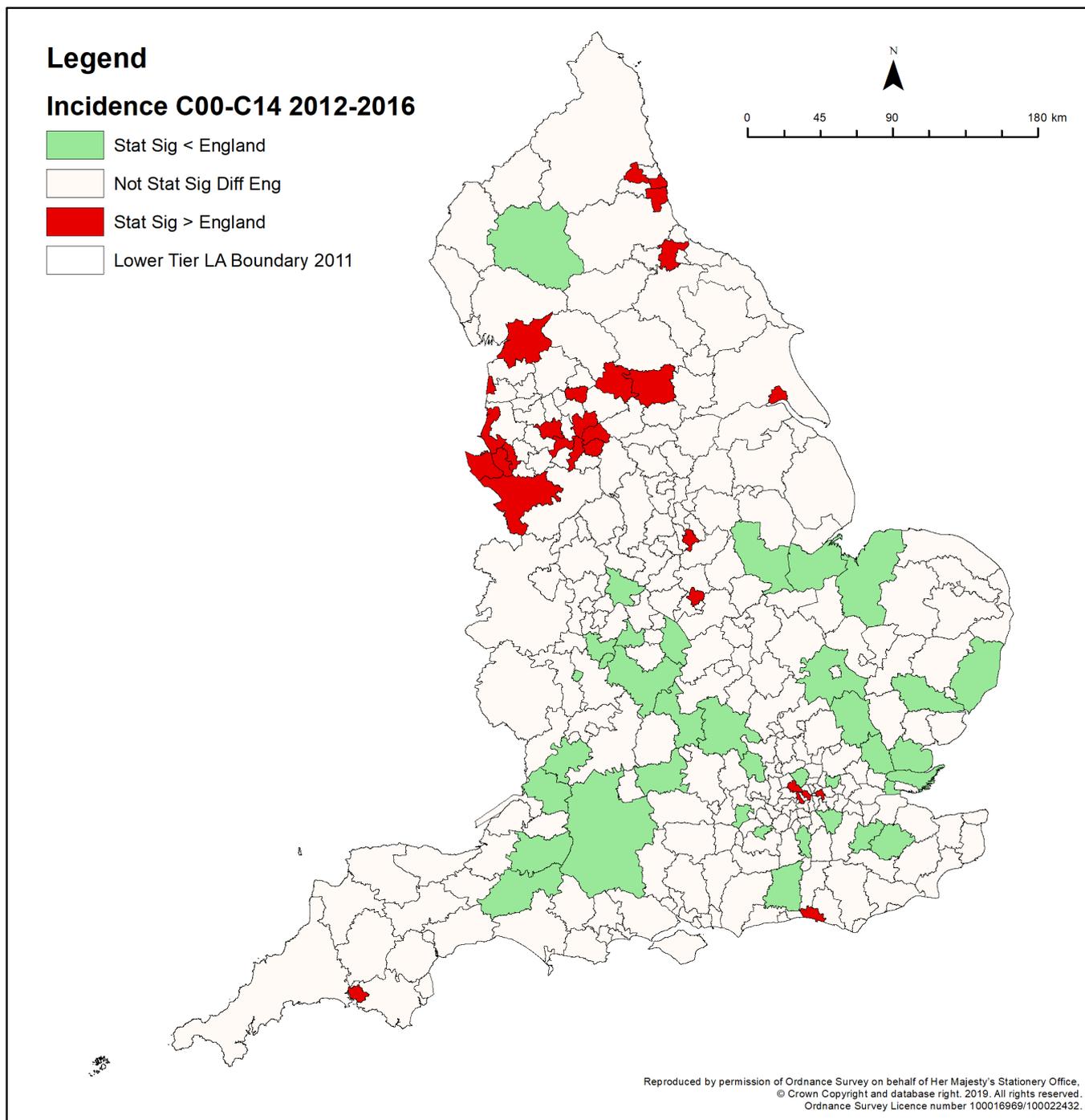
Source: PHE 2020

## 3.3.2 Child oral health data

The 2013 NDEP showed that there was variation in the levels of dental caries experienced by the 3 year olds living in different parts of the country in 2013 from 8% in the East of England to 16% in the East Midlands. There was also wide variation at upper-tier local authority level from 2% in South Gloucestershire to 34% in Leicester. The prevalence of untreated active dental

caries also varied similarly from 1% in South Gloucestershire to 34% in Leicester. There was little variation in the presence of dental abscess or fistula, which was present in less than 1% of 3 year olds.

According to the 2019 NDEP, dental caries experience amongst 5 year olds varied across regions from 18% in the South East to 32% in the North West (Figure 4.6). There was even greater variation at upper-tier local authority level ranging from 9% in East Sussex to 51% in Blackburn with Darwen. The prevalence of untreated active dental caries also varied widely at upper tier local authority level ranging from 7% in East Sussex to 48% in Blackburn with Darwen. The prevalence of dental abscess or fistula also varied at regional and upper-tier local authority level from less than 1% in the South East to 2% in the North East, and 0% in several areas including Bexley and Southward to 5% in North East Lincolnshire.

Figure 3.6 Prevalence of tooth decay in 5 year old children in England in 2019, by region
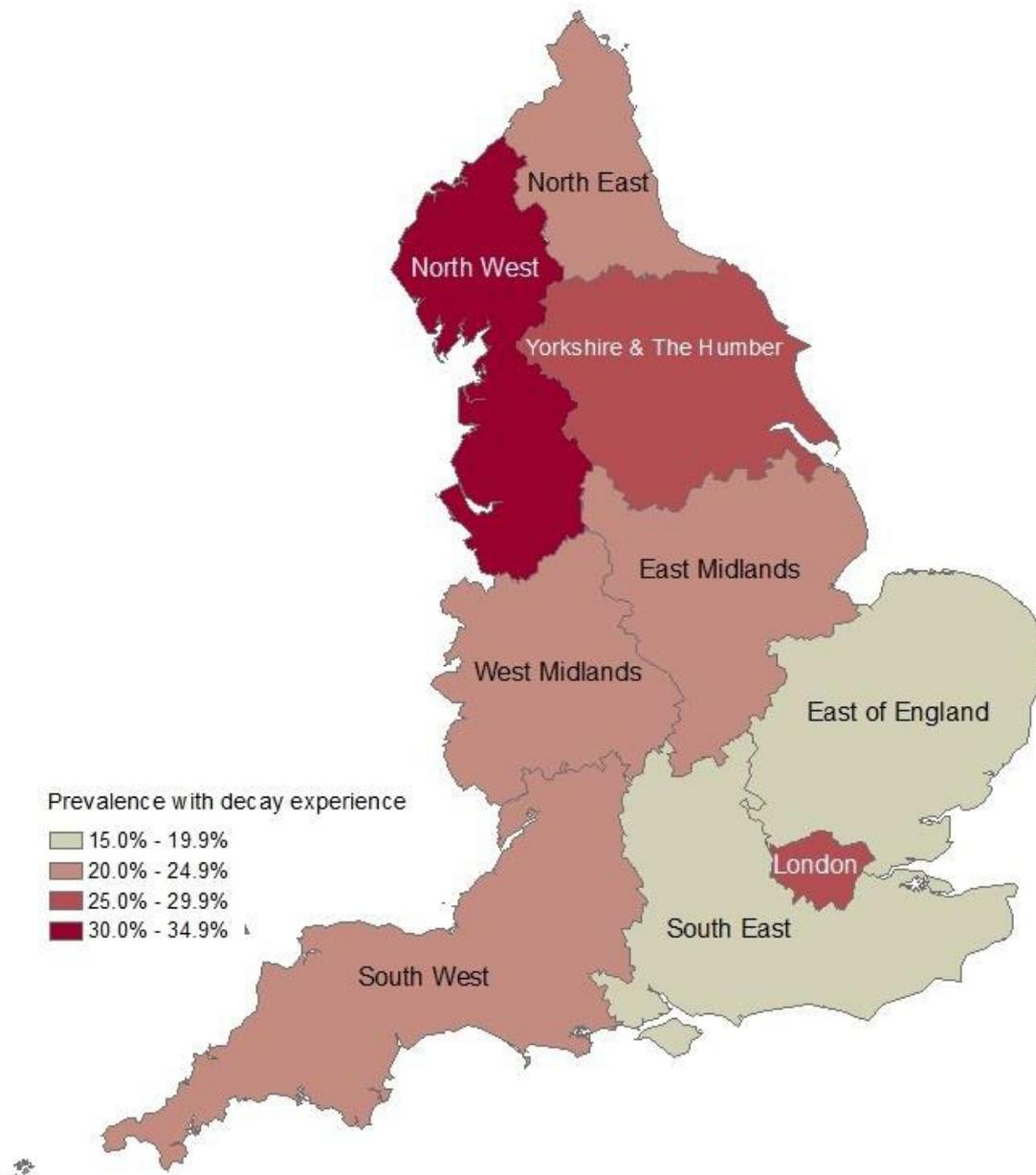
Source: PHE, 2020

Similarly, according to the 2009 NDEP there was variation in the prevalence of dental caries amongst 12 year old children at regional level from 27% in the South East to 45% in Yorkshire and the Humber (Figure 3.7). At local level, prevalence varied from 13% in Southwark to 56% in Knowsley.

Figure 3.7 Percentage of 12 year old children with dental caries experience by region, 2008 to 2009
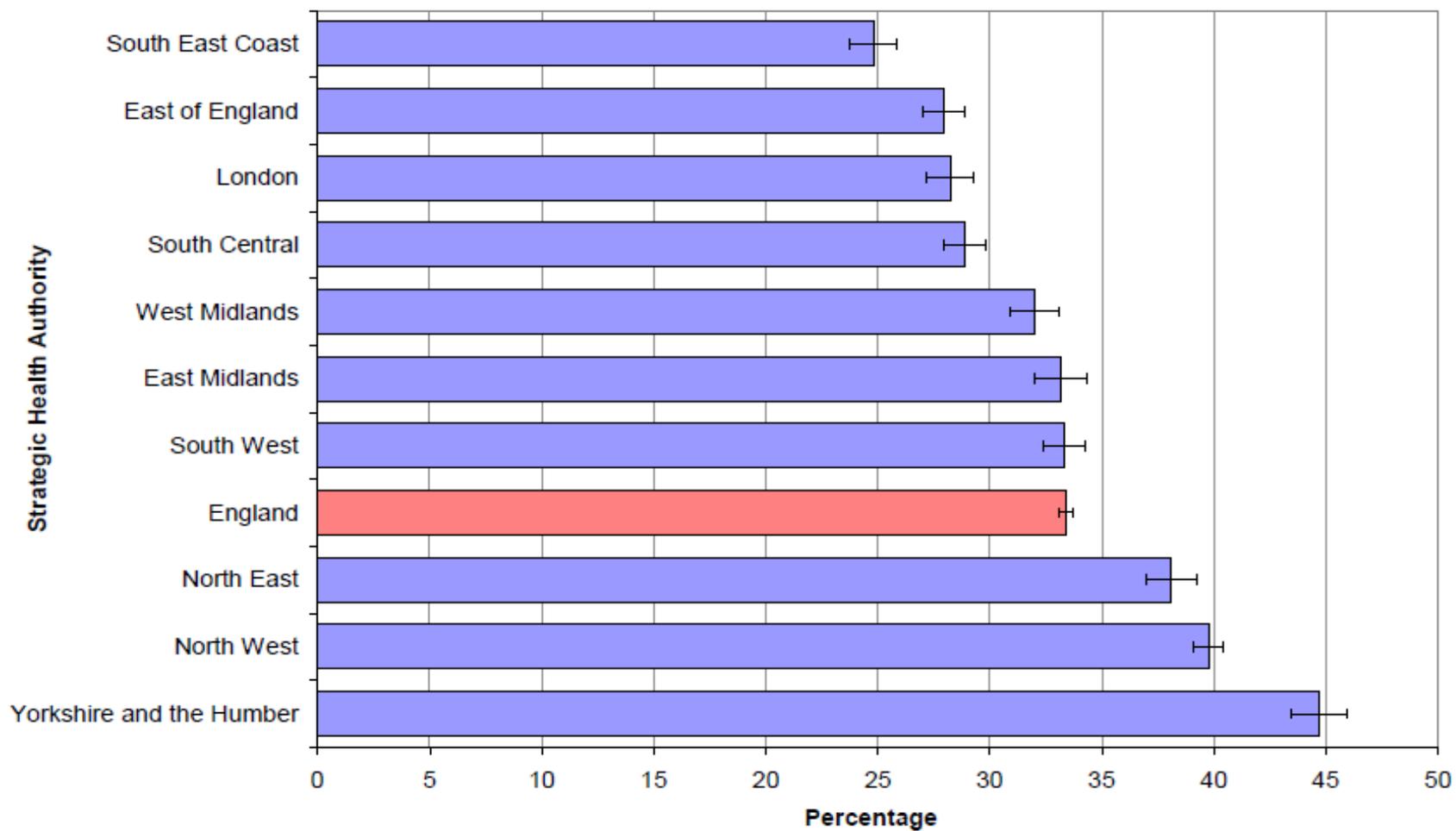
Source: National Dental Epidemiology Programme 2008 to 2009

The prevalence of untreated active dental caries also varied widely at lower-tier local authority level from 2% in Brighton and Hove City to 45% in Leicester City.

With respect to periodontal health, according to the 2013 NDEP, the proportion of 3 year olds in England with substantial amounts of plaque varied from 0% in many areas to 20% in Hounslow. Similarly, according to the 2019 NDEP, the proportion of 5 year olds in England with substantial amounts of plaque varied from 0% in several areas to 17% in Trafford. The 2009 NDEP reported variation in the proportion of 12 year olds in England with substantial amounts of plaque ranging between 7% in South East Coast and 18% in London.

The prevalence of self-reported oral health problems in the previous 3 months and the reported impact of oral symptoms on eating amongst 12 year olds in 2009 varied by region from 38% in South East Coast to 46% in East of England, and from 32% in the North East and East Midlands to 37% in the East of England, respectively.

The reported 73% prevalence of twice-a-day toothbrushing amongst 12-year-olds in 2009 varied across regions from 77% in the East of England to 69% in the West Midlands.

3.3.3 NHS dental service data

The number of Units of Dental Activity (UDAs) commissioned varied by region with the greatest number being commissioned in North region (Table 4.4). At an NHS local office geography, the greatest number of UDAs were commissioned by London.

Table 3.4 Units of Dental Activity (UDAs) commissioned in September 2019 by geographical area

Region	UDAs commissioned (September 2019)	Population Estimate (June 2018)	Commissioned UDAs per head of population
England	87,137,512	55,977,178	1.56
North (North East, North West, Yorkshire and Humber)	27,638,664	15,429,617	1.79
Midlands and East (East Midlands, West Midlands, East of England)	26,565,472	16,906,120	1.57
London	12,157,914	8,908,081	1.36
South (South West, South East)	20,775,462	14,733,360	1.41

Source: NHS England and the National Office for Statistics

To accurately compare the activity commissioned between regions, the different population sizes of the regions needs to be taken into consideration. When commissioned activity was divided by the population of the region, variation was again apparent (Table 3.5). The North commissioned the greatest number of UDAs per head of population and London the lowest.

Table 3.5 Units of Dental Activity (UDAs) delivered in September 2019 per head of population by geographical region

Region	UDAs delivered in 2018 to 2019 (rounded values)	Population estimate (June 2018)	Delivered UDAs per population head
England	83,058,000	55,977,178	1.48
North (North East, North West, Yorkshire and Humber)	26,105,000	15,429,617	1.69
Midlands and East (East Midlands, West Midlands, East of England)	25,005,000	16,906,120	1.48
London	12,027,000	8,908,081	1.35
South (South West, South East)	19,701,000	14,733,360	1.34

Source: NHS digital 2019

There was also variation in UDAs delivery across England (Table 3.6). The greatest number of UDAs delivered per head of population was in the North region and the lowest in the South of England and London.

Table 3.6 Units of Dental Activity (UDAs) commissioned as of September 2019 by geographical region

Region or Local Office Name	UDAs commissioned in contracts which are delivering services
England	87,366,948
North	27,819,000
Midlands and East	26,639,973
London*	12,255,313
South	20,652,662
Wessex	4,063,841
London	12,255,313

Region or Local Office Name	UDAs commissioned in contracts which are delivering services
Yorkshire and the Humber	9,638,963
Lancashire and South Cumbria	2,812,505
Cumbria and North East	5,529,119
Cheshire and Merseyside	4,785,472
North Midlands	6,152,837
West Midlands	6,721,486
Central Midlands	6,920,444
East	6,845,206
South West	5,340,957
South East	6,367,677
South Central	4,880,187
Greater Manchester	5,052,941

Source: NHS England

When data describing population uptake of NHS dental services was examined, regional variations in uptake across England were observed (Table 3.7 and Table 3.8). The North West saw the greatest proportion of adults accessing care (56%) and London the lowest (44%) (Table 3.7). With respect to children, the North East and Yorkshire region had the greatest proportion accessing care (64%) and London had the lowest proportion (51%) (Table 3.8).

Table 3.7 Numbers and proportion of the population, of adult patients, seen in the previous 24 months by NHS commissioning region

Organisation name	Number adults seen as 30 June 2019 (000s)	Percent of population (30 June 19)
England	**21,960**	**50.19**
London	3,005	44.04
South West of England	2,231	49.95
South East of England	3,139	45.31
Midlands	4,156	50.5
East of England	2,551	50.4
North West	3,059	55.72
North East and Yorkshire	3,752	55.54

Source: NHS digital 2019

Table 3.8 Numbers and proportion of the population, of child patients, seen in the previous 12 months by NHS commissioning region

Organisation Name	Number of children seen as of 30 June 2019 (000s)	Percent of population (30 June 19)
England	**7,001**	**59.0**
London	1,013	50.63
South West of England	661	60.21
South East of England	1,100	58.73
Midlands	1,311	58.6
East of England	812	58.11
North West	950	63.7
North East and Yorkshire	1,133	64.11

Source: NHS digital 2019

Based on the summary of the dental results from the GP Patient Survey, the proportion of patients who tried and were successful at getting an NHS dental appointment varied across regions. For example, people from the North East and Yorkshire who tried to access NHS care were most successful in getting an appointment and those in the South East were least successful. Assuming that those people who tried to get an NHS appointment felt that they had a need for dental care (perceived need) the data suggest that for those with an oral health need there is an inequality in access to NHS care.

Regionally, the largest proportions of respondents who have not tried to make an NHS dental appointment in the last 2 years were seen in London (Figure 3.8). NHS Richmond Clinical Commissioning Group (CCG), in London, had the highest proportion, with 59% of respondents who had not tried in the 2-year period. In comparison, NHS Great Yarmouth and Waveney CCG, in the East of England, had the lowest proportion, with only 27% of respondents not attempting to get an NHS appointment in the last 2 years. London has the highest proportion of respondents who have never tried to get an NHS dental appointment.

Figure 3.8 Percentage of respondents who did not try to get an NHS dental appointment (either more than 2 years ago or never tried) by geographical region
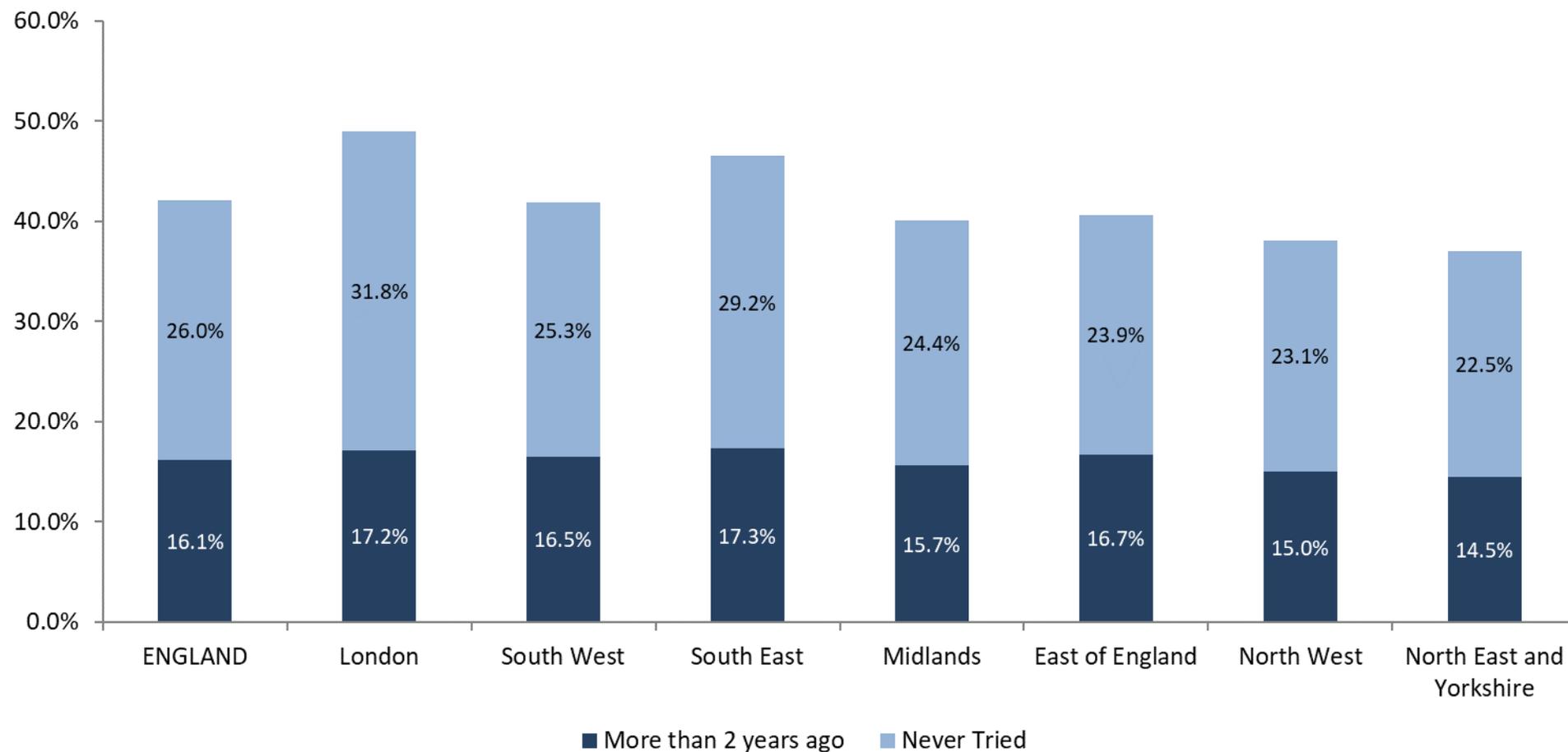
Source: Summary of the Dental Results from the GP Patient Survey: January to March 2019

Patients who prefer to go to a private dentist or stayed with their dentist when changed from NHS to private accounted for over a third of all responses (38%) of those who have not tried to get an NHS dental appointment in the last 2 years. However, there were marked regional differences, varying from 31% in South West to 47% in the South East.

3.4 Oral health inequalities by protected characteristics

3.4.1 Oral health inequalities by age

3.4.1.1 Adult oral health data

Table 3.9 summarises variation in oral health outcomes amongst adults by age. Some oral diseases and conditions, such as dental caries, periodontal pocketing and tooth loss, are chronic and irreversible in nature, which means they tend to increase in prevalence and severity with increasing age. For some oral health outcomes, such as unrestorable dental caries, this pattern was less clear or absent. With respect to oral health related quality of life, different age patterns were observed. For example, adults aged 65 years and older were more likely to report functional limitations and younger age groups were more likely to report psychological disability.

According to 2016 NDEP, amongst mildly dependent older adults, 8% had one or more PUFA signs, 70% had visible plaque, 27% had lost all their natural teeth, 9% were in pain at the time of the examination, 51% reported having at least one oral impact on daily performance, and 34% had not seen a dentist for more than 2 years.

Cancer registry data showed that oral cancer incidence and mortality increased with age.

Table 3.9 Variations in adult oral health by age (in percentage, based on the UK adult dental health survey 2009)

Oral health indicators	Age groups							
	16-24	25-34	35-44	45-54	55-64	65-74	75-84	85+
Dental Caries	30	37	30	27	29	27	40	33
Unrestorable caries	6	9	7	8	10	9	15	10
PUFA[^]	6	6	6	7	8	6	8	10
Periodontal condition[+]								
Visible plaque	64	65	64	67	70	66	68	67
Bleeding on probing	50	55	52	59	57	48	53	48
Pocketing (4+mm)	19	36	43	53	61	60	61	46
Tooth loss[+]	-	0	0	1	5	15	29	45
Excellent Oral Health[^^]	23	16	12	5	1	1	0	-

[+] England-only figures
[^] PUFA: pulp involvement, ulceration, fistula, abscess
[^^] Excellent oral health included having 21 or more teeth, 18 or more sound and untreated teeth/roots, no active decay and being periodontally healthy with no calculus or bleeding.

Table 3.10 (continued) Variations in adult oral health by age groups (in percentage, based on the UK adult dental health survey 2009)

Oral health indicators	Age groups							
	16-24	25-34	35-44	45-54	55-64	65-74	75-84	85+
Self-rated oral health^^^	79	70	72	65	66	73	71	59
Oral health related quality of life								
Functional limitation*	9	9	12	13	18	14	14	21
Physical pain*	51	59	61	62	68	56	49	68
Psychological discomfort*	26	42	44	47	46	32	28	26
Physical disability*	11	18	16	18	16	15	13	19
Psychological disability*	23	35	32	32	30	18	20	14
Social disability*	12	16	16	15	13	5	2	2
Handicap*	7	12	12	12	14	8	8	8
At least one problem**	32	39	41	40	43	36	34	42
At least one oral impact***	29	35	33	34	36	30	26	34

^^^ Good & very good
* Occasionally, often or very often
** Based on the frequency of impacts on quality of life
*** Based on the severity of impacts on daily performance.

Table 3.9 (continued) Variations in adult oral health by age groups (in percentage, based on the UK adult dental health survey 2009)

Oral health indicators	Age groups							
	16-24	25-34	35-44	45-54	55-64	65-74	75-84	85+
Oral health related behaviours[+]								
Frequency of tooth brushing[$]	72	76	80	75	73	71	71	63
High Sugar intake[$$]	60	51	46	41	44	49	61	66
Dental service attendance								
Regular attendees	51	44	60	66	72	77	70	65
Only with trouble	33	38	27	25	21	17	22	26

[+] England-only figures
[$] Twice a day or more
[$$] Having 6 or more intakes a week of puddings, cakes, biscuits, sweets, chocolate, pastries and fizzy drinks.

3.4.1.2 Child oral health data

Table 3.10 summarises variation in oral health amongst children by age.

Table 3.10 Variations in child oral health by age

Oral health indicators	Age in years					
	3^	5	8^^^		12	15^^^
Dental Caries (%)	12	23^^	45*	13**	23^^^	44
Dental caries experience (average teeth number)	3.1	3.4^^	-		2.2^^^	-
Untreated active dental caries (%)	12	20^^	-		18^^^	-
pufa/PUFA* (%)		4^^^+				2+
Dental abscess or fistula (%)	0.4	1^^	-		-	-
Periodontal Condition						
Visible Plaque+ (%)	-	46^^^	71		64^^^	49
Substantial amount of plaque (%)	1	1^^	-		11^^^^	-
Presence of gingivitis (%)	-	22^^^	46		61^^^+	40+
Self-rated oral health (good/very good; %)	-	-	-		66^^^+	75+
Dental problems in last 6 months (%)	-	37^^^	56		-	-
Dental problems in last 3 months (%)	-	-	-		68^^^	66
Oral health related quality of life+						
Avoiding smiling/laughing (%)	-	-	-		36^^^	27
Difficulty eating (%)	-	-	-		22^^^	19
Difficulty cleaning teeth (%)	-	-	-		22^^^	14
Any difficulty in last 3 months (%)	-	-	-		58^^^	45

+ England-only figures
* Primary dentition
** Permanent dentition
^ Data from the 2013 NDEP
^^ Data from the 2019 NDEP
^^^ Data from the 2013 child dental health survey
^^^^ Data from the 2009 NDEP

Table 3.10 (continued) Variations in child oral health by age

Oral health indicators	Age in years				
	3	5	8	12	15
Oral health related behaviours[+^] (%)					
Parental reported frequency of tooth brushing*(%)	-	82	84	79	84
Self-reported frequency of tooth brushing* (%)	-	-	-	77	81
Sugar drinks intake** (%)	-	-		16	14
Parents-reported dental attendance[+^] (%)					
A check-up (%)	-	88	-	94	-
Only with trouble/never been (%)	-	6/6	-	5/1	-
Self-reported dental attendance[+^] (%)					
A check-up (%)	-	-	-	81	82
Only with trouble/never been (%)	-	-	-	16/3	16/2

[+] England-only figures
[^] Data from the 2013 child dental health survey
* Two or more a day
** Four or more a day.

3.4.1.3 NHS dental service data

The adult population accessed care in differing proportions across the different age bands (Figure 3.9). Younger adults (aged 18 to 19) had the highest rates of access. In males the lowest proportion of the population accessing care was seen in the 20 to 64 age band and in females it was in the 85+ age band.

Figure 3.9 proportion of adults accessing care in the 24 months preceding March 2019 by age band
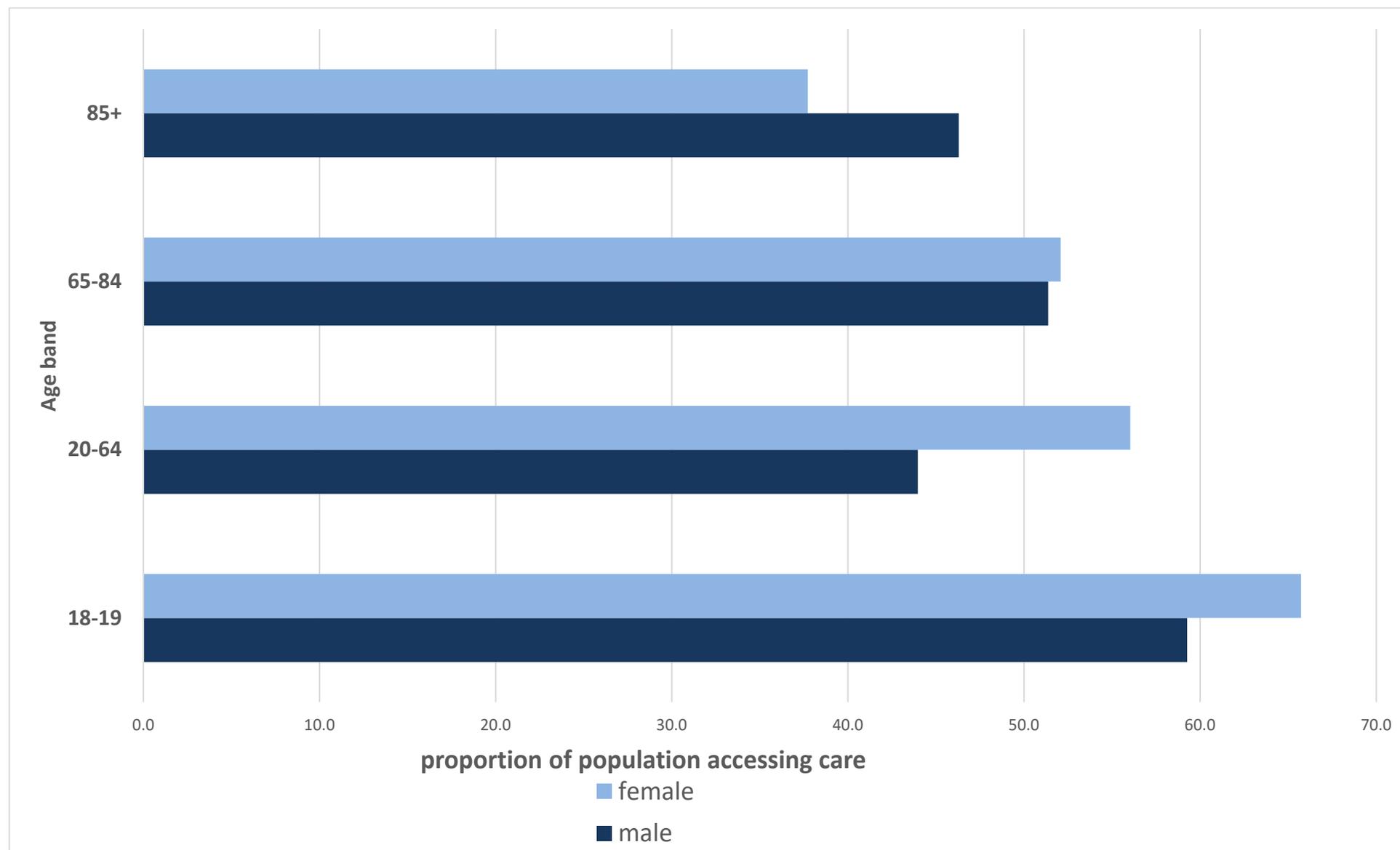
Source: NHS digital 2019

Amongst children, when the uptake of NHS care was broken down by child age group (Figure 3.10), lower levels of access were reported for younger age groups. In every region in England the age group with the greatest proportion accessing care was the 6 to 11 year old band. Whilst the proportion with the lowest uptake was the 0 to 2 year old age band.

Figure 3.10 Proportion of children accessing care in the 12 months preceding March 2019 by age band
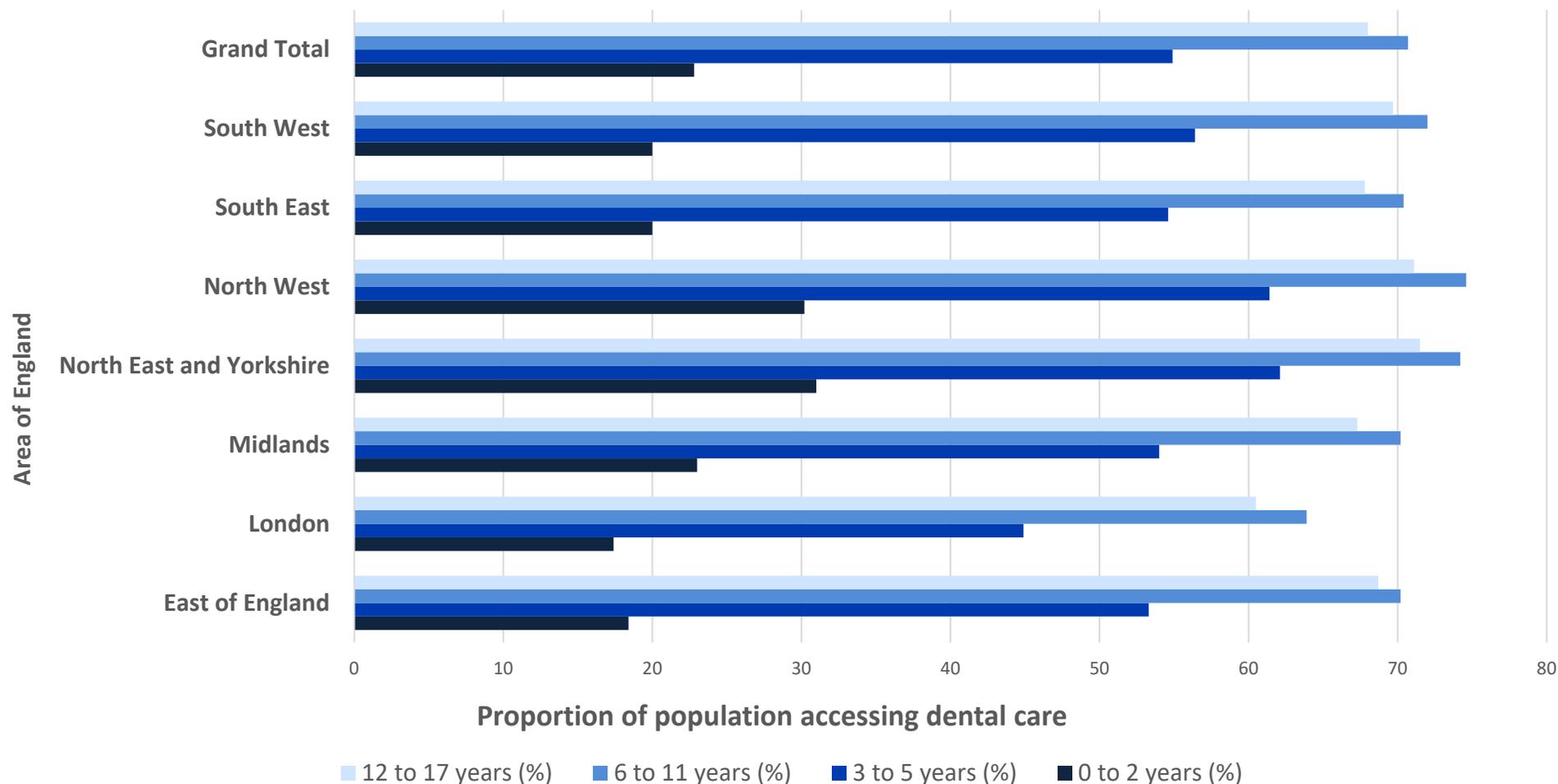
Source: NHS digital 2019

3.4.2 Oral health inequalities by sex

3.4.2.1 Adult oral health data

Table 3.11 summarises variation in oral health indicators amongst adults by sex, based on the 2009 adult dental health survey. Female adults enjoyed better oral health with respect to all outcomes except tooth loss and oral health related quality of life. Regarding the latter, they scored worse than their male counterparts in all domains except functional limitation and handicap.

With regard to oral cancer, the cancer registry data showed that the incidence of disease has increased steadily since 2001 in both sexes, but the rate of increase is greater in men than women, having nearly doubled in that time (Figure 3.11).

Table 3.11 Variations in adult oral health by sex (in percentage, based on the UK adult dental health survey 2009)

Oral health indicators	Sex		Oral health indicators	Sex	
	Male	Female		Male	Female
			Oral health related quality of life		
Dental Caries	34	28	Functional limitation*	12	13
Unrestorable caries	11	6	Physical pain*	16	62
PUFA^	8	6	Psychological discomfort *	34	44
Periodontal condition+			Physical disability *	15	17
Visible plaque	71	61	Psychological disability*	24	32
Bleeding on probing	56	52	Social disability*	11	14
Pocketing (4+mm)	47	43	Handicap*	11	11
Tooth loss+	4	7	At least one problem**	36	41
Excellent Oral Health^^	9	11	At least one oral impact***	31	34
Self-rated oral health^^^	68	73			
Oral health related behaviours+					
			Dental service attendance		
Frequency of tooth brushing$	67	82	Regular attendees	54	67
High sugar intake$$	53	46	Only with trouble	33	22

+ England-only figures
^ PUFA: pulp involvement, ulceration, fistula, abscess
^^ Excellent oral health included having 21 or more teeth, 18 or more sound and untreated teeth/roots, no active decay and being periodontally healthy with no calculus or bleeding
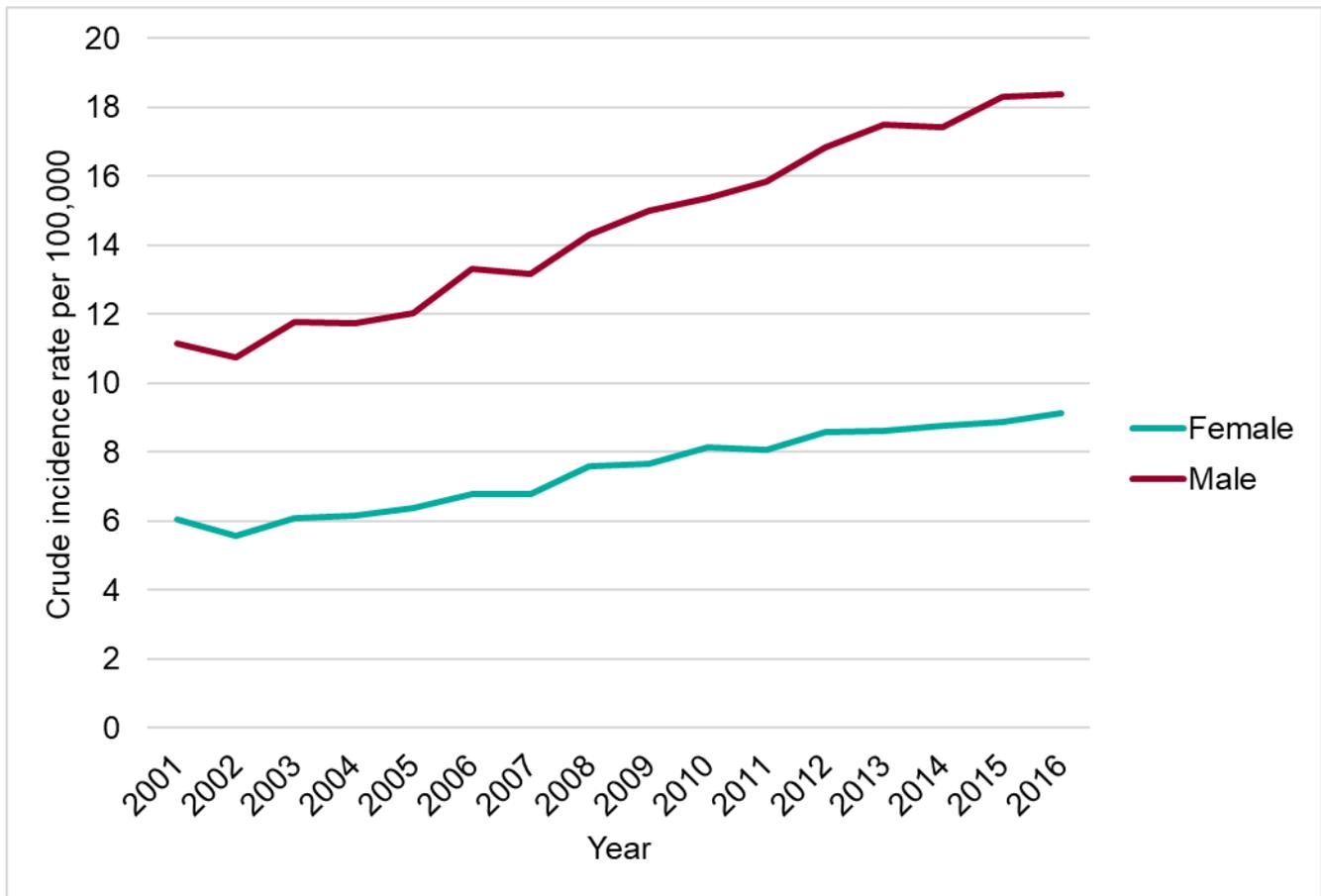^^^ Good and very good
* Occasionally, often or very often
** Based on the frequency of impacts on quality of life
*** Based on the severity of impacts on daily performance
$ Twice a day or more
$$ Having 6 or more intakes a week of puddings, cakes, biscuits, sweets, chocolate, pastries and fizzy drinks.

Figure 3.11 Incidence of oral cancer (C00-C14 cancers) 2001 to 2016 by sex, in England

Source: PHE 2020

3.4.2.2 Child epidemiological data

According to the 2013 child dental health survey, girls were more likely than boys to report their oral health as good or very good at 12 years of age (72% vs 59%) and 15 years of age (82% vs 68%). However, 12 and 15-year-olds girls were more likely to report toothache than boys of the same age (19% and 21% vs 11% and 16%) and 15 year old boys were more likely to report bad breath than 15 year old girls (15% vs 22%). Furthermore, 15 year old girls were more likely to report oral impacts over the previous 3 months (50%) than boys (40%).

With respect to oral health behaviours, 12 year old girls (86%) and 15 year old girls (89%) were more likely to report brushing their teeth at least twice a day than boys of the same age (69% and 73%). The reported frequency of consumption of sugary drinks varied by sex at 12 years of age and boys (19%) were more likely to drink sugary drinks at least 4 times a day than girls (13%).

3.4.2.3 NHS dental service data

No NHS dental service data was available publically on sex variation.

3.4.3 Oral health inequalities by ethnicity

3.4.3.1 Adult oral health data

Amongst adults, variations in oral health indicators by ethnicity were not reported in the 2009 adult dental health survey.

With respect to oral cancer, the cancer registers showed the highest incidence rate was reported for the Other ethnic group (Standardised incidence rate per 100,000: 20.04), followed by White (10.68) and Asian (9.00), respectively. Both Mixed (5.73) and Black (5.70) ethnic groups had similar incidence rates. The particularly high incidence rate found in the Other ethnic group might be due to reporting bias in hospital data, with incident cases assigned to the Other ethnic group in instances where a different broad ethnic group should have been used. Consequently, these figures should be interpreted with caution.

3.4.3.2 Child oral health data

The 2019 NDEP showed that amongst 5 year old children there was variation in dental caries prevalence by ethnic group with 44% of children from the Other ethnic group and 21% of children from the White ethnic group having dental caries experience. The severity of dental caries in those children with any dental caries experience also varied by ethnic group and was highest in the Other ethnic groups.

3.4.3.3 NHS dental service data

People from Black, Asian and minority ethnic groups (Figure 3.12) were less likely than White people to report that they had been successful in getting an NHS dental appointment in the last 2 years. The survey results do not give reasons as to why this difference occurs, but the figures suggest that people from Black, Asian and minority ethnic groups may find it more difficult to access dental care.

Figure 3.12 Percentage of those who tried to get an NHS dental appointment in the last 2 years and succeeded, by ethnicity
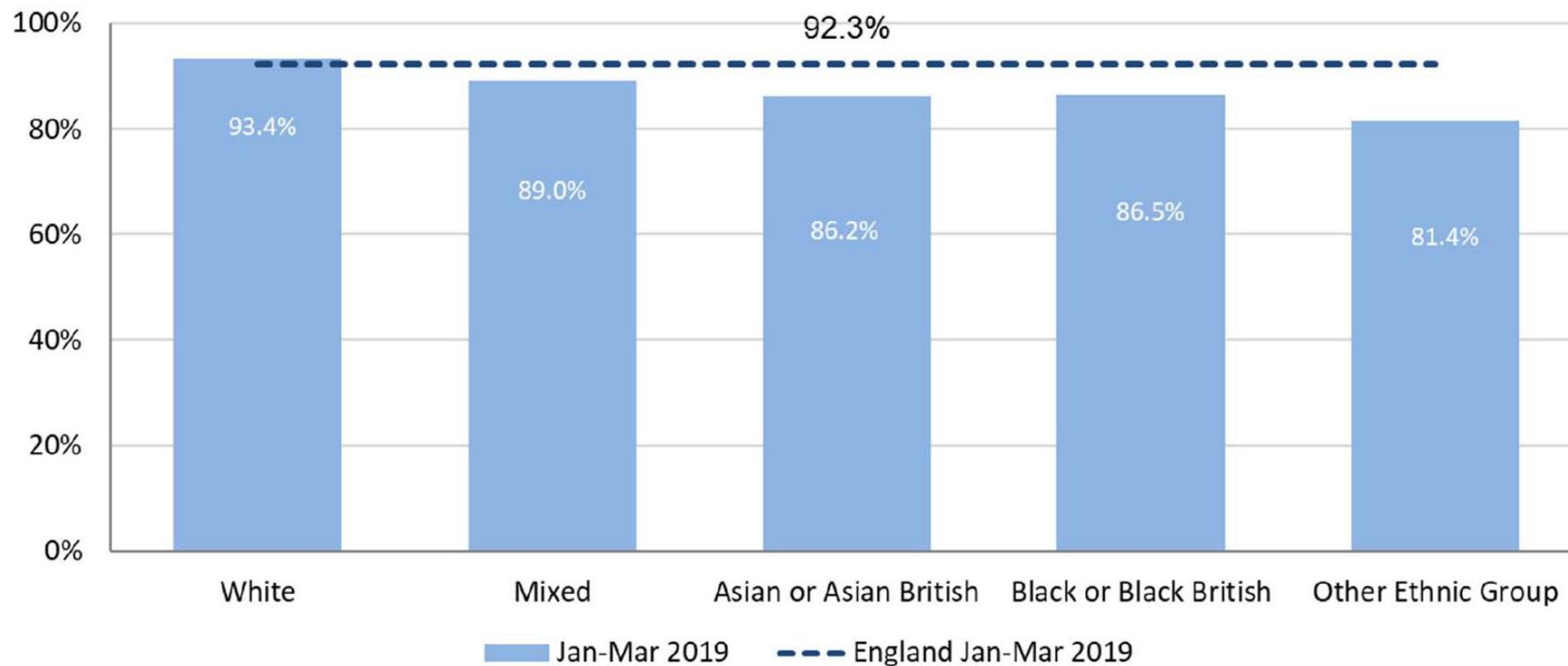
Source: Summary of the Dental Results from the GP Patient Survey: January to March 2019

3.4.4 Oral health inequalities by disability

3.4.4.1 Adult oral health data

From the 2009 adults subgroup surveys, 8% of adults with learning disabilities had one or more PUFA signs. This figure was similar to the wider population as reported in the 2009 adult dental health survey. Furthermore, 5% of adults with learning disabilities had lost all their natural teeth, 9% experienced current pain, 26% reported pain occasionally or more often in the preceding 12 months, 7% experienced psychological discomfort, 41% reported having at least one oral impact on daily performance, and 63% reported to brush their teeth twice or more times a day.

With respect to adults attending domiciliary care services, 9% had one or more PUFA signs, 31% had lost all their natural teeth, 14% were experiencing current pain, 30% reported pain occasionally or more often in the preceding 12 months, 14% experienced psychological discomfort, 48% reported having at least one oral impact on daily performance, and 43% reported to brush their teeth at least twice a day.

3.4.4.2 Child oral health data

According to the first nationally co-ordinated local survey of children in special support schools in 2013 to 2014 (the 2014 NDEP), 22% of 5 year olds had experienced dental caries of whom each had on average 3.9 affected primary teeth. Twenty-nine per cent of 12 year olds had experienced dental caries of whom each had on average 2.4 affected permanent teeth. One per cent of 5 year olds and less than 1% of 12 year olds had an abscess of fistula.

The prevalence and severity of dental caries amongst children in special support schools were slightly lower than in 5 and 12 year old children attending mainstream schools. Four per cent of 5 year olds and 20% of 12 year olds in special support schools had substantial amounts of dental plaque. Both figures were higher than for children attending mainstream schools. Six per cent of 5 year olds had one or more teeth extracted on one or more occasions, across England. This figure is significantly higher than that found among children attending mainstream schools (3%).

3.4.4.3 NHS dental service data

No NHS information was available regarding variation in dental service commissioning, delivery or utilisation by disability.

## 3.5 Trends in oral health inequalities in children

Despite continuing improvements in oral health in 5 year old children, stark inequalities remain. This inequality can be summarised by examining dental caries prevalence across the 5-year-old population of England divided into 10 groups defined according to their level of area deprivation. According to the 2019 NDEP, 5 year old children living in the most deprived areas in the country (37%) were almost 3 times more likely to have experienced dental caries than children living in the least deprived areas (13%). Moreover, there was a clear gradient in the association between area deprivation and prevalence of decay experience, with higher levels of the outcome in successively more deprived areas (Figure 3.13).

Absolute and relative socioeconomic inequalities may be estimated using the Slope Index of Inequality and the Relative Index of Inequality respectively. These are regression-based indices which take into account the distribution of the population across all socioeconomic groups and, therefore, remove any variation in the magnitude of health inequalities due to differences in the size of socioeconomic groups. In general, higher scores on these indices indicate larger inequalities across the socioeconomic hierarchy.

The slope index of inequality corresponds to the absolute difference in prevalence of dental caries experience between people living in the most deprived and the least deprived areas in England. In 2019, the slope index of inequality for the prevalence of dental caries in 5 year old children was 26.8, indicating large absolute inequalities (Figure 3.13).

The relative index of inequality can be interpreted as the prevalence ratio of dental caries experience between 5 years old children at the bottom and those at the top of the area deprivation hierarchy, with values greater than 1 indicating inequality. In 2019, this index was 3.8, again demonstrating the existence of considerable relative inequalities in dental caries experience among 5 year olds.

**Figure 3.13 Slope index of inequality in prevalence of dental caries in 5 year old children in England, 2019**
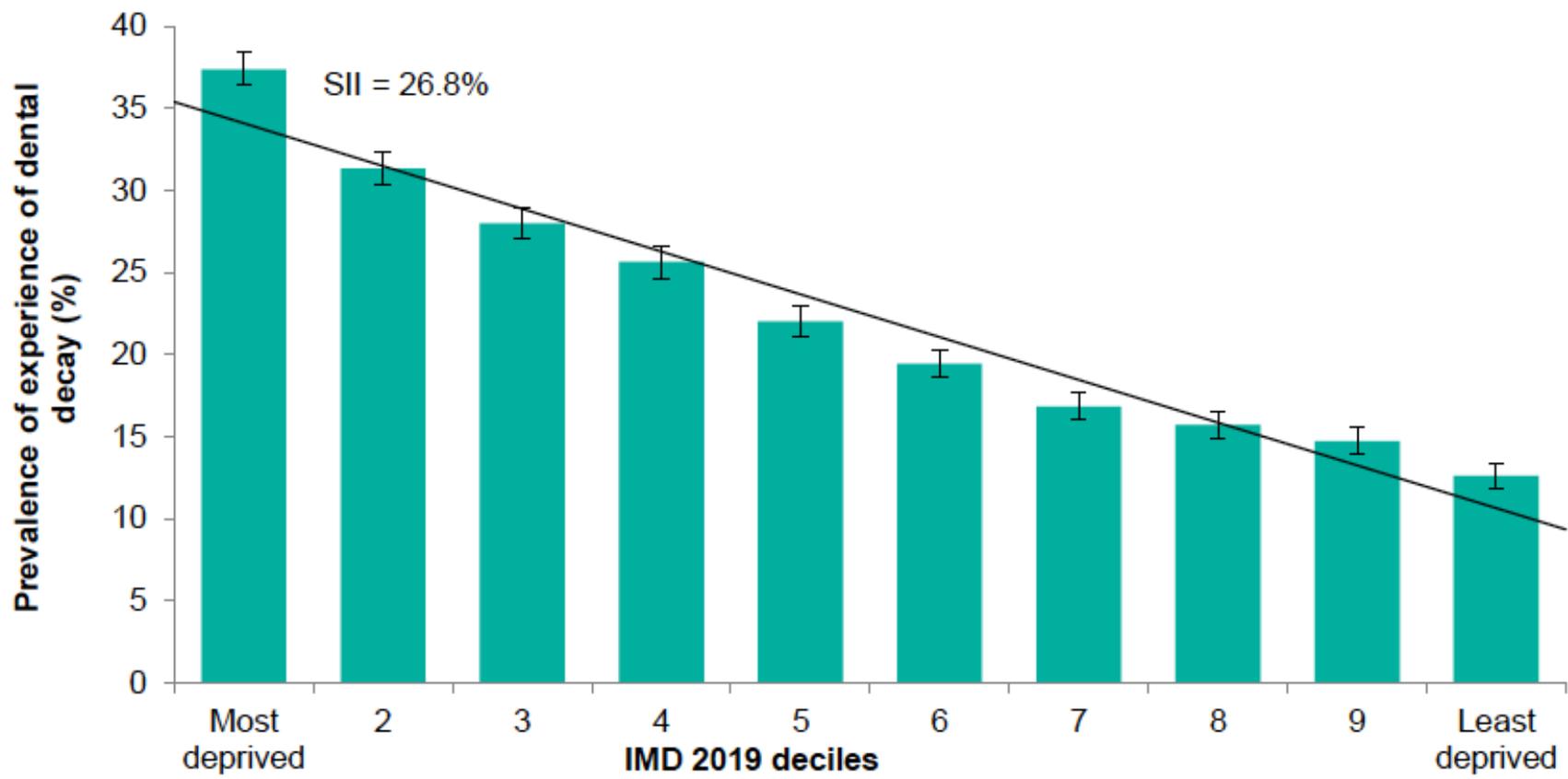
Source: PHE 2020Both the slope and the relative indices of inequality can also be used to describe changes in inequalities over time. Absolute inequalities in dental caries prevalence in 5 year old children had slightly reduced from 30.2 in 2008 to 26.8 in 2019 (Figure 3.14). While absolute inequalities in dental caries prevalence had reduced since 2008, it is also important to consider relative inequalities, as an improvement in one may not always follow an improvement in the other. Relative inequalities in the prevalence of dental caries in 5 year old children had increased from 2008 to 2019. In 2008, the proportion of children with dental caries was 2.9 times higher in the most deprived areas than the least deprived areas and in 2019 it was 3.8 times higher (Figure 3.15).

Figure 3.14 Slope index of inequality in dental caries prevalence in 5 year old children, 2008 to 2019
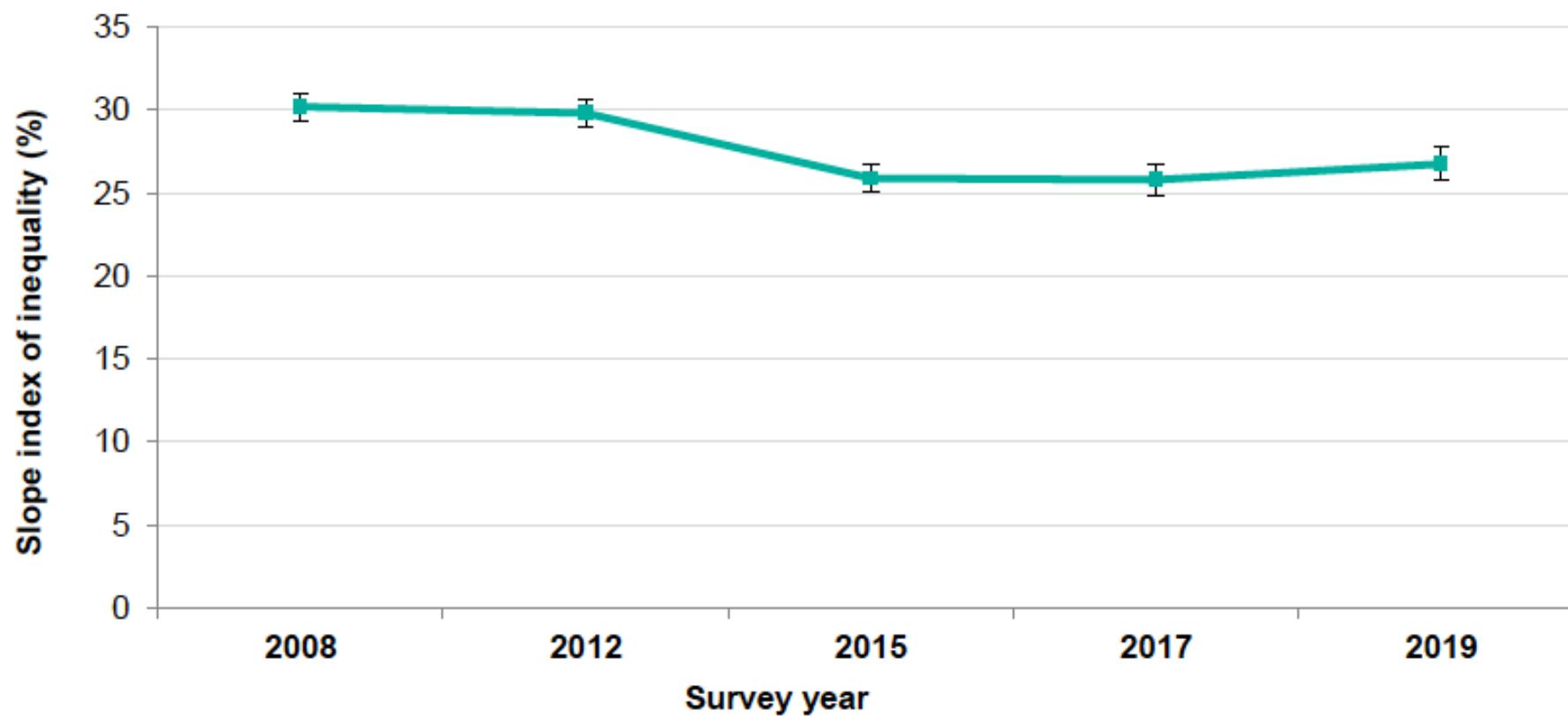
Source: PHE 2020

Figure 3.15 Relative index of inequality in dental caries prevalence in 5 year old children, 2008 to 2019
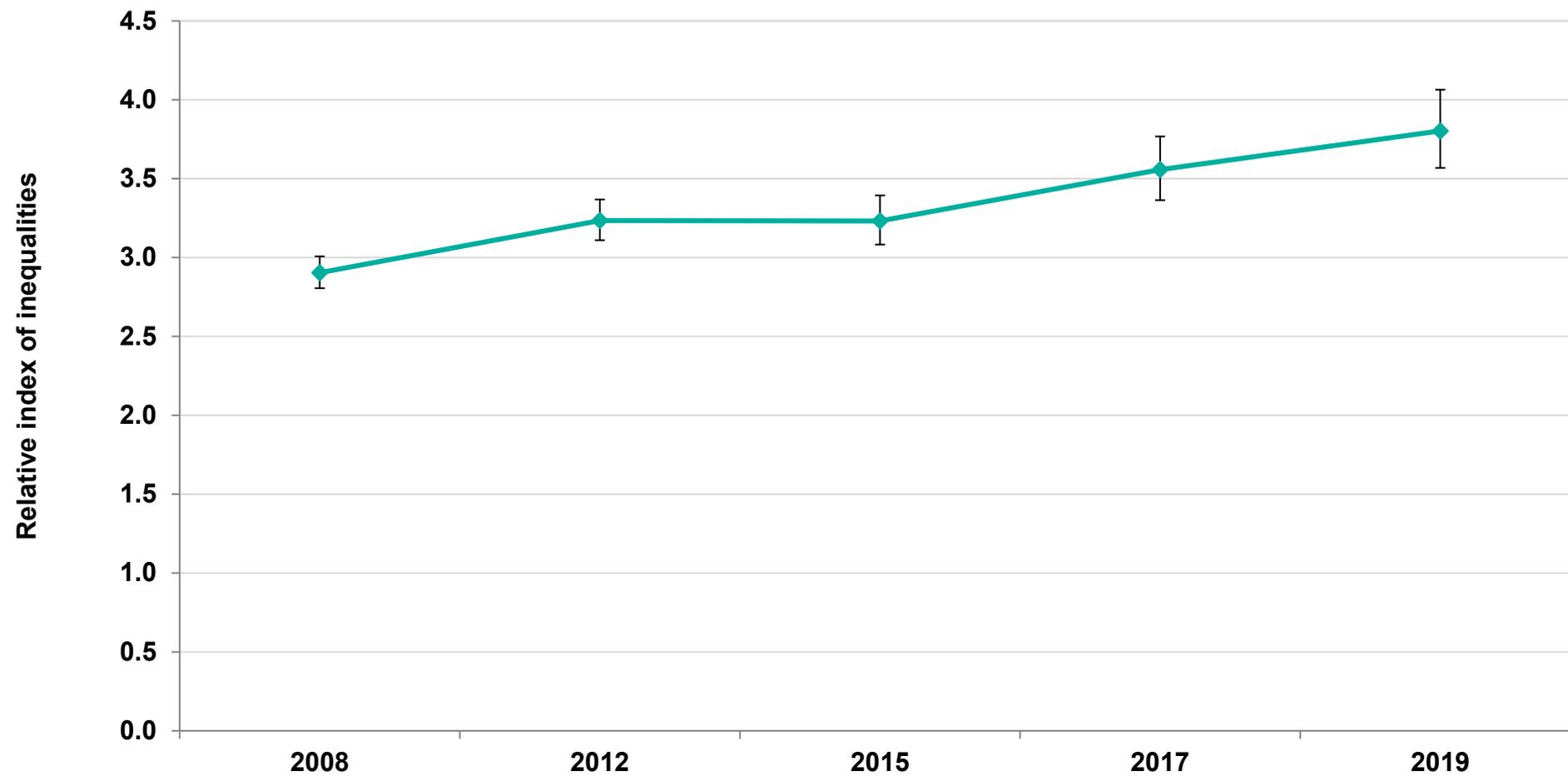
Source: PHE 2020

3.6 Limitations of epidemiological and NHS data

Variations in oral health were not reported in epidemiological surveys and registers across all dimensions of inequality. For example, variation in oral health diseases by area deprivation was not reported in the 2009 adult dental health survey. Furthermore, there was no information describing variations in oral health by ethnicity, pregnancy and maternity, religion or homelessness in the 2009 adult dental health survey or the 2009 oral health surveys of adult subgroups. Prisoners were not included in these surveys. None of the adult dental surveys reported on trends in oral health inequalities.

Variation in oral cancer by socioeconomic position, protected characteristics (except sex) or vulnerability types was also not reported in the cancer registers.

With respect to children, there was no information describing variations in oral health by religion or vulnerability types in any of the children's surveys.

Variations in dental service commissioning, delivery and utilisation were not reported across all dimensions of inequality. For example, no information was available of such variations by the majority of protected characteristics (for example, disability, pregnancy and maternity, religion) or vulnerability types. Additionally, no data was available from the private dental sector or on inequalities in access to specialised care (apart from hospital tooth extraction).

3.7 Summary

There is evidence from epidemiological surveys and cancer registers that there are marked inequalities in oral health in England across all stages of the life course and over a number of different clinical indicators and related quality of life measures.

There is also evidence from NHS data that there are inequalities in the availability and utilisation of dental services across ages, sex, geographies and different social groups.

Relative inequalities in the prevalence of dental caries in 5 year old children in England had increased from 2008 to 2019.

In terms of recommendations, future epidemiological surveys should endeavour to report on variation in oral health across additional dimensions of inequality and data should be collected to enable trends of oral health inequalities amongst adults to be determined.

Future NHS data should include information on variations by different dimensions of inequalities in relation to general and specialised care. A system should be set to collect data from the private dental sector.

4. Oral health inequalities: what does the academic literature tell us?

4.1 Introduction

This chapter summarises one scoping review of oral health inequalities (sections 5.2 to 5.4) and 2 rapid reviews (section 5.5) on barriers to the receipt of dental care in the UK. Detailed search strategies are described in Appendices 4 to 6. Details of the studies included in sections 5.2 to 5.4 can be found in Supplementary Tables (available as a separate document).

The scoping review aimed to provide an overview of the evidence on oral health inequalities in the UK. The remit of the review was broad and included socio-economic inequalities, and inequalities affecting those with protected characteristics and vulnerable groups. Definitions and explanations of the different terms used in this chapter are presented in Appendix 2. The scoping review included empirical and peer-reviewed research articles reporting on UK data that were published between January 2000 and June 2017. It also included grey literature for those characteristics where evidence from peer-reviewed studies was very limited but good quality grey literature was available (homelessness, prisoners, travellers, and looked after children). A more detailed account of the scoping review methodology can be found in Appendix 4, while the relevant information for the 2 rapid reviews is presented in Appendix 5 and Appendix 6, respectively.

4.2 Oral health inequalities by socioeconomic position

Socioeconomic position is a broad term that refers to the social and economic factors that influence what positions individuals or groups hold within the structure of a society. It is measured both at the individual and also at the area level. Education, income and occupation based social class are the most widely used relevant measures for individual socioeconomic position, while area deprivation is also a key area-level socioeconomic position marker. Table 4.1 provides a brief overview of the evidence for oral health inequalities by socioeconomic position in the UK.

4.2.1 Oral health inequalities by individual-level socioeconomic position

Individual-level socioeconomic position and clinical outcomes

Details for studies on socioeconomic position and clinical outcomes (dental caries, periodontal disease, tooth loss, dental trauma, and oral cancer) are shown in supplementary Table S1-1.

Individual-level socioeconomic position and dental caries

The search identified 10 studies, of which 3 were conducted among children and 7 among adults. There is clear and consistent evidence for social gradients in the prevalence of dental caries among UK children and adults.

Studies on children and adolescents consistently found social inequalities in dental caries, measured by dmft/DMFT (number of decayed, missing and filled teeth in primary and permanet teeth respectively) or prevalence of decayed teeth (1, 2, 3). Data from the Children's Dental Health Survey (CDHS) 2013, which contained a representative sample of children aged 5, 8, 12 and 15 years in England, Wales and Northern Ireland, were analysed using free school meal eligibility as a proxy measure of socioeconomic position (SEP). At all ages, those eligible for free school meals were significantly more likely to have obvious decay experience compared to those not eligible (3). A study among adolescents aged 15 to 16 years from East London, using parental employment status to measure SEP, found a clear social gradient with the lowest mean DMFT among adolescents with 2 working parents and the highest mean DMFT among those whose parents were both unemployed (1). Large differences in DMFT by parental social class were also reported in a small, non-representative study among child patients aged 5 to 16 years from one dental surgery in London (2).

Three studies analysed data from the most recent Adult Dental Health Survey (ADHS), conducted in 2009. Two of these assessed the unadjusted prevalence of decayed teeth, finding linear, stepwise social gradients by social class and education (4, 5). The third study examined a range of caries-related outcomes in models mutually adjusted for several SEP measures and other factors, showing clear social inequalities in caries experience by education, income and social class (6).

Studies using data from the ADHS 1998 also consistently reported social inequalities in caries experience among UK adults (7, 8, 9). Separate analysis of DMFT components found clear social gradients in the number of decayed and number of missing teeth by education, income and social class; while the number of filled teeth followed a reverse social gradient (7). Similarly, a study carried out among adolescents and adults in East London also found social gradients in the number of decayed teeth by education and social class, and a reverse social class gradient in the number of filled teeth (10).

Pathway analysis (structural equation models) of ADHS 1998 data showed that the association between SEP and number of sound teeth was partially explained by barriers to dental attendance (8).

Individual-level socioeconomic position and periodontal disease

Nine studies on SEP and periodontal disease were identified. Of these, one assessed plaque scores among young children, and 8 examined periodontal disease among dentate adults.

One small, non-representative study surveyed children born in 1995 to 1996 at ages 12 and 18 months for the presence of visible plaque. There were no statistically significant differences in visible plaque levels by maternal education (11).

For adults, the existing research shows social inequalities in the prevalence of periodontal disease by education and social class. However, the available evidence is not entirely consistent and pathways between SEP and periodontal disease have rarely been explored. Two studies reported on data from the ADHS 2009. One study suggested a social gradient by social class for periodontal pockets of ≥6mm (4). The other study estimated that the probability of having any pockets of ≥6mm was 4% higher among participants with no qualifications compared to those with a degree; and 2% higher among those in routine and manual compared to managerial and professional social classes, in models that adjusted simultaneously for several SEP indicators and a wide range of other covariates (6).

Three studies analysed data from the ADHS 1998, with inconsistent results. One study found that those with higher levels of education and those in higher social classes had fewer teeth with pocket depth of ≥4mm, and fewer teeth with loss of attachment of ≥4mm (12). Higher odds of attachment loss of ≥4mm were associated with lower educational level also in another study, however there was no association with social class in fully adjusted models (9). A third study only analysed ADHS 1998 data for Scotland, and found no relationship between periodontal pocketing of ≥4mm and either education, income, or social class in models adjusted for all 3 SEP measures simultaneously (13).

Loss of attachment, but not pocket depth, was associated with lower levels of education and lower social class also in a study among a large sample of adults from East London (14); and with manual social class among a sample of older British men (15). A study among a large but non-representative sample of pregnant women reported higher plaque scores, bleeding scores and mean probing depth among those from lower social classes, but no significant differences by social class in loss of attachment (16).

Individual-level socioeconomic position and tooth loss

Tooth loss was examined in 19 studies on adult samples. The evidence for social gradients in tooth loss among UK adults is clear and highly consistent, irrespective of the outcome assessed or SEP indicator used. All of the reviewed studies reported stark social inequalities in tooth loss, and all 11 studies that examined SEP measures with more than 2 categories reported the existence of social gradients.

Edentulism (total tooth loss) was the outcome measure in 13 studies (9, 15, 17 to 27). Six studies assessed the number of remaining natural teeth (6, 9, 14, 17, 28, 29), 3 studies analysed the presence of a functional dentition (15, 17, 30), and 2 studies looked at the number of teeth lost (18, 31). Most studies analysed large and representative datasets such as the ADHS 1998 and 2009, the English Longitudinal Study of Ageing, the UK Low Income Diet and

Nutrition Survey, the Newcastle Thousand Families Study, the Scottish Health Surveys, the British Regional Heart Study and the East London Oral Health Inequality Study.

Three studies analysed time trends. Data from the ADHS 1988, 1998 and 2009 showed that despite overall improvements over time, linear social gradients by social class were apparent for total tooth loss, number of teeth, and functional dentition in each survey year. Absolute inequality in total tooth loss decreased over the 2 decades, while relative inequality increased: between 1988 and 2009 total tooth loss declined by 80% for the highest but only 48% for the lowest social class. Among dentate adults, absolute and relative inequalities in number of teeth and proportion with functional dentition remained relatively stable over time (17). Jagger et al. (19) analysed data from the Scottish Health Surveys 1995, 1998, 2003 and 2008 to 2009. Among Scottish adults, absolute inequalities decreased over time, but only among those under 65 years old. However, relative inequalities (measured by education) increased (19). Similarly, data from Scottish adults who participated in the ADHS 1972, 1978, 1988 and 1998 showed that while the prevalence of total tooth loss declined over time (from 44% in 1972 to 18% in 1998), social gradients persisted (27).

A life course approach was taken by 3 studies that analysed data from the Newcastle Thousand Families cohort to establish the relative importance of childhood and adulthood SEP for tooth retention at age 50 years (28, 30, 31). Median number of teeth lost was related to childhood and adult social class in unadjusted analyses (31). In another study on this sample, higher childhood SEP predicted a higher number of retained teeth at age 50 among women, and this relationship was fully explained after adjustment for adult SEP (28). Also among women, retaining a functional dentition was related to social mobility trajectories: compared to being in the stable non-manual group (that is, in a non-manual social class family in childhood and non-manual social class in adulthood), those in the stable manual group were 94% less likely to have retained a functional dentition at age 50 (30).

Individual-level socioeconomic position and dental trauma

Only 3 studies on SEP and dental trauma were identified (32 to 34). All were conducted on children and adolescents. The evidence in relation to social inequalities in the prevalence of dental trauma is mixed.

One study analysed data from the CDHS 2013, containing a large representative sample of children aged 8, 12 and 15 years in England, Wales and Northern Ireland. There were no differences in the prevalence of dental trauma to permanent incisors between free school meal eligible and non-eligible children (33). An East London school-based study among 15 to 16 year old adolescents found that adolescents whose parents were both unemployed were about 90% more likely to have experienced dental trauma than those with at least one employed parent (32). The third study, carried out on a small and non-representative sample of 7 to 15 year old patients attending a clinic at the Royal London Dental School, reported that children whose fathers had completed up to 16 years of education were less likely to have traumatic dental injuries than those whose fathers had more than 16 years of schooling (34).

Individual-level socioeconomic position and oral cancer

For the purpose of this review, the definition of 'oral cancer' included oral and pharyngeal cancers. Studies that used 'head and neck cancer' as their outcome measure (which include oral and pharyngeal cancers), were also included.

Four studies on SEP and oral cancer were identified, one large and 3 small case-control studies (35 to 38). All studies concluded that lower SEP was related to a higher risk of oral cancer. Cancers of the upper aerodigestive tract (UADT) were examined in a large cross-country case-control study involving 14 centres from 10 European countries (including 3 UK centres). UADT cancer risk significantly increased with lower levels of educational attainment, with a 3-fold increased risk for those with no formal education compared to those with university education. Lower social class was also associated with increased risk of UADT cancer. In analyses stratified by sex, gradients by education and social class were statistically significant only among men (36). Diagnoses of head and neck cancer, oral cancer, and referral after oral cancer screening were linked to lower levels of education and lifetime experience of unemployment also in the smaller studies (35, 37, 38).

Three studies examined potential explanations for the associations between SEP and oral cancer. All 3 found that the observed social inequalities by education were at least partly explained by smoking and alcohol consumption (35 to 37).

Individual-level socioeconomic position and subjective oral health or Oral Health Related Quality of Life

Details for studies on socioeconomic position and subjective oral health or Oral Health Related Quality of Life (OHRQoL) are shown in supplementary Table S1-2.

Individual-level socioeconomic position and subjective or perceived oral health

Seven studies met the inclusion criteria. Of these, 6 studies examined self-rated oral health (15, 18, 21, 25, 39, 40), one study also analysed self-reports of dental problems (15), and one study examined 'persistent trouble with gums or mouth' (41). Six studies were on adults and one study on children. All studies used data from large, representative surveys.

Self-rated oral health was measured among children aged 12 and 15 years in the CDHS 2013. At both ages, the prevalence of good or very good self-rated oral health was markedly higher among children who were not eligible for free school meals than among those who were eligible. For example, in 15 year olds, 77% among those not eligible and 64% among eligible for free school meals reported good or very good oral health (40).

Social inequalities in self-rated oral health were consistently found among dentate adults, with linear gradients by education (18, 25, 39), income (18, 25, 39), social class (39), and wealth (21,

25). Studies that analysed dentate and edentate participants separately tended to find social inequalities in self-rated oral health only among the dentate (25, 39).

Associations between trajectories of intergenerational mobility and persistent trouble with gums or mouth (in the past 12 months or ever), measured at age 33 years were assessed using longitudinal data from the 1958 National Child Development Study. Those in the stable manual trajectory (that is, the most disadvantaged) were more likely to report persistent trouble with gums or mouth compared to those in any other social class trajectory, suggesting that perceived adult oral health may be more influenced by current rather than childhood SEP (41).

Individual-level socioeconomic position and orofacial pain

Four studies on orofacial pain were identified, of these, 2 were carried out among children and 2 among adults.

Analysis of the CDHS 2003 reported overall higher prevalence of dental pain among children from routine and manual social classes compared to children from managerial and professional social classes, but did not find consistent social gradients (42). In the CDHS 2013, children who were eligible for free school meals were consistently more likely to have experienced dental pain than children not eligible for free school meals, at ages 5, 8, 12 and 15 years (40).

Among adults, analysis of the ADHS 1998 data showed that those in manual social classes were 21% more likely to report dental pain than those in non-manual social classes, after adjusting for age group and sex (43).

Facial pain was analysed in a study on a very large sample (n=500,488) using UK Biobank data (44). This study found a linear social gradient by income; and also social inequalities by education and employment status for both facial pain and chronic facial pain. For example, those in the richest income group were about 57% less likely to report facial pain and 62% less likely to report chronic facial pain than those in the poorest.

Individual-level socioeconomic position and Oral Health Related Quality of Life

Twenty studies met the inclusion criteria. Two were conducted among children and 18 among adults. The majority of studies used data from large, representative surveys. The evidence for social inequalities in OHRQoL is fairly consistent.

The CDHS 2003 collected data on parent-reported oral impacts for children aged 5, 8, 12 and 15 years, at a time when validated measures of OHRQoL in children were not yet available. The most frequently reported items in this study (apart from dental pain, described above) were impacts on oral function and self-confidence, but there were no consistent social gradients by social class (42). A later study analysing data from the CDHS 2013 using the Child-OIDP (Oral Impacts on Daily Performances) found that the prevalence of oral impacts on quality of life was higher among children eligible for free school meals than for non-eligible children, among both

12 year olds and 15 year olds. In the same study, parents of 5 and 8 year olds eligible for free school meals were more likely to report that their children's oral health impacted on the family (40).

Three studies on data from the ADHS 2009 reported social gradients in OHRQoL by education (18, 39, 45), income (18, 39), and social class (39, 45). One study found associations between the 3 SEP measures and OHRQoL among dentate participants only (39). Two studies on dentate adults from the ADHS 1998 reported social gradients by income and social class, but not education, in models simultaneously adjusted for all 3 SEP measures (29, 46).

Analyses of 2 Office of National Statistics (ONS) surveys which were carried out in 1998 and 1999 consistently found that those belonging to professional and non-manual social classes had better OHRQoL than those belonging to manual social classes (47 to 51).

Data on older adults (aged 50+ years) from the English Longitudinal Study of Ageing were analysed by 3 studies, showing significant inequalities in OHRQoL by education (21, 25, 52), income (25), and wealth (21, 25, 52), although social gradients were not always linear.

Individual-level socioeconomic position and oral health related behaviours

The search identified 22 eligible studies, of which 7 assessed oral hygiene or toothbrushing and 17 assessed sugar consumption. Details are shown in supplementary Table S1.3.

Individual-level socioeconomic position and oral hygiene

Seven studies assessed SEP and oral hygiene (5 among children and 2 among adults). Tooth brushing was the most commonly assessed outcome. There was consistent evidence for social inequalities in twice-daily tooth brushing.

Five studies examined tooth brushing behaviour among children. Four of them were secondary analyses of large, representative data. In the CDHS 2013, children eligible for free school meals were less likely to brush their teeth twice daily than non-eligible children across all sampled ages (5, 8, 12 and 15 years). Among 5 year olds, 12% of free school meals eligible children had started brushing before the age of 6 months, compared to 23% among 5-year-olds not eligible for free school meals (53).

Social gradients in tooth brushing behaviour by family affluence were reported in 3 studies on data from the Health Behaviour in School-aged Children (HBSC) Scotland survey (54 to 56). For example, among 13 year olds in the HBSC 2006, boys and girls from the highest family affluence tertile were 46% and 44% more likely to brush their teeth twice daily than those from the lowest tertile (55).

A small, non-representative study on a hospital sample of 163 children born in 1995/96 and surveyed at ages 12 and 18 months found no difference by social class in the age when parents started brushing the children's teeth (11).

Social gradients in tooth brushing were also reported for adults: in the ADHS 2009, among those with no qualifications, 35.9% brushed less than twice a day; among those educated below degree level this was 26.9% and among those with a degree it was 16.2% (57).

The use of mouthwash among adult residents of the Grampian region of Scotland was more common among individuals with a technical college education (50.1%) than among those with a university or postgraduate degree (39%), however the type of mouthwash or its fluoride concentration were not reported (58).

Individual-level socioeconomic position and sugar consumption

Of the 17 studies on sugar consumption, 11 were on children and 6 on adults. Of 11 studies carried out among children, 8 found evidence for associations between family SEP and sugar consumption in the expected direction, meaning the evidence for social inequalities in children's sugar intake is fairly consistent. For adults, the available data also suggest that sugar consumption is socially patterned, however with some conflicting findings. Most of the studies were carried out on large samples, and most used diet diaries to collect nutritional data.

Two studies reported on data from the Avon Longitudinal Study of Parents and Children (ALSPAC). Analysis of data from about 1,000 ALSPAC children born in 1991 to 1992 and aged 18 months when dietary data were collected showed that non-milk extrinsic sugar (NMES) intake decreased with increasing maternal educational level (59). The other study was carried out on a sample of about 4,000 10 year old children, demonstrating that lower maternal education was associated with higher intake of confectionery and biscuits as well as diet soft drinks, but not with intake of sugary drinks and puddings. Intake of buns, cakes and pastries, sweet spreads and fruit juice increased with increasing level of education in this study (60).

Significant differences were found in sugary drinks intake by free school meal eligibility among children from CDHS 2013. Consumption of sugary drinks 4 times a day or more was reported by 26% of 12 and 15 year olds who were eligible for free school meals versus 13% (12 year olds) and 12% (15 year olds) of non-eligible children (53).

Scottish data were analysed in 2 studies, one on children aged 11 to 15 years from the HBSC survey (61) and one on children aged 2 to 5 years from the Growing Up in Scotland cohort study (62). Both studies reported a higher intake of sugary drinks and sweets/chocolates among children from more disadvantaged families. The latter study also assessed whether changes in objective and subjective family income predicted changes in children's diets over time. While changes in objective income were not related to changes in sugary food or drinks consumption, children of mothers who transitioned from 'living very comfortably' towards 'finding it very difficult' more than doubled their consumption of sweets from ages 2 to 5 (62).

One study examined infant feeding practices in a sample of predominantly ethnic minority mothers from 41 UK Local Authorities. In analyses simultaneously adjusted for ethnicity, income, social class/employment, income support, family credit, access to a car and maternal education, mothers belonging to the poorest income quintile were about 5 times more likely to add sugary foods to their child's bottle that mothers from the richest quintile. Maternal education was not independently related to the outcome (63).

Three studies did not find any association between family SEP and sugar consumption among children. One was a study on children aged 11 to 12 years from 7 schools in South Northumberland who were surveyed in 1980, 1990, and 2000 (64); another was on a very small, non-representative hospital sample of 163 children born in 1995/96 and surveyed at ages 12 and 18 months (11). The third study used data from the 1993 National Diet and Nutrition Survey from a sample of 1,675 children aged 1.5 to 4.5 years. This study found that a higher proportion of children from manual backgrounds consumed carbonated drinks more than once a day (10.4% vs. 2.7% of children from non-manual backgrounds), while in the non-manual group, more children consumed fruit juice (48% vs. 26% in manual group). There was however no difference in overall free sugar intake between these groups (65).

Validated dietary assessments from over 4,000 children and adults from the National Diet and Nutrition Survey (NDNS) rolling programme from 2008 to 2012 were used to estimate consumption of sugar-sweetened beverages (including fruit juices) by household income, using sales data to adjust for under-reporting. Sugar-sweetened drink consumption was highest in low-income households – 32g/day of free sugars from sugar-sweetened beverages were consumed per person among those in the lowest income group compared to 24g/day per person in the highest income group (66). The NDNS 2008 to 2011 also showed that individuals with higher levels of education, higher income and from higher managerial and professional social classes consumed less NMES, measured as percentage of daily food energy, than those with lower education levels, lower income and from routine occupations (67).

A study on data from the UK Low Income Diet and Nutrition Survey found that across all age groups, study participants consistently consumed more NMES compared to the general population, although there were no consistent associations between NMES intake and SEP within this low income sample (68).

Data from a large sample of UK participants aged 44+ years from the European Prospective Investigation of Cancer (EPIC) cohort showed that compared to highly educated individuals, those with lower levels of education consumed sugary foods and cakes at least 20% more often (69).

UK data on take-home purchasing of food and drink from the Kantar WorldPanel 2010 showed that lower social class groups bought greater proportions of their total energy from less healthy food categories such as sweet snacks, puddings, and chocolate or confectionary. Higher social class groups purchased a greater percentage of their total energy from total sugars (which

include sugars from fruit and vegetables). A limitation of this study is that NMES (or free sugars) were not separately reported, and there were no data on out-of-home-purchasing (70).

The information on the consumption of sugary foods and drinks that is available in the ADHS 2009 has been analysed with 'high sugar consumption' defined as the consumption of cakes, sweets, or fizzy drinks 6 or more times a week. There was no significant association between high sugar consumption and education. However, it should be born in mind that the available measures of dietary intake in the ADHS are rather crude (57).

A study on a representative sample of 793 85 year olds from North-West England, which included institutionalised and cognitively impaired participants and used the 24-hour multiple-pass recall method, did not find statistically significant associations between daily NMES intake and education or social class (71).

Individual-level socioeconomic position and service use

On SEP and service use, 22 studies fit the inclusion criteria. Seventeen studies examined dental attendance and 7 studies examined other outcomes related to service use. Details are provided in supplementary Table S1-4.

Individual-level socioeconomic position and dental attendance

Of the 17 studies that assessed dental attendance, 15 were carried out on adult samples and 2 were conducted among children. None of the studies examined pathways between SEP and service use, that is, the mechanisms through which SEP influences dental attendance patterns.

The 2 studies on children's dental attendance used data from the CDHS 2003 and 2013. In the CDHS 2003, inequalities were assessed by parental social class. Social class differences in dental attendance were greater among younger ages. For example, 39% of 5 year olds from routine and manual social class backgrounds were symptomatic attenders compared to 25% of 5 year olds from managerial and professional class families (72). In the CDHS 2013, self-reported dental attendance varied considerably by free school meal eligibility among 12 and 15 year olds. Among 12 year olds, about 66% of eligible children reported visiting the dentist for a check-up compared to 86% of those not eligible. Among 15-year-olds, the respective prevalences were 74% (among those eligible) and 85% (among those not eligible for free school meals) (73).

The evidence for social inequalities in dental attendance among adults is highly consistent, with 12 out of the 15 reviewed studies finding that dental attendance was socially patterned (5, 7, 12, 43, 57, 74 to 80), and only 3 studies not reporting any associations between SEP and dental attendance (81 to 83). Most studies were based on secondary analyses of large samples.

Three studies analysed data from the ADHS 2009 (5, 7, 57) and 2 studies used the ADHS 1998 (12, 43). All of these reported associations between lower SEP (measured via education, income and social class) and less favourable (irregular) dental attendance patterns.

Longitudinal data from the British Household Panel Survey were analysed in 2 studies, which followed their samples over long periods; between 1991 to 2003 (78) and 1992 to 2008 (76). Both studies found that higher average household income over the entire study period predicted uptake of dental check-ups.

Individual-level socioeconomic position and other outcomes related to dental attendance

On other outcomes related to service use, 3 studies were conducted among children, and 4 among adults. Six studies analysed data from large samples, and all of these found evidence for social inequalities in relation to the aspect of service use they assessed.

According to data from the CDHS 2013, a higher proportion of parents of free school meal eligible children reported difficulties finding an NHS dentist compared to parents of children not eligible (73). Analyses of data from the Northern Ireland Longitudinal Study showed that provision of orthodontic treatments was highly concentrated among children from higher social classes and with higher education level; while all restorative treatments and extractions were more concentrated among lower socioeconomic groups. In addition, children from lower socioeconomic backgrounds were on average registered with a GDP for a significantly shorter amount of time than children from the highest socioeconomic groups (84, 85).

In a study that used data from the ADHS 2009 to assess the lifetime use of dental services, participants with no qualifications and those in routine or manual occupations were significantly less likely to ever receive preventive or restorative services and more likely to receive extractions than those with a degree and those in managerial and professional occupations (5). Another study carried out among a random sample of 1855 adults reported that individuals from lower social classes were less likely to use a removable dental prosthesis despite having less than 20 teeth than those from higher social classes, however there was no association with income (86). Data from the British Women's Heart and Health Study showed that among women aged 62 to 83 years, those from manual occupations were less likely to report ever having had a dental examination and also less likely to have had a recent dental examination than women from non-manual social classes (87).

A study on a non-representative sample of 555 adults with orofacial pain from one general practice found no association between health seeking behaviour for orofacial pain and level of education (88).

Strengths and limitations of the reviewed studies on individual level socioeconomic and oral health

Most of the reviewed studies on individual-level socioeconomic position and oral health

were based on large, representative samples, providing robust estimates.

For the purpose of assessing social gradients, minimal adjustment for other factors would be desirable – ideally models are adjusted only for age and sex. This is because the extent of social inequalities might be underestimated if factors that might be on the causal pathway between SEP and oral health are adjusted for. Similarly, if several indicators of SEP are modelled simultaneously, true relationships may be masked. Potential over-adjustment was a limitation in many studies, often because the assessment of social gradients had not been the primary focus of the research. On the other hand, factors that might explain the observed social inequalities in oral health (that is, pathways to oral health inequalities) have been rarely examined – this is an area which should be addressed by future research.

4.2.2 Oral health inequalities by area-level socioeconomic position

The search identified 87 individual studies on oral health inequalities by area deprivation that were published in the UK since the year 2000. The most studied outcome in this group was dental caries, followed by service use and oral cancer. A brief overview of the findings can be found in Table 4.1.

Area-level socioeconomic position and clinical outcomes

Details for studies on area deprivation and clinical outcomes (dental caries, odontogenic infections, periodontal disease, tooth loss, dental trauma, and oral cancer) are shown in supplementary Table S2-1.

Area-level socioeconomic position and dental caries

Twenty-nine studies examined inequalities in dental caries by area deprivation. Only 4 studies were conducted on adult samples (6, 13, 27, 89), all others were on children (90 to 114). Of the available studies on children, 14 were conducted in England, 10 in Scotland, and one in England and Wales. Twenty-two studies used large or very large samples, many analysing data from BASCD surveys and the Scottish Dental Epidemiological and National Dental Inspection Programmes.

Overall, the picture was clear and consistent: all of the larger studies and most of the smaller studies (except 2) reported social gradients in dental caries, with stark inequalities found between children from the most and least deprived areas. For example, in 2008/09 in Manchester, the percentage of caries-free children aged 11 to 13 years was 72% among those living in the least deprived areas and 39% among those in the most deprived (103). Inequalities were apparent already at a very young age and were seen even among infants (104, 105, 108). Furthermore, one study found that children in more deprived areas were less likely to have teeth restored (100).

Encouragingly, studies that analysed series of cross-sectional surveys found that caries levels have decreased over time and gaps between most and least deprived areas have narrowed,

which was partly attributed to preventive population programmes such as Childsmile in Scotland (101, 105, 106). However one study conducted in Scotland that examined trends in inequalities between 1997 to 1998 and 2007 to 2008 found that while absolute inequalities had reduced over time, relative inequalities had not (91).

Four studies examined the effect of water fluoridation on inequalities in caries levels among children. These studies consistently found that inequalities by area deprivation were less pronounced in fluoridated areas (97 to 99, 103).

Of the 4 studies on adults, one used a large sample from the ADHS 2009 (6), 2 analysed data from the ADHS 1998 but for Scotland only (13, 27), and one was a small, non-representative study of older people carried out in primary dental care clinics in London (89).

The large study on the ADHS 2009 found that area deprivation, measured via the Index of Multiple Deprivation (IMD), was independently associated with both the presence of decay and the presence of unrestorable teeth, even after adjusting for individual-level income, education, and social class (associations with IMD only were not reported). In this study, the probability of having any untreated decay was 8% higher among those living in the most deprived areas compared to those living in the least deprived areas (6). These findings suggest that living in a deprived area constitutes an additional disadvantage over and above the effect of household-level socioeconomic position.

Both studies on Scottish participants in the ADHS 1998 found evidence for social gradients by area deprivation (measured via Carstairs Index). Bower et al. (13) reported a lower number of sound teeth among those living in the most deprived areas compared to those living in the least deprived, but no significant differences in the presence of unsound teeth. Nuttall et al. (27) found that those in the most deprived areas had on average fewer decayed and more filled teeth than those in the least deprived.

The small study among older adults in London found that individuals from the most deprived areas had significantly more missing and fewer filled surfaces, but there were no significant differences for mean DMFS (number of decayed, missing and filled permanent surfaces) (89).

Area-level socioeconomic position and odontogenic infections

Only 3 studies examined odontogenic infections by area deprivation. One study was carried out on a large sample of 5 year old children in Scotland. This study found that children living in the most deprived areas (measured via Carstairs Index) were 40% more likely to present with dental sepsis than those living in less deprived areas, after adjustment for numbers of decayed, filled and extracted teeth, and presence of plaque (115). Two studies examined odontogenic infections among adults, both based on small, clinical samples of patients. Both studies found that the majority of patients were resident in areas with high or very high levels of deprivation (116, 117).

Area-level socioeconomic position and periodontal disease

Four studies on periodontal disease by area deprivation were identified, all were on adult participants. Among a large sample from the ADHS 2009, area deprivation (IMD) was independently associated with having at least one periodontal pocket of ≥6mm. The probability of having any pockets of ≥6mm was 6% higher among those in the most deprived compared to the least deprived areas. Results were adjusted for a wide range of covariates including income, education, and social class. Unadjusted results were not reported (6). In contrast, a study on ADHS 1998 data from 632 participants in Scotland did not find any associations between the presence of periodontal pockets of ≥4mm and area deprivation measured via the Carstairs Index (13). A small, non-representative study on older adults in London found that participants from the most deprived areas (measured via IMD) had significantly greater Plaque Index scores than those from the least deprived areas, but there were no differences in Gingival Index scores. After controlling for age, sex, and ethnicity, differences in Plaque Index were no longer statistically significant (89).

Area-level socioeconomic position and tooth loss

Inequalities in tooth loss by area deprivation were examined in 5 studies on adult samples, of which 3 were conducted on large samples and 2 on small, non-representative samples. Results from the 3 large studies (6, 19, 27) and one small study (89) suggest clear social gradients in tooth loss and edentulism.

A study on a large sample from the ADHS 2009 reported a clear social gradient with the number of natural teeth decreasing as levels of area deprivation (IMD) increased, after adjusting for covariates including income, education, and social class. Those in the most deprived areas had on average 1.13 fewer natural teeth compared to those in least deprived areas. In addition, the probability of having 3 or more unfilled upper spaces was 3% higher among those resident in the most deprived compared to those in the least deprived areas (6). These findings are supported by 2 large studies on adults in Scotland, which found that the prevalence of edentulism was highest for the most deprived and lowest for the least deprived groups (19, 27). There was also evidence for higher absolute inequality among older age groups and higher relative inequality among younger age groups (19).

Area-level socioeconomic position and dental trauma

Four studies were identified, all of them conducted on children (33, 118 to 120). None of these studies found significant associations between dental trauma and overall levels of area deprivation. Two of the studies, conducted 3 years apart on 14 year olds in Newham, London, found no association between overall Jarman scores and experience of dental trauma, but reported associations with individual components of the index, namely overcrowded households and ethnicity (118, 119).

Area-level socioeconomic position and oral cancer

For the purpose of this review, the definition of 'oral cancer' included oral and pharyngeal cancers. Many studies used 'head and neck cancer' as their outcome measure (7 studies) which include oral and pharyngeal cancers; therefore, these studies were also included. Seventeen studies on associations between area deprivation and oral cancer were identified. Eleven studies were based on cancer registry data, and 6 on hospital data. Six studies measured survival after diagnosis (121 to 126), 5 studies measured age-standardised incidence rates (127 to 131), 3 studies measured cancer risk (35, 37, 132), one study examined professional delay in cancer referrals (133), one study measured tumour size at presentation (134), and one study analysed diagnosis through emergency presentation (135). Overall, there is good evidence from large-scale studies for social inequalities in oral cancer survival as well as incidence of oral cancer in the UK.

Oral cancer survival after diagnosis

Studies on survival after cancer diagnosis tended to find that relative survival (adjusted for background mortality) was better for those living in less deprived areas, with some differences between studies. For example, relative survival after diagnosis of nasopharyngeal and oropharyngeal cancer was highest in patients from the least deprived groups (121, 126). Significant gaps were also found after diagnosis of laryngeal cancer, with lower probability of 1-year and 5-year survival for patients from the most deprived areas, but only for men and not for women (122). A study on survival after diagnosis of head and neck cancer reported significant social inequalities only within the first 18 months but not for those who survived beyond that time (123). Another study on head and neck cancer reported a 50% higher relative risk of death for those resident in the most deprived IMD quartile compared to the least deprived, and this difference was not explained after adjusting for age, gender, pathology stage, tumour site, year of surgery and adjuvant radiotherapy (125).

Age-standardised oral cancer incidence rates

Time trends in incidence rates of oral and oropharyngeal cancer were analysed in 2 studies using data from the Scottish Cancer Registry. Both studies found that cancer rates increased with increasing levels of deprivation and that social inequalities in oral cancer have widened over time, explained by a disproportionate increase in incidence in the most deprived group (127, 131). Incidence projections up to 2025 showed an expected rapid increase in the rates of oropharyngeal cancer (131).

Inequality indices were calculated in another large Scottish study, which reported that social inequalities in head and neck cancer were greater among men than women. Of all head and neck cancers, relative inequalities were greatest for laryngeal cancers for both men and women (128).

Professional delay in oral cancer referral and diagnosis through emergency presentation

There was evidence that patients living in the most deprived areas are at greater risk of emergency presentation for oral, oropharyngeal and laryngeal cancers (135) and are also more likely to experience professional delay in referral for head and neck cancers (133).

Explanations for social inequalities in oral cancer

Three studies examined potential mechanisms for social inequalities in oral cancer, but no clear picture emerged. A small case-control study on head and neck cancer patients found that associations between cancer risk and area deprivation were explained by smoking and alcohol (35). Clinical and tumour-specific factors did not explain social inequalities in head and neck cancer survival in one study (125), while in another study tumour stage and treatment type partly explained the gap in survival among younger but not older patients (126).

Area-level socioeconomic position and subjective oral health or Oral Health Related Quality of Life

Details for studies on area deprivation and subjective outcomes including OHRQoL are shown in supplementary Table S2-2.

Area-level socioeconomic position and subjective or perceived oral health

Two studies on perceived oral health and area deprivation were identified, both examined self-rated oral health among adults in England and measured area deprivation via the IMD. Both found that higher levels of deprivation were associated with poorer self-rated oral health (136, 137), with one of the studies reporting a clear social gradient (137).

Area-level socioeconomic position and dental pain or facial pain

Only one study examined facial pain, analysing a very large sample (n=500,488) using UK Biobank data (44). There were clear and linear social gradients for both facial pain and chronic facial pain: compared to those living in the least deprived areas (Townsend Index decile), those in the most deprived areas had an increased risk of facial pain (Risk Ratio (RR) = 1.47) and chronic facial pain (RR = 1.79) after adjustment for sex and age.

Area-level socioeconomic position and Oral Health Related Quality of Life

Six papers were identified. Of these, 3 examined quality of life in adult oral cancer patients (125, 138, 139), one examined OHRQoL among older adults from the ADHS 2009 (45), one was a large questionnaire survey among English adults (140), and one was a small study on children (141).

OHRQoL was independently associated with IMD in the expected direction among a small sample of 11 to 12 year old children after adjusting for gender, self-esteem, child self-assessed Index of Orthodontic Treatment Need, and DMFS (141).

In a sample of older adults from the ADHS 2009, those living in the most deprived areas (IMD quintile) reported poorer OHRQoL than those in the least deprived areas. Significant differences remained even after adjustment for a wide range of socio-demographic and oral health variables, including education and social class (45). A questionnaire survey carried out in 2009

on over 3,000 dentate and edentate English adults suggested a social gradient in the prevalence of oral impacts by deprivation level (IMD), however the gradient was not entirely linear (140).

All 3 studies that investigated quality of life among cancer patients found that patients living in less deprived areas reported significantly better quality of life after treatment than patients residing in more deprived areas (125, 138, 139).

Area-level socioeconomic position and oral health related behaviours

Details for studies on area deprivation and oral health related behaviours are shown in supplementary Table S2-3.

Area-level socioeconomic position and oral hygiene

Three studies were identified on tooth brushing frequency or habits among children. All found that tooth brushing was socially patterned.

A large study among Scottish 15 year olds reported that the odds for twice-a-day tooth brushing were greater among those living in the least deprived areas (Odds Ratio: OR=1.80 for boys; OR=2.77 for girls) compared to those living in the most deprived areas, after adjusting for age, family structure, family affluence, school type, and rurality (56). Parents of very young children living in less deprived areas were significantly more likely to brush their children's teeth twice a day, to assist the child with brushing, and to have started brushing before age one, than parents living in more deprived areas (142, 143).

In contrast, the use of mouthwash in Scottish adults was more common among individuals residing in the most deprived areas (50.6%) than in participants from the most affluent areas (40.7%), however information on the type of mouthwash or fluoride concentration was not reported (58).

Area-level socioeconomic position and sugar consumption

Social inequalities by area deprivation in sugar consumption were examined in 6 studies, of which 4 were conducted on children. All but one study found significant differences in the consumption of NMES (or free sugars), that is, children and adults living in more deprived areas had a higher percentage of daily energy coming from free sugars (142, 144 to 146). The one study that did not find differences by area deprivation was based on a cross-country questionnaire survey with a very low UK response rate (147).

Area-level socioeconomic position and service use

Details for studies on area deprivation and service use are presented in supplementary Table S2-4. There were 20 studies on service use and area deprivation, of which 11 had examined dental attendance.

Area-level socioeconomic position and dental attendance

Dental attendance was assessed in 11 studies. Five studies were conducted on children, 5 on adult samples and one study examined both children and adults.

Studies based on self-reported attendance consistently found that participants residing in the most deprived areas were less likely to report regular dental attendance and more likely to report symptomatic attendance, than those from less deprived areas, and this was true for both children and adults (27, 77, 136, 137, 140, 142). For example, a study using data from the ADHS 2009 found that compared to those living in areas belonging to the most deprived quintile, those from the least deprived quintile were 65% less likely to report symptomatic dental attendance (136).

Four studies used routinely collected NHS registration data to assess registration or contact with dental services in relation to area deprivation measures. All these studies suggested an inverse dental care law for children in England, with lower registration rates and higher lapse rates found in areas with higher levels of deprivation (148 to 150), and higher contact rates in less deprived areas (113).

One study assessed dental attendance and treatment received after screening among a large sample of children aged 6 to 9 years. In this study, children living in the least deprived areas were less likely to be referred from dental screening than children living in the most deprived areas. However, once referred, children in the least deprived areas were more likely to attend a dentist than children in the most deprived. Treatment for carious teeth identified through screening was received by 34% of children from the least deprived but only by 16% of children living in the most deprived areas. The authors concluded that the screening programme "fails to reduce inequalities in utilisation of dental services" (151).

Area-level socioeconomic position and other outcomes related to service use

Two studies looked at the type of care received by children in the North West of England, using data from case notes 1990 to 1999. Included were only children who were regular attenders over this ten-year period, therefore the sample was not representative. In this sample, area deprivation was not significantly associated with number of carious teeth, but children living in the most deprived areas had on average more teeth extracted compared to children from the least deprived areas (114). In the same sample, no association was found between area deprivation and provision of dietary advice or prescription of fluoride tablets, but children from

more deprived areas were significantly more likely to receive oral hygiene instructions and less likely to receive applications of fluoride varnish than those from less deprived areas (152).

There is also evidence that higher proportions of children from more deprived areas use emergency dental services (153) and are admitted to a hospital for dental care (154). They are also less likely to access orthodontic treatment (155) and emergency treatment for dental trauma (156). Finally, children using the Community Dental Service are more likely to come from the most deprived areas (157).

Strengths and limitations of the reviewed studies on area-level socioeconomic position and oral health

Area deprivation indices have been most commonly used in studies on dental caries, oral cancer and dental service use.

Most studies on area deprivation and dental caries used large, representative samples, and some have analysed time series of cross-sectional studies providing valuable information. The smaller studies were limited in terms of statistical power to detect differences, and some were conducted on non-representative samples. The majority of studies were conducted on children, while studies on adults were scarce. Very few studies calculated inequality indices. No study had attempted to examine potential pathways between area deprivation and dental caries, most likely due to a lack of relevant data. Apart from further monitoring inequalities in dental caries over time, examining potential mechanisms should be a priority of future research.

Studies on oral cancer and area deprivation have used large samples from cancer registry data, and 2 studies analysed time trends. Direct comparisons between studies are difficult because studies have examined different cancer types and have used different outcome measures. One limitation of existing research is the relative lack of studies exploring potential mechanism or mediating factors that might explain social inequalities in oral cancer, mainly due to a paucity of relevant data.

The majority of service use analyses were carried out on representative samples and have produced consistent findings of social gradients. Again, further research is warranted on potential mechanisms and pathways.

Table 4.1 Evidence for oral health inequalities by individual and area-level socioeconomic position: summary table.

Outcome	Evidence for social inequalities by SEP or area SEP?
Caries	Yes
Periodontal disease	Yes; but some inconsistencies.
Tooth loss	Yes

Outcome	Evidence for social inequalities by SEP or area SEP?
Oral cancer	Yes
Odontogenic infections	Yes; but limited data available.
Traumatic dental injuries	Inconsistent. No evidence for social inequalities in studies conducted on large samples, and no evidence for inequalities by area SEP.
Self-rated oral health	Yes; but among dentate only.
OHRQoL	Yes; but among dentate only.
Oral health related behaviours	Yes; stronger evidence for inequalities in oral hygiene than in sugar intake.
Service use	Yes

4.3 Oral health inequalities by protected characteristics

4.3.1 Oral health inequalities by ethnicity

The Equality Act 2010 protects against race discrimination and this refers to discrimination because of colour, nationality, national origin and ethnicity. Ethnicity and national identity are self-defined and therefore subjectively meaningful to an individual. Table 5.2 provides an overview of the evidence for oral health inequalities by ethnicity in the UK.

Ethnicity and clinical outcomes

Details for studies on ethnicity and clinical outcomes (dental caries, periodontal disease, tooth loss, dental trauma, and oral cancer) are shown in supplementary Table S3-1.

Ethnicity and dental caries

Eleven relevant papers were identified. Seven of these referred to child populations and 4 papers focused on adults. Overall, the findings indicate the existence of ethnic differences in dental caries among children and adults, but patterns were inconsistent.

Some studies on children found that Asian children had worse caries levels than their White counterparts (93, 158 to 161), but there was also some evidence for lower levels of caries among South Asians (95). In one study in East London, Eastern European White 3 to 4 year old children fared much worse than their other White counterparts (160), while a study in Manchester indicated that 4 to 5 year old African-Caribbean children had lower prevalence of caries (and rampant caries) than White children (158).

Analysis from the ADHS 2009 indicated that South Asian adults were less likely to have untreated decay than Whites (162). A large study in East London also indicated lower caries levels among Asian and among Black ethnic groups, compared to those classified as White (10); again, Eastern European and other White groups fared worse than White British in that respect.

Some of the aforementioned studies adjusted their findings for potential confounding or mediating factors (10, 93, 95, 160 to 162). These studies indicated that ethnic differences persisted even when adjusting for socioeconomic position; this was the case also in a nationally representative study of adults that accounted for both individual socioeconomic position and area deprivation (162). Two studies on children examined whether the association between ethnicity and oral health varied by the level of area deprivation; one study in Glasgow indicated no difference in the ethnic groups differences in dental caries between areas with different levels of deprivation (93), while another study in Leicestershire and Rutland showed ethnic group differences only in areas of high deprivation but not in the more affluent areas (95). Based on this limited evidence coming from different contexts, it is not possible to draw firm conclusions about the potential interaction between deprivation and ethnic differences in caries levels.

Ethnicity and periodontal disease

Four studies on adults were included. Three of these studies were local (14, 16, 163), and one study was based on secondary data analysis of the ADHS 2009 (162).

The evidence from the analysis of nationally representative data showed no significant difference in periodontal pockets between White and South Asian participants, either before or after extensive adjustment that considered demographics, socioeconomic position, behavioural factors and dental service use (162). In contrast to this, a study in East London reported that different Asian groups (Pakistani, Indian, Bangladeshi and Asian Others) had worse pocket depth levels and White Eastern Europeans, Black Africans and Bangladeshis had higher loss of attachment levels compared to White British (14). However, such differences were found only among those with higher education levels but not among the less educated participants, indicating that education could act as a moderator in the association between ethnicity and periodontal outcomes.

Ethnicity and tooth loss

Four papers were identified. One was a secondary data analysis from the ADHS 2009 (162) and 3 were local studies; a large study on a random sample from East London (10), a study sampling only minority ethnic groups in the South Thames region (164) and a small pilot study among Chinese older adults (165).

The analysis of nationally representative data showed clear differences in tooth loss between different ethnic groups, with higher levels of tooth loss and edentulousness rates among Whites,

followed by Blacks, and lower tooth loss and edentulousness among Indians and Pakistani or Bangladeshis. After adjusting for demographics, socioeconomic position, behavioural factors and dental service use, Indians were 70% less likely and Pakistani/Bangladeshis were 74% less likely to have less than 20 teeth compared to Whites; however, there were no differences between Whites and Blacks (162). After adjustment, age, sex, socioeconomic position and health-related behaviours (but not dental service use) partly explained the ethnic differences (162). The local study in East London showed broadly similar findings with lower levels of tooth loss among Indians, Pakistanis, Bangladeshis and Blacks compared to Whites, with Eastern European Whites having the highest levels of tooth loss (10).

Overall, the data suggest that tooth loss and edentulousness rates may be higher among Whites than among ethnic minority groups in the UK, however the evidence for differences between White and Black population groups is limited.

Ethnicity and Dental Trauma

Three papers were included in this section. None of these found significant differences between ethnic groups in the prevalence of dental trauma (32, 166, 167). This was the case also after adjusting for demographics, parental socioeconomic position, overjet and bullying experience (32, 166). All 3 papers reported from local studies among adolescents in East London, and 2 used the same data source (32, 166).

Ethnicity and Oral Cancer

Seven papers were eligible for review. Five studies referred to analysis of cancer-registry data (130, 132, 168 to 170), one used retrospective and prospective data from a hospital (171), and another was an ecological study based on library resources (172). Overall, the available data indicates ethnic inequalities in oral cancer.

In terms of the key findings, South Asian women had considerably higher risk of oral (RR=3.67) and pharyngeal (RR=2.06) cancers than non-South Asian women (132). This finding among women in the Thames cancer registry was confirmed for women in the West Yorkshire registry (168) and also in studies using self-reported ethnicity and a finer classification (with separate groups for Indian, Pakistani and Bangladeshi women) of the Thames cancer registry data (130, 169). The ethnic differences in oral and pharyngeal cancer among men are more modest and the evidence is inconsistent, with one study reporting South Asian men having slightly higher relative risk of oral, but not pharyngeal cancer, than non-South Asian men (132). Looking at survival, British South Asian males had significantly better survival rates than their non-south Asian peers but the respective difference among females was non-significant after adjustment (170).

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Ethnicity and subjective oral health or Oral Health Related Quality of Life

Details for studies on ethnicity and subjective outcomes including OHRQoL are shown in supplementary Table S3-2.

Ethnicity and subjective or perceived oral health

Seven relevant papers from cross-sectional studies were identified. Four papers related to people's perception about their oral health and another 4 covered outcomes related specifically to oral or facial pain (one paper had both oral health perceptions and oral pain outcomes).

Three of the 4 papers on ethnic differences in people's oral health perceptions used self-rated oral health as the outcome (136, 162, 165), while the fourth paper referred to perceptions of aesthetics and orthodontic treatment need among adolescents (173). Two papers on self-rated oral health used the nationally representative data from the ADHS 2009 (136, 162), which is limited in this respect due to relatively small numbers for ethnic minority groups as there was no oversampling for ethnic minority groups.

Findings from both analyses using ADHS data were very similar, despite one study reporting only unadjusted estimates (162), and the other only adjusted estimates (for age, sex, area deprivation, geographical region and smoking) (136). Pakistani or Bangladeshi participants were more likely (OR = 2.16) to report poor self-rated oral health than Whites, but there were no significant differences between Whites and other ethnic groups. None of these studies looked at the role of mediating factors that could potentially explain these ethnic differences.

The only study that looked at ethnic differences in perceptions related to orthodontics among adolescents was carried out in Manchester and found that ethnicity (Asians vs Caucasians) was not associated with either orthodontic aesthetic self-perception or perceived treatment need for orthodontics (173).

Four studies examined outcomes related to dental and facial pain. There was again considerable heterogeneity between them. One study used a very large sample from the UK Biobank study and the outcome was facial pain (44), an outcome not necessarily related to oral health. Another study in South East England focused on toothache and pain when eating certain foods (174), while another in the same area assessed ethnic differences in oral and facial pain (163). The fourth study referred to toothache prevalence among a very small sample of Chinese elders in London (165). Due to these characteristics, it is not possible to draw any firm conclusions on ethnic differences in oral pain from the aforementioned studies.

Overall, there seems to be some evidence in terms of ethnic differences in self-rated oral health, with Pakistani or Bangladeshi groups reporting worse oral health than Whites, but there is a dearth of relevant studies to address the same question for other outcomes related to people's perceptions about oral health (for example, toothache, orthodontic treatment need).

Ethnicity and oral health related quality of life

The literature search identified 6 studies. Two of these studies used random samples, one from 3 areas in South London (175) and the other employed the large national sample of the ADHS (162), while the rest used convenience samples (47, 163, 174, 176).

Overall, there were inequalities in oral health related quality of life by ethnicity, particularly in terms of Blacks reporting worse quality of life (47, 175) and also higher prevalence of eating difficulties (162) than Whites. In one of the studies that also looked into the role of socioeconomic position, this difference between Blacks and Whites was explained once social grade was adjusted for (175); other studies did not look into potential explanations for the observed associations. The pattern was much more inconsistent in relation to differences in OHRQoL between Whites and populations of Asian origin, with one study indicating better quality of life among White participants (175) and another worse (162). Other studies that did not include a White population subgroup found no differences in oral symptoms and impacts between minority ethnic groups (174, 176).

Ethnicity and oral health related behaviours

Four studies on oral hygiene practices and seven studies on sugar consumption were included. Details for these studies are shown in supplementary Table S3-3.

In terms of oral hygiene practices, the review included 3 large epidemiological studies (158, 162, 164), one of them using ADHS data (162), and one very small study on Chinese older adults in London (165). Overall, the limited available evidence indicated an inconclusive pattern, with some studies showing no significant differences (164), while others showed ethnic inequalities in oral hygiene (158, 162). Among the studies that indicated ethnic inequalities in oral hygiene, the general pattern was that the Black population (described as Blacks in one study and African Caribbean in another) reported poorer oral hygiene than White or Asian groups (158, 162).

For sugar consumption, the review included a study that reported on analysis from the ADHS 2009 (162), 4 studies were based on large local samples (63, 164, 177, 178), while the others were based on smaller convenience samples (179, 180). Looking at the limited evidence in its totality, the pattern of ethnic inequalities in sugar consumption was somewhat fragmented. Studies from Bradford showed a higher consumption of sugary foods and drinks by Pakistani children compared to their White counterparts (177, 179). A large study among Indian, Pakistani, Bangladeshi and White mothers from 41 Local Authorities in England found that Bangladeshi mothers were 3.6 times and Pakistani mothers 1.7 times more likely to add sugar to their baby's bottle than White mothers, however these ethnic differences were explained to a large extent by socioeconomic factors (63). Another large study found no significant differences in sugar consumption between the different ethnic groups (178). The analysis from the national representative sample shows a complex picture with no clear pattern of ethnic differences in the consumption of sugary foods and drinks (162).

Ethnicity and service use

Five papers were identified. Details can be found in supplementary Table S3-4. Two studies used analyses of a large national sample of the ADHS (136, 162), one study used a random sample from 3 boroughs in South London (74), one used a non-random sample of ethnic minorities (164), and one was on a very small sample of Chinese older adults in London (165).

The evidence from the studies using national data provided a general pattern of ethnic inequalities in dental service use, where Whites were more likely to be regular dental attenders (136), to have visited the dentist in the last year (162), and were also more likely to receive private dental care (162) than ethnic minorities. However, the local study in South London highlighted a somewhat different pattern with Asian ethnic groups visiting the dentist more frequently than Whites (74). It is unclear whether this local pattern is relevant also for other parts of London or the country and further research could show whether the evidence from the nationally representative data varies between different areas of the UK.

Strengths and limitations of the reviewed studies on ethnicity and oral health

A number of methodological issues need to be considered when interpreting the relevant evidence for oral health inequalities in relation to ethnicity. The vast majority of the reviewed studies were local. Some studies included non-random, non-representative samples (16, 44, 47, 163 to 165, 174, 176), therefore it is unclear whether their findings can be generalised to the UK population.

Another important limitation is related to the classification of the samples into different ethnic groups. Some studies contained small numbers of participants from certain ethnic groups that resulted in relatively crude aggregate categorisations of ethnicity (10, 14, 16, 136, 162, 164), while others employed very broad ethnic groups, such as Asians or South Asians (93, 158, 173, 181). The relevance of such broad categorisations is questionable and there is evidence of variation in oral conditions between different ethnic groups belonging to these broad categories (10, 160, 176). Other studies did not include a White ethnic group (163, 164, 174, 176, 180), or focused on only one ethnic minority (165). In some studies, ethnicity was assessed on the basis of names (132, 168, 170) or even visually by the examiner (95, 159) rather than through self-identification, therefore questioning the validity of the data.

These features present challenges to the direct comparability between the studies and the drawing of robust conclusions about the association between ethnicity and oral health outcomes. Further good quality studies that are based on representative national data and assess ethnicity in an appropriate way, potentially including oversampling in order to avoid crude aggregate categorisations of ethnicity, would help provide more reliable and robust evidence about the presence and nature of ethnic inequalities in oral health outcomes. More importantly, studies should focus also on the factors (for example, socio-economic factors and behaviours such as diet) that can potentially explain such ethnic differences in oral health, thereby informing relevant policies.

Table 4.2 Evidence for oral health inequalities by ethnicity: summary table

Outcome	Evidence for inequalities in relation to ethnicity
Caries	Children: Some evidence for higher levels of dental caries among Asian and Eastern European White groups compared to other White children, but some inconsistencies. Limited data available. Adults: Some evidence for lower caries levels among Asian and Black ethnic groups, compared to White groups.
Periodontal disease	Inconclusive; limited data available.
Tooth loss	Yes; some evidence that tooth loss and edentulousness rates are higher among Whites than among ethnic minority groups, possibly with the exception of Blacks. Limited data available.
Oral cancer	Yes; some evidence that South Asian women have higher risk of oral and pharyngeal cancers than White women; evidence for men inconclusive.
Odontogenic infections	No data
Traumatic dental injuries	No; but based on limited data.
Self-rated oral health	Inconclusive; limited data available. Some evidence for poorer self-rated oral health among Pakistani / Bangladeshi compared to White groups.
OHRQoL	Some inconsistent evidence for poorer OHRQoL among Blacks than among Whites, partly explained by differences in socioeconomic position. Limited data available.
Oral health related behaviours	Inconclusive; limited data available.
Service use	Yes; but some inconsistencies.

4.3.2 Oral health inequalities in relation to disability

The types of disability that have been investigated for their relationship with oral health are very diverse and include cleft palate, learning disabilities, mental illness, schizophrenia, epilepsy, liver disease, kidney disease, HIV, multiple sclerosis, stroke-related disability, hearing loss and visual impairment. A brief overview of the findings in relation to disability and oral health is provided in Table 5.3.

Disability and clinical outcomes

The details of included studies on disability and clinical outcomes are shown in supplementary Table S4-1.

Disability and dental caries

Associations between disability and dental caries were assessed in 12 studies. The most frequently examined disability was cleft palate among children (6 studies) (182 to 187), followed by learning disabilities in adults (2 studies) (188, 189). Other disabilities explored in relation to dental caries were HIV in children (190), epilepsy in children (191), liver disease requiring liver transplantation in children (192), and visual impairment among older adults (193).

All 6 studies on children with cleft palate were conducted on small hospital samples. Of the 2 studies that included a control group, one found that children with cleft palate had higher caries levels than control children (182), while the other did not find any differences (186). Another study compared caries levels among Scottish children with cleft palate to data from the 2008 National Dental Inspection Program of Scotland (NDIP). While there were no differences in caries levels among 3 year olds, 5 year old children with cleft palate were less likely to be caries free and had higher dmft scores than 5 year olds in the NDIP (183). There was also evidence that caries levels were higher in children with fistula compared to children without fistula (187), and that caries prevalence increased with increasing severity of cleft type (185).

Two studies investigated associations between learning disabilities and dental caries. A small study on adults on a Special Needs Register found that study participants had more decayed and missing teeth but fewer filled teeth than adults from the ADHS 1988 (188). Another study assessed prevalence of fillings and untreated decay among more than 1,000 individuals with learning disabilities participating in the 2005 Glasgow Special Olympics (SO). Compared to general population estimates from the ADHS 1998, SO participants were more likely to be free from fillings and untreated caries (189).

There was evidence from a very small study (n=30) for high caries levels (with much of the disease untreated) among HIV infected children (190). Small case-control studies on children with epilepsy (191) and children undergoing liver transplantations (192) did not find significant associations with dental caries. There were also no differences in DMFT between older adults with visual impairment and comparable participants of the ADHS 1998 (193).

Disability and periodontal disease

Six of the studies that had examined dental caries also assessed plaque scores and gingivitis.

Of 2 case-control studies on children with cleft palate, one reported higher plaque and gingival index scores for children with cleft palate compared to controls (182), while the other did not find any differences between the groups (186).

In both studies on adults with learning disabilities the prevalence of gingivitis was about 65%, however neither study included a control group (188, 189). In the case-control study on children with intractable epilepsy, higher plaque scores and gingivitis scores were found in children with the condition compared to control children, but only in the permanent dentition (191). There were no differences in plaque or gingivitis indices between children undergoing liver transplantation and healthy controls (192).

Disability and dental trauma

Only one study on dental trauma was identified. This was a small case-control study showing that children with epilepsy were much more likely to have experienced dental trauma to anterior teeth than control group children (54% vs. 12.5%) (191).

Disability and tooth loss

Tooth loss was assessed in 6 studies. There was evidence that compared to the general population, the prevalence of edentulousness was lower among patients with multiple sclerosis (194), and higher among renal dialysis patients (195). Schizophrenia was related to a higher prevalence of total tooth loss, but only among younger age groups; and a lower prevalence of retaining a functional dentition (196). There was also some evidence for associations between learning disabilities and tooth loss in a study among over 1,000 individuals with learning disabilities participating in the 2005 Glasgow Special Olympics (189). Visual impairment among older people was unrelated to tooth loss (193).

Disability and subjective oral health or Oral Health Related Quality of Life

There were 3 studies on disability and subjective measures of oral health, one of these assessed OHRQoL (Table 5.3).

Disability and subjective oral health

One study using data from the 1993 Scottish Survey assessed satisfaction with appearance, dental pain and perceived treatment need among patients with schizophrenia. None of the results were significantly different from those in the Scottish general population (196).

Perceived treatment need was also assessed in a study among visually impaired older people. There were no significant differences for treatment need outcomes, except for study participants with a visual impairment being more likely to report that they 'don't need treatment' than comparable participants in the ADHS 1998 from Southern England (193).

Disability and Oral Health Related Quality of Life

Only one study could be identified. This was a small study from Scotland that assessed OHRQoL among 41 stroke patients, 40% of whom experienced moderate or greater disability

after their stroke. The more frequently reported oral impacts were having trouble pronouncing words and feeling self-conscious. A quarter of all participants had a worsened sense of taste in the year since suffering their stroke. Compared to the ADHS 1998, a smaller proportion of stroke patients experienced pain, possibly related to loss of sensation (197).

Disability and oral health related behaviours

Nine studies were identified (supplementary Table S4-3). Eight studies assessed associations between disability and oral hygiene practices, and one assessed sugar intake.

Disability and oral hygiene

There was some evidence for poorer oral hygiene among children with cleft palate (182), children infected with HIV (190), and adults with schizophrenia (196), compared to the general population. There was no difference in frequency of tooth brushing between renal dialysis patients and participants in the ADHS 2009 (195). Oral hygiene practices were better among a sample of older adults with visual impairment compared to adults who took part in the ADHS 1998 (193).

The aforementioned Scottish study among stroke patients reported that over a third of participants experienced difficulties with tooth brushing, which was associated with the degree of disability (197).

Disability and sugar intake

Only one study was identified, on a very small sample (n=20) of children infected with HIV. Ten parents reported that their children consumed sugars more than once a day and 16 children had sugary snacks or drinks on most days of the week. Half of the parents of these children stated that they were over-indulgent in terms of sugar consumption because of the child's HIV status and suffering related to this (190).

Disability and service use

Service use was examined in 11 studies. Eight studies were conducted on children and 3 on adults. All referred to dental attendance (study details are presented in supplementary Table S4-4). Eight out of 11 studies found some evidence for problems accessing care among individuals with a disability.

There was evidence for problems in communicating with the dentist among children with hearing loss (198); lower dental attendance among adults with learning disabilities (188, 199) and schizophrenia (196); more missed paediatric dental appointments among children with cleft palate (200); and lower levels of regular attendance among adults with kidney disease requiring dialysis (195), and older adults with visual impairment (193). Among the sample of stroke

survivors, 30% stated that they would attend the dentist less often than before the stroke, mainly due to stroke related disability (197).

In contrast, a study among adults with multiple sclerosis reported higher levels of dental attendance for regular check-ups compared to the general population (194).

Strengths and limitations of the reviewed studies on disability and oral health

The literature on disabilities and oral health in the UK is very limited, and the heterogeneity in the disabilities under study makes it difficult to summarise the findings. The only condition that has been examined by more than 2 studies was cleft palate among children, in relation to clinical outcomes. Due to the nature of disability, most studies used small or very small convenience samples of hospital patients, and many did not include a control group. Several studies however compared their data to findings from nationally representative surveys.

Overall, the picture was mixed: whether disability was related to oral health outcomes varied by type of disability and nature of the sample involved. The majority of studies suggested poorer oral health outcomes and more problems accessing services among disabled people, however for some conditions there were no differences or even better outcomes among disabled compared to non-disabled individuals. Very few studies assessed pathways or mechanisms through which people with disabilities might be disadvantaged in terms of their oral health and access to care. Further research is needed to strengthen the evidence base and to determine how outcomes and services for disabled people can be improved.

Table 4.3 Evidence for oral health inequalities by disability: summary table

Outcome	Evidence for inequalities in relation to disability?
Caries	Yes for children with cleft palate, but limited number of studies. Evidence mixed for adults with intellectual disability (only 2 studies). Some evidence for higher caries levels among children with HIV (only one study).
Periodontal disease	Inconclusive.
Tooth loss	Some but very limited evidence for association with intellectual disability and schizophrenia.
Oral cancer	No data
Odontogenic infections	No data
Traumatic dental injuries	Yes for children with epilepsy (only one study).

Outcome	Evidence for inequalities in relation to disability?
Self-rated oral health	No (only 2 studies, on schizophrenia and visual impairment).
OHRQoL	Evidence for impacts on OHRQoL among stroke survivors, based on one small study.
Oral health related behaviours	Some very limited evidence for poorer oral hygiene among children with cleft palate, children with HIV, and adults with schizophrenia (only one study on each condition). Evidence that ability to carry out oral hygiene is affected by stroke related disability (one study).
Service use	Yes, but only one study on each condition.

4.3.3 Oral health inequalities in relation to pregnancy and maternity

The literature on oral health outcomes during pregnancy and maternity in the UK is very limited. Only 5 relevant papers were identified, and only 2 of these provided comparisons with the general population of women, using ADHS data. A brief overview of the findings is given in Table 5.4.

Clinical outcomes during pregnancy and maternity

Details of the relevant studies on clinical outcomes during pregnancy and maternity are shown in supplementary Table S5-1. Evidence on clinical outcomes was only available in relation to periodontal disease and tooth loss.

Periodontal disease during pregnancy and maternity

Four papers examined periodontal disease amon pregnant women. Two studies were on large samples of pregnant women from a London hospital and compared their findings to data from the ADHS 1998 (16, 201). Both studies concluded that the prevalence of deep pockets and loss of periodontal attachment was higher among pregnant women than among participants of similar age in the ADHS, however given that the study samples were not representative of all pregnant women, these findings need to be viewed with caution. Two studies were carried out on small convenience samples, again on pregnant women recruited from hospitals. One reported a prevalence of 48% for bleeding on probing in more than half of the examined sites (202), the other that 44% of the surveyed women experienced problems with their gums during pregnancy (75).

Tooth loss during pregnancy and maternity

Only one study was identified. This was a large cross-sectional study on a sample of pregnant women (mean age 29.8 years) that reported an average of 27.4 natural teeth, but without providing a comparison with non-pregnant women (16).

Subjective oral health or Oral Health Related Quality of Life during pregnancy and maternity

There was only one relevant study that referred to subjective oral health and dental pain, and no relevant study on OHRQoL. Details can be found in supplementary Table S5-2. Among a convenience sample of pregnant women in a North London hospital, about one third (36%) of women reported that the condition of their teeth had deteriorated during pregnancy, while 34% reported that they had never experienced dental pain (75).

Oral health related behaviours during pregnancy and maternity

Only one study was eligible for inclusion in this review (details in supplementary Table S5-3). This was the previously mentioned study on pregnant women from a North London hospital, which showed that about three quarters of the sample reported brushing their teeth more than once a day during pregnancy (75).

Service use during pregnancy and maternity

Two papers were considered eligible. One referred to the North London hospital study reporting that one third visited a dentist during pregnancy, with half of them receiving treatment (75). The other was a larger study on a representative sample of mothers with dependent children, of whom 81% reported that they attended the dentist in the last year and 73% reported to be regular attenders in general (82). Details can be found in supplementary Table S5-4.

Strengths and limitations of the reviewed studies on pregnancy, maternity and oral health

Overall, there is very limited evidence on oral health in relation to pregnancy and maternity in the UK. Almost all studies were conducted on non-representative samples. Only 2 studies attempted to compare their findings with data from representative surveys, and while these comparisons are useful, they have limitations given the non-representative nature of the data on pregnant women, and differing methodologies.

Table 4.4 Evidence for oral health inequalities by pregnancy and maternity: summary table

Outcome	Evidence for inequalities in relation to pregnancy and maternity?
Caries	No data
Periodontal disease	Very weak evidence for higher prevalence of periodontal disease among pregnant women than among general population.
Tooth loss	Inconclusive
Oral cancer	No data
Odontogenic infections	No data
Traumatic dental injuries	No data
Self-rated oral health	Inconclusive
OHRQoL	No data
Oral health related behaviours	Inconclusive
Service use	Inconclusive

4.3.4 Oral health inequalities by religion

The literature on religion and oral health inequalities in the UK is extremely limited (see overview Table 5.5). We identified only one relevant study on a random sample of 12 year old children in Leicestershire and Rutland (details shown in supplementray Table S6-1). In this study, non-Muslim Asian children had lower DMFT scores, proportions with caries experience and active decay than Muslim Asian children (95). However, this was only a local study and the selection of Asian children from the original sample was done visually by the researchers. Furthermore, these broad classifications (Muslim vs non-Muslim Asian) are not helpful to draw relevant conclusions.

There were no studies on any of the other oral health outcomes investigated in this review. We were unable to locate any relevant grey literature on oral health inequalities by religion. Future good quality studies should address the role of religion in oral health inequalities.

Table 4.5 Evidence for oral health inequalities by religion: summary table

Outcome	Evidence for inequalities in relation to religion?
Caries	Inconclusive, only one study available.
Periodontal disease	No data
Tooth loss	No data
Oral cancer	No data
Odontogenic infections	No data
Traumatic dental injuries	No data
Self-rated oral health	No data
OHRQoL	No data
Oral health related behaviours	No data
Service use	No data

4.4. Oral health inequalities affecting vulnerable groups

4.4.1 Oral health inequalities effecting homeless people

Very few peer-reviewed studies examined oral health outcomes among homeless people in the UK. Given the lack of data, it was deemed appropriate to include findings from a report on the Healthy Mouths study conducted by the Groundswell charity in London (so-called 'grey' literature) in this section (203).

Overall, the available evidence suggests high levels of need among this vulnerable population. Compared to the general population, homeless individuals have higher levels of untreated decay and periodontal disease, and poorer OHRQoL. On service use, the research indicates that homeless people are mainly symptomatic attenders, with dental pain being the most important reason for seeking treatment. A brief overview of the findings is presented in Table 4.6.

Clinical outcomes among homeless people

The identified relevant studies on clinical outcomes refer to dental caries, odontogenic infections, periodontal disease, oral cancer, and tooth loss. Details are shown in supplementary Table S7-1. Only the Groundswell Healthy Mouths study included data on dental trauma (203).

Dental caries among homeless people

Five peer-reviewed studies on homelessness and dental caries were identified. Only one of these was conducted on a large sample (n=853) (204), the others used small (205, 206) or very small (207, 208) samples. All studies were based on convenience samples due to the nature of homelessness and difficulty in reaching this vulnerable population.

Overall, studies consistently found that homeless individuals, across all age bands, had high levels of untreated dental caries, with between 71% and 76% of study participants requiring restorative dental treatment (206 to 208). While no study used a comparison group from the housed population, one study from Northern Ireland directly compared the study sample with Northern Ireland adults who took part in the ADHS 1998. This study found that the homeless study population had greater numbers of missing teeth and decayed teeth, and lower numbers of filled teeth compared to the overall population in Northern Ireland (205). The evidence on root caries was more variable, but overall the findings suggest that levels of root caries among the homeless population are high (206 to 208).

The Groundswell Healthy Mouths study was based on 204 one-to-one survey interviews with participants representative of the wider homeless population in London. Interviews were conducted by peer researchers. In this study, 46% of participants reported experiencing 'holes in teeth' since becoming homeless (203).

Odontogenic infections among homeless people

Pulpal involvement was reported in a small study of 70 participants with a mean age of 55 years. Among this sample, 54% had one or more teeth with obvious pulpal involvement (208). In the Groundswell Healthy Mouths study, 24% of participants had been told by a medical professional that they had a dental abscess at some point since becoming homeless (203).

Periodontal disease among homeless people

Four peer-reviewed studies assessed periodontal outcomes (205 to 208). Overall, the available evidence suggests that among homeless individuals levels of periodontal disease are high and oral hygiene is poor, with a large majority of study participants presenting with bleeding gums and calculus.

Among participants of the Groundswell Healthy Mouths study, 56% reported bleeding gums, 32% reported swollen gums, 44% reported loose teeth, and 28% had at some point been

diagnosed with gum disease by a medical professional. Thirty-five per cent reported 'teeth falling out on their own' since becoming homeless (203).

Tooth loss among homeless people

Only 2 studies assessed tooth loss, and both were conducted on very small samples, therefore limiting our ability to draw any conclusions (207, 208). In a small sample of older homeless people living in Birmingham, about one-third was edentulous and the majority of edentulous participants did not wear any dentures (208).

Dental trauma among homeless people

Respondents in the Groundswell Healthy Mouths study were asked if and how they had lost teeth since becoming homeless. A relatively large proportion reported to have lost teeth following acts of violence (17%) or due to accidents (12%). Other aspects of trauma (such as broken teeth) were not assessed in the study (203).

Oral cancer among homeless people

Only one study reported on oral cancer. In a sample of 317 homeless people aged 16 to 91 years and living in Belfast, 5% (n=16) of participants had soft tissue lesions. Two of these were later diagnosed as oral cancer (squamous cell carcinoma). The authors calculated that being homeless increased the risk of contracting oral cancer by 95 times compared with the general NI population, however given the small sample size, this result should be viewed with caution (205).

Subjective oral health or Oral Health Related Quality of Life among homeless people

We identified 4 peer-reviewed studies in terms of homelessness and subjective oral health, all of which assessed OHRQoL. Details are shown in supplementary Table S7-2. The Groundswell Healthy Mouths study included data on OHRQoL, as well as on dental pain (203).

Dental pain among homeless people

Dental pain was highly prevalent among participants in the Groundswell Healthy Mouths study: 60% had experienced pain in their mouths since becoming homeless, while 30% reported experiencing dental pain every day. Of those currently experiencing pain, 75% rated their pain as higher than a '5' on a numeric scale ranging from 0 to 10 (203).

Oral Health Related Quality of Life among homeless people

All 4 of the peer-reviewed studies on OHRQoL were cross-sectional. On the whole, the evidence suggests that homeless people experience poorer OHRQoL compared to the wider UK population (204, 205, 207, 209). Commonly experienced impacts among homeless

individuals were pain in the mouth and toothache, difficulty eating meals, and feeling self-conscious or embarrassed about the appearance of their teeth (204, 205, 207, 209). In the study with the largest sample size (n=853), conducted in Scotland, 26% of participants reported feeling self-conscious very often and 24% reported feeling embarrassed about the appearance of their mouth and teeth very often (204).

The Groundswell Healthy Mouths study compared data on OHRQoL (measured via the the short version of the Oral Health Impact Profile (OHIP-14) questionnaire) among their participants with findings from the ADHS 2009. Healthy Mouth participants had a much higher prevalence of oral impacts: 87% reported at least one problem with their teeth or mouth experienced occasionally or more often, compared to 39% in the ADHS 2009. The mean number of problems reported was 8 in the Healthy Mouths study compared to only one in the ADHS 2009. These problems had substantial psychological and functional impacts. For example, 69% of the homeless Healthy Mouths participants felt self-conscious or tense about the condition of their teeth and mouth, and 59% had trouble pronouncing words or had their sense of taste affected occasionally or more often; while in the ADHS 2009 this was 19% and 7% respectively (203).

Oral health related behaviours among homeless people

Only 2 papers on oral health related behaviours could be identified. Both studies were conducted on very small samples, which are unlikely to be representative of the wider homeless population, thus severely limiting our ability to draw conclusions (210, 211). Details are presented in supplementary Table S7-3. Further relevant data are available from the Groundswell Healthy Mouths study (203).

Oral hygiene among homeless people

In a study on 27 adult homeless people, most of whom were recruited from dedicated dental clinics, 95% reported to own a toothbrush and 59% reported to brush twice a day. Among the 5 study participants drawn from a homeless shelter, only one brushed twice daily (210). Among respondents in the Groundswell Healthy Mouths study, 35% reported to brush their teeth at least twice a day, compared to 75% in the ADHS 2009. On the other hand, a higher proportion of the homeless sample used mouthwash (46%) compared to the ADHS sample (31%) (203).

Sugar intake among homeless people

One peer-reviewed study reported on dietary habits among homeless families living in temporary accommodation (n=24). Participants filled in multiple 24-hour dietary recall questionnaires. Findings suggest that overall energy intake was significantly lower than the estimated average requirement, while the contribution of NMES to total energy intake was significantly higher than the recommended population average intake (211). These findings are supported by data from the Groundswell Healthy Mouths study, with 60% of participants classified as consuming a high amount of sugar, compared to 50% in the ADHS 2009 (203).

Service use among homeless people

Four papers were identified that had examined patterns of dental service use among homeless people in the UK (supplementary Table S7-4). Of these, 2 were observational studies (208, 210) and 2 were based on retrospective assessment of patient records (206, 212).

The available evidence suggests that dental pain is by far the most important reason why homeless individuals access dental care. In a random sample of 349 case notes from homeless patients who attended Community Dental Services in East London, 40% had presented with dental pain (212). A very similar proportion of attenders due to dental pain was reported in another case-note review on 201 homeless people from South East London (206). Other common reasons for dental attendance include swelling or problems with teeth, gums or dentures, but also dental check-ups – 28% in the South East London study (206, 210). Further, the evidence indicates that about half of homeless patients do not attend follow-up appointments (206, 210, 212). The 2 (very small) observational studies reported that barriers to regular attendance include cost, fear, low priority, lack of perceived need and fatalism (208, 210). The majority of treatments received by homeless people were reported as being temporary and permanent fillings, management of swellings and extractions or dentures (210, 212).

Again, the Groundswell Healthy Mouths study provided additional data. Respondents faced substantial difficulties accessing dental care, with 31% reporting that they had made an unsuccessful attempt to register with a dentist and 36% had not tried to sign up since becoming homeless. Main reasons for not attempting to register was being unsure whether they were entitled to NHS treatment (22%), and previous negative experiences (15%). Another barrier to seeking dental treatment was fear (reported by 24%). A large number of respondents (38%) reported that they had needed emergency dental treatment at some point since becoming homeless, and 31% had accessed such treatment, while 27% had accessed A&E services for dental problems (203).

Strengths and limitations of the reviewed studies on homelessness and oral health

Research on oral health inequalities in relation to homelessness in the UK is scarce. The main limitations of the available studies are small sample sizes and lack of comparison groups from the housed population, as well as issues around the representativeness of the study samples.

Table 4.6 Evidence for oral health inequalities by homelessness: summary table

Outcome	Evidence for inequalities in relation to homelessness
Caries	Yes, but limited data available.
Periodontal disease	Yes, but limited data available.

Outcome	Evidence for inequalities in relation to homelessness
Tooth loss	Yes, but limited data available.
Oral cancer	Yes, based on only one small study.
Odontogenic infections	Yes, but limited data available.
Traumatic dental injuries	Yes, based on one study (grey literature).
Self-rated oral health	Yes, based on one study (grey literature).
OHRQoL	Yes.
Oral health related behaviours	Yes, but limited data available.
Service use	Yes, but limited data available.

4.4.2 Oral health inequalities affecting prisoners

Prisoners are one of the established vulnerable or 'seldom heard' groups. The literature on the oral health of prisoners in the UK is scarce. Therefore, findings from grey literature were included in this section, namely from the Scottish Oral Health Improvement Prison Programme (SOHIPP) survey conducted in 2011 (213).

Clinical outcomes among prisoners

The evidence on prisoners and clinical oral health in the UK rests on only 6 studies. These studies examined dental caries, periodontal disease and oral sepsis (details are shown in supplementary Table S8-1). There were no relevant UK studies on tooth loss, dental trauma and oral cancer among prisoners.

Dental caries among prisoners

Six studies were identified (214 to 219), of which three provided comparisons with the general population using data from the ADHS 1998 and 2009 (215, 216, 219). Overall, the evidence indicated that prisoners had more decayed, fewer sound and fewer filled teeth compared to the general population. However, the respective comparison for missing teeth did not provide a consistent picture with one study indicating that prisoners had fewer missing teeth (215), while another study found no difference (219) with the general population. The differences in terms of decayed teeth and the prevalence of decay were substantial.

Odontogenic infections among prisoners

The only relevant study was carried out among female prisoners in a London prison, showing that the prevalence of oral sepsis (PUFA) among prisoners was excessive and more than 5 times higher than among the general population (219).

Periodontal disease among prisoners

Three of the aforementioned studies provided also some information on periodontal disease. Two studies on convenience samples of prisoners reported high levels of gingival bleeding (215), calculus (215), and pocket depth (214), but without directly comparing these estimates to the general population. A study on a random sample of female prisoners in Holloway showed that prisoners had a considerably higher prevalence of gingival bleeding, much higher prevalence of deep periodontal pockets and also higher prevalence of calculus than the general female population (219).

Subjective oral health or Oral Health Related Quality of Life among prisoners

We identified three relevant studies on subjective oral health, and 2 studies on OHRQoL among prisoners. Details are shown in supplementary Table S8-2. There were no relevant studies on dental pain.

Subjective oral health among prisoners

We identified 2 studies with smaller samples in Brixton prison (214, 215), and one larger study among males in three prisons (218). Overall, a large proportion of prisoners reported poor self-rated oral health, dissatisfaction with oral health and perceived dental treatment needs; however, none of the studies directly compared the estimates with those from the general population.

Oral health related quality of life among prisoners

Two relevant studies were identified, one using a large sample of male prisoners from three prisons (218) and another using a representative sample of female prisoners from a London prison (219). Both studies showed very high prevalence of oral impacts, much higher than the respective estimate in the general population (ADHS 2009), indicating that prisoners experience much poorer OHRQoL.

Relevant data collected via the SOHIPP survey conducted in 2011 are in line with the findings from the peer-reviewed studies (213). The SOHIPP survey included 342 prisoners from 4 prisons in Scotland, with a mean age of 28 years. According to the survey report, prisoners experienced greater impacts on their OHRQoL than Scottish participants of the ADHS 1998. For example, 13% of prisoners reported to experience a 'painful aching mouth' very often, compared to 2% in the Scottish ADHS sample. Feeling very often embarrassed due to the

appearance of their teeth was reported by 28% of the prison population but only by 2% of the ADHS 1998 sample from Scotland (213).

Oral health related behaviours among prisoners

Three papers were included for the review of oral health related behaviours among prisoners; all three assessed both tooth brushing and sugar consumption (214, 215, 219). Details are presented in supplementary Table S8-3.

Two studies on convenience samples of prisoners in a South London prison reported the prevalence of tooth brushing, which was 70% in both samples (214, 215). In the study of female prisoners in Holloway prison in North London, 82% reported brushing their teeth twice daily; this was slightly higher than the national average reported in the ADHS (77%) (219).

In contrast, there was a substantive difference for sugar consumption, with considerably higher prevalence of high sugar intake among female prisoners compared to the general population (219).

Service use among prisoners

Four papers were included in this review (214, 215, 218, 219). They are presented in supplementary Table S8-4. Overall, a large proportion of prisoners reported dental attendance in the last year (214, 215), however the pattern of dental attendance was characterised by dental visits only when in trouble, similar to what was the case for this population group before imprisonment (218). In the only study that compared with national estimates, prevalence of regular dental attendance was much lower and prevalence of visiting only when in trouble much higher in female prisoners than in the general population (219).

Strengths and limitations of the reviewed studies on oral health among prisoners

There are very few studies on prisoners' oral health in the UK. All identified studies were local and most had relatively small samples, although there were 2 studies (216, 218) and one survey report (213) with larger sample sizes.

Three studies employed convenience samples (214, 215, 217). Larger representative studies in multiple prison sites covering a wide range of oral health outcomes and comparing appropriately with the general population are needed to document the extent of oral health inequalities in this field.

Table 5.7 Evidence for oral health inequalities in prisoners: summary table

Outcome	Evidence for inequalities in relation to prisoners?
Caries	Yes, but based on limited data.
Periodontal disease	Yes, but based on limited data.
Tooth loss	No data
Oral cancer	No data
Odontogenic infections	Yes, but based on only one study.
Traumatic dental injuries	No data
Self-rated oral health	Yes, but limited data.
OHRQoL	Yes.
Oral health related behaviours	Inconclusive, limited data available.
Service use	Yes, but based on limited data.

4.4.3 Oral health inequalities affecting travellers

Only one peer reviewed study could be identified, which assessed dental caries, oral hygiene and sugar consumption in a small sample on 37 traveller children aged up to 16 years based in Hackney, East London. The study reported on the piloting of an outreach dental service provision programme (220). Therefore this section includes grey literature on dental service use from a needs assessment survey among gypsies and travellers conducted in Devon in 2006 (221). The overall evidence is briefly sumarised in Table 4.8.

Clinical outcomes among travellers

The only clinical outcome assessed in the Hackney study was dental caries. Visually obvious decay was present in two-thirds of this small sample of traveller children (220). Details are shown in supplementary Table S9-1.

Oral health related behaviours among travellers

The Hackney study on traveller children documented a relatively low prevalence of tooth brushing twice a day (40%) and a highly cariogenic diet (95%) among this sample (220). Details are in supplementary Table S9-2.

Service use among travellers

In the Hackney study, 85% of this sample of traveller children had visited the dentist in the last 2 years (220); details in supplementary Table S9-3. The needs assessment survey conducted among 128 gypsies and travellers in Devon included a question on health services utilisation. Only 41% of the sample reported the use of dental care, and access to dental services was identified as a significant problem in qualitative interviews that were part of the same study (221).

Strengths and limitations of the reviewed studies on oral health among travellers

The literature on oral health among travellers in the UK is extremely limited. There is a need for relevant larger, well-conducted studies on this underserved population. Future research should focus on comparing oral health outcomes between travellers and the general population in order to establish the existence and extent of inequalities.

Table 4.8 Evidence for oral health inequalities in travellers: summary table

Outcome	Evidence for inequalities in relation to travellers?
Caries	Yes, but based on only one study.
Periodontal disease	No data
Tooth loss	No data
Oral cancer	No data
Odontogenic infections	No data
Traumatic dental injuries	No data
Self-rated oral health	No data
OHRQoL	No data
Oral health related behaviours	Yes, but based on only one study.
Service use	Yes, based on one report (grey literature).

4.4.4 Oral health inequalities affecting looked after children

The literature on oral health inequalities that focuses on looked after children in the UK is very limited. Only 3 peer-reviewed papers were identified. We therefore included findings reported in grey literature in this section.

Clinical outcomes among looked after children

Details of the relevant studies reporting on and clinical outcomes among looked after children are shown in supplementary Table S10-1. The literature search identified relevant studies only in relation to dental caries and dental trauma.

Dental caries among looked after children

Two cross-sectional studies on dental caries were retained. One was a study on young children (aged 2 to 11 years) in Bradford. The sample (n=158) included children who were under a child protection plan and a non-random sample of children attending hospital clinics (222). The other was a larger (n=965) epidemiological study of 15 to 16 year old adolescents in North East London (223).

Overall, the limited evidence available suggests that looked after children experience higher caries levels than children not being subject to a protection plan. The Bradford study used a range of caries outcomes and showed children with a protection plan to be worse off compared to the control group of children attending hospital clinics; 42% of the former and 68% of the latter were caries-free, a considerable and statistically significant difference, while children with a protection plan had also a significantly lower Care Index. However, the differences were evident in the primary dentition only, as children under a protection plan had higher dmft, but not DMFT, compared to the controls, after adjusting for area deprivation and sex (222). This may be due to the age of the sample, as a considerable proportion would have very few permanent teeth. The study on adolescents in North East London presented descriptive statistics on dental neglect, determined through aggregated outcome measures combining clinical and self-reported indicators (caries, dental trauma and oral pain). Only 3.3% of children reported being classified as "looked after", and they experienced higher levels of caries compared to the rest of the sample (223).

Dental trauma among looked after children

Only one study was eligible to be included in this review. This was the previously mentioned study on 15 to 16 year old adolescents in 3 boroughs in North East London (223). As for caries, the study provided descriptive statistics and showed a considerably higher prevalence of traumatic dental injuries among children who reported being "looked after" compared with the rest of the sample (10% vs. 4.5% respectively).

Subjective oral health or Oral Health Related Quality of Life among looked after children

There was only one relevant study for this section, which referred to dental pain. No study was identified on looked after children's OHRQoL.

The same study on adolescents in North East London that focused on dental neglect also contained descriptive information on experience of dental pain. Again, looked after adolescents had experienced dental pain at a higher proportion than the rest of the sample (223). Details are shown in supplementary Table S10-2.

Service use among looked after children

Only 2 studies assessed service use among looked after children (details shown in supplementary Table S10-3) (222, 224). The study on children aged 2 to 11 years in Bradford (222) found that among children under a protection plan, fewer had their own dentist or had visited a dentist in the past year, compared to a non-random sample of children attending hospital clinics. In a case-control study conducted in Wales among 142 children aged 5 to 16 years in local authority care, and 119 controls matched by age and sex, self-reported regular dental attendance for a check-up was less frequently reported by children in care compared to controls. When they did visit a dentist, children in care were more likely to need dental treatment than the control children (224).

The above findings from peer-reviewed studies are corroborated by the available grey literature. A report on the health of looked after and accommodated children and young people in Scotland, published in 2006 by the Social Work Inspection Agency, also suggested that oral health is a neglected area among this group based on dental attendance data from a small survey (225).

Strengths and limitations of the reviewed studies on oral health among looked after children

Only 3 peer-reviewed studies on the oral health of looked after children were identified. The limited evidence suggests inequalities in caries, dental trauma, pain and dental attendance, with looked after children faring worse than either patient controls or the general population sample in all of these outcomes. However, all studies were local and it is unclear whether their results are representative across the UK. One study had a small sample with a non-randomly selected control from hospital clinics (222). The study on adolescents in North East London was a larger epidemiological study but provided only descriptive statistics for caries, trauma and pain in looked after children, because the focus of the study was dental neglect. Furthermore, the classification of children as being "looked after" was based solely on self-reports (223).

Future studies should focus specifically on inequalities in oral health comparing looked after children and adolescents with those not being subject to a protection plan over a range of clinical and subjective oral health outcomes.

Table 4.9 Evidence for oral health inequalities in looked after children: summary table

Outcome	Evidence for inequalities in relation to looked after children?
Caries	Yes, but based on only 2 studies.
Periodontal disease	No data
Tooth loss	No data
Oral cancer	No data
Odontogenic infections	No data
Traumatic dental injuries	Yes, but based on only one study.
Self-rated oral health	Yes, in relation to dental pain; but based on only one study.
OHRQoL	No data
Oral health related behaviours	No data
Service use	Yes, based on 2 studies and findings from grey literature.

4.5 Barriers to dental service utilisation

Two rapid reviews of the literature were undertaken to review barriers to dental care experienced amongst people with protected characteristics and vulnerable groups (226, 227). They included literature from the UK only from 2007 to 2017.

4.5.1 Barriers to dental service utilisation in relation to protected characteristics

Barriers were categorised at an individual, organisational and policy level. There were common barriers for people with protected characteristics. The most common barriers identified across all of the protected characteristic groups were at the individual level. These included dental anxiety, a perceived lack of need, often associated with a lack of knowledge of oral health or oral healthcare services, and cost. The inability or the perceived inability to afford oral healthcare included direct costs such as paying for treatment services and/or indirect costs such as transportation and loss of pay due to time off work. This financial barrier was often magnified by a lack of awareness of the costs of oral healthcare services and exemptions from NHS dental charges.

Specific barriers were also identified for certain protected characteristic groups. These barriers are summarised in Table 4.10.

Table 4.10 Summary of the specific barriers for certain protected characteristic groups.

Protected characteristic group	Barrier
Age	**Children (individual level barriers):** Cost and dental anxiety Parents with dental anxiety Low socio-economic status **Older people (individual level barriers):** Perceived difficulty in finding a dentist Lack of awareness of dental care pathways, cost of treatment and how to access information about dental services Past negative dental experiences Difficulties in finding suitable transport and availability of an escort **Organisational barriers:** Lack of availability of dental professionals17,19 and of domiciliary care Difficulty providing clinical care in a non-dental environment Inadequate patient management skills for geriatric patients Physical barriers to accessing the dental practice Location of dental practices Working hours of a dental practice Carers' inadequate knowledge of patients' medical history, required medications and the payment process Carers' lack of motivation in training on oral health
Disability	**Individual level barriers:** Inability to tolerate treatment Lack of knowledge of accessing oral healthcare services Lack of social support **Organisational barriers:** Difficulties in finding a dentist willing to provide treatment Shortage of dentists with adequate knowledge, training and confidence in caring for people with disabilities Lack of perceived need for training Lack of awareness of legal responsibilities as service providers towards overcoming barriers Communication barriers Poor patient management skills and perceived negative attitudes of dental staff Dental professionals perceive the additional time and effort required to treat patients is not fairly compensated by the remuneration system

Protected characteristic group	Barrier
	Lack of availability of domiciliary equipment Lack of information on oral health and oral healthcare services in the appropriate format Physical barriers to accessing dental services such as finding suitable transport along with the lack of availability of accessible waiting areas and toilet facilities Oral health knowledge and oral health beliefs of carers and their expectations of dentists Oral health perceived as a low priority among other health problems Lack of continuity of care and a lack of collaboration between and within
Race	**Individual level barriers:** Communication between the dental practitioners and the patient8,10,11,12,13,23,24,28,33,49,50 and an inability to obtain consent Cultural barriers Fear of misunderstanding and fear of conflicts arising during dental treatments Dental professionals perceived to have a negative attitude Lack of trust of dentists Concerns over standards of hygiene in dental practices **Organisational barriers:** Communication between the dental practitioners and the patient Difficulties in finding a dentist Lack of information on oral health and oral health services in appropriate formats Lack of dental practices offering flexible working hours Lack of child-friendly waiting rooms and long waiting times
Religion	**Individual level barriers:** Communication barriers **Organisational barriers:** Communication barriers Unsuitable appointment timing due to lack of awareness and lack of flexible working hours Difficulties in accessing a dentist of the same gender Lack of child-friendly waiting rooms and long waiting times
Pregnancy or maternity	**Individual level barriers:** Illness Managing work and family responsibilities

Protected characteristic group	Barrier
	Lack of awareness that NHS provides oral healthcare free of charge during pregnancy and 12 months after birth
Gender	**Individual level barriers:** Family structure; for example, single mothers or young mothers Language barriers were also more common in women particularly those from ethnic minorities

4.5.2 Barriers to dental service utilisation affecting vulnerable groups

Most of the literature investigated and reported barriers at group level. However, there were several common barriers noted across most of these vulnerable groups. These barriers have been summarised at the level of the individual person or patient, the level of the dental service organisation and at the higher policy level (Figure 4.1)

Individual level barriers common across vulnerable groups

The most common individual level barrier was that services were unaffordable or perceived to be unaffordable for the public, patients or parents/carers. Lack of affordability was not confined to people of low socioeconomic status but was an issue across most vulnerable groups and from most countries. The cost of transport was also highlighted as an issue along with difficulty obtaining appropriate transport.

People from various vulnerable groups were said to perceive oral health as a low priority due to other daily difficulties in their lives. Low levels of oral health literacy were cited for many groups which has been described as the ability to access or process information to improve oral health. Related to this people were found to lack knowledge of what services were available and how to make appointments. Previous difficulties accessing dental care were cited as barriers to accessing services in future. Difficulties were also identified in keeping appointments due to health problems, getting time off work or lack of a carer. Language or communication difficulties were common barriers with specific problems highlighted for groups such as those from minority ethnic groups, refugees, migrants or those with hearing impairments.

Dental fear and anxiety and a perceived negative attitude from the dental workforce were common individual levels barriers identified across vulnerable groups.

Organisational level barriers common across vulnerable groups

The most common organisational level barrier was the lack of availability of dental care to meet the needs of vulnerable groups including routine, preventive, urgent and specialised care. This lack of availability was said to lead to long waiting times. Referral pathways between services were also stated to be difficult to negotiate for organisations involved in the care of vulnerable

groups. Poor transition arrangements were found to be a barrier, for example moving from services for children to adults or for patients moving from living at home to residential care.

Some organisational level barriers mirrored the individual barriers described above such as insufficient information provided by organisations to individuals in appropriate formats, communication difficulties during dental care and lack of cultural or disability awareness among the dental workforce. Dental professionals were found to lack confidence and training in treating patients from vulnerable groups. Similarly, carers and other health, social, education or community services were said to have a lack of knowledge about key oral health messages and ways to access dental services.

Finally physical barriers to accessing dental care were cited including location of services (and appropriate transport to them), lack of car parking as well as physical barriers for the practices themselves.

Policy level barriers common across vulnerable groups

Policy level barriers were less commonly referred to in the literature although 3 types were identified. The main policy level barrier was a lack of public funding for dental services for vulnerable groups. The second main policy level barrier was a lack of integration between dental and other health, social, education or community services. The third policy level barrier was that dental services were not commissioned based on oral health needs assessments so were not of sufficient capacity or design to meet the needs of vulnerable groups.

Figure 4.1 Summary of common barriers across vulnerable groups

Individual level

- services unaffordable or perceived to be unaffordable for the public, patients and parents or carers
- oral health not perceived as a priority for patients or carers due to other daily difficulties
- low levels of oral health literacy
- lack of appropriate knowledge of what services are available and their cost
- previous difficulties accessing dental care
- difficulties with obtaining affordable and appropriate transport
- difficulties making and keeping appointments due to health problems, getting time off work or lack of a carer
- language or communication difficulties
- perceived negative attitude from dental workforce
- dental fear and/or anxiety

Organisational level

- lack of availability of routine, preventive, urgent and specialised care.
- insufficient appropriate information provided to patients, the public, parents and carer
- communication difficulties with patients and carers
- lack of cultural or disability awareness
- lack of confidence and training of dental professionals in treating patients from vulnerable groups
- lack of knowledge among carers and other health, social, education or community services about key oral health messages and ways to access dental services
- poor transition arrangements, for example, child to adult services or home dwelling to institutional
- physical barriers to accessing dental care

Policy level

- lack of public funding for dental services for vulnerable groups
- lack of integration between dental and other health, social, education or community services
- services not commissioned based on oral health needs assessments
- workforce not trained to meet the needs of specific vulnerable groups
- services fail to meet the needs of vulnerable groups
- policies fail to address the social determinants of health

4.6 Summary

4.6.1 Scoping review of oral health inequalities in the UK

The scoping review examined the evidence for oral health inequalities in the UK, including socio-economic inequalities, and inequalities affecting those with protected characteristics and vulnerable groups. Table 4.11 provides an overview of the findings.

Inequalities by individual socio-economic position and area deprivation were by far the most researched topics. There is clear and consistent evidence for social gradients in the prevalence of dental caries, tooth loss, oral cancer, self-rated oral health, OHRQoL, oral hygiene, and service use. For dental caries and tooth loss, studies that assessed time trends tended to find that absolute inequalities have narrowed over time, however relative inequalities have not. Inequalities in dental caries were less pronounced in fluoridated areas. The pathways between socio-economic disadvantage and poorer oral health are still under researched. There is some evidence that differences in access to dental services partly explain social inequalities in dental caries, while smoking plays a role for inequalities in periodontal disease. Inequalities in oral cancer by level of education may be partly due to differences in smoking and alcohol consumption.

For oral health inequalities by ethnicity, the evidence was inconsistent, with some studies reporting poorer oral health among ethnic minority groups when compared to the white majority population, while others did not. The literature on ethnicity and oral health has methodological limitations around representativeness and the combination of ethnic groups with very different characteristics into broad categories.

The available research evidence on oral health inequalities affecting people with protected characteristics (disability, pregnancy or maternity, religion) was rather limited. Associations between disability and oral health outcomes varied by type of disability and nature of the sample. Most studies suggested poorer oral health outcomes and greater difficulties accessing services for people with disabilities, compared to non-disabled individuals; however for some conditions there were no differences or even better outcomes among disabled. Studies on oral health in pregnancy and maternity were scarce and on unrepresentative samples, and findings were therefore inconclusive. No conclusions could be drawn on associations between religion and oral health.

For vulnerable groups including homeless people, prisoners, travellers, and looked after children, the available evidence was very limited, with the existing studies showing that these populations have considerably poorer oral health across all assessed outcomes, and face substantial difficulties accessing dental care.

Further research is needed in particular on inequalities affecting ethnic minorities, those with protected characteristics and vulnerable populations, as well as studies addressing the causal pathways and mechanisms to explain why oral health inequalities exist.

4.6.2 Rapid reviews on barriers to dental service utilisation

Barriers to NHS dental care are found at the individual, organisational and policy level and may be common across vulnerable groups or specific to one group. Such barriers include costs, lack of availability of services and services not commissioned based on local needs.

Suggested ways of overcoming barriers to care include provision of appropriate training to both service users and care providers, policies to ensure dental services meet the needs of vulnerable people and the use of appropriate skill mix to deliver services.

Table 4.11 Scoping review of oral health inequalities in the UK: overview of findings

	Caries	Odontogenic infections	Tooth loss	Oral cancer	Periodontal disease	Traumatic dental injuries	Self-rated oral health or pain	OHRQoL	Oral health related behaviours	Service use
SEP	++	n.d.	++	++	inc.	inc.	++	++	++	++
Area deprivation	++	+	++	++	inc.	–	+	++	+	++
Ethnicity	+	n.d.	+	+	inc.	–	inc.	+	inc.	inc.
Disability	+	n.d.	+	n.d.	inc.	+	–	+	+	+
Pregnancy/ maternity	n.d.	n.d.	inc.	n.d.	inc.	n.d.	inc.	n.d.	inc.	inc.
Religion	inc.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Homelessness	+	+	+	+	+	+	+	++	+	+
Prisoners	+	+	n.d.	n.d.	+	n.d.	+	++	inc.	+
Travellers	+	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	+	+
Looked-after children	+	n.d.	n.d.	n.d.	n.d.	+	+	n.d.	n.d.	+

++ Strong evidence for inequalities
+ Evidence for inequalities based on limited data
– No evidence for inequalities
inc. Mixed or inconclusive evidence
n.d. No data

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5. Reducing oral health inequalities: what does the academic literature tell us?

5.1 Introduction

Taking actions to reduce health (including oral health) inequalities is becoming a matter of urgency, especially in light of the evidence on widening health inequalities and worsening health outcomes in England in the last ten years (1). Furthermore, the Covid 19 pandemic has revealed and amplified pre-pandemic socioeconomic and ethnic inequalities (2).

According to Marmot the most effective evidence-based strategies for reducing health inequalities (3):

- should focus on reducing the gradient in health
- require action across all the social determinants of health

Marmot proposed that action should not focus solely on the most disadvantaged as this will not reduce health inequalities sufficiently to reduce the steepness of the social gradient in health. Actions must be universal, but with a scale and intensity that is proportionate to the level of disadvantage 'proportionate universalism'.

Marmot outlined 6 policy objectives to reduce health inequalities:

- give every child the best start in life
- enable all children, young people and adults to maximise their capabilities and have control over their lives
- create fair employment and good work for all
- ensure healthy standard of living for all
- create and develop healthy and sustainable places and communities
- strengthen the role and impact of ill health prevention

In line with the NHS public duty to reduce health inequalities, NHS England and Improvement, collaborating with Public Health England (PHE) and partners in the voluntary and community sector and local government, has worked to develop a 'menu of evidence-based interventions for addressing health inequalities – (Menu). The Menu provides a catalogue of interventions that local healthcare systems and commissioners, working with partners across the system, can draw on to take effective action at neighbourhood, place and system-level to reduce health inequalities (4). The Menu includes evidence-based interventions to reduce oral health inequalities. These included water fluoridation, supervised toothbrushing and care home interventions.

Alongside the abovementioned Menu, Public Health England, the Local Government Association and the Association of Directors of Public Health have published guidance to support local actions on inequalities, entitled Place Based Approaches for Reducing Health Inequalities. The Place Based Approach (PBA) focuses on how the system can work together through civic, service and community centred approaches to reduce health inequalities (5). The context and causes of health inequalities highlight their multiple aspects which are complex, interactive and simultaneous in their combined actions, with their roots in the wider determinants of health. A joined-up approach that treats the 'place', and not just individual problems or issues, is therefore necessary if we are to measurably reduce inequalities in health and wellbeing (6). Place-based approaches emerged as an important foundation of producing population level change in outcomes when the Health Inequalities National Support Team (HINST) were supporting the most deprived areas with the poorest health to narrow the national health inequalities gap.

The population intervention triangle (PIT) describes how the main components of intervention capable of producing measurable population level change relate to each other. PIT brings together a number of important constituent elements which together form the main elements of effective place-based working. It was developed through practical experience working to achieve measurable population level change in health and wellbeing outcomes, including addressing health inequalities between and within local geographies.

Figure 5.1 shows the 3 'segments' which make up the population intervention triangle:

- civic-level interventions (for example, policy and strategy development, legislation, fiscal measures, spatial and environmental planning to reduce health inequalities)
- community-centred or community-based interventions (for example, interventions to reduce health inequalities in a community setting, using non-clinical methods)
- service-based interventions (for example, interventions to reduce unwarranted variability in service quality and delivery)

Figure 5.1 Population intervention triangle
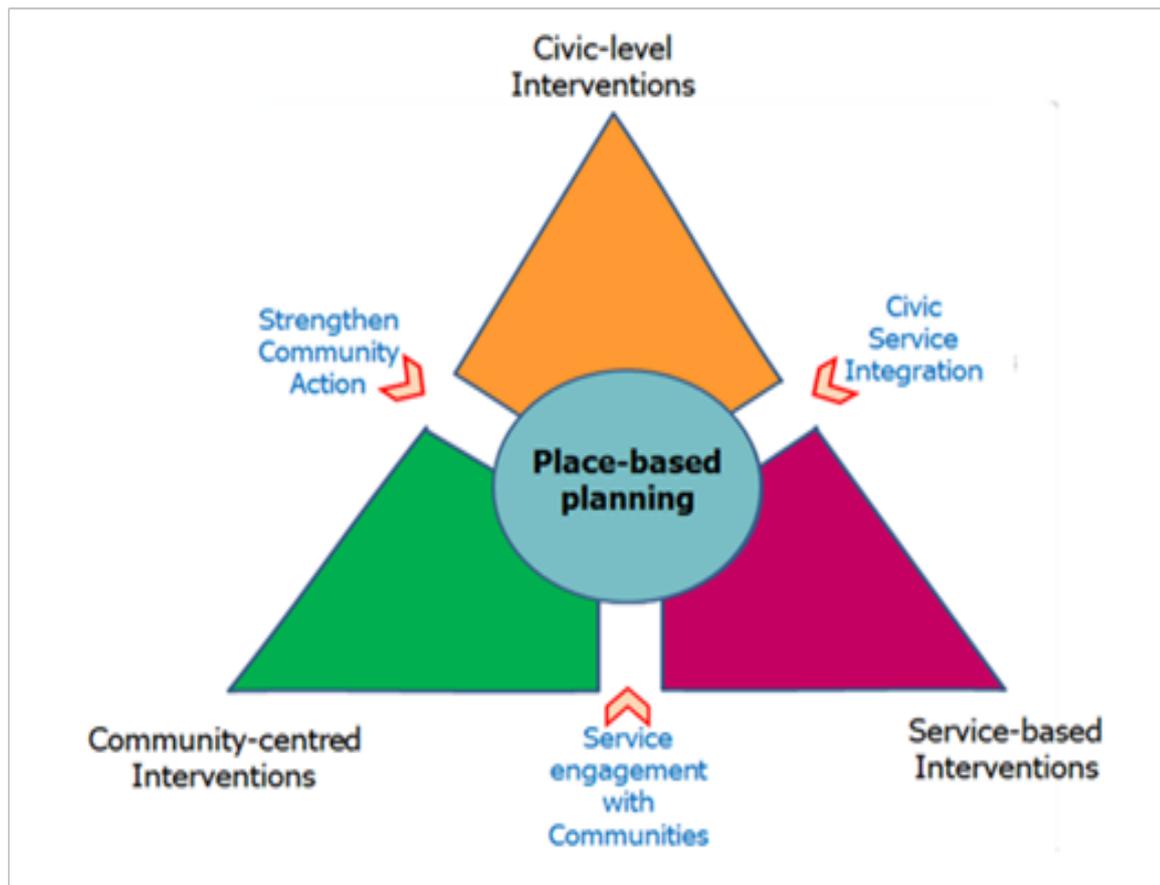
Each of these categories of input - pursued with attention to system, scale and sustainability - can individually deliver percentage change at a population level. Place-based planning is built on strong leadership, effective partnership, joint vision and credible strategies. It can drive measurable change bringing the impact of the individual segments together.

Effective place-based planning can also enhance impact by focussing on the 3 interfaces or 'seams' between the segments. With creative working across these dimensions, the whole can become greater than just the sum of the parts.

Several overviews of reviews of the published evidence on strategies to reduce health inequalities have highlighted some useful general insights to inform future policy to tackle the health gap (7 to 12). The most promising interventions or polices to tackle health inequalities include macroeconomic policies promoting employment and improvements in workplace conditions; market regulation of the tobacco, alcohol and food industries including fiscal measures and restrictions on advertising and availability of harmful products; and more integrated intersectoral and multidisciplinary strategies working across professional and institutional boundaries. Evidence also indicates educational information-based interventions may increase health inequalities (7,13). In the oral health literature, the evaluation of 2 dental health education programmes that were delivered in a universal and untargeted manner demonstrated that the information-based approach increased oral health inequalities widening the oral health gap in school aged children (14 to 16). On the contrary, whole population

interventions such as water fluoridation are more likely to reduce inequalities in children's oral health (17).

Commissioning better oral health (CBOH) for children and young people was published by PHE in 2014 to support local authorities (LAs) to commission oral health improvement programmes for children and young people aged up to 19 years (18). It recommended programmes with evidence of effectiveness and enabled LAs to review and evaluate their existing commissions and consider future commissioning intentions. Programmes were classified and assessed using a range of key public health criteria for example the strength of evidence of effectiveness, the likely impact on reducing oral health inequalities, cost or resource implications and the deliverability.

The assessment of the likely impact on reducing oral health inequalities was made, based on public health principles of intervention design and whether the intervention focused on the underlying determinants of inequalities. CBOH's final recommendations were then based on the totality of the evidence of interventions that improve oral health and have encouraging impacts on the reduction of oral health inequalities. These included targeted supervised-tooth brushing in childhood settings, targeted community-based fluoride varnish schemes, water fluoridation, integration of oral health into targeted home visits by health and social care workers, targeted provision of toothbrushes and paste by health visitors or post, healthy food and drink policies, targeted peer support groups, oral health training for the wider professional workforce and influencing local or national government policy (18).

For the purpose of this document, 2 rapid reviews were undertaken to summarise and assess up-to-date evidence on community-level and service utilisation interventions to reduce oral health inequalities. Appendix 7 and Appendix 8 describe the search strategies of these 2 rapid reviews.

5.2 Community-level interventions to reduce oral health inequalities

A rapid review to assess the evidence on community-level interventions to reduce oral health inequalities identified 2 umbrella reviews (19, 20) and one additional systematic review (21). Eight further reviews evaluated the effectiveness of population level intervention on groups characterised by specific socioeconomic position or protected characteristic or identified as vulnerable (22 to 29). Whilst these reviews provided data on oral health clinical or behavioural outcomes, they did not explore changes in oral health inequalities. They have been included to inform discussions regarding the applicability of certain interventions for different populations.

In addition to the evidence from the abovementioned reviews of populations characterised by specific socioeconomic positions, protected characteristics or identified as vulnerable, several systematic reviews were identified that evaluated the effectiveness of community-based oral health programmes in the general population. Interventions evaluated included:

- school-based sealant programmes (30)
- fluoride mouthrinse programmes (31)
- fluoridated foods (32)
- oral health promotion/education (33 to 37)
- school-based screening (38 to 40)
- school-based dental health education (41, 42)
- motivational interviewing (43 to 45)
- screening by primary care clinician (46)
- computer aided learning (47)
- oral cancer screening (48 to 52)

The evidence to support these interventions is mixed. However, oral health inequalities were not assessed within these reviews, and thus their findings were not included in this chapter.

Furthermore, a recent rapid review on school-based educational interventions to improve children's oral health has highlighted that the benefits of such interventions might be limited to children from higher socioeconomic groups (16). For example, the Scottish national prevention programme, Childsmile, incorporating universal daily supervised toothbrushing in nurseries, free toothpaste or toothbrushes for home use and more targeted interventions, such as fluoride varnish application, has been in place for the past decade. Early evaluation of the national nursery toothbrushing initiative demonstrated that most deprived children showed a greater decrease in mean $d_3$mft in the post-intervention periods compared with the least deprived children, levelling up oral health inequalities (53). Targeted supervised-toothbrushing in childhood settings, provision of toothpaste and/or toothbrushes, community-based fluoride varnish schemes and healthy food and drink policies in childhood settings are all recommended within the PHE report on Commissioning better oral health for children and young people (18). NICE also recommend the consideration of both supervised tooth brushing schemes and fluoride varnish programmes, where resources allow, for children who are at high risk of poor oral health (54).

5.2.1 Community-level interventions to reduce socioeconomic inequalities in oral health

Community water fluoridation

The wider evidence for community water fluoridation (CWF) can be found in Public Health England's toolkit for local authorities (2016, updated 2020) (55). Community water fluoridation is known to reduce levels of tooth decay in populations, but the evidence in relation of reducing oral health inequalities is more limited, being generally found in more recent cross-sectional studies comparing fluoridated and non-fluoridated populations. Put succinctly, does CWF benefit all sectors of society equally or do some groups benefit more than others?

This section summarises findings from evidence syntheses of the international literature, incorporating evidence from the 2014 and 2018 water fluoridation health monitoring reports published by PHE, which highlight more recent findings from data for England (56, 57).

Evidence from 2 umbrella reviews (19, 20), and one additional systematic review (21) report on the impact of water fluoridation on oral health inequalities as measured by socioeconomic position indicators (social class, social deprivation as measured by Townsend and Jarman indices and Index of Multiple Deprivation).

The most recent, comprehensive summary of the research literature in this area was conducted by the Australian NHMRC Clinical Trials Centre (19). Their umbrella review provides evidence regarding inequalities from 2 systematic reviews (58, 59), supplemented by additional primary studies.

The systematic reviews investigated the effect of water fluoridation on inequalities in dental health across social classes (58, 59). McDonagh et al. (2000) provided evidence from 15 primary studies, conducted in the UK (59). All except 2 of the 15 studies were cross-sectional surveys. Six of these studies provided information about the proportion of caries-free children and young people aged 5 to 16 years. Data was not able to be pooled, but 5 of the studies showed that for all social classes the proportion caries-free was greater in the areas with fluoridated water. With regard to the proportion of children who were caries-free, this was higher in the higher social classes (social class I, II and III) than the lower social classes in both areas with and without fluoridated water. In virtually all age groups and fluoridated or non-fluoridated areas, inequalities between social classes in the proportion caries-free were shown, suggesting that CWF does not eliminate oral health inequalities.

McDonagh et al. (2000) also identified 7 studies evaluating inequalities in dmft/DMFT of participants aged 5 to 16 years (59). All studies demonstrated that for all age groups and social classes dmft/DMFT was lower in those living in areas with fluoridated water than non-fluoridated water. With regard to inequalities in 5 year olds, the absolute difference in mean dmft between higher social classes (classes I and II) and lower social classes (IV and V) in the fluoridated area is 0.7 and 2.0 in the non-fluoridated areas. However, this data for other age groups did not support this. The authors concluded that, based on a small number of low quality, heterogeneous studies, there was: "some evidence that water fluoridation reduces the inequalities in dental health across social classes in 5 and 12 year olds, using the dmft/DMFT measure. This effect was not seen in the proportion of caries-free children among 5 year olds. The data for the effects in children of other ages did not show an effect." Two additional studies included in the McDonagh review used measures of social deprivation (Townsend and Jarman indices). Regression analysis found water fluoridation to have a greater effect in the most deprived groups. The authors suggested caution in interpreting the results relating to oral health inequalities in children due to the small number of studies and their low quality rating (59). There were no data for inequalities in caries levels amongst adults.

Iheozor-Ejiofor et al (58) included 155 observational studies within their review, assessing the effects of water fluoridation on caries. Three of the included studies evaluated the impact of water fluoridation on oral health inequalities but did not provide data suitable for analysis. All 3 included studies were conducted in the UK. Caries measures reported were deft, dmft and percentage of caries-free children. The authors of the review report insufficient data to

determine whether initiation of a water fluoridation programme results in a change in inequalities in caries levels across different groups of people. It should be acknowledged that the inclusion criteria for this review were stricter than McDonagh et al. (2000) (59), excluding cross-sectional studies, arguing that they are not an appropriate design to address the question of whether water fluoridation results in a reduction in inequalities in caries levels. This approach has been challenged and considered to be too restrictive (60). However, whilst McDonagh et al. (2000) do report some evidence that water fluoridation reduces the inequalities when measuring dmft/DMFT for 2 ages groups, neither review demonstrated high quality, consistent evidence of reductions in inequalities across all measures used (58, 59). Similarly, neither review identified data regarding inequalities in caries levels amongst adults (58, 59).

Within the NHMRC report (19), 3 additional primary studies were identified that evaluated the impact of water fluoridation on oral health inequalities as measured by social deprivation indices (56, 61, 62). McGrady et al. (2012) provide very low certainty evidence of a reduction in the inequality in caries experience, associated with water fluoridation, by social deprivation (61). The study included 1,783 students aged 11 to 13 years attending schools in a non-fluoridated area (Manchester) and a fluoridated area (Newcastle). Individual level measure of social deprivation was determined using the Index of Multiple Deprivation (IMD), linking the postcode with the Local Super Output Area IMD score. The difference in the mean D4-6MFT (teeth with dentinal caries) score between quintile 1 and quintile 5 was 0.61 in Newcastle and 1.07 in Manchester, suggesting that the inequality in caries score between the most and least deprived participants was less in the city with fluoridated water. Clinical assessments of caries were performed on permanent teeth using ICDAS and it was shown that the fluoridated population had statistically significantly less caries experience across all quintiles of deprivation apart from the least deprived quintile, with increased improvement in oral health with increased deprivation (61) (Table 5.1). A similar pattern was seen for the average number of permanent teeth affected (mean D4-6MFT) where the difference was statistically significant for all but the least deprived groups and the magnitude of improvement increased with increasing deprivation.

Table 5.1 Proportion of children caries-free (clinical assessment) by quintile of deprivation

|	Proportion of children caries-free (clinical assessment)*	
	Non-fluoridated area	Fluoridated area
Quintile 1 (least deprived)**	72%	78%
Quintile 2	59%	75%
Quintile 3	57%	68%
Quintile 4	46%	58%
Quintile 5 (most deprived)	39%	56%

* Clinical examination; $D_{4-6}MFT=0$
** 6% difference between least deprived populations not statistically significant

Public Health England (2014) (56), as part of regular monitoring of the effects of water fluoridation schemes on the health of people living in the areas covered, provide evidence that the reduction in tooth decay in children in fluoridated areas appears greatest among those living in the most deprived local authorities. Area-level deprivation status was measured by the Index of Multiple Deprivation (IMD). A further analysis with more recent data and a more refined exposure model was published in 2018 (57), comparing the dental health effects of populations in receipt of public water supplies with a fluoridation scheme where the fluoride concentration averaged ≥0.7mg/l, versus populations where fluoride concentration averaged <0.2mg/l. For children aged five-years-old living in fluoridated areas with concentrations of ≥0.7mg/l, compared to the lowest fluoride concentration of <0.1mg/l, the odds of experiencing caries were reduced by 23% (95% confidence interval (CI) 9% to 39%) in the least deprived areas and 52% (95% CI 47% to 56%) for those living in the most deprived, showing a greater impact (benefit) from water fluoridation in deprived areas . Figure 6.2 illustrates the association between fluoride concentration and odds of a surveyed 5 year old being in the highest d3mft category, stratified by index of multiple deprivation (57).

With regard to hospital extractions, an effect (benefit) was seen in all quintiles of deprivation but no difference was shown in the strength of association between the mean fluoride concentration and the risk of dental caries related hospital extractions between the different quintiles of deprivation (57). The absolute change in number of children requiring hospital extractions because of caries did differ, however, because more children and young people aged 0 to 19 years require caries-related extractions in more deprived areas and the greatest absolute reduction in admissions was seen for the most deprived children, which would narrow dental health inequalities.

Figure 5.2 Deprivation quintile stratum-specific predicted odds* of 5 year old children being in the highest versus any other d3mft category, by fluoride concentration (n = 111,455 children in 24,704 Lower Layer Super Output Areas), England 2014 to 2015
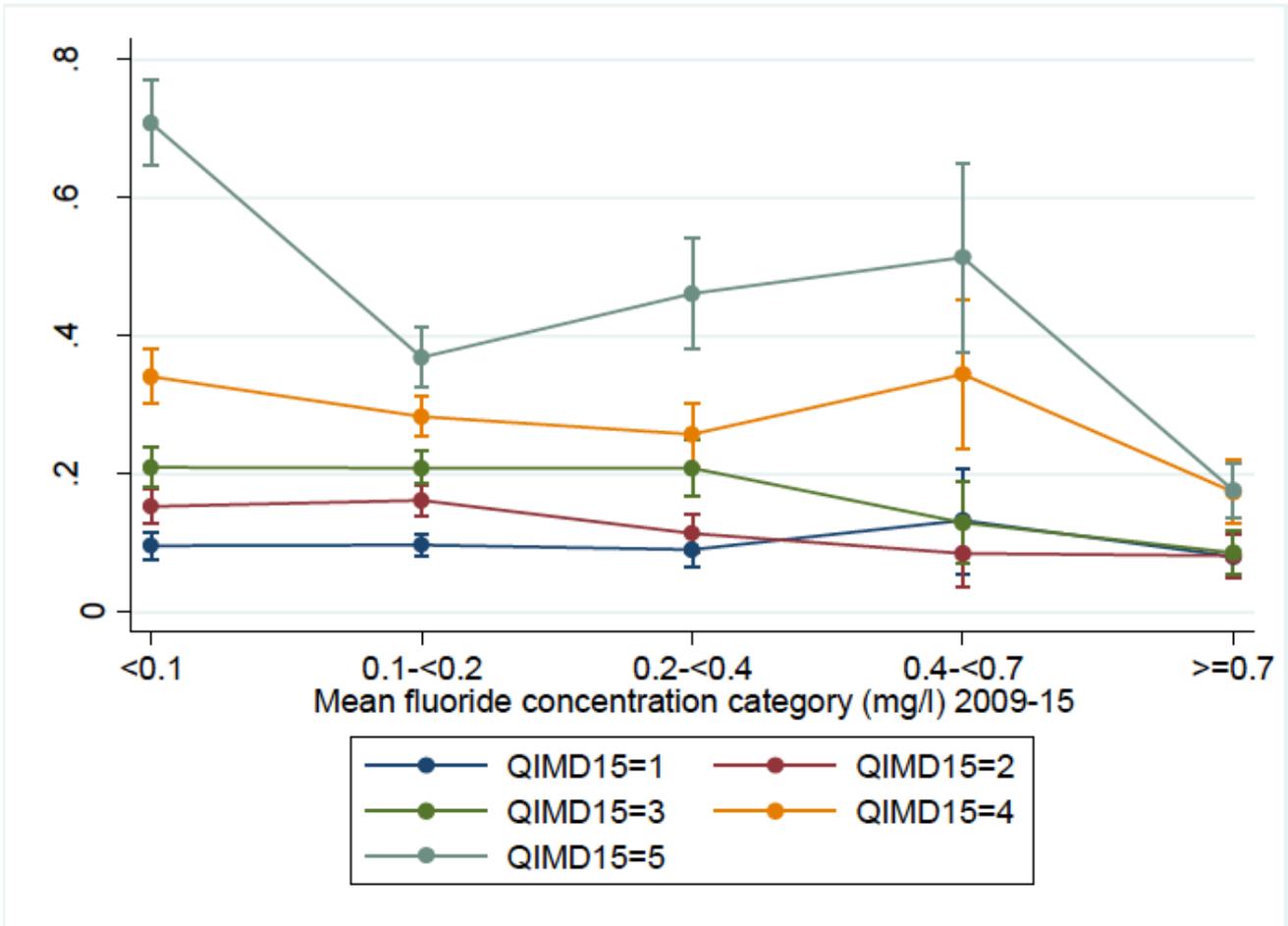
Source: PHE 2018

The third additional primary study included within the NHMRC report was a US study utilised data from the Behavioral Risk Factor Surveillance System, and the 1992 Water Fluoridation Census (62). The aim of the study was to estimate interval regression models relating to community water fluoridation exposure and tooth loss. The findings suggest that exposure to community water fluoridation is associated with a greater impact for those of lower socioeconomic status than for individuals of higher socioeconomic status (the measure of socioeconomic status was not stated).

The health technology assessment published by the Canadian Agency for Drugs and Technologies in Health (CADTH) in 2019 (20) identified 2 studies not included in the 2016 NHMRC review which were assessed as 'low' and 'moderate' quality and used data from Australia and the US. Both studies used data on children in the most deprived groups only. The US study only measured untreated decay and the Australian study was focussed on indigenous children only. The review also included the 2018 PHE health monitoring report (57), which was assessed as 'acceptable quality'.

One systematic review evaluating the impact of cessation of community water fluoridation schemes also aimed to explore the impact of such an intervention on inequalities in oral health outcomes. However, no studies reporting on inequalities, meeting the reviews inclusion criteria were identified and the authors highlight the lack of evidence on the equity implications of discontinuing community water fluoridation as a knowledge gap (21).

5.2.2 Community-level interventions to reduce oral health inequalities amongst people with protected characteristics

Evidence from 2 umbrella reviews reported on oral health inequalities and protected characteristics (19, 20). Five further systematic reviews evaluating the effectiveness of community-level interventions in populations with protected characteristics were identified, but do not present findings on changes in inequalities. They are presented here to inform decisions around applicability of different interventions focussed on different populations.

No systematic reviews focusing on the following protected characteristics, were identified: religion, sexual orientation and gender reassignment.

Ethnicity

Water fluoridation
NHMRC (19) reported very low certainty evidence from a single, but large observational study (n=97809) that water fluoridation increases the gap in the proportion of caries-free children between Indigenous and non-Indigenous Australian children (5 to 15 years of age) (63). For those living in a fluoridated area (≥0.5 ppm fluoride), the difference in the proportion of non-Indigenous and Indigenous caries-free children for deciduous dentition was 25.2%, compared to 13.4% for those living in non-fluoridated areas. For permanent dentition, for those living in a fluoridated area, the difference in the proportion of non-Indigenous and Indigenous caries-free children was 20%, compared to 9.5% for those living in non-fluoridated areas. The authors acknowledge that the absolute differences highlight the positive impact of water fluoridation in both Indigenous and non-Indigenous children. However, they also discuss the need to address important risk factors such a diet/sugar intake to help reduce the inequalities between Indigenous and non-Indigenous communities.

The 2019 review by CADTH (20) identified one study from New Zealand which was assessed as 'low quality' and investigated the effect of fluoridation on dental caries in New Zealand, comparing non-Māori and Māori children aged 5 and 12 to 13 years. Mean dmft (5 year) and DMFT (12 to 13 year) for both non-Māori and Māori was significantly lower in fluoridated areas compared with non-fluoridated areas (P < 0.001) but inequalities between groups were still apparent (64).

Social support
Dahlan et al. (2019) included studies that evaluated the impact of social support on oral health and/or behaviours in at least one immigrant or ethnic group (23). No restrictions were applied on age, sex or socioeconomic status. Twenty-six observational studies, conducted predominantly

in the United States (n=19) were included. Social support level was assessed by various social support indicators including social network size, social engagement, connection and integration, emotional support, financial support and instrumental support. Twenty-six observational studies were included; quantitative analysis was not feasible. The evidence was deemed to be of low certainty and, due to significant clinical and methodological heterogeneity in the included studies it is not possible to identify the most appropriate forms of social support for different populations.

Disability

Multiple interventions

Waldron et al. (2019) evaluated the effectiveness of oral hygiene interventions for people with intellectual disabilities (28). Studies were conducted across Europe, the US and South America in residential, school and day centre settings. The review excluded studies that evaluated chemical removal of plaque, or mechanical and chemical removal of plaque combined. Interventions identified included: electric toothbrushes, oral hygiene training of carers, scheduled dental visits plus supervised toothbrushing, plaque-disclosing agents, individualised care plans. None of the studies reported on dental caries. The clinical importance of any benefits identified were unclear and the certainty of the evidence assessed as low or very low. There was moderate-certainty evidence for one comparison, suggesting electric and manual toothbrushes are similarly effective for reducing gingival inflammation in people with intellectual disabilities in the medium term.

Pregnancy and maternity

Oral health promotion and education

Three systematic reviews evaluated the effectiveness of health promotion interventions amongst pregnant women or mothers of young children for improving child's oral health measures (for example, Early Childhood Caries, dmfs (number of decayed, missing and filled primary surfaces) and dmft), oral health behaviours, or mothers' oral heath knowledge or attitudes (24, 27, 29).

In one review the health promotion interventions, which could include oral health assessment or screening and referral of participants to dental services were aimed at expectant mothers (antenatal period) or mothers with young infants up to 24 months (postnatal period) (24). The 9 included studies were conducted in Canada, the US, Brazil, Ireland and Iran. All interventions were delivered by non-dental health professionals, or as part of a multidisciplinary team. The review presents very low certainty evidence that mothers receiving prenatal counselling and care had fewer dental caries lesions (31% vs 61%, p=0.019) and fewer extractions (7% vs 31%, p=0.021) than mothers in a no-intervention control group. Whilst there was no evidence of a difference in caries in children at 2 years of age, the authors report a higher caries level in children (2 to 4 years of age) whose mothers did not participate in the intervention (very low certainty evidence).

Children whose mothers received oral health promotion during the postnatal period were shown to have fewer decayed surfaces (p = 0.03) and lower enamel caries (de) increment (p < 0.05) in the short-term. These findings continued post 1-year follow-up (24).

With regard to behavioural changes in mother's parenting practices, mothers receiving oral health promotion demonstrated reduced use of sleep-time and daytime bottles (p < 0.005), improved dietary practices including duration of exclusive breastfeeding (p < 0.0001) and reduced introduction of sugar (p = 0.005). The certainty of the evidence was low; some findings were short-term only. There was contradictory evidence regarding oral health education and service uptake (24).

Vamos et al. (2015) included studies recruiting pregnant women from prenatal settings (27). Seven studies from the US, Canada and Lithuania were included. The clinical and methodological heterogeneity of the included studies limits the ability to draw conclusions on the effectiveness of a specific oral health promotion programme, as determined by oral health knowledge, attitudes and behaviours, for pregnant women.

A third review recruited pregnant women or caregivers of children aged 0 to 5 years of age (29). They aimed to evaluate the effectiveness of integrating promotion of oral health of young children and their mothers into nursing and midwifery practice. The majority of programmes were implemented in the US (n=8) and the UK (n=5), with other studies conducted in Brazil, Iran, Belgium, Australia and India. The authors report positive outcomes for several programmes evaluated and discuss the potential for integrating oral care interventions into nursing practice to serve different community groups across a variety of settings. However, insufficient details were provided within the review to determine the clinical and statistical significance of the findings.

5.2.3 Community-level interventions to reduce oral health inequalities in vulnerable groups

Three systematic reviews evaluating the effectiveness of community-based interventions in vulnerable groups were identified, but do not present findings on changes in inequalities. They are presented here to inform decisions around applicability of different interventions focussed on different populations.

Refugee communities

Nutrition

The effectiveness of nutrition programmes in refugee communities or school-based settings was assessed in terms of promoting oral health and/or restoring healthy body weight in refugee school-aged children (22). The community-based studies were conducted in the Congo, Copenhagen, Latino immigrant refugee communities and Sahrawi refugee camps in America. Children could be of primary or secondary school age and the interventions could include behavioural elements, addition of nutrients, provision of food supplements, regulation of nutrition-related activities or behaviours which would have an impact on health outcomes. The

review included a wide range of study designs, including non-randomised studies, randomised controlled trials and systematic reviews. However, despite the broad inclusion criteria, no evidence that aimed to promote oral health and restore healthy body weight in school-aged refugee or school-aged immigrant refugee children was identified.

Multiple caries prevention interventions (excluding water fluoridation and toothpaste)
Skeie and Klock (2018) evaluated peer-review articles that recruited children and adolescents from immigrant or low socioeconomic backgrounds (26). Thirty-seven studies (predominantly from Europe) were included evaluating fluoride supplements, sealants, supervised toothbrushing, nutrition, motivational interviews, oral health education and remineralising paste. From the data presented it is not feasible to determine the clinical or statistical significance of the findings.

Longstanding medical conditions

Oral hygiene interventions

An Australian review evaluated the effectiveness of preventive oral hygiene interventions, oral health care training and oral hygiene care provision for people with dementia or adults with special needs (25). A broad range of study designs were included, both experimental and observational. The review reported limited evidence addressing the long-term effectiveness of preventive interventions for this specific population. The authors highlighted interventions that had been found to be effective in the general population (for example, regular brushing with fluoride toothpaste, use of therapeutic fluoride products and application of therapeutic chlorhexidine gluconate products), stating that until further research is undertaken in adults with dementia, these interventions provide the best option for maintaining their oral health.

5.3 Service utilisation interventions to reduce oral health inequalities

Five systematic reviews meeting the inclusion criteria relating to dental service utilisation were identified (65 to 69). These are broadly grouped according whether they targeted remuneration system, workforce or patient behaviour. Systematic reviews evaluating variations in recall intervals were also included as it has been argued that extending recall intervals for patients at low risk of dental disease may provide the opportunity for greater focus on tackling oral health inequalities (70). It should be noted, however, that the included reviews did not fully meet the rapid review's inclusion criteria and they did not present data on oral health inequalities (71, 72).

Remuneration systems

Financial incentives within health care remuneration systems have the potential to make services more effective, more equitable or more patient-centred (65). Within dental services, the primary mechanisms for remunerating primary care dentists include fee-for-service, fixed salary and capitation payments (73). Evidence suggests that the behaviour of primary care dentists in the UK are sensitive to changes to remuneration (74). In order to understand the effects that

different remuneration systems have on the pattern of service activity in dentistry and the patient outcomes generated, Brocklehurst et al. undertook a systematic review of the evidence (65). Only 2 RCTs were identified (other study designs were sought but not identified). One trial reported that there was a statistically significant increase in clinical activity among those incentivised with a fee-for-service payment compared with an educational intervention, a combination of fee-for-service and education, or a no-intervention control (75). The second trial compared capitation remuneration for initial treatment to make the children dentally fit before entering the capitation system with a fee-for-service remuneration for dental care of children (74). Clinical heterogeneity prevented any statistical pooling of data, however, there was very low certainty evidence that financial incentives within the remuneration system were associated with changes in clinical activity undertaken by primary care dentists. Despite the review aiming to evaluate measures of health service utilisation in terms of reducing oral health inequalities (by socioeconomic status, education or income) in the proportion of a population receiving care, recall frequency and re-attendance rates, no studies reporting these outcomes were identified (65).

Workforce

Two systematic reviews evaluated different aspects of workforce (66, 67). Dyer et al (2014) discuss the potential for 'task shifting' to allow dental care professionals (such as therapists or hygienists) to undertake tasks traditionally performed by dentists. They suggest that by doing this, limited or inequitable access to oral health care could be alleviated (66). Their systematic review assessed the impact of such task-shifting on access and equity of access, alongside primary outcomes related to clinical performance. Unfortunately, due to the limited evidence identified and the risk of bias within the identified studies, no clear implications for practice could be drawn. None of the included studies (n=5) presented data on role of dental care professionals for reducing inequalities in access to dental care.

Jager et al. (2017) focused on the spatial distribution of dentists or dental care professionals (67). They argue that a spatially unequal distribution of dentists or dental care professionals may lead to a reduction in the access to, and quality of health services. This in turn leads to increase oral health inequalities. Jager et al. (2017) presented the findings of a systematic review of interventions to enhance the distribution of dentists and/or dental care professionals. The interventions of interest were grouped into four categories: educational interventions; financial interventions; regulatory strategies, and personal and professional support strategies. Only 3 studies met the review's inclusion criteria, all of which were interrupted time series. Two were at high risk of bias and the third unclear risk of bias. Two studies evaluated the effect of increasing the overall number of dentists with ambiguous findings. The third study suggests that the introduction of a universal health coverage insurance reduced inequalities in the distribution of dentists. A potential explanation for this is that the universal coverage insurance helps increase demand in areas that couldn't previously afford dental care (67). Overall, there was insufficient information to determine whether interventions to enhance the spatial distribution of dentists and/or dental care professionals are effective at reducing oral health inequalities.

Patient-focused interventions

A systematic review to evaluate interventions to improve dental service utilisation behaviour of adults, with the aim of reducing socioeconomic inequalities, was undertaken by Raison et al. (2019) (69). The interventions at an individual, community or macro-level were included as long as they explored socioeconomic differences in dental service use. Six studies were included: 3 RCTs, one cluster RCT, one NRCT and one repeated cross-sectional study. All studies were conducted in the US and targeted pregnant women, parents or communities. Two studies targeted pregnant women, evaluating multicomponent interventions. Findings with regard to dental attendance were inconsistent. Three studies targeted parents and, again, interventions were multicomponent, encompassing postal reminders and scheduling of appointments. Whilst one study showed an increase in initial dental visit and follow-up visits following written prompts, the applicability of these findings from a study published in 1976 was unclear. The other 2 studies showed no statistically significant increase in dental service utilisation following scheduling of appointments or prompts (69).

One study included in the review by Raison et al. (2019) evaluated a community level intervention (69). The multi-component intervention, encompassing prompts alongside regular presentations at community events and via local media, showed no increase in dental visit frequency.

The authors of the review conclude there is a need for further research in this area to determine the effectiveness of interventions to reduce socioeconomic inequalities. In particular, research should evaluate interventions in different healthcare systems and different populations (69).

A second review by Raison et al. (2018) evaluated the effectiveness of cue-automaticity to underpin the promotion of preventive care (68). Cue-automacity refers to how repetition of behaviour, prompted by a certain 'cue', leads to the automatic execution of a particular behaviour. Six studies were identified, all utilising an Implementation Intention (if-then) component. Findings were promising, however the studies did not focus on oral health behaviour. The authors suggest that: "cue-automaticity interventions may be of particular benefit to low socioeconomic groups, however research is needed to investigate whether cue-automaticity interventions can translate into reducing inequalities in attendance for dental check-ups". (68)

Recall intervals

Two evidence syntheses evaluated the effectiveness of different recall intervals for oral health in primary care patients (71, 72). The most recent review compared recall intervals for dental check-ups of any fixed length against an alternative fixed-length interval, a clinician determined, risk-based interval or no recall (71). Measures of clinical status, patient-centred outcomes, costs and harms were collated. Only 2 trials were included in the review, one study conducted in a Norway, recruiting regular attenders under 20 years of age. A comparison was made between a 12-month recall interval with a 24-month recall. Evidence from the trial was unable to determine if there was a caries difference between 24-month and 12-month recalls for either 3 to 5 year

olds or 16 to 20 year olds. The second study was conducted in general dental practices in the UK, recruiting adults who were regular attenders. A comparison was made between a 6-month recall interval, 24-month interval and risk-based recall intervals. The trial provided high-certainty evidence that there is little to no difference between risk-based and 6-month recall intervals for adults at 4-year follow-up for the following outcomes:

- number of tooth surfaces with any caries (mean difference (MD) 0.15; 95% CI −0.77 to 1.08; 1478 participants)
- proportion of sites with gingival bleeding (MD 0.78%; 95% CI −1.17% to 2.73%; 1472 participants
- oral-health-related quality of life (MD −0.35; 95% CI −1.02 to 0.32; 1551 participants)

The trial provided moderate-certainty evidence of little to no difference in the prevalence of moderate to extensive caries between the groups (risk ratio (RR) 1.04; 95% CI 0.99 to 1.09; 1478 participants; moderate-certainty evidence).

When comparing a 24-month recall versus 6-month recall, there was little to no difference with regard to:

- number of tooth surfaces with any caries (MD −0.60; 95% CI −2.54 to 1.34; 271 participants; moderate-certainty evidence)
- percentage of sites with gingival bleeding (MD −0.91%; 95% CI −5.02% to 3.20%; 271 participants; moderate-certainty evidence)
- oral-health-related quality of life between the groups (MD −0.24; 95% CI −1.55 to 1.07; 305 participants; high-certainty evidence)
- prevalence of moderate to extensive caries (RR 1.05; 95% CI 0.92 to 1.20; 271 participants; low-certainty evidence)

With regard to a clinician defined, risk-based recall compared with a 24-month recall, outcomes at 4 years again showed little or no difference in:

- prevalence of moderate to extensive caries (RR 1.06; 95% CI 0.95 to 1.19; 279 participants; moderate-certainty evidence)
- number of tooth surfaces with any caries (MD 1.40, 95% CI −0.69 to 3.49; 279 participants; moderate-certainty evidence)

There was no important difference between a risk-based recall compared with a 24-month recall with regard to:

- percentage of sites with gingival bleeding (MD −0.07%; 95% CI −4.10% to 3.96%; 279 participants; high-certainty evidence)
- oral-health-related quality of life (MD −0.37; 95% CI −1.69 to 0.95; 298 participants; high-certainty evidence)

No data on inequalities or harms were presented in either trial.

Overall, the authors of the review concluded the "available evidence on recall intervals between dental check-ups for children and adolescents is uncertain" (71).

The earlier review conducted by Davenport et al. (2003) had boarder inclusion criteria, however, it still identified little evidence to support or refute the practice 6-monthly recall intervals in adults and children (72). Decision modelling analysis suggested that longer duration recall intervals may be more cost-effective, although the cost-effectiveness varied across risk groups.

Future research, both primary and secondary, need to consider the evaluation of inequalities within their design and conduct. The importance of systematic reviews in the provision of comprehensive, robust synthesised evidence to inform decision making is well recognised.

However, they have criticised by decision makers for lacking evidence on equity (77). MacIntyre et al. (2020) highlight the role of PRISMA-E 2012 guidelines to help identify the most effective interventions for tackling health inequalities (70). More recently, an explanation and elaboration paper has been published to improve understanding, and hopefully uptake, of the reporting guideline for users (77).

5.4 Summary

There was a paucity of evidence on whether and how community-level and service utilisation interventions impacted on oral health inequalities.

PHE and NICE (PH55) have recommended programmes that not only improve oral health but also have encouraging impacts on reducing oral health inequalities.

PHE have recommended targeted supervised-tooth brushing in childhood settings, targeted community-based fluoride varnish schemes, integration of oral health into targeted home visits by health and social care workers, targeted provision of toothbrushes and toothpaste by health visitors or post, healthy food and drink policies, targeted peer support groups, oral health training for the wider professional workforce and influencing local or national government policy (for instance fiscal policy).

PHE have also recommended water fluoridation as a whole population intervention as there is evidence that it reduces oral health inequalities with a greater benefit for those living in more deprived areas.

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6. Next steps

It is recognised that although this report describes oral health inequalities, further action is needed to reduce these inequalities.

Collaboration by a number of partners is already happening across the health and social care system and Public Health England intends to publish a companion piece to this report, setting out in more detail what further action is needed to address research and epidemiological gaps, and reduce oral health inequalities. Work will also include addressing the impact of oral health inequalities created by the COVID-19 pandemic.

7. Glossary

ADHS	Adult Dental Health Survey
ALSPAC	Avon Longitudinal Study of Parents and Children
BSA	Business Services Authority
CADTH	Canadian Agency for Drugs and Technologies in Health
CBOH	Commissioning better oral health
CCG	Clinical Commissioning Group
CDHS	Children's Dental Health Survey
CWF	Community water fluoridation
DMFT	Decayed, missing and filled permanent teeth
dmft	Decayed, missing and filled primary teeth
DMFS	Decayed, missing and filled permanent surfaces
dmfs	Decayed, missing and filled primary surfaces
EPIC	European Prospective Investigation of Cancer
HBSC	Health Behaviour in School-aged Children
HINST	Health Inequalities National Support Team
HMIC	Health Management Information Consortium
IMD	Index of Multiple Deprivation
LA	Local authorities
MD	Mean difference
NDEP	National Dental Epidemiology Programme
NDNP	National Diet and Nutrition Survey
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NMES	Non-milk extrinsic sugar
NS-SEC	National Statistics Socioeconomic Classification
OHI	Oral Health Inequalities
OHIP	Oral Health Impact Profile

OHRQoL	Oral Health Related Quality of Life
OIDP	Oral Impacts on Daily Performances
ONS	Office of National Statistics
OR	Odds Ratio
PBA	Place Based Approach
PHE	Public Health England
PIT	Population intervention triangle
PUFA	Pulpal involvement, ulceration, fistula, abscess in permanent teeth
pufa	Pulpal involvement, ulceration, fistula, abscess in primary teeth
RR	Risk Ratio
SOHIPP	Scottish Oral Health Improvement Prison Programme
UADT	upper aerodigestive tract
UDAs	Units of Dental Activity
UK	United Kingdom
WHO	World Health Organization

8. Development of the report and acknowledgements

The development process

- Dr Sandra White was the Senior Reporting Officer for this report and the Chair of the Oral Health Inequalities (OHI) Working Group
- Matt Gill managed the process and co-ordinated the contributions for the report
- Satveer Kour provided Secretariat to the working group

The OHI Working Group was initially set up on 7 March 2016 and included partners from:

- DHSC, Helen Miscampbell
- NHSE, Carol Reece
- Office of the Chief Dental Officer England, Janet Clarke
- British Dental Association, Arianne Matlin
- Internal teams from PHE

Others were co-opted onto the working group during the process including academics from UCL (see contributors below) and the University of Glasgow (Professor Lorna MacPherson and Professor David Conway).

The report was delayed by 12 months due to the Covid-19 pandemic.

A draft of the report was circulated to the OHI Working Group and other key partners, and Public Health England's Publication Standards Panel for review in February 2021.

The report was revised on the basis of feedback and recommendations and submitted to Public Health England's Publication Gateway team in March 2021.

Authors and contributors

The final document was edited by Dr Easter Joury (PHE & Queen Mary University of London).

Colleagues at the Institute of Epidemiology and Health Care at University College London (UCL) provided major contributions as well as feedback and were involved in the development of the report:

- Dr. Anja Heilmann
- Professor Georgios Tsakos
- Renato Venturelli Garay
- Professor Richard Watt

The following colleagues contributed in the search and extraction of data for the scoping review presented in chapter 4:

- Dr Masuma Mishu (University of York)

- Alex Blokland (UCL)
- Egle Petrauskiene (UCL)
- Janine Doughty (UCL)
- Dr Martha Paisi (University of Plymouth)
- Maryam Ahmadyar (University of Oxford)

Sections of the report were informed by evidence reviews undertaken by the following academics:

- Professor Anne-Marie Glenny, The Cochrane Oral Health Group
- Professor Zoe Marshman, Sheffield University

The following PHE colleagues provided content and/or authored sections:

- Dr Easter Joury (admin support from Rania Soudan)
- Dr Sandra White
- Matt Gill
- Dr Jenny Godson
- Dr Kate Jones
- Dr Semina Makhani
- Dr Anna Ireland
- Janet Neville
- David Wilcox
- Colum Durkan
- Dr John Mair-Jenkins
- Dr Rebecca Girdler
- Dr Yvonne Daley
- Dr Gill Davies
- Dr Julia Csikar
- Lina Toleikyte
- Alyson Jones
- Dr John Morris (University of Birmingham)

Feedback

Fedback was received from the following organisations and individuals:

- Nigel Carter, CEO, responding on behalf of the Oral Health Foundation
- Office of the Chief Dental Officer (OCDO) Policy and Leadership Team
- Arianne Matlin, Head of Health and Science Policy, responding on behalf of the British Dental Association
- Professor Richard Watt, UCL
- Professor Georgios Tsakos, UCL
- Dr. Anja Heilmann, UCL

9. Appendices

Appendix 1. Legal duties and responsibilities of public bodies across the health sector to address inequalities

The public sector equality duty is a general duty on public bodies to ensure that they consider the needs of all individuals in their day to day work in shaping policy, in delivering services, and in relation to their own employees. The equality duty has 3 aims:

- to eliminate unlawful discrimination, harassment, victimisation and any other conduct prohibited by the Equality Act 2010
- to advance equality of opportunity between people who share a protected characteristic and people who do not share it
- to foster good relations between people who share a protected characteristic and people who do not share it

The equality duty covers 9 protected characteristics:

- age
- disability
- gender reassignment
- marriage and civil partnership (but only in respect of eliminating unlawful discrimination)
- pregnancy and maternity
- race — this includes ethnic or national origins, colour or nationality
- religion or belief — this includes lack of belief
- sex
- sexual orientation

The Health and Social Care Act 2012 introduced the health inequalities duty which gives specific legal duties for the Secretary of State for Health (and by extension Public Health England), NHS England, Clinical Commissioning Groups and NHS Improvement. These duties came into effect in April 2013.

The conceptual framework underpinning the legislation is that health inequalities:

- relate to anyone experiencing health inequalities and is not defined in terms of any specific groups or 'protected characteristics'
- take a whole population approach, not an individualistic one
- are concerned with achieving equitable access and outcomes. This can mean provision of services or support is focused on particular groups, taking account of population group characteristics such as disadvantage, education, wealth or any aspect affecting health

- focus on the 'social gradient' acknowledging health inequalities exist throughout society and are not just experienced by the poorest"

The Secretary of State's legal duties regarding health inequalities are:

- "In exercising functions in relation to the health service, the Secretary of State must have regard to the need to reduce inequalities between the people of England with respect to the benefits that they can obtain from the health service".(Section 1C of the NHS Act 2006, as amended by the Health and Social Care Act 2012)
- to include in his annual report on the performance of the health service in England, an assessment of how effectively he has discharged his duty to have regard to the need to reduce inequalities
- to set out in a letter to NHS England, which is published and laid before Parliament, his assessment of how it has discharged its duty to have regard to the need to reduce health inequalities, based on NHS England's annual report

The Secretary of State's duty covers both NHS and public health functions, and relates to the whole population of England including those who are not registered with general practice or who are not patients. The Department's Special Health Authorities (so far as they are exercising delegated functions of the Secretary of State) and Executive Agencies are also bound by it. The duty encompasses all health inequalities dimensions, not just income or socioeconomic inequalities.

The NHS Constitution states that the NHS has a duty to "…pay particular attention to groups or sections of society where improvements in health and life expectancy are not keeping pace with the rest of the population". This is reflected in the National Health Service Act 2006 (as amended by the Health and Social Care Act 2012), which introduced for the first-time legal duties to reduce health inequalities, with specific duties on Clinical Commissioning Groups and NHS England.

Appendix 2. Definitions of types of oral health inequalities

Socioeconomic position

Socioeconomic position (SEP) refers to "the social and economic factors that influence what positions individuals or groups hold within the structure of a society". SEP is measured in different ways. The 3 measures that are most commonly used and widely considered to be key markers of SEP ¬are education, income and social class based on occupation. While interrelated, each of these measures captures different aspects of SEP. Education captures knowledge related or intellectual assets and is measured via the highest level of education achieved or years of schooling. Income is a direct measure of material resources, measured commonly at household level adjusted for family size (equivalised income). Social class, based on occupation, reflects a person's place in society, that is, their social standing, and is also strongly related to material resources. The 2 most frequently used classifications in the reviewed literature were the more recent National Statistics Socioeconomic Classification (NS-SEC), which is based on differences between employment conditions and relations and accounts for levels of autonomy, authority and control; and the older UK Registrar General's Social Class, which was widely used before the NS-SEC became available and is based on the prestige or social standing that a given occupation has in society.

Measures of area socioeconomic deprivation are often used in health research as proxy measures for household or individual SEP, when individual measures of SEP are not available but research participants' postcodes are known. They are also used in addition to individual SEP measures, to examine whether contextual factors, such as the level of deprivation in a given neighbourhood, influence people over and above their individual circumstances. Area and individual-level socioeconomic characteristics are usually highly correlated, however it should be born in mind that being poor (or affluent) and living in a poor (or affluent) area are 2 separate factors that do not always go hand in hand.

The most commonly used measures for area deprivation in the studies included in this review were:

- the Indices of Multiple Deprivation (IMD)
- the Carstairs Index
- the Townsend Index
- the Jarman Under Privileged Area score

All have been developed to measure deprivation at the small area level. Here they are briefly explained.

Indices of Multiple Deprivation

Indices of multiple deprivation are available for all UK countries. The English Index of Multiple Deprivation is made up of 7 domain indices: income deprivation; employment deprivation;

health deprivation and disability; education, skills and training deprivation; barriers to housing and services; living environment deprivation; and crime. The living environment domain consists of 2 indicators: a measure of the 'indoors' environment (private and social housing in poor condition and houses without central heating) and a measure of the 'outdoors' environment (air quality and road accidents involving injury to pedestrians and cyclists). The ranking is based on an weighted cumulative model of these domains. (91) The IMDs for the other UK countries are constructed in a very similar way.

Carstairs Index

The Carstairs Index was developed by Carstairs and Morris in the 1980s, and is calculated using an unweighted combination of 4 census variables: unemployment, overcrowding, car ownership and low social class (defined as social classes IV and V).

Townsend Index

The Townsend Index, also developed in the 1980s, is constructed from the following 4 census variables: unemployment, overcrowding, households with no car ownership and households not owner-occupied.

Jarman Under Privileged Area score

Jarman scores were developed, again in the 1980s, to measure additional workload or pressure on health services and are based on a weighted cumulative model of the following 8 census variables: elderly living alone, children aged under 5, one parent families, social class V, unemployment, overcrowding, moved house recently and residents born in the New Commonwealth.

Protected characteristics

Protected characteristics include age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex, and sexual orientation.
Age refers to a person belonging to a particular age (for example 32 year olds) or range of ages (for example, 18 to 30 year olds).

Disability

Disability is defined as a 'physical or mental impairment that has a substantial and long-term negative effect on the ability to do normal daily activities'. Disability is a protected characteristic and defined in the Equality Act 2010. Disability is a protected characteristic under the Equality Act 2010, and defined as a 'physical or mental impairment that has a substantial and long-term negative effect on the ability to do normal daily activities'.

Gender reassignment

Gender reassignment refers to the process of transitioning from one gender to another.

Marriage and civil partnership

Marriage and civil partnership refers to a union between a man and a woman or between a same-sex couple. Same-sex couples can also have their relationships legally recognised as

'civil partnerships'. Civil partners must not be treated less favourably than married couples (except where permitted by the Equality Act).

Pregnancy or maternity
Pregnancy or maternity is a period defined as follows: 'a woman is protected against discrimination on the grounds of pregnancy and maternity during the period of her pregnancy and any statutory maternity leave to which she is entitled'. Pregnancy or maternity is a protected characteristic and defined in the Equality Act 2010. Pregnancy and maternity fall under the protected characteristics of the Equality Act 2010. According to this, 'a woman is protected against discrimination on the grounds of pregnancy and maternity during the period of her pregnancy and any statutory maternity leave to which she is entitled'.

Race
Race refers to the protected characteristic of race. It refers to a group of people defined by their race, colour, and nationality (including citizenship) ethnic or national origins.

Religion
Religion refers 'to any religion, including a lack of religion', while belief is linked to choices in life and covers 'any religious or philosophical belief and includes a lack of belief'. Religion is a protected characteristic and defined in the Equality Act 2010. Another protected characteristic of the Equality Act 2010 refers to religion or belief. The Equality Act specifies that religion refers 'to any religion, including a lack of religion', while belief is linked to choices in life and covers 'any religious or philosophical belief and includes a lack of belief'.
Sex refers to being a man or a woman.

Sexual orientation
Sexual orientation refers to whether a person's sexual attraction is towards their own sex, the opposite sex or to both sexes.

Vulnerable groups

Vulnerable groups include, but are not limited to: homeless people; prisoners; travellers; people with longstanding medical conditions; refugees; looked-after children; sex workers.

Homelessness
Homelessness is defined in Part VII of the Housing Act 1996: "A person is homeless if he has no accommodation available for his occupation, in the United Kingdom or elsewhere, which he: (a) is entitled to occupy by virtue of an interest in it or by virtue of an order of a court, (b) has an express or implied licence to occupy, or (c) occupies as a residence by virtue of any enactment or rule of law giving him the right to remain in occupation or restricting the right of another person to recover possession. A person is also homeless if he has accommodation but (a) he cannot secure entry to it, or (b) it consists of a moveable structure, vehicle or vessel designed or adapted for human habitation and there is no place where he is entitled or permitted both to place it and to reside in it." Homelessness means not having a permanent home. Homelessness comes in many different forms, of which sleeping rough is the most extreme. Homeless people

often live in temporary accommodation, such as bed and breakfast hotels, hostels, night shelters and refuges, or stay with relatives or friends.210 The legal definition of homelessness is given in Part VII of the Housing Act 1996: "A person is homeless if he has no accommodation available for his occupation, in the United Kingdom or elsewhere, which he: (a) is entitled to occupy by virtue of an interest in it or by virtue of an order of a court, (b) has an express or implied licence to occupy, or (c) occupies as a residence by virtue of any enactment or rule of law giving him the right to remain in occupation or restricting the right of another person to recover possession. A person is also homeless if he has accommodation but (a) he cannot secure entry to it, or (b) it consists of a moveable structure, vehicle or vessel designed or adapted for human habitation and there is no place where he is entitled or permitted both to place it and to reside in it."

Prisoners

Prisoners are defined in the Prison Security Act 1992 as "any person for the time being in a prison as a result of any requirement imposed by a court or otherwise that he be detained in legal custody".

Travellers

Travellers have been defined as 'persons of nomadic habit of life whatever their race or origin, including such persons who on grounds only of their own or their family's or dependants' educational or health needs or old age have ceased to travel temporarily, but excluding members of an organised group of travelling show people or circus people travelling together as such.'

People with longstanding medical conditions or chronic diseases

People with longstanding medical conditions or chronic diseases are persons who have conditions for which there is currently no cure, and which are managed with drugs and other treatment, for example: diabetes, chronic obstructive pulmonary disease, arthritis and hypertension.

Refugees

Refugees are persons who fled their own country because of a "well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion. Asylum seekers are persons who applied for refugee status or one of other forms of international protection, and are awaiting a decision on that application.

Looked after children

'Looked after children' are defined in the Children Act 1989. A child is 'looked after' by a local authority if he or she gets accommodation from the local authority for a continuous period of more than 24 hours; or is subject to a care or a placement order. 'Looked after children' refers to children in care and to those that live with foster parents, at home with their parents under the supervision of social services, in residential children's homes, or other residential settings like schools or secure units. The Children Act 1989 legally defines a child as 'looked after' by a local authority if he or she gets accommodation from the local authority for a continuous period of more than 24 hours; or is subject to a care or a placement order.

Sex workers

Sex workers are persons who are engaged in prostitution. Sex work is a term used to describe a wide range of activities relating to the exchange of money (or its equivalent) for the provision of a sexual service. There are different types of sexual services practiced by sex workers. These types of sexual services are grouped into 2 categories; direct and indirect sex work. Direct sex work refers to services, such as indoor and outdoor prostitution as well as escort services. This type of sex work typically involves the exchange of sex for a fee in which genital contact is common. Indirect sex work refers to services, such as lap dancing, stripping and virtual sex services (over the internet or phone). Genital contact is less common in this type of sex work. However, a fee is still exchanged for the service.

Appendix 3. Sources of epidemiological and NHS data

Epidemiological data were used from the following surveys and registers:

- The 2009 Adult Dental Health Survey
- The 2013 Child Dental Health Survey
- The series of the National Dental Epidemiology Programme surveys
- The National Cancer Registration and Analysis Service

Publicly available NHS data were used from the following sources:

- NHS England commissioning and activity statistics (for NHS primary care dental services)
- NHS Dental Statistics for England 2018 to 2019
- Hospital Episode Statistics data on extractions for children (0 to 19 years), where dental caries is the primary diagnosis
- Summary of the Dental Results from the GP Patient Survey: January to March 2019.

Data on population estimates from the National Office for Statistics was also used.

The following provides more details on the abovementioned epidemiological surveys:

The 2009 Adult Dental Health Survey

The decennial surveys of dental health are a series of adult and child dental health surveys. The adult dental health surveys have taken place every 10 years from 1968 to 2009 and the child dental health surveys have taken place every 10 years from 1973 to 2013.

The 2009 adult dental health survey was carried out in England, Wales and Northern Ireland. Scotland opted not to participate in the survey. The survey sampled 13,400 households, 1,150 in each English Strategic Health Authority and Wales and 750 households in Northern Ireland. Interviews were conducted on 11,380 people were interviewed and 6,469 people had a clinical examination.

The 2009 survey consisted of a questionnaire interview with all adults aged over 16 years at all sampled households. A clinical oral examination of the mouth and teeth was also completed for interviewed adults who had at least one natural tooth, who consented to the oral examination and who were available to be examined within the field work period. The aims of the survey were to establish the condition of the natural teeth and supporting tissues, to investigate dental experiences and knowledge and attitudes towards dental care and oral hygiene, to examine changes over time in dental health, attitudes and behaviour and to monitor the extent to which dental health targets set by the government were being met. The results were presented at national and old strategic health authority level and by 10-year age bands, sex and socioeconomic classification of household.

Where possible data is presented for England. Where no England level data is available, England, Wales and Northern Ireland level data is presented.

The 2013 Child Dental Health Survey

The aims of the 2013 children's dental health survey were to describe the pattern of oral diseases and conditions in children and describe oral health related behaviours, experiences and perceptions. It was carried out in England, Wales and Northern Ireland and sampled 5, 8, 12 and 15 year old children. The sampling process was designed to provide a sample of 2,500 children for each age cohort. The sampling process also factored in a measure of deprivation so that schools where 30% or more children were entitled to free school meals were oversampled.

Clinical examinations were carried out in schools on a random sample of children. Information on children's oral health experiences, perceptions and behaviours was also collected through a self-completion questionnaire. Twelve and 15 year old children completed the questionnaire themselves and parents or guardians completed the questionnaire for children aged 5 and 8 years old. A clinical examination was carried out on 6,866.

The National Dental Epidemiology Programme

The National Dental Epidemiology Programme has taken place annually since 1983. These surveys are nationally coordinated and provide information on oral health at lower or upper-tier local authority level and regional and national level. The surveys involve a clinical examination of a sample of the survey population. The minimum sample size for the surveys is usually set at 250 people for each lower-tier local authority so at national level the numbers of people examined run into the tens of thousands. The series of surveys use standardised methods to allow for surveillance of trends across different geographical areas and over time.

The most recent surveys have looked at the following populations:

- Oral health survey of 12 year old children 2009
- Oral health surveys of adult subgroups 2009:
    - Adults with learning disabilities
    - Adults in contact with domiciliary services
    - Adults attending out of hours unscheduled dental care services
- Oral health survey of 5 year old children 2012
- Oral health survey of 3 year old children 2013
- Oral health survey of children attending special support schools 2014
- Oral health survey of 5 year old children 2015
- Oral health survey of mildly dependent older people 2016
- Oral health survey of 5 year old children 2017
- Oral health survey of adults attending dental practices 2018
- Oral health survey of 5 year old children 2019

For the oral health surveys of 5 year old children in 2012, 2015 and 2019, more detailed reports were also produced for each local authority that included data at sub-lower tier local authority level. For the purpose of this document the data of the 2019 oral health surveys of 5 year old children was presented, as it is the most recent data available on this age group.

Data on oral health inequalities in children was presented by socioeconomic position, geographical area, age, sex, ethnicity and disability. Where possible, data is presented for England. Where no England level data is available, England, Wales and Northern Ireland level data is presented.

Appendix 4. Search strategy of the review on oral health inequalities

Aim

The aim of this scoping review was to provide an overview of the evidence on oral health inequalities in the UK in the broadest sense.

Methods

A scoping review methodology was employed. A scoping review or scoping study is a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting and synthesising existing knowledge.

Based on the 5-stage methodological framework for scoping studies, the following steps (stages) were undertaken:

Stage 1: Definitions
Stage 2: Inclusion and exclusion criteria
Stage 3: Search strategy
Stage 4: Data extraction
Stage 5: Summarising and reporting the results

Stage 1: Definitions

The main exposures and oral health outcomes considered in the review were determined by the steering group and are presented in Tables A 4.1 and A 4.2. Detailed explanations for the characteristics that were considered in the review and their measurement are provided in Appendix 2.

Table A 4.1 Exposures considered in the scoping review

	Measures
Socioeconomic position	Education; income/wealth; occupation / social class; employment status; eligibility for free school meals; area-based measures of deprivation (for example, Indices of Multiple Deprivation, Townsend Index, Carstairs Index, Jarman Under Privileged Area score)
Protected characteristics	Ethnicity; disability; pregnancy and maternity; religion; sexual orientation; gender reassignment
Vulnerable groups	Homeless; prisoners; travellers; people with longstanding medical conditions; refugees; looked-after children; sex workers

Table A 4.2 Oral health outcomes considered in the scoping review

	Measures
Clinical	Dental caries; odontogenic infections / sepsis; periodontal disease; tooth loss; dental trauma; oral cancer
Subjective	Self-rated oral health; dental pain; Oral Health Related Quality of Life (OHRQoL); perceived treatment needs
Behavioural	Oral hygiene / toothbrushing; fluoride use; sugar consumption
Service-related	Dental attendance; other outcomes related to service use (for example, access to services; satisfaction with services; receipt of preventive or restorative care)

Stage 2: Inclusion and exclusion criteria

Inclusion and exclusion criteria were agreed by the steering group with the aim of identifying the most relevant literature in relation to the research questions, while ensuring feasibility and manageability.

The review focuses on evidence for oral health inequalities in the UK. Included were studies that addressed the research question through empirical research, were peer-reviewed articles reporting on UK data, and published in English. The search was limited to studies published since January 2000. This limit was deemed appropriate because 2 key reviews on socioeconomic inequalities in oral health were published in 1999 and 2000, serving as the starting point for the current review. No study was excluded based on its quality, but main limitations were noted.

Excluded were:

- studies reporting data from countries other than the UK
- grey literature – except for those characteristics where evidence from peer-reviewed studies was very limited but good quality grey literature was available (homelessness, prisoners, travellers, and looked after children)
- publications not in English
- articles published before 2000 or after June 2017

Stage 3: Search strategy

A systematic search was undertaken to identify relevant studies. The literature search was carried out between April and June 2017 and covered relevant papers published between January 2000 and June 2017.

A search syntax was developed based on subject knowledge and through using relevant MESH terms. The draft search strategy was reviewed and agreed by the PHE oral health inequalities steering group. The search terms were used to form a detailed search strategy and are presented below. Exposures and outcomes were grouped into appropriate categories. A comprehensive literature search was undertaken by combining each of the exposures with each of the outcomes.

The search included the following databases: Cochrane, PubMed, OVID (Embase, MEDLINE, and PsycINFO). In addition, the reference lists of articles identified for review were also screened. Papers were screened by title and abstract for relevance by 2 independent assessors. After title or abstract screening and removal of duplicates, the identified papers were read in full. Papers that fitted the inclusion criteria were included in the scoping review and synthesis of findings. Disagreements between the reviewers about inclusion/exclusion were resolved by discussion.

Stage 4: Data extraction

The following information was extracted and reported in standardised tables:

- publication details – author and date
- outcomes
- study design
- exposures
- study population and sample size
- main findings on oral health inequalities
- mediating factors between exposure and outcome (if applicable)
- strengths and limitations

For each selected paper, data extraction was carried out by one researcher, including a critical appraisal using published criteria appropriate for the respective study design. Strengths and limitations were noted in the respective column in the summary tables and considered when summarising and reporting the results, however a full quality assessment of the included papers was outside the scope of this work.

Stage 5: Summarising and reporting the results

The extracted data are presented in separate tables for each of the main exposure and outcome groups. For each of the characteristics of interest (socioeconomic position; protected characteristics and vulnerable groups), a set of tables were created, one for each group of oral health outcomes (clinical outcomes, subjective outcomes, behavioural outcomes and service-related outcomes).

Search Strategy

No	Exposure or characteristic	Letter	Oral health outcome
1	Socioeconomic position Search terms: socioeconomic status, socioeconomic position, socioeconomic status, socioeconomic position, social gradient, gradient, SES, SEP, social inequalit*, material disadvantage, deprivation, social status education, educate*, schooling, qualification*, degree, university, income, wealth, poverty, poor, poverty-income ratio, poverty income ratio, PIR, material conditions, free school meal*, FSM, benefit receipt* occupation, social class, unemployment, manual, non-manual	A	Dental caries Search terms: caries, decay, DMFT, dmft, cavit*
2	Area-based SES measures Search terms: Index of Multiple Deprivation, IMD, Townsend* index, area deprivation, area socioeconomic status, area disadvantage, area SES, area deprivation, neighbourhood deprivation, neighbourhood socioeconomic status, neighbourhood disadvantage, neighbourhood SES, neighbourhood income, neighbourhood affluence	B	Periodontal disease Search terms: Periodontal, perio*, gum disease, gingivitis, attachment loss, loss of attachment, pocket depth, gingival bleeding
3	Ethnicity and religion Search terms: Ethnicity, ethnic minority, ethnic group, race, racial group, immigrant status, national origin*	C	Tooth loss Search terms: Tooth loss, functional dentition, number of teeth, edentulous*, edentate, dental status, oral health status

No	Exposure or characteristic	Letter	Oral health outcome
4	Disability or long-term illness Search terms: Disability, disabled, impairment, handicap* long-term illness, long-standing illness, long-standing condition	D	Oral cancer Search terms: Oral cancer, head and neck cancer, oropharyngeal cancer, mouth cancer
5	Pregnancy or maternity Search terms: Pregnancy, maternity, pregnant, motherhood,	E	PUFA Search terms: PUFA, pufa, pulpal involvement, ulceration, fistula, abscess
6	Gender or sexual orientation Search terms: Gender, sexual orientation, LGBT, gay, lesbian, transgender	F	Traumatic dental injuries Search terms: traumatic dental injur*, TDI, dental trauma, tooth fracture, dental injur*, tooth injur*
7	Religion Search terms: religion, belief	G	Self rated oral health and other measures of subjective perception Search terms: subjective oral health, perceived oral health, self-rated oral health, self rated oral health, dental pain, toothache, dry mouth
8	Homelessness Search terms: Homeless*, rough sleepers	H	OHRQoL Search terms: Oral impact*, OHRQoL, oral health related quality of life, oral-health-related quality of life, oral health-related quality of life, OHIP, Oral Health Impact Profile, OIDP, Oral Impact on Daily Performance, GOHAI, OHQoL-UK, CPQ, ECOHIS, FIS, Family Impact Scale

No	Exposure or characteristic	Letter	Oral health outcome
9	Prisoners Search terms: prison*, inmate, custody, offender*	I	Oral health related behaviours Search terms: Smoking, smok*, tobacco, betel, paan, areca, guthka tooth brushing, toothpaste, fluorid*, oral hygiene, alcohol, drinking, diet, sugar consumption, sugar intake, sugar* drink*, sugar* food*, fruit* and vegetable*, fruit*, vegetable*
10	Travellers Search terms: Irish Traveller*, Scottish Traveller*, travellers, Romany, Gyps*	J	Service use Search terms: dental service use, dental service utilisation, dental service utilization, dental attendance, dental attend*, dental visit*, visiting AND dentist, dental AND preventive services, dental AND preventive care, dental AND health care, dental AND service AND satisfaction
11	Refugees Search terms: Refugee*, migrant*, asylum-seek*		
12	Sex workers Search terms: Sex worker*, prostitut*		
13	Looked after children Search terms: Looked-after children, children in care		

Appendix 5. Search strategy of the review on service utilisation barriers amongst people with protected characteristics

Aim

The aim was to conduct a rapid review of current UK literature on barriers to oral healthcare for people with protected characteristics.

Method

Electronic database searches were carried out using Medline via Ovid. A broad search strategy was used and included the following terms: oral/dental care, dental health services, pregnancy, maternity, racial and ethnic groups, religion, belief, culture, women, men, gender, disabled persons, physical disability, intellectual disability, mental disorders, learning disorders, and age factors. A combination of search terms was used, including 'Boolean' operators (and/or) and medical subject heading (MeSH) terms. A separate search was conducted for each protected characteristic group.

There was no restriction on study design or date of publication. The publication types included in the search were primary and secondary evidence from peer-reviewed journals and reports. As the concept of 'protected characteristics' is one that is unique to the UK, the search was consequently limited to publications in English from the UK. Relevant articles were selected according to the following inclusion criteria:

- aim of the study focused on barriers to oral healthcare or dental attendance
- full-text articles available in English
- peer-reviewed studies from the UK

The results of all the searches were exported into a reference manager. Duplicate references were recorded and removed, and the title and abstract of the remaining studies were assessed against the inclusion criteria. The full text was obtained for all potentially relevant papers. Full text was also obtained if the title and abstract were inconclusive for further assessment. Additionally, the reference lists of all relevant studies were searched for further references.

Appendix 6. Search strategy of the review on service utilisation barriers amongst people with protected characteristics

Aim

The aim of this rapid review was to describe the current literature related to barriers to oral healthcare for people from vulnerable groups.

Method

In this review electronic database searches were carried out using MEDLINE via Ovid, covering articles from 2007 to 2017. The search strategy included the following terms: oral or dental health, oral/dental care, oral or dental hygiene, dental health services, challenges, barriers, access, hindrance, impediment, disabled persons, intellectual disability, special care, special needs, elderly, assisted living, institutional, care homes, nursing homes, physically challenged, mental disorders, vulnerable populations, underserved, homeless, refugees, prisoners, ethnic, low-income, social class, and socioeconomic. Three separate searches were conducted, each focusing on different groups of vulnerable people. The publication types included in the search were primary and secondary evidence from peer-reviewed journals and reports. The search was restricted to publications in English. The results of all 3 searches were exported into a reference manager. Duplicates were then recorded and removed before the titles and abstracts of the remaining articles were reviewed. Where titles and abstracts appeared to be relevant, the full text was obtained for inclusion in the review. Reference list searching was also conducted. For each included article the barriers, as identified in the publication, were extracted, collated and summarised for each vulnerable group. Where stated, potential solutions to overcome these barriers were also summarised.

Appendix 7. Search strategy of the review on community-level interventions to reduce oral health inequalities

Aim

This rapid review aimed to answer the following review question using rapid review methods: What interventions are effective at reducing oral health inequalities for adults and children at a population level?

Methods

1. Types of study to be included

Synthesised evidence was the primary source of evidence included (that is, systematic reviews, policy guidance), and if necessary, primary research (acknowledging observational designs may be used to inform future research or indicate potential risk factors if required).

Only English-language full-text publications from between 2000 to 2020 were included.

The inclusion of the most recent and comprehensive synthesised evidence was prioritised, in the event that multiple secondary evidence publications were identified that address the same research question.

2. Inclusion criteria

Population: adults or children characterised by specific socioeconomic position or protected characteristics or identified as vulnerable.

- Socioeconomic position measures include: Education, income or wealth, occupation or social class, employment status, eligibility for free school meals, area-based measures of deprivation.
- Protected characteristics include: ethnicity, disability, pregnancy and maternity, religion, sexual orientation, gender reassignment.
- Vulnerable groups include: homeless, prisoners, travellers, people with longstanding medical conditions, refuges, looked-after children, sex workers.

Interventions: population level interventions delivered external to clinical settings (for example, interventions delivered in the home, community, childcare facilities, care/nursing homes, residential homes, educational settings, healthcare sites). Single-component and multi-component interventions were included. There were no restrictions on who delivered the interventions (for example, oral health professionals, other health or allied health professionals, teachers, care providers, health promotion practitioners).

Comparator: Non-intervention comparisons or controls consisting of usual care or another active intervention, or pre-intervention measures provided through an Interrupted Time Series design.

Outcomes

Primary
- Inequalities in clinical oral health measures (including caries, periodontal disease, odontogenic infections or sepsis, tooth loss, dental trauma and oral cancer)

Secondary
- Inequalities in subjective measures of oral health (including self-rated oral health, dental pain, Oral Health Related Quality of Life (OHRQoL), perceived treatment needs
- Inequalities in behavioural measures (including oral hygiene or toothbrushing, fluoride use, sugar consumption)

Measures using a validated assessment tool were prioritised over potential proxy measures.

Context: included was UK-focused or applicable research relating to social determinants of oral health from OECD countries (Australia; Austria; Belgium; Canada; Chile; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Israel; Italy; Japan; Latvia; Lithuania; Luxembourg; Mexico; Netherlands; New Zealand; Norway; Poland; Portugal; Slovak Republic; Slovenia; South Korea; Spain; Sweden; Switzerland; Turkey; United Kingdom; United States of America).

3. Searches

Searches on 4 November 2020 were undertaken to identify full-text English language publications during the period 2000 to 2020 (prioritising inclusion of synthesised evidence over primary studies) for the following 6 relevant literature databases: MEDLINE via Ovid; Embase via Ovid; Cochrane Library; Health Management Information Consortium (HMIC) via Ovid; Cumulative Index to Nursing and Allied Health Literature (CINAHL) Plus via EBSCO; National Institute for Health and Care Excellence (NICE) Evidence.

The search strategy for MEDLINE is presented below.

The search strategies utilised a combination of free-text search terms and controlled vocabulary subject headings (relevant to each database) to obtain comprehensive record retrieval. Boolean operators (AND and OR) were applied to refine the relevancy of retrieved records. After conducting the searches, identified records were explored in RIS format and imported them into EndNote X9 for screening.

Teams of 2 authors screened these records.

4. Data extraction (selection and coding)

A single author extracted data, using a predefined data extraction form, including: evidence design, location, characteristics of setting and population (included/excluded studies or participants); age; oral disease status; ethnicity; socioeconomic status; co-morbidities), follow-up duration/time period covered, assessed/reported outcomes relevant to review scope, and outcome data. A subset of quantitative data was to be audited by a second author.

5. GRADE assessment

The GRADE approach was used to summarise the overall certainty of evidence presented by each included systematic review. One author assessed the included reviews according to key criteria specified by GRADE to provide outcome-level evidence assessed at one of 4 levels.

The key criteria assessed were: risk of bias in included primary studies, inconsistency of findings; applicability of findings; imprecision, and publication bias.

The 4 levels of certainty were:

- High certainty: we are very confident that the true effect lies close to that of the estimate of the effect
- Moderate certainty: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
- Low certainty: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect
- Very low certainty: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

The GRADE assessment was downgraded for applicability if the relevance of the findings was not directly applicable to the UK. Where relevant, and where no downgrading had occurred in any other domain, upgrading evidence strength was considered in 3 domains: large magnitude of an effect; dose-response gradient; effect of plausible residual confounding.

6. Analysis

A narrative (descriptive) synthesis of identified data was undertaken, reporting relevant quantitative data in context to thematically describe patterns of effect size and direction, and variation between/within contributing literature, where feasible.

If the identified evidence allowed, the following associated effects were qualitatively explored:

- different types of participants or oral disease status (as publication-reported)
- different settings (country of origin, intervention setting for example, school-based).

7. Applied rapid evidence review limitations

- search focused upon English language articles
- to ensure applicability of identified evidence to UK population, only evidence from OECD countries was eligible for inclusion
- synthesised evidence prioritised for inclusion over primary sources
- in the event multiple relevant sources were identifiable, we prioritised inclusion of the most recent and comprehensive
- a standardised data extraction form was used by one author

8. Search strategy

MEDLINE via Ovid [Ovid MEDLINE(R) 2000 to November Week 1 2020] – Search run 04 November 2020

1   ORAL HEALTH/

2   exp Stomatognathic Diseases/

3   Halitosis/

4   ((dental or tooth or teeth or enamel or root$) adj3 (decay$ or caries or cariousor white spot$ or plaque or reminerali$ or demineralI$ or loss$ or extract$ or remov$)).mp.

5   (periodont$ or gingivitis or "gingival$ inflamm$" or "gingival$ bleed$" or "gingival pocket$" or "periodont$ pocket$" or (periodont$ adj3 attachment) or (gingival$ adj3 attachment)).mp.

6   ("oral health" or "dental health").mp.

7   ("tooth wear" or ((tooth or dental or teeth or enamel) and erosion or abrasion)).mp.

8   (halitosis or "mouth odour$" or "mouth odor$" or "mouth malodour$" or "mouth malodor$" or "oral malodour$" or "oral malodour" or breath adj3malodour$ or (breath adj3 odour$) or (breath adj3 odor$)).mp.

9   ("bottle caries" or "nursing caries" or "bottle decay$" or ("early childhood" and (caries or decay$))).mp.

10   (toothache or "tooth ache" or odontalgia).mp.

11   or/1-10

12   exp ORAL HYGIENE/

13   Preventive dentistry/

14   exp MOUTHWASHES/

15   exp DENTIFRICES/

16   "Pit and fissure sealants"/

17   Dental prophylaxis/

18   Fluorides/

19   ("oral hygiene" or (mouth adj3 care) or (dental adj3 care) or (care adj3 teeth) or (mouth adj3 hygiene) or (plaque adj4 control$) or (plaque adj4 remov$)).mp.

20   ((dental adj3 prophyla$) or scal$ or polis$).mp.

21   (toothbrush$ or tooth-brush$ or toothpaste$ or dentifrice$ or mouthwash$ ormouth-wash$ or mouthrinse$ or mouth-rinse$ or fluoride$).mp.

22   ("interdental clean$" or "inter-dental clean$" or (tooth adj4 clean$) or teethadj4 clean$ or (denture$ adj4 hygiene) or (denture$ adj4 clean$) or "tonguescrap$" or (tongue adj3 brush$) or "chewing stick$" or "chewing gum$" or ("orthodontic appliance$" adj3 clean$)).mp.

23   sealant$.mp.

24   (fluorid$ adj3 (toothpaste or "tooth paste" or varnish$ or gel$ or mouthrins$ or mouthwash$ or "mouth rins$" or "mouth wash$" or supplement$ or tablet$ ordrop$ or topical or milk$ or salt$)).mp.

25   (chewing-gum or "sugar-free gum").mp.

26   ((dental or tooth or teeth or interdental$ or inter-dental$) and floss$).mp.

27   ("dental plaque index" or "dental plaque indices" or "DMF? index" or "DMF?indices" or "periodontal index" or "periodontal indices" or "oral hygiene index or oral hygiene indices" or "gingival index").mp.

28   Health Education, Dental/

29   exp Health Promotion/

30   Motivational interviewing/

31   (motivation$ adj3 interview$).mp.

32   (instruct$ or advice or advise$ or educat$ or teach$ or train$ or supervis$).mp.

33   ((health$ adj3 promot$) and (dental or teeth or mouth or periodont$ or gingival$ or "oral health")).mp.

34   ((behavior$ or behaviour$) and (change or changed or changing or modify or modified or modification)).mp.

35   ("feed back device$" or "feedback device$").mp.

36   ((attitude$ adj3 "oral health") or (attitude adj3 "oral care") or (attitude adj3 "dental health") or (attitude adj3 "mouth hygiene") or (attitude adj3 "oralhygiene")).mp.

37   (("oral hygiene" adj3 improv$) or ("oral health" adj3 improv$) or ("gingivalhealth" adj3 improv$) or ("periodontal health" adj3 improv$) or ("periodontalcondition" adj3 improv$) or (caries adj3 reduc$)).mp.

38   Mass screening/

39   ((dental or oral) adj3 (check$ or screen$ or assess$ or appointment$)).mp.

40   ((dental or "oral health") adj3 (outreach$ or service$ or program$ or initiative$)).mp.

41   ((diet$ or sugar$ or food$ or drink$ or juice$ or beverage$ or sweet$ or snack$ or meal$) adj5 (advice or advise or recommend$ or guide$ or advocat$)).mp.

42   (dentist$ and prevent$).mp.

43   Healthcare Disparities/ or Health Status Disparities/

44   ((oral or dental) adj3 (disparit$ or inequal$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

45   43 or 44

46   or/12-42

47   11 and 45 and 46

Appendix 8. Search strategy of the review on dental service utilisation interventions to reduce oral health inequalities

Aim

This rapid review aimed to answer the following review questions:

What dental service utilisation interventions (including adjustments and/or commissioning approaches) are effective at reducing oral health inequalities for adults and children?

Methods

1. Types of study to be included

Synthesised evidence was the primary source of evidence included (that is, systematic reviews, policy guidance), and if necessary, primary research was to be sought.

Only English-language full-text publications from between 2000 to 2020 were included.

The inclusion of the most recent and comprehensive synthesised evidence was prioritised, in the event that multiple secondary evidence publications were identified that address the same research question.

2. Inclusion criteria

Population: adults or children characterised by specific socioeconomic position or protected characteristics or identified as vulnerable.

- Socioeconomic position measures include: Education, income/wealth, occupation/social class, employment status, eligibility for free school meals, area-based measures of deprivation.
- Protected characteristics include: ethnicity, disability, pregnancy and maternity, religion, sexual orientation, gender reassignment.
- Vulnerable groups include: homeless, prisoners, travellers, people with longstanding medical conditions, refuges, looked-after children, sex workers.

Interventions: those aimed at improving dental services utilisation to reduce oral health inequalities.

Comparator: Non-intervention comparisons or controls consisting of usual care or another active intervention, or pre-intervention measures provided through an Interrupted Time Series design.

Outcomes: reduction in oral health inequalities as measured by dental service utilisation (uptake and/or regular check-ups), clinical outcomes (caries, perio, oral cancer, pain), OHRQoL outcomes, PROMS/PREMS, oral health behaviours/knowledge/attitudes, costs

Dental service settings: NHS, private, primary care, secondary care, community dental services, urgent care, mobile clinics, and non-healthcare settings (for example, early year settings, domiciliary dental care provided in residential homes, care homes, and so on).

Context: included was UK-focused or applicable research relating to social determinants of oral health from OECD countries (Australia; Austria; Belgium; Canada; Chile; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Israel; Italy; Japan; Latvia; Lithuania; Luxembourg; Mexico; Netherlands; New Zealand; Norway; Poland; Portugal; Slovak Republic; Slovenia; South Korea; Spain; Sweden; Switzerland; Turkey; United Kingdom; United States of America).

3. Search

Searches on 4 November 2020 were undertaken to identify full-text English language publications during the period 2000 to 2020 (prioritising inclusion of synthesised evidence over primary studies) for the following 6 relevant literature databases: MEDLINE via Ovid; Embase via Ovid; Cochrane Library; Health Management Information Consortium (HMIC) via Ovid; National Institute for Health and Care Excellence (NICE) Evidence.

The search strategy for MEDLINE is presented below.

The search strategies utilised a combination of free-text search terms and controlled vocabulary subject headings (relevant to each database) to obtain comprehensive record retrieval. Boolean operators (AND and OR) were applied to refine the relevancy of retrieved records. After conducting the searches, identified records were explored in RIS format and imported them into EndNote X9 for screening.

Teams of 2 authors screened these records.

4. Data extraction (selection and coding)

A single author extracted data, using a predefined data extraction form, including: evidence design, location, characteristics of setting and population (age; oral disease status; ethnicity; socioeconomic status; co-morbidities), follow-up duration/time period covered, assessed or reported outcomes relevant to review scope, outcome data. A subset of quantitative data was to be audited by a second author.

5. GRADE assessment

The GRADE approach was used to summarise the overall certainty of evidence presented by each included systematic review. One author assessed the included reviews according to key criteria specified by GRADE to provide outcome-level evidence assessed at one of 4 levels.

The key criteria assessed were: risk of bias in included primary studies, inconsistency of findings; applicability of findings; imprecision, and publication bias.

The 4 levels of certainty were:

- High certainty: we are very confident that the true effect lies close to that of the estimate of the effect
- Moderate certainty: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
- Low certainty: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect
- Very low certainty: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

The GRADE assessment was downgraded for applicability if the relevance of the findings was not directly applicable to the UK. Where relevant, and where no downgrading had occurred in any other domain, upgrading evidence strength was considered in 3 domains: large magnitude of an effect; dose-response gradient; effect of plausible residual confounding.

6. Analysis

A narrative (descriptive) synthesis of identified data was undertaken, reporting relevant quantitative data in context to thematically describe patterns of effect size and direction, and variation between/within contributing literature, where feasible.

Had the identified evidence allowed, the following associated effects were qualitatively explored:

- Different types of interventions
- Different types of participants or oral disease status (as publication-reported)
- Different settings (country of origin, intervention setting, for example, school-based).

7. Applied rapid evidence review limitations

- Search focused upon English language articles
- To ensure applicability of identified evidence to UK population, only evidence from OECD countries was eligible for inclusion
- Synthesised evidence prioritised for inclusion over primary sources

- In the event multiple relevant sources were identifiable, we prioritised inclusion of the most recent and comprehensive
- A standardised data extraction form was used by one author.

8. Search strategy

MEDLINE via Ovid [1946 to November Week 1 2020] – Search run 04 November 2020; Search Strategy (adapted from {Raison, 2019 #730}):

1   ((SES or socio-economic* or socioeconomic* or social* or economic* or material* or structural* or income or educat* or occupation* or insurance) adj3 (disparit* or inequal* or inequit* or equit* or equalit* or exclude* or exclusion or include* or inclusion or gradient or hierarchy or class or deter-minant* or variation* or status or advantage* or disadvantage* or factors or depriv*)).ti,ab.

2   (inner city or innercity or inner-city or deprived areas or low$ income or receiving welfare or in receipt of welfare or on welfare or receiving benefits or in receipt of benefits or on benefits or public assistance).ti,ab.

3   ((disparit* or inequal* or inequit* or equit* or equalit* or gradient or hierarchy or determinant* or variation* or advantage* or disadvantage* or depriv*) adj3 (access* or inaccess* or utilis* or utiliz*or attend* or demand or visit* or treatment or care or healthcare or seek* or uptake or take?up or attend* or non-attend* or obtain* or unobtain*)).ti,ab.

4   ((disparit* or inequal* or inequit* or equit* or equalit* or gradient or hierarchy or determinant* or variation* or advantage* or disadvantage* or depriv*) adj3 (enable* or enabling or facilitat* or enhanc* or increas* or improv* or maximis* or promot* or permit* or allow* or ability to pay or inability to pay or cost or afford* or unafford* or financial* or barrier* or prevent* or limit* or reduc* or inhibit* or fear or afraid or anxiety* or anxious* or phobia or phobic or discourage* or perception of need or perceived need or perception of treatment need or perceived treatment need or lifestyle commitment* or time commitment* or work commitment* or leisure commitment* or employment commitment* or care commitment* or caring commitment* or other commitment* or work obligation* or employment obligation* or care obligation* or caring obligation* or other obligation* or work responsibilit* or employment responsibilit* or care responsibilit* or caring responsibilit* or other responsibilit* or work duties or employment duties or care duties or caring duties or other du- ties or work duty or employment duty or care duty or caring duty or other duty)).ti,ab.

5   (dental* or dentist* or oral health or oral care or oral hygiene).ti,ab.

6   1 or 2 or 3 or 4

7   5 and 6

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