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Inequalities in children's tooth decay requiring dental extraction under general anaesthetic: a longitudinal study using linked electronic health records

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ABSTRACT

Background Dental extraction under general anaesthetic (DGA) is the most severe and irreversible dental treatment for childhood tooth decay. We investigated inequalities in DGA in an ethnically diverse, disadvantaged school-age population and associations of DGA with prior excess weight.

Methods We identified 608 278 children aged 5–16 years in 2017–2022 from linked hospital and primary care electronic health records (EHRs) for a London, UK region. We estimated ORs (95% CI) for DGA, adjusting for sex, ethnicity, locality and deprivation. We linked 120 985 EHRs to school weight records and estimated HRs (95% CI) for DGA by excess weight (body mass index ≥91st centile) using Cox's proportional regression.

Results 3034 children had at least one DGA (0.50%; 95% CI 0.48 to 0.52). Children from white Irish (OR: 1.96; 95% CI 1.17 to 3.29), other Asian (1.23; 95% CI 1.01 to 1.50), Bangladeshi (1.49; 95% CI 1.30 to 1.70) and Pakistani (1.41; 95% CI 1.21 to 1.65) ethnicities were more likely and those from Chinese (0.48; 95% CI 0.27 to 0.86), white and black African (0.59; 95% CI 0.35 to 0.98), other mixed (0.69; 95% CI 0.50 to 0.95), Indian (0.65; 95% CI 0.53 to 0.81), black African (0.79; 95% CI 0.66 to 0.93) and other black (0.62; 95% CI 0.48 to 0.82) ethnicities and living in less deprived areas less likely, to have had a DGA. Five- (HR: 0.80; 95% CI 0.66 to 0.94) and 11- year-olds (0.78; 95% CI 0.62 to 0.99) with excess weight were less likely to have had a DGA.

Conclusion We found marked ethnic and socioeconomic inequalities in childhood DGA. Further research is needed to understand factors mediating inequalities in DGA. These findings emphasise the importance of targeting the wider determinants of inequalities in tooth extraction and ensuring equitable access to preventive and restorative dentistry.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ There is some evidence that children living with overweight or obesity are more likely to experience tooth decay than those with a healthy weight.

⇒ No previous studies have used linked school weight measurement data and hospital records to investigate inequalities in dental extraction under general anaesthetic and its association with childhood excess weight.

WHAT THIS STUDY ADDS

⇒ We investigated inequalities in dental extraction under general anaesthetic and, in a subsample of children with school measurements, associations with excess weight among an ethnically diverse, disadvantaged school-age population living in London, UK.

⇒ In north-east London, around 1 in 200 children had at least one procedure, most having multiple teeth extracted. Children living in areas with the highest proportion of low-income households and those from white Irish, other Asian, Bangladeshi and Pakistani ethnic backgrounds were more likely, and those with excess weight less likely, to require dental extraction.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ There are marked ethnic and socioeconomic inequalities in childhood dental extractions under anaesthetic. The apparent lower prevalence of dental extractions under anaesthetic among children with excess weight may reflect differences in access to restorative or preventive dentistry as well as different dietary factors implicated in obesity and dental caries.

INTRODUCTION

Children's oral health has been described as a 'national disgrace' in the UK.[1] Left untreated, dental problems can impact well-being throughout childhood, adolescence and into adulthood,[2] affecting language development, school attendance and educational outcomes, potentially exacerbating social inequalities.[3]

The prevalence and severity of tooth decay vary by deprivation and ethnic background.

In 2022, the prevalence of tooth decay among children living in the most deprived areas (35.1%) was more than double that of children living in the least deprived areas (13.5%).[4] In London, 23.2% of 5-year-olds had untreated tooth decay.[4] The final negative outcome of untreated tooth decay is extraction when a tooth can no longer be treated. For young children, where cooperation is required, or for those with complex needs, a general dental practitioner (GDP) may refer children for dental extraction under general anaesthetic (DGA).[5] In England, this can only be performed in hospital settings.[6] Tooth decay is the most common reason for hospital admission among 6–10 year-old, with decay-related extractions costing the National Health Service (NHS) England £33 million in the 2019–20 financial year (for all 0–19-year-olds).[7]

DGA varies by sociodemographic factors: DGA incidence has been reported as higher among children from black and minority ethnic backgrounds,[8] and lower with increasing family socioeconomic status.[9] Others have highlighted a 'postcode lottery' in DGA, with children living in areas with non-fluoridated water[10] and those in urban areas,[8] more likely to have had at least one DGA.

As well as sociodemographic inequalities, there is evidence of an association between weight status and tooth decay.[11–13] While an analysis of 67 033 children participating in both the National Dental Epidemiology Programme (NDEP) and the National Child Measurement Programme (NCMP) found higher prevalence of tooth decay in children living with overweight or obesity, there was a reduction in the number of decayed teeth (severity).[14]

We investigated ethnic and sociodemographic inequalities in DGA in an ethnically diverse, disadvantaged school-age population and evaluated associations of DGA with prior excess childhood weight. As an indicator of severe tooth decay and access to preventive care, we hypothesised that the likelihood of DGA would be higher among those living with excess weight and those in more deprived areas.

METHODS

Study design and setting

We carried out a retrospective cohort study using linked primary care and hospital electronic health records (EHRs) of children ever registered with a general medical practitioner (GMP) in the north-east London (NEL) Integrated Care Board, covering seven local government areas: Barking and Dagenham, City and Hackney, Havering, Newham, Redbridge, Tower Hamlets, and Waltham Forest.

Study population

We included 608 278 children aged 5–16 years born between 1 January 2001 and 31 December 2017 and registered with an NEL GMP during the study period (online supplemental figure S1).

Data source

Pseudonymised hospital data were provided from the NEL Discovery Data Service, which receives primary care EHR data from all GMPs in NEL and hospital data from Barts NHS Trust hospitals. Coded demographic and clinical data were extracted on 1 December 2022 and included all clinical events up to 1 November 2022.

Outcome measures

Having at least one DGA was the primary outcome of interest. This was considered an indicator of severe tooth decay and access to preventive care. DGA was defined as having a hospital record of a surgical extraction of a tooth under general anaesthetic identified from Operating Procedure Code Supplement-4 codes (see online supplemental table S1). The first instance of an extraction was retained if a child had more than one of any of the prespecified clinical codes.

Explanatory variables

The child's sex, year of birth and local government area of their GMP were included as covariates. Ethnicity (as recorded in the primary care record) was classified using the NHS 16+1 categorisation: white British, white Irish, other white, Chinese, white and Asian, white and black African, white and black Caribbean, other Asian, other mixed, other, Bangladeshi, Indian, Pakistani, black African, black Caribbean and other black. We included children with missing ethnic backgrounds as a separate group.

We merged 2019 Income Deprivation Affecting Children Index (IDACI) decile[15] into the datafile using the 2011 lower layer super output area: an area with an average population of 1500 people or 650 households, as the linkage field. The IDACI score measures the proportion of children under 16 in low-income households for an area. IDACI deciles were concatenated into quintiles and the three least deprived quintiles combined due to small numbers.

Statistical analyses

We described the proportion of children with and without at least one DGA by sociodemographic variables and estimated the incidence of DGA by age, per 100 000 children. We conducted univariable and multivariable binary logistic regression to estimate the likelihood (OR and 95% CIs) of undergoing DGA by the explanatory variables. All analyses were conducted by using Stata (MP/V.15.0).

Subsample exploring the association between weight status and DGA

Study design and setting

We linked, using pseudonymised NHS numbers, children's EHRs to NCMP records collected by four local authority public health departments: City and Hackney, Newham, Tower Hamlets, and Waltham Forest. The NCMP measures the height and weight of children in the first (reception) and last years (year 6) of state-maintained primary schools when aged approximately 5 and 11 years, respectively.

Study population

We received 136 560 NCMP records. We excluded records with missing NHS numbers (n=2603), body mass index (BMI) measurements (n=5110) and duplicates (n=304) and linked 126 829 of 128 544 remaining records (98.7%), using pseudonymised NHS numbers, to EHRs. Given the low prevalence of underweight in this sample, we were unable to explore the relationship between underweight and DGA. We consequently excluded 1652 children with a BMI considered underweight. Further details of other exclusions are given in online supplemental figure S2. The final study sample was 120 985.

Data source

As well as the pseudonymised hospital data described above, NCMP data were available for children attending state schools in City and Hackney (2013–2019), Newham (2014–2019), Tower Hamlets (2015–2019) and Waltham Forest (2013/2014 and 2015–2019). As the NCMP date was restricted to month and year, we randomly assigned a day of measurement within term-time, excluding weekends and bank holidays (R Studio; V.1.0.153; code available here: bit.ly/random_day).

Outcome measures

A binary variable was derived indicating those with or without at least one DGA following NCMP measurement. The censor date was the date of the first DGA. The censor date for children with no DGA was the earliest of the date at which clinical data were extracted (1 November 2022) or the general practitioner registration end date.

Explanatory variables

In addition to sex and IDACI quintile as reported above, we used the NHS 5+1 categories and supplemented missing NCMP ethnic background with that recorded in the EHR: white (white British, white Irish or other white background); a combination of mixed and other ethnic backgrounds (Chinese, white and Asian, white and black African, white and black Caribbean, other Asian, other mixed or other); South Asian (Indian, Pakistani or Bangladeshi) and black (African, Caribbean or other black background). It was necessary to group ethnic background into these high-level groups in the subsample to minimise disclosive risk.

Other covariates were the local authority of the school where the child participated in the NCMP, and NCMP-recorded clinical excess weight status (age-specific and sex-specific BMI greater than or equal to the 91st centile[16] after applying ethnic-specific BMI adjustments).[17]

Statistical analyses

We calculated follow-up time in years between the date of NCMP and censor date. We calculated DGA incidence per 100 000 person-years by excess weight status and estimated univariable and multivariable HRs and 95% CIs using Cox's proportional hazard models of at least one DGA. Proportional hazards assumptions were tested using a log-log plot (−ln [−ln(survival)] curves) and deemed to be met if the curves were parallel. We investigated interactions between sex, ethnic background, area-level deprivation and excess weight status. We used forest plots to visualise regression coefficients, stratified by school year of participation in the NCMP (reception and year 6). We conducted sensitivity analyses using clinical obesity (age-specific and sex-specific BMI≥98th centile after applying ethnic-specific BMI adjustments) as the exposure variable.

Patients and the public were not involved in the research.

RESULTS

Prevalence and incidence of DGA

Overall, 3034 of 608 278 (0.50%; 95% CI: 0.48 to 0.52) children had at least one DGA, of whom 5.5% had more than one (n=165; 0.03% of the study population). This varied by local government area, ethnic background and area-level deprivation (table 1). Most children who had at least one DGA had multiple teeth extracted (online supplemental table S2). DGA incidence decreased with age at the procedure: 212.1 per 100 000 children (95% CI 193.9 to 230.3) among 5 year-olds, compared with 56.1 per 100 000 children (95% CI 44.5 to 67.7) among 16 year-olds (online supplemental table S3).

Estimating the likelihood of DGA

In multivariable analyses, younger children, children from white Irish, other Asian, Bangladeshi and Pakistani ethnic backgrounds and registered with a GMP in Tower Hamlets were more likely to have had at least one DGA (figure 1 and online supplemental table S4) compared with children born earlier, from white British ethnic backgrounds, and registered with a GMP in Newham. Conversely, children from Chinese, white and black African, other mixed, Indian, black African, other black and missing ethnic backgrounds, and registered with a GMP in Barking and Dagenham, Havering, Redbridge and Waltham Forest were less likely to have had at least one DGA. There was a strong negative social gradient with IDACI quintile: children living in areas with the lowest proportions of low-income households were less likely to have at least one DGA (Wald test statistic: 17.2, p=0.002).

Subsample exploring the association between weight status and DGA

Prevalence of DGA

A greater proportion of Reception year NCMP participants (n=846, 1.3%; approximately 5 years at the time of measurement) had at least one DGA, compared with year 6 NCMP participants (n=326, 0.6%; approximately 11 years at the time of measurement). There was no difference in either age group in the proportion of children with excess weight in participants who had and did

Table 1 Sample characteristics

	Children with at least one hospital dental extraction under general anaesthetic (n=3034)			Children with no hospital dental extractions under general anaesthetic (n=605 244)		
	n	%	95% CI	n	%	95% CI
Sex						
Male	1557	51.3	49.6 to 53.1	309 101	51.1	50.9 to 51.2
Female	1477	48.7	46.9 to 50.4	296 143	48.9	48.8 to 49.1
Local government area*						
Barking and Dagenham	215	7.1	6.3 to 8.1	78 466	13.0	12.9 to 13.0
City and Hackney	501	16.5	15.1 to 17.8	79 779	13.2	13.1 to 13.3
Havering	123	4.1	3.4 to 4.8	69 823	11.5	11.5 to 11.6
Newham	793	26.1	24.5 to 27.6	115 199	19.0	18.9 to 19.1
Redbridge	238	7.8	7.0 to 8.9	98 523	16.3	16.2 to 16.4
Tower Hamlets	742	24.5	23.0 to 26.1	78 161	12.9	12.8 to 13.0
Waltham Forest	422	13.9	12.8 to 15.2	85 293	14.1	14.0 to 14.2
Ethnic background						
White	**892**	**29.4**	**27.8 to 31.1**	199 551	**33.0**	**32.9 to 33.1**
White British	*477*	*15.7*	*14.5 to 17.1*	114 486	*18.9*	*18.8 to 19.0*
White Irish	*15*	*0.5*	*0.3 to 0.8*	*1745*	*0.3*	*0.3 to 0.3*
Other white	*400*	*13.2*	*12.0 to 14.4*	83 320	*13.8*	*13.7 to 13.9*
Mixed and other	**408**	**13.4**	**12.2 to 14.6**	80 445	**13.3**	**13.2 to 13.4**
Chinese	*12*	*0.4*	*0.2 to 0.7*	*4237*	*0.7*	*0.7 to 0.7*
White and Asian	*15*	*0.5*	*0.3 to 0.8*	*4925*	*0.8*	*0.8 to 0.8*
White and black African	*15*	*0.5*	*0.3 to 0.8*	*5462*	*0.9*	*0.9 to 0.9*
White and black Caribbean	*28*	*28*	*0.9*	*0.6,1.3*	*6054*	*1.0*
Other Asian	*126*	*4.2*	*3.5 to 4.9*	22 652	*3.7*	*3.7 to 3.8*
Other Mixed	*40*	*1.3*	*1.0 to 1.8*	11 360	*1.9*	*1.8 to 1.9*
Other	*172*	*5.7*	*4.9 to 6.5*	25 755	*4.3*	*4.2 to 4.3*
South Asian	**964**	**31.8**	**30.2 to 33.5**	143 763	**23.8**	**23.6 to 23.9**
Bangladeshi	*603*	*19.9*	*18.5 to 21.3*	63 325	*10.5*	*10.4 to 10.5*
Indian	*106*	*3.5*	*2.9 to 4.2*	37 687	*6.2*	*6.2 to 6.3*
Pakistani	*255*	*8.4*	*7.5 to 9.4*	42 751	*7.1*	*7.0 to 7.1*
Black	**297**	**9.8**	**8.8 to 10.9**	79 807	**13.2**	**13.1 to 13.3**
Black African	*189*	*6.2*	*5.5 to 7.2*	51 271	*8.5*	*8.4 to 8.5*
Black Caribbean	*48*	*1.6*	*1.2 to 2.1*	*9229*	*1.5*	*1.5 to 1.6*
Other black	*60*	*2.0*	*1.5 to 2.5*	19 307	*3.2*	*3.1 to 3.2*
Missing	**473**	**15.6**	**14.4 to 17.0**	101 678	**16.8**	**16.7 to 16.9**
IDACI quintile†						
Most deprived	1556	51.3	49.4 to 53.0	249 274	41.2	41.1 to 41.3
2	1063	35.0	33.4 to 36.8	221 281	36.6	36.4 to 36.7
3	295	9.7	8.9 to 10.9	83 888	13.9	13.8 to 13.9
4	91	3.0	2.5 to 3.7	33 568	5.5	5.5 to 5.6
Least deprived	28	0.9	0.6 to 1.3	15 139	2.5	2.5 to 2.5
Missing	1	0.0	0.0 to 0.2	2094	0.3	0.3 to 0.4

Values in italics indicate the proportion of children with/without at least one hospital dental extraction under general anaesthetic by ethnic background using the NHS 16+1 categorisation. Valus in bold indicate the proportion of children with/without at least one hospital dental extraction under general anaesthetic by ethnic background using high-level ethnic background categorisation.
*Local government area where the child is registered with a general medical practitioner.
†2019 IDACI quintile. Values highlighted in bold indicate instances where the proportion of children with at least one dental extraction under general anaesthetic is significantly different to the proportion among those with no dental extraction under general anaesthetic.
IDACI, Income Deprivation Affecting Children Index.

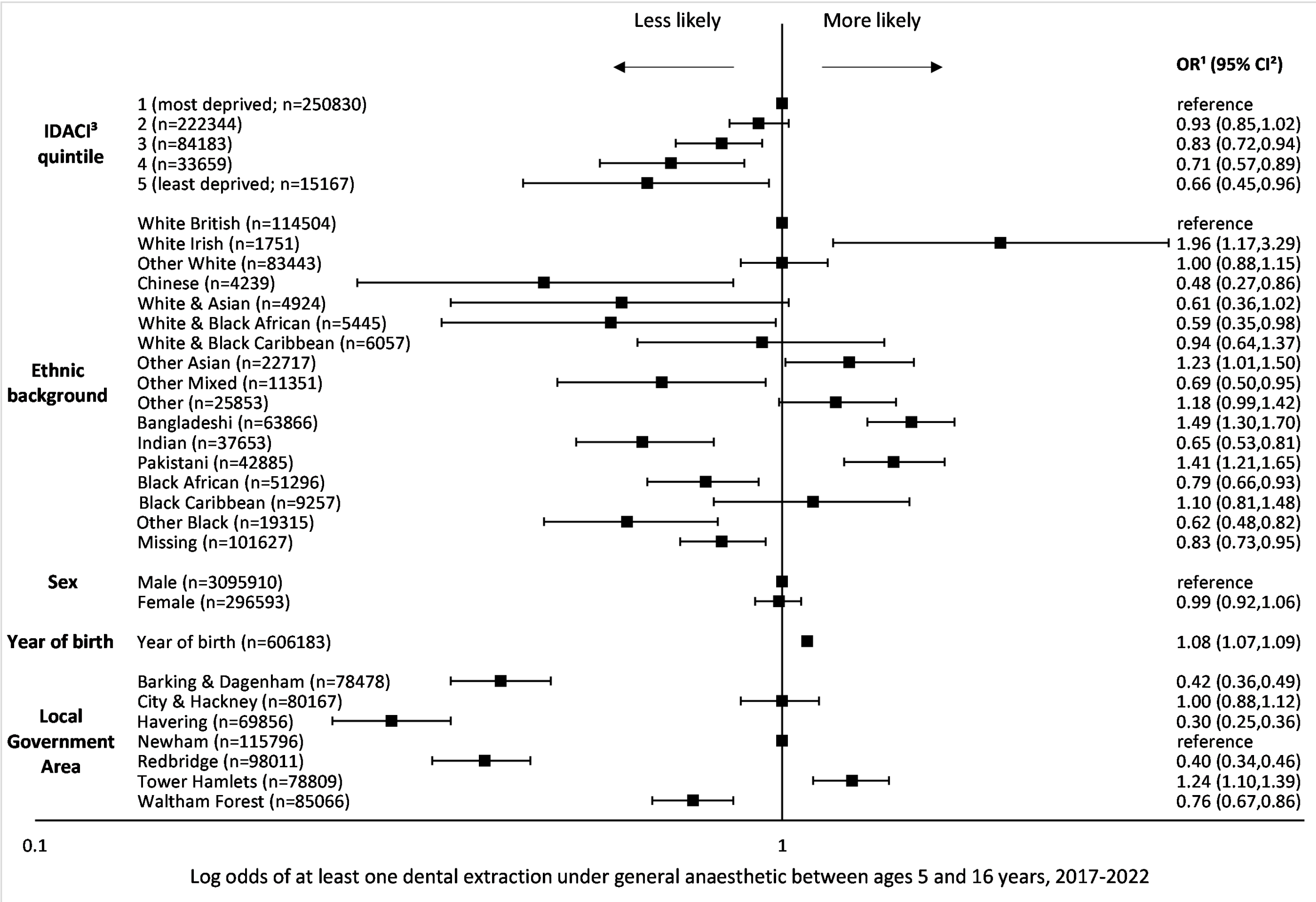

Figure 1 Multivariable logistic regression ORs estimating the likelihood of at least one hospital dental extraction under general anaesthetic: [1]OR after mutual adjustment for sex, local government area where the child is registered with a general practitioner, ethnic background, 2019 Income Deprivation Affecting Children Index (IDACI) quintile and year of birth (as a continuous variable where every 1-unit increase in the year of birth (ie, children born more recently) increases the likelihood of at least one hospital dental extraction under general anaesthetic). [2]CI. [3]2019 IDACI quintile. N=606 183.

not have at least one DGA, nor were there differences by sex. Children from South Asian ethnic backgrounds were over-represented among those who had at least one DGA in both school years. Children from black ethnic backgrounds were under-represented, and those from the two most deprived IDACI quintiles over-represented, in reception year only (table 2).

More than 80% of reception NCMP participants who had at least one DGA had multiple teeth extracted compared with 46.6% of year 6 NCMP participants (online supplemental table S5). ‘Unspecified simple extraction of tooth’ was the most common procedure in older children. Person-years of follow-up ranged from 0 to 9.2 years among children participating in the NCMP in both reception and year 6. The median interval between NCMP measurement and DGA date was 2.6 (IQR: 1.4–3.7) and 2.9 (1.5–3.9) years for reception and year 6 NCMP measurements, respectively.

Incidence of at least one DGA

The incidence of at least one DGA in reception and year 6 children was 291.8 and 114.8 per 100 000 person-years, respectively (table 3) and this did not differ by weight status or sex. DGA incidence was higher in reception children from South Asian ethnic backgrounds and those living in the most deprived areas compared with children from white ethnic backgrounds and those living in less deprived areas. DGA incidence did not vary by ethnic background or IDACI quintile among year 6 NCMP participants.

Cox’s proportional hazard models of at least one DGA

In adjusted analyses, reception and year 6 NCMP participants with excess weight were less likely to have had at least one DGA compared with those with a healthy weight (figure 2, online supplemental table S6). Reception children from black ethnic backgrounds were less likely to have at least one DGA compared with children from white ethnic backgrounds. There was no ethnic variation among year 6 children. The risk of at least one DGA declined with decreasing IDACI quintile among children in reception (Wald test statistic: 9.6;p=0.008), but not among year 6 children. Interactions between sex, ethnic background and IDACI quintile were not statistically significant at the 5% level.

Table 2 Sample characteristics of children participating in the National Child Measurement Programme, by experience of at least one hospital dental extraction under general anaesthetic

	Reception (ages 4–5 years, n=63 142)						Year 6 (ages 10–11 years, n=57 843)					
	Children with at least one hospital dental extraction under general anaesthetic (n=846)			Children with no hospital dental extractions under general anaesthetic (n=62 296)			Children with at least one hospital dental extraction under general anaesthetic (n=326)			Children with no hospital dental extractions under general anaesthetic (n=57 517)		
	n	%	95% CI	n	%	95% CI	n	%	95% CI	n	%	95% CI
Weight status*												
Healthy weight	696	82.3	79.4 to 84.6	50 722	81.4	81.1 to 81.7	225	69.0	63.6 to 73.6	37 226	64.7	64.3 to 65.1
Excess weight	150	17.7	15.4 to 20.6	11 574	18.6	18.3 to 18.9	101	31.0	26.4 to 36.4	20 291	35.3	34.9 to 35.7
Sex												
Male	433	51.2	47.9 to 54.6	31 597	50.7	50.3 to 51.1	164	50.3	45.5 to 56.3	29 293	50.9	50.5 to 51.3
Female	413	48.8	45.4 to 52.1	30 699	49.3	48.9 to 49.7	162	49.7	43.7 to 54.5	28 224	49.1	48.7 to 49.5
Ethnic background												
White	233	27.5	24.5 to 30.5	17 791	28.6	28.2 to 28.9	73	22.4	18.2 to 27.2	13 913	24.2	23.8 to 24.5
Mixed and other	153	18.1	15.8 to 21.0	12 540	20.1	19.8 to 20.4	62	19.0	14.9 to 23.4	11 594	20.2	19.8 to 20.5
South Asian	384	45.4	42.2 to 48.8	20 460	32.8	32.5 to 33.2	131	40.2	35.4 to 46.0	19 901	34.6	34.2 to 35.0
Black	76	9.0	7.2 to 11.0	11 505	18.5	18.2 to 18.8	60	18.4	14.4 to 22.7	12 109	21.1	20.7 to 21.4
IDACI quintile†												
1 (most deprived)	505	59.7	56.1 to 62.7	32 448	52.1	51.7 to 52.5	185	56.7	51.9 to 62.5	31 572	54.9	54.5 to 55.3
2	283	33.5	30.6 to 37.0	23 800	38.2	37.8 to 38.9	118	36.2	30.8 to 41.1	20 837	36.2	35.8 to 36.6
3–5 (least deprived)	57	6.7	5.2 to 8.6	5963	9.6	9.3 to 9.8	22	6.7	4.4 to 9.9	5028	8.7	8.5 to 9.0
Missing	1	0.1	0.01 to 0.1	85	0.1	0.1 to 0.2	1	0.3	0.01 to 2.1	80	0.1	0.1 to 0.2

*Derived from National Child Measurement Programme-recorded body mass index (BMI), after application of ethnic-specific BMI adjustments, categorised according to the UK1990 clinical reference standard where excess weight is defined as a BMI with age-specific and sex-specific BMI is greater than or equal to the 91st centile.
†2019 quintile.
IDACI, Income Deprivation Affecting Children Index.

Table 3 Incidence (per 100 000 person-years and 95% CI) of at least one hospital dental extraction under general anaesthetic among children participating in the National Child Measurement Programme in Reception and year 6, by sociodemographic characteristics

	Reception (ages 4–5 years)				Year 6 (ages 10–11 years)			
	n	Person-years*	Rate*	95% CI	n	Person-years*	Rate*	95% CI
All	846	2.9	291.8	272.8 to 312.1	326	2.8	114.8	103.0 to 127.9
Weight status†								
Healthy weight	696	2.4	294.6	273.5 to 317.3	225	1.8	122.0	107.1 to 139.1
Excess weight	150	0.5	279.4	238.1 to 327.9	101	1.0	101.3	83.4 to 123.1
Sex								
Male	433	1.5	295.5	269.0 to 324.7	164	1.4	113.3	97.2 to 132.0
Female	413	1.4	288.0	261.5 to 317.2	162	1.4	116.3	99.7 to 135.7
Ethnic background								
White	233	0.8	277.9	244.5 to 316.0	73	0.7	106.6	84.8 to 134.1
Mixed and other	153	0.6	264.5	225.7 to 309.9	62	0.6	106.3	82.9 to 136.4
South Asian	384	0.9	411.6	372.4 to 454.9	131	1.0	135.2	113.9 to 160.5
Black	76	0.5	138.3	110.5 to 173.2	60	0.6	99.3	77.1 to 127.9
IDACI quintile								
1 (most deprived)	505	1.5	334.6	306.7 to 365.1	185	1.6	118.0	102.2 to 136.3
2	283	1.1	256.6	228.4 to 288.4	118	1.0	116.1	96.9 to 139.0
3–5 (least deprived)	57	0.3	200.6	154.7 to 260.0	22	0.3	86.9	57.2 to 132.0

*Per 100 000.
†Derived from National Child Measurement Programme-recorded body mass index (BMI), after application of ethnic-specific BMI adjustments, categorised according to the UK1990 clinical reference standard where excess weight is defined as a BMI with age-specific and sex-specific BMI is greater than or equal to the 91st centile.
‡2019 IDACI quintile. Empty cells indicate where there were too few children to produce estimates.
IDACI, Income Deprivation Affecting Children Index.

Sensitivity analyses

Sensitivity analyses with obesity as the exposure of interest also found a reduced likelihood of DGA among children with obesity, compared with those with a healthy weight, although the small number of children with obesity and at least one DGA was low resulting in wide CIs (Reception HR 0.80; 95% CI 0.62 to 1.03; year 6 hours: 0.79; 0.58 to 1.07; online supplemental table S7).

DISCUSSION

Summary of key findings

Although the prevalence of at least one DGA among 5–16-year-olds was low, there were marked ethnic inequalities in DGA and the prevalence in the most deprived areas was more than three times higher than in the least deprived areas. Children registered with a GMP in Barking and Dagenham, Havering, Redbridge and Waltham Forest were less likely, and those in Tower Hamlets more likely, to have at least one DGA. Children living with excess weight were less likely to undergo DGA.

Strengths and limitations

This study contributes to the body of evidence describing and assessing inequalities in DGA. Using linked EHRs for a large ethnically diverse and disadvantaged childhood population enabled quantification of ethnic inequalities in these procedures at a more granular level than available from other routine data sources while accounting for sex, area-level deprivation and weight status.

While Barts Health NHS Trust is commissioned to provide DGA procedures to children in this region, we cannot exclude the possibility that some children may have had DGA elsewhere. We were unable to stratify analyses by deciduous or permanent teeth, and we did not have information on children's use of preventive or restorative dental services. However, the 2022 NDEP found that only 13% of decayed teeth in 5-year-old children in London had been filled.[4] We were unable to account for physical or learning disability, which may influence a GDP's decision to refer a child for DGA. We also did not have information about diet or consumption of sugar-sweetened beverages.

To our knowledge, this is the first time that school weight records have been linked to hospital records. Previous reports of the associations between childhood obesity and dental caries have relied on small-scale observational surveys. We used robust statistical methods and a longitudinal study design to estimate DGA incidence. However, the duration of follow-up, particularly among children participating in the school measurement programme in

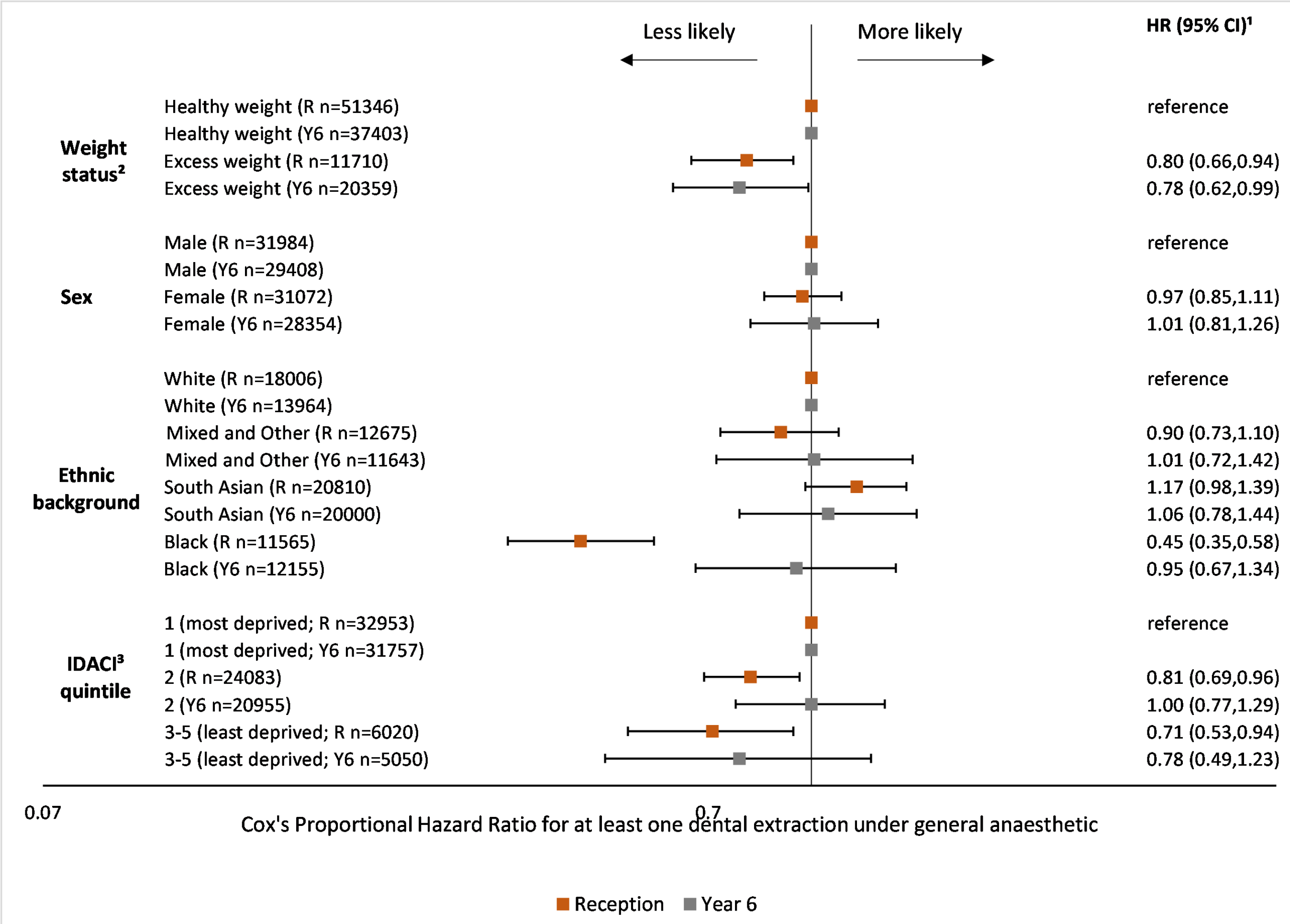

Figure 2 Multivariable Cox's proportional HRs estimating the likelihood of at least hospital dental extraction under general anaesthetic following National Child Measurement Programme measurement, by school year. [1]Cox's proportional HR and 95% CI after mutual adjustment for National Child Measurement Programme-recorded clinical excess weight status, sex, ethnic background, 2019 Income Deprivation Affecting Children Index (IDACI) quintile and local authority where the child attended school. [2]Derived from National Child Measurement Programme-recorded body mass index (BMI), after application of ethnic-specific BMI adjustments, categorised according to the UK1990 clinical reference standard where excess weight is defined as a BMI with age-specific and sex-specific BMI is greater than or equal to the 91st centile. [3]2019 IDACI quintile. Children participating in the National Child Measurement Programme in Reception year are aged 4–5 years and those participating in year 6 are aged 10–11 years. The reception and year 6 multivariable models included 63 054 and 57 759 children, respectively.

more recent years, was limited. Due to the smaller sample size, we were unable to explore the relationship between underweight and DGA and were restricted to using high-level ethnic background in the subsample.

Comparison with existing literature

Our estimates of DGA prevalence are consistent with figures published for 0–19 year-olds for 2016–2020, with the London region having one of the highest DGA rates in England.[18] The NDEP found that Tower Hamlets had the highest prevalence of tooth decay among 5 year-olds in the seven local government areas included in this study and that London overall had among the highest rates of caries.[4]

After accounting for ethnic background and deprivation, we found that DGA varied by local government area, with an increased risk of DGA in Tower Hamlets and a decreased risk in Barking and Dagenham, Havering, Redbridge, and Waltham Forest. The very low proportion of children accessing GDP services in NEL could explain this difference, with dental attendance percentages ranging from 35.2% in Tower Hamlets to 57.4% in Redbridge in 2019.[19]

In the main sample, we used the NHS 16+1 ethnic categories to explore the relationship between ethnic background and DGA. Exploring heterogeneity within high-level ethnic groups has not been possible in most previous reports. Notably, we found the risk of DGA was highest for those from white Irish, other Asian, Bangladeshi and Pakistani ethnic backgrounds. These findings are consistent with those reported by the NDEP.[4] The higher risk of DGA among children from some ethnic backgrounds may reflect differences in child diet, however, there is a paucity of data on dietary intake by ethnic background, with the National Diet and Nutrition

Survey in general lacking sufficient ethnic sample size to explore dietary intakes at a more granular level.[20]

The likelihood of DGA increased with area-level deprivation as measured by the proportion of children under 16 living in low-income households. This is consistent with the most recent findings of the NDEP[4] which found that deprivation explained 38.4% of the variance in tooth decay in 5 year-olds. Existing inequalities may reflect dietary patterns, the adoption of evidence-based preventive behaviours including twice daily toothbrushing with fluoridated toothpastes, as well as differences in water fluoridation.[21]

In the subsample, excess weight was associated with reduced likelihood of DGA. While in national analyses of the 2019 NDEP obesity was associated with an increased likelihood of tooth decay, among only those children with tooth decay, the likelihood of having more severe decay (as assessed by the number of teeth with decay) was lower for those with obesity.[14] By contrast, Paisi *et al* identified two studies with a low risk of bias which reported a higher risk of tooth decay in children living with obesity in their systematic review investigating the relationship between obesity and decay.[13] Our findings may reflect varied dietary patterns among our multiethnic urban study population. Ultraprocessed foods are high in saturated fats but low in added sugars. This 'sugar-fat seesaw' could suggest a more complex dietary relationship between different macronutrients, particularly in disadvantaged communities, related to diet quality and food security, confounding the relationship between tooth decay and excess weight.[22] This highlights the need for further research to better understand the link between excess weight, diet quality and DGA.

Implications for research, policy and practice

Our findings highlight the importance of policies to reduce ethnic and social inequalities in DGA caused by severe tooth decay. Population-based interventions such as water fluoridation can reduce oral health inequalities. Hospital admissions for decay-related extractions were 59% lower in areas of England with water fluoridation levels greater than 0.7 mg/L, compared with areas with no water fluoridation.[23]

The UK Scientific Advisory Committee on Nutrition recommends sugar control to reduce the amount of free sugars in food and drinks.[24] The UK's Soft Drinks Industry Levy (SDIL) is one such approach included in the UK Child Obesity Plan aiming to reduce consumption of sugar-sweetened beverages.[25] A recent evaluation of the SDIL suggests a 28.6% and 5.5% reduction in hospital admissions for decay-related extractions in children aged 0–4 and 5–9 years, respectively.[26] The SDIL has also been associated with a 1.6% reduction in obesity prevalence among girls aged 11 years.[27] Further research assessing the joint impact of the SDIL on obesity and tooth decay at the individual level would improve our understanding of the potentially multifaceted impact of such public health measures.

Primary prevention of tooth decay and access to dental treatment can also reduce oral health inequalities in children. The Core20PLUS5 is a national approach to support the reduction of health inequalities[28] targeting the most deprived 20% of the population and including a focus on people from minority ethnic backgrounds. Oral health is one of the five children's Core20PLUS5 domains.

Geographical variation in DGA could be a consequence of limited access to dental services. In 2022, only 12.9% of 5 year-olds who had tooth decay had their teeth filled in London.[4] Addressing barriers to access to dental care is important so that children can receive timely prevention and treatment. England does not have a universal school toothbrushing programme and supervised toothbrushing is only offered in four schools in NEL.[29] In contrast, in Scotland, a public health programme involving supervised daily toothbrushing and primary care dental practice visits has been shown to reduce the likelihood of dental caries by as much as 60%.[30]

CONCLUSION

There are significant ethnic and socioeconomic inequalities in the DGA experience related to severe tooth decay and access to care in children living in NEL. Children living with obesity do not appear to have a higher risk of tooth extractions but information on the use of preventive and restorative dentistry, diet and toothbrushing behaviours was not available. Further research is needed to understand the different factors mediating inequalities in excess weight and tooth extraction. Our findings emphasise the importance of implementing population-based interventions to reduce inequalities in childhood dental health targeted at the wider determinants of dental health and of providing equitable access to primary prevention and dental treatment.

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Patient consent for publication Not applicable.

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