Dental extraction under general anaesthesia in east London: study protocol

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

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Background/rationale

Left untreated, dental problems can impact a child's wellbeing throughout childhood, adolescence and into adulthood,[1, 2] and may affect language development, school attendance and educational outcomes with the possibility of exacerbating social inequalities.[3] This is particularly important in London, where 29% of five year-olds had experience of tooth decay in 2022.[4]

Variation in prevalence and severity of tooth decay has been identified by deprivation and ethnic background.[5, 6] The National Dental Epidemiology Programme (NDEP), which monitors oral health among five year-olds,[7] found the prevalence of tooth decay among children living in the most deprived areas (35·1%) was more than double that of those in the least deprived areas (13·5%).[4] A greater proportion of children from Asian and Other ethnic backgrounds had experience of tooth decay, compared with children from White and Black ethnic backgrounds.[4]

The final outcome of untreated tooth decay is extraction, when a tooth can no longer be saved or restored. Tooth extractions can be performed under local anaesthetic by a General Dental Practitioner (GDP). For young children, where cooperation is required, or for those with complex needs,[8] a GDP may refer the child for dental extraction under general anaesthetic (DGA). In England, this can only be performed in hospital settings.[9] Tooth decay is the most common reason for hospital admission among six to ten year-olds, 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).[10]

There is evidence that DGA varies by sociodemographic factors. DGA incidence in children aged <16 years living in south-west England increased with area-level deprivation, and was higher among children from Black and minority ethnic backgrounds.[11] The 2013 UK Children's Dental Health Survey found lower DGA with higher family socioeconomic status.[12] Others have highlighted a "postcode lottery" in DGA, with children living in areas with non-fluoridated water[13] and those in urban areas,[11] more likely to have had at least one DGA.

High and frequent dietary intake of free (added) sugars by children is a risk factor for both tooth decay and childhood obesity. However, systematic reviews investigating the association between childhood obesity and tooth decay have reported inconsistent and inconclusive results due to the inclusion of predominantly cross-sectional studies, sampling biases and varying definitions of obesity. Linked analysis of 67,033 children participating in both the NDEP and the National Child Measurement Programme (NCMP) found higher prevalence of tooth decay in children living with overweight or obesity, but there was a reduction in the number of decayed teeth (severity).[14] This analysis adjusted for deprivation and water fluoridation but not for ethnic background.

We have the opportunity to link National Child Measurement Programme (NCMP) data collected in four inner north-east London local authorities (City & Hackney, Newham, Tower Hamlets and Waltham Forest) to secondary care electronic health records (EHRs) for children attending Barts and The Royal London hospitals for dental treatment. This is a novel linkage opportunity among a large, ethnically-diverse child population with high levels of obesity and deprivation. Secondary care EHRs provide data on dental procedures, as opposed to the visual observation of decay recorded in the NDEP. We are able to extract historic secondary care data enabling investigation of the temporal relationship between obesity and hospital dental treatment.

Objective

To explore sociodemographic characteristics associated with attending hospital for dental extraction, and to investigate the association between childhood excess weight and dental extractions occurring during childhood.

Research questions

1. What proportion of children have at least one dental extraction/root canal treatment recorded in their secondary care electronic health record (EHR)?
   a. How do sociodemographic characteristics vary among children with and without at least one dental extraction/root canal treatment recorded in their secondary care EHR?
   b. How does the likelihood of at least one hospital dental extraction/root canal vary by sociodemographic characteristics?
2. What proportion of children have at least one dental extraction/root canal treatment recorded in their secondary care EHR after their NCMP measurement date?
   a. How does this proportion vary by excess weight status and sociodemographic characteristics?
      i. Stratified by school year

Study design

Longitudinal

Target and observed population

Research question 1

The target population is all five to 16 year-olds living in one of the seven north-east London (NEL) local government areas. The observed population is all 5-16-year-olds ever registered with a regular registration with a general medical practitioner (GMP) in one of the seven NEL local government areas contributing to the Discovery Data Service (DDS) at any time between January 2017 and November 2022.

Research question 2

The target population is all children attending primary schools in City & Hackney, Newham, Tower Hamlets and Waltham Forest, in the 2013-19 academic years. The observed population is all children participating in the NCMP in City & Hackney, Newham, Tower Hamlets and Waltham Forest in the 2013-19 academic years (Table 1), with a regular registration with a GMP in one of the seven NEL local government areas contributing to the DDS at any time between September 2001 and November 2022.

Table 1 – Observed population of NCMP participants

Academic year	City & Hackney	Newham	Tower Hamlets	Waltham Forest
2013/14		x	x	
2014/15			x	x
2015/16				
2016/17				
2017/18				
2018/19				

Data sources and inclusion/exclusion criteria

Secondary care data

Data were extracted from the Discovery Data Service for the wider Research-EnAbled Learning (REAL) Child Health team within the Queen Mary Clinical Effectiveness Group (CEG). The cohort of children for whom data

were extracted were all children born since 1st September 2001, including those who de-registered or died, ever registered with one of 285 GMPs in one of the seven NEL local government areas (Barking & Dagenham, City & Hackney, Havering, Newham, Redbridge, Tower Hamlets and Waltham Forest) contributing to the DDS at any time between September 2001 and November 2022.

For all children identified as part of this cohort, we extracted demographic and clinical data from their primary and secondary care EHRs, respectively. Children were identified via the pseudonymised NHS number.

A dental procedures data extract is provided in long format, whereby each row represented an entry of one of the pre-specified Operating Procedure Code Supplement (OPCS-4) clinical codes. For each clinical code, the following additional data is provided: date code was entered, a description of the code, the NHS Trust, the hospital site, the child's age at the time of event (in years to two decimal places). The OPCS-4 clinical codes specified for extraction from DDS are shown in Table 2.

Table 2 – Operating Procedure Code Supplement (OPCS-4) clinical code specification

Procedure description	OPCS-4 code
Surgical removal of impacted wisdom tooth	F09.1
Surgical removal of impacted tooth NEC	F09.2
Surgical removal of wisdom tooth	F09.3
Surgical removal of tooth NEC	F09.4
Surgical removal of retained root of tooth	F09.5
Coronectomy NEC	F09.6
Surgical removal of other teeth or tooth	F09.8
Surgical removal of other teeth or tooth	F09.9
Simple extraction other teeth or tooth: full dental clearance	F10.1
Simple extraction other teeth or tooth: upper dental clearance	F10.2
Simple extraction other teeth or tooth: lower dental clearance	F10.3
Simple extraction other teeth or tooth: extraction of multiple teeth	F10.4
Simple extraction other teeth or tooth: other specified	F10.8
Simple extraction other teeth or tooth: unspecified	F10.9
Surgery on apex of tooth: apicectomy	F12.1
Surgery on apex of tooth: root canal treatment to tooth	F12.2
Surgery on apex of tooth: other specified	F12.8
Surgery on apex of tooth: unspecified	F12.9
Orthodontic operations: surgical exposure of tooth	F14.5
Drainage of abscess of aveolus of tooth	F16.1
Surgical arrest of postoperative bleeding from tooth socket	F16.2
Packing of tooth socket	F16.3
Scaling of tooth	F16.4
Application of fissure sealant	F16.5
Application of topical flouride	F16.6
Polishing teeth	F16.7
Other operations on tooth: other specified	F16.8
Other operations on tooth: unspecified	F16.9
Excision of gingiva	F20.1
Excision of lesion of gingiva	F20.2
Biopsy of lesion of gingiva	F20.3
Gingivoplasty	F20.4

Suture of gingiva	F20.5
Operations on gingiva: other specified	F20.8
Operations on gingiva: unspecified	F20.9

All children identified in the REAL Child Health cohort will be linked to this hospital dental extract. If a child could not be linked, it is assumed they did not have any hospital dental events. However, the DDS only started receiving daily deltas of hospital data from 2017 onwards, and whilst the hospital dental data extracts includes events prior to 2017, we assume this is not complete. **For this reason, we will exclude children not aged 5-16 years of age between 1st January 2017 and 1st November 2022.**

Figure 1 – Flow chart illustrating processing of demographic and dental data extracts
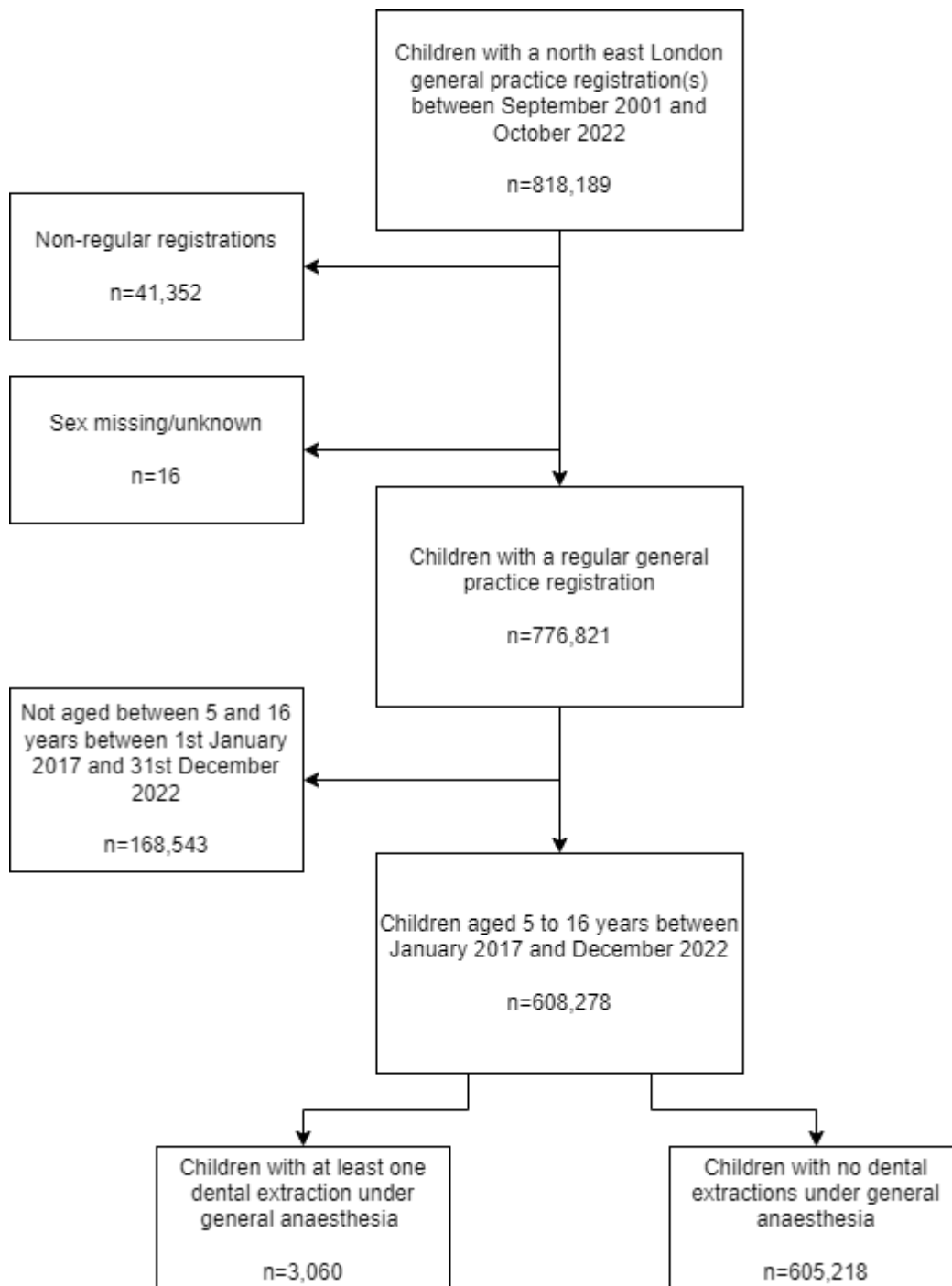
NCMP

The NCMP annually measures the heights and weights of five and 11 year-old children attending state-maintained schools in England. The programme began in 2006 and data collection is carried out by local authority (LA) public health departments. All children in the first and last years of primary school are invited to participate in the NCMP on an opt-out basis. LA public health departments instruct teams to measure weight and height in state-maintained schools in the local authority area. Measurement protocols produced by Public Health England detail that weight is to be measured to the nearest 0.1 kg, and height with the child's heels together and the head in the Frankfurt plane to the nearest 0.1 cm. Height and weight data, in addition to other personal information, are submitted to the NCMP electronic system and are validated by NHS Digital.

In collaboration with four inner NEL London local authorities, we developed data processing agreements allowing the sharing of de-personalised NCMP data. We received data from City & Hackney (2013-19), Newham (2014-19), Tower Hamlets (2015-19) and Waltham Forest (2013/14 and 2015-19) for the academic years 2013/14 to 2018/19. The data processing agreements allowed deterministic linkage to primary care EHRs based on pseudonymised NHS numbers created using a study-specific encryption key and Open-Pseudonymiser software.(15)

NCMP records will be included if a valid NHS number is present and a BMI recording identified. Duplicate NCMP measurements for the same children will be removed. Further details are included in Figure 2.

Figure 2 – Flow chart illustrating exclusion criteria for NCMP
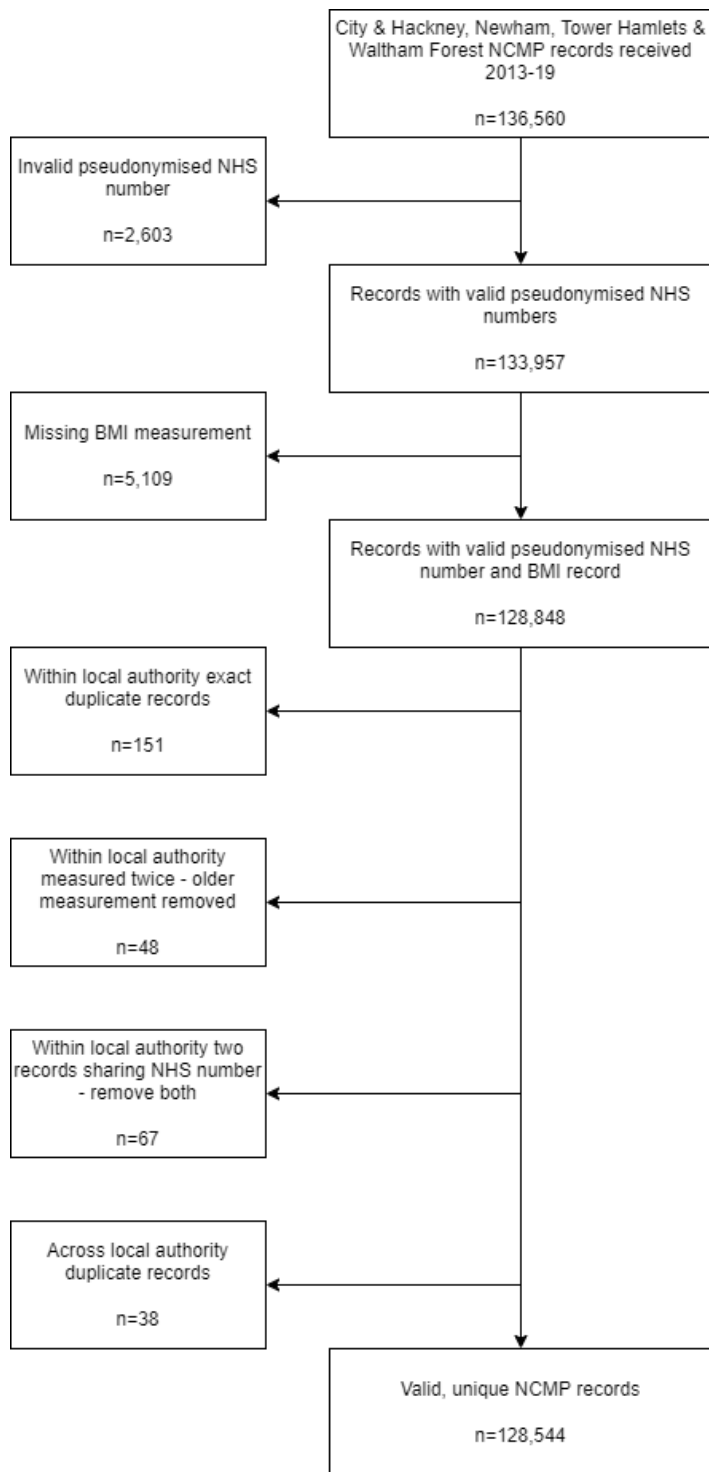
Linkage process

In order to answer research question 2, NCMP data will be deterministically linked to DDS data extracts using the pseudonymised NHS number as the linkage field. An explanation for non-linkage is that children participating in the NCMP in City & Hackney, Newham, Tower Hamlets and Waltham Forest may not be registered to a general practice in one of the seven NEL local government areas.

Additional data processing (Figure 3) will include removal of children with missing ethnic background, and children with hospital dental treatment prior to NCMP measurement.

Figure 3 – Linkage process
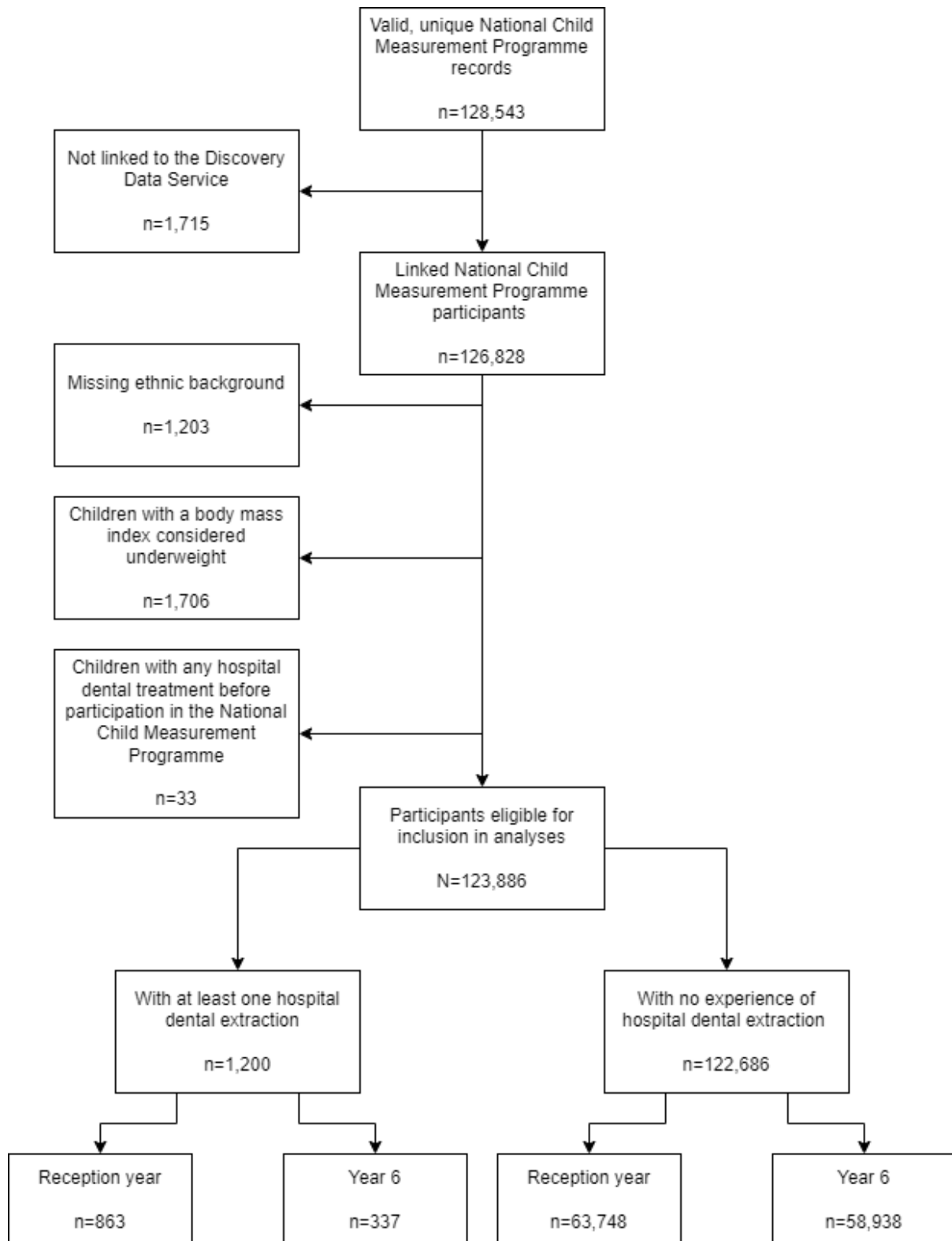
Ethics

The Discovery Board has approved this protocol of analysis of pseudonymised data, with no access to any identifiable information. This protocol describes secondary analysis of pseudonymised data and therefore further ethics approval is not required. For the linkage of NCMP data to the DDS: we developed data processing agreements with each of the public health teams within the local authorities of interest (who are

the data controllers). The data processing agreements detail how the data shared are de-personalised and pseudonymised (using a project-specific encryption key). This study analyses pseudonymised secondary data and therefore does not require additional ethics approval. We will follow disclosure guidelines when publishing any work to ensure no individual children can be identified.

Variables of interest

Outcome variable

Experience of DGA was created as a binary variable indicating whether or not the child has ever undergone surgical extraction of a tooth or root canal treatment in a secondary care setting. These events were identified as those coded with one of the OPCS-4 codes listed in supplementary table S1. If a child had more than one instance of any of the listed clinical codes, the first event was retained.

Table 3 – Outcome of interest

Code description	OPCS-4 code[1]
Simple extraction other teeth or tooth : full dental clearance	F10.1
Simple extraction other teeth or tooth: upper dental clearance	F10.2
Simple extraction other teeth or tooth: lower dental clearance	F10.3
Simple extraction other teeth or tooth: extraction of multiple teeth	F10.4
Simple extraction other teeth or tooth: other specified	F10.8
Simple extraction other teeth or tooth: unspecified	F10.9
Surgery on apex of tooth: root canal treatment to tooth	F12.2

[1] Operating Procedure Code Supplement version 4 code. [2] Removal of the nerve to preserve the tooth.

Explanatory variables

Table 4 – Covariates

Variable	Description	Adjustment or stratification
Sex	GMP- or NCMP-recorded sex	Adjustment
Ethnic background	Ethnic background, as recorded in the primary care record was classified according to the NHS 16+1 categorisation: White British, White Irish, Other White, Chinese, White & Asian, White & Black African, White & Black Caribbean, Other Asian, Other Mixed, Other, Bangladeshi, Indian, Pakistani, Black African, Black Caribbean, Other Black African or Caribbean. We also included children with missing ethnic background. In the sub-sample NCMP participants, we used five mutually exclusive high-level groups to categorise ethnic background: White (White British, White Irish, or Other White background); a combination of Mixed and Other ethnic backgrounds (Chinese, White & Asian, White & Black African, White & Black Caribbean, Other Asian, Other Mixed, or Other); South Asian (Indian, Pakistani, or Bangladeshi) and Black (African, Caribbean, or Other Black background).	Adjustment
Local government area/local authority	Research question 1: Local government area in which the GMP registration is located as indicated in the DDS. Categorised into one of seven localities: Barking & Dagenham, City & Hackney,	Adjustment

	Havering, Newham, Redbridge, Tower Hamlets & Waltham Forest	
	Research question 2: Local authority of the school where NCMP took place: City & Hackney, Newham, Tower Hamlets and Waltham Forest	
Income Deprivation Affecting Children Index quintile	2019 Income Deprivation Affecting Children Index (IDACI) score(16) will be merged into the datafile using the GMP-recorded patient address 2011 LSOA as the linkage field.	Adjustment
Excess weight	Research question 2 only Weight status will be determined from NCMP-recorded BMI, adjusted for ethnic background: BMI should be adjusted by a constant term of +1.12 and +1.07 kg/m^2 in South Asian boys and girls, respectively. For children from Black ethnic backgrounds, ethnic-specific BMI adjustments vary between -0.12 and -5.52 kg/m^2 depending on age group and body fatness. No adjustment is available to apply to children from Mixed or Other ethnic backgrounds.(17) Ethnic-adjusted BMI will be categorised according to the UK1990 clinical cut-offs and excess weight defined as BMI ≥91st age- and sex-specific centile	Adjustment
School year	Research question 2 only School year in which the child's NCMP took place, either Reception (4-5 years) or Year six (10-11 years)	Stratification

Statistical analyses

Analyses will be performed using Stata/MP 17 (StataCorp LP):

Research question 1:

1. Descriptive statistics to describe prevalence of at least one dental extraction by sociodemographic characteristics
    a. Comparison of the distribution of children with and without at least one hospital dental extraction by sex, local government area, ethnic background and IDACI quintile
2. Estimation of the rate of DGA by age at event (per 1,000 person-years)
3. Univariable and multivariable binary logistic regression to estimate the likelihood of DGA by covariates of interest

Research question 2:

1. Descriptive statistics to describe prevalence of at least one dental extraction by sociodemographic characteristics and excess weight status
    a. Comparison of the distribution of children with and without at least one hospital dental extraction by sex, local authority, ethnic background, IDACI quintile and excess weight status
2. Among NCMP participants with at least one hospital dental extraction, description of the average time between NCMP measurement date and first hospital dental extraction
    a. Estimation of the incidence rate by sex, local authority, ethnic background, IDACI quintile and excess weight status
3. Cox's Proportional Hazard regression to estimate hazard ratio of the likelihood of DGA by sociodemographic characteristics and excess weight status
    a. Investigation of interaction between sex, ethnic background, deprivation and weight status

4.   Investigation of interactions between sex, ethnic background, area-level deprivation and excess weight status

Sensitivity analyses

Sensitivity analyses, using clinical obesity (age- and sex-specific BMI greater 98th centile after application of ethnic-specific BMI adjustments) as the exposure of interest will be conducted.

Manuscript preparation

The REporting of studies Conducted using Observational Routinely-collected Data (RECORD) guidelines will be followed.(18)

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