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Oral Health Inequalities in 0-17-year-old Children Referred for Dental Extractions Under General Anaesthesia in Wolverhampton

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Objective: Describe the inequalities in oral health in children treated in a hospital located in a deprived urban area in the UK. ***Research design***: Case-note review of 1911 0-17-year-olds who underwent dental extractions under a general anaesthetic (DGA). ***Main outcome measures***: Associations between Age, Ethnicity, Year-of-Treatment and Index of Multiple Deprivation (IMD) with the number of teeth extracted. Analysis used multilevel modelling assuming a Poisson distribution. ***Results***: Mean number of teeth extracted was higher in the youngest children treated aged 0-5 years (relative risk coefficient, (RR=exp(β)=1.39; 95% CI 1.24 to 1.56) compared to those aged 6-17 years and in 'Other Whites' (predominantly immigrants from Eastern Europe) (RR=exp(β)=1.34; 95% CI 1.25 to 1.43), 'South Asians' (RR=exp(β)=1.15; 95% CI 1.08 to 1.23) but fewer in the 'Black' ethnic group (RR=exp(β)=0.85; 95% CI 0.76 to 0.95). DGA increased during the study with more teeth extracted in 2015, 2016 and 2017 (RR=exp(β)=1.12, 95% CI 1.22, 1.25) and with a negative gradient in the rate of DGA's (per decile) in children from the most deprived to most affluent locations (RR=exp(β)=0.98; 95% CI 0.97 to 0.99). ***Conclusions***: Significant oral health inequalities exist in children from a deprived urban area in the UK. A preventive approach to children's oral health is needed to reduce such inequalities, including public health and healthcare agencies to informing parents of children whose first language is not English about dental caries.

Keywords*: General anaesthesia, caries, ethnicity, inequalities, deprivation*

Although there have been improvements in children's oral health, inequalities remain and are a cause for concern. The Nuffield Trust and the Health Foundation report reveals significant regional and socioeconomic differences in dental health with populations in the North of England and from more deprived backgrounds generally experiencing poorer dental health (Appleby *et al*., 2017). National surveys examining caries in five-year-olds in England (PHE, 2018) have found a correlation between dental experience and deprivation with variations in decay experience at regional and national levels. Overall, 23.3% of children examined had some experience of dental decay with levels of decay higher in some ethnic groups.

Children who have toothache, or who need treatment as a result of dental decay, may have pain, infections and difficulties in eating, sleeping and socialising and disruption with school attendance (PHE, 2017). Extraction of teeth in young children often involves admission to hospital for a dental general anaesthetic (DGA). Extraction of decayed teeth is the most common reason for children aged 5-9 years to be admitted to hospital for a DGA placing a considerable financial burden on the National Health Service (RCS, 2015).

Data from Hospital Episodes Statistics (HES) show that there has been a steady increase in the numbers of hospital admissions for DGA due to caries particularly in children from lower socioeconomic groups (Moles and Ashley, 2009). Wolverhampton has a multi-ethnic population of 260,000 with 35.5% Black and Minority Ethnic (BME) and a high immigrant population (City of Wolverhampton, 2019). Deprivation is disproportionately spread across the city with a marked disparity between residents in affluent wards and those in less affluent wards in the east and the south east of the city where there is high unemployment.

This hospital DGA records-based study aims to:

1. Investigate the socioeconomic factors involved in referrals of 0-17-year olds for a DGA in a socially deprived urban area with high BME and immigrant populations
2. Increase understanding of the value of DGA data as an indicator of the impact and inequalities associated with dental decay (caries) in Wolverhampton
3. Show changes in patterns of DGA referrals over a period of five years from 2013-2017

METHODS

The study population consisted of 1911 residents aged 0-17 years in Wolverhampton who had been referred for a DGA by General Dental Practitioners (GDP's) to New Cross Hospital, Wolverhampton over the 5 -year period 2013 to 2017. Referrals are assessed pre-operatively in

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a Community Dental Service clinic. Due to risks of general anaesthesia (GA), it is only considered for patients unsuitable for alternative treatments. Patients suitable for local anaesthesia are returned to the referrer and suitable patients are redirected for care under sedation. Intra-oral radiographs are used wherever possible, and to avoid repeat DGA's all carious and symptomatic teeth are extracted. GA is provided by a consultant anaesthetist. Oral health prevention advice is given to all patients at the pre-operative assessment and again after the DGA for those patients treated in hospital. No restorative care is provided during the DGA.

Data were collected from the theatre register and the electronic hospital Patient Activity Summary system (PAS). Details included date of treatment, age, teeth extracted, ethnicity and family postcodes. Postcodes were used to determine wards of residence and deprivation decile using the Index of Multiple Deprivation 2015 (Department for Community and Local Government, 2015). The data were collated on an EXCEL spreadsheet using descriptive statistics including means and 95% confidence levels.

Differences between categories (e.g., age groups, ethnic origin and year of treatment) and relationships associated with the number of teeth extracted were analysed assuming a Poisson distribution using a statistical software package (MLwiN, Version 3.03, Centre for Multilevel Modelling, University of Bristol, UK). MLwiN performs the analysis using a log transformation, known as a log-link function to ensure that the number of teeth remained positive under all circumstances. We assessed the effects between age group, ethnic origin, year of treatment and the index of multiple deprivation and the number of teeth extracted using the following model

$$\text{Log}(\pi_i)=\text{cons} + \beta_2\text{*year 6-11} + \beta_3\text{*year 0-5} + \beta_4\text{*NOT STATED} + \beta_5\text{*OTHER WHITE} + \beta_6\text{*South Asian} + \beta_7\text{*Mixed race} + \beta_8\text{*Black} + \beta_9\text{*Year treated 2014} + \beta_{10}\text{*Year treated 2015} + \beta_{11}\text{*Year treated 2016} + \beta_{12}\text{*Year treated 2017} + \beta_{13}\text{*Index of multiple deprivation, (Eq. 1)}$$

where cons is the constant intercept parameter for British white children, aged 12 to 17 years who were treated in 2013 and had the mean index of deprivation found to be 2.408 (taken as the reference or baseline group). All other age groups, ethnic groups and treated years are estimated relative to this reference group, estimated as $\beta_2, \beta_3 \ldots$ etc.]

Results

Table 1 describes the number of children receiving a DGA. Almost half (48%) were from BME groups, although the largest single ethnic group (41%) was White British and 11% did not state their ethnicity. The greatest number of children treated were aged 6-11-years. DGA rates varied from year to year from around 6.5 to 7 per 1000 0-17-year olds living in Wolverhampton.

A total of 8073 teeth were extracted with the mean number of 4.22 teeth extracted over the 5 years (Figure 1). The frequency distribution of the number of teeth extracted, appeared to follow a Poisson rather than normal distribution (Kolmogorov-Smirnov and Shapiro-Wilk's tests of normality, both $P<0.001$).

Table 1. Ethnicity and age of 1911 children receiving extractions under DGA by year

Ethnic & age group	*2013*	*2014*	*2015*	*2016*	*2017*	*Total*	*%*
Black	20	17	21	23	19	100	5.23
0-5y	10	9	7	5	7	38	
6-11y	8	8	14	18	12	60	
12-17y	2					2	
Mixed Race	46	50	59	55	62	272	14.23
0-5y	18	20	19	20	22	99	
6-11y	28	27	38	35	36	164	
12-17y		3	2		4	9	
Not stated	84	67	41	12	2	206	10.78
0-5y	6	7	4	2		19	
6-11y	74	56	34	10	2	176	
12-17y	4	4	3			11	
Other white	37	41	44	39	53	214	11.20
0-5y	21	14	21	19	21	96	
6-11y	15	21	22	30	32	122	
12-17y	1	6	1		4	12	
South Asian	52	49	76	83	71	331	17.32
0-5y	18	20	22	30	32	122	
6-11y	33	29	53	53	39	207	
12-17y	1		1			2	
White British	146	167	151	152	172	788	41.23
0-5y	61	54	59	56	50	280	
6-11y	64	88	81	86	114	433	
12-17y	21	25	11	10	8	75	
Total	385	391	392	364	379	1911	

The numbers of teeth extracted by age group, ethnic origin and year of treatment are given in Figures 2a, 2b and 2c. Children aged 0-5 years and 'other whites' had more teeth extracted. The number of teeth extracted increased each year except for 2014.

Multilevel analysis of the number of teeth extracted revealed significant differences associated with age group, ethnicity, year of treatment and index of multiple deprivation (Table 2).

The reference group was taken as British whites, aged 12 to 17 who were treated in 2013 and had a mean Index of Multiple Deprivation (IMD) of 2.408 (Decile 1 being the most deprived and decile 10 being the least derived). Relative to this, the risk of more extractions was greater in younger children and in those of South Asian or Mixed-Race ethnicity, but lower in children categorised as Black.

Fewer teeth were extracted in lower Index of multiple deprivation deciles, although the RR is smaller as it represents the increased risk for each decile of this ordinal scale.

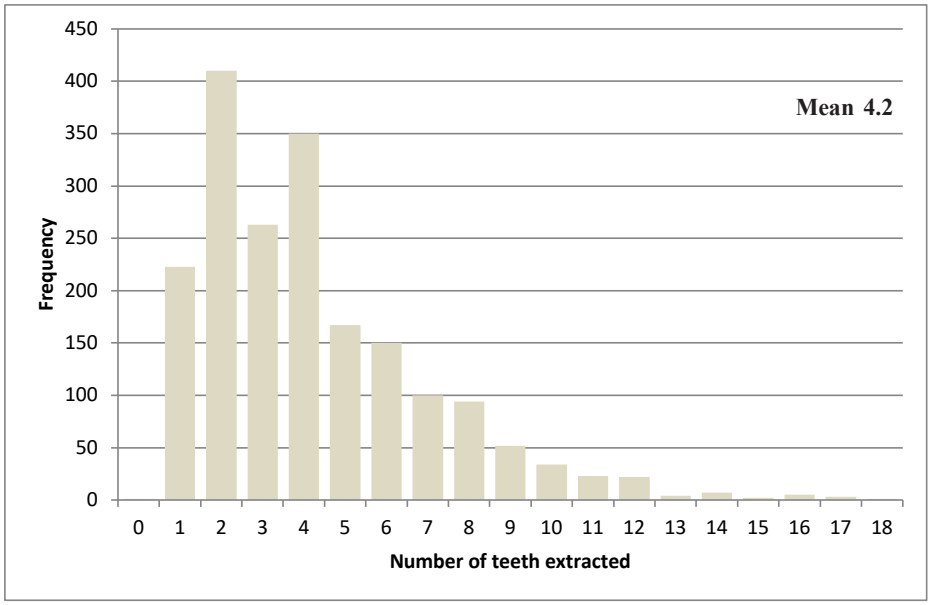

Figure 1. Frequency distribution for the number of teeth extracted.

Discussion

Despite caries being largely preventable, this study shows that there are high numbers of 0-17-year-olds of families resident in Wolverhampton attending New Cross Hospital for DGA. More teeth were extracted in the youngest age group of 0-5-year-olds. An important reason for this may be that patients of this age are less likely to be acclimatised or exposed to dentistry, or suitable for other treatment modalities including local anaesthesia or sedation and are more likely to be referred for DGA. In addition, all carious teeth are extracted to prevent the need for an additional DGA.

High numbers of children treated were aged 6-11 years, where caries may have developed in earlier childhood or may have been identified by their schools. Some children may also have received more than one DGA, although efforts are made to reduce this as much as possible by extracting all carious and symptomatic teeth especially in the youngest children. It is possible that some children may have arrived in Wolverhampton from other countries with pre-existing caries, although details of this were not recorded. More teeth were extracted in children of 'Other Whites' ethnicity compared with other ethnic groups

The number of teeth extracted increased from 2015 onwards. Treatment also showed a socioeconomic gradient, with more teeth extracted for children from the most deprived locations. The incidence rates for DGA extractions in our study (6.5 to 7 per 1000) were slightly lower than those reported in a community dental clinic in Southampton (Mortimer *et al*., 2017), but were similar to those in a study carried in the South West of England (Lucas *et al*., 2018). Both of these areas are very different in terms of size and demography compared with Wolverhampton, so it is difficult to draw any conclusions from this. The Southampton study also reported the highest proportion of extraction rates in 0-5 –year-olds. Whilst neither of these studies considered the role of ethnicity, there is evidence that ethnicity can affect oral health inequalities after controlling for levels of socioeconomic deprivation. This has been demonstrated among pre-school and school children from Pakistani, Bangladeshi, Chinese and East European communities (Rouxel and Chandola, 2018). A previous study of hospital records in Wolverhampton found DGA rates due to dental caries were associated with social deprivation and ethnicity in very young 2 and 3-year-olds (Harper *et al*., 2019). Although Wolverhampton receives fluoridated water, which is effective in reducing caries incidence, these data indicate that water fluoridation only mitigates the caries process. For example, Weston-Price et al. (2018) showed that water fluoridation was most effective in 5-year-old children from the most deprived areas. Caries is a multifactorial disease with high sugar diets a significant risk factor (Moynihan and Kelly, 2014) and is also linked to obesity and other health problems (Sheiham and Watt, 2000). Wolverhampton has a high prevalence of obesity in the population (Baker, 2019), which may be linked to many low-income families consuming low-cost cariogenic energy dense -foods and beverages, which may also help explain the high caries rates.

Our study draws attention to the inequalities in oral health experience of children from more deprived areas and from certain communities, particularly in Other White groups. The current analysis raises some important points for discussion in relation to oral health inequalities. It is likely that caries once established continues throughout childhood. Indications of this can be seen in this study as high numbers of children having extractions were found in all age groups. This reinforces the case for preventing caries, or instituting early interventions to stop the disease progressing as soon as possible as a public health priority. There are several ways how this can be achieved such as set out in *Commissioning Better Oral Health* (PHE, 2014a) encouraging local authorities to commission evidence-based oral health improvement programmes based on examples of good practice for 0-19-year-olds. The preventive toolkit *Delivering Better Oral Health*

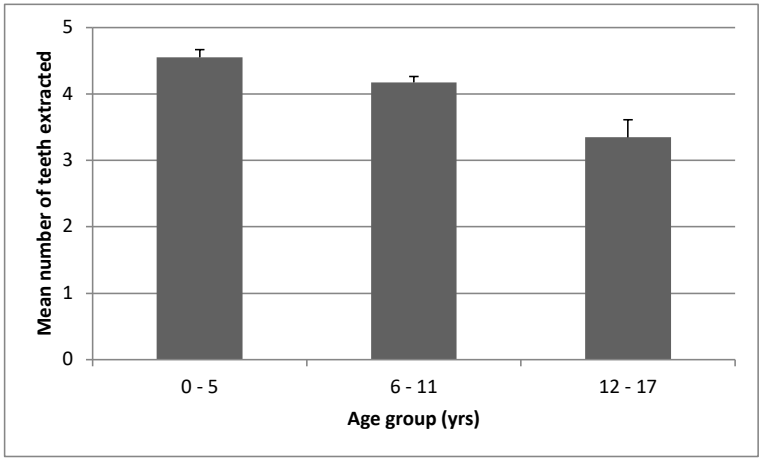

Figure 2a. Number of teeth extracted by age group. Values are means and standard errors.

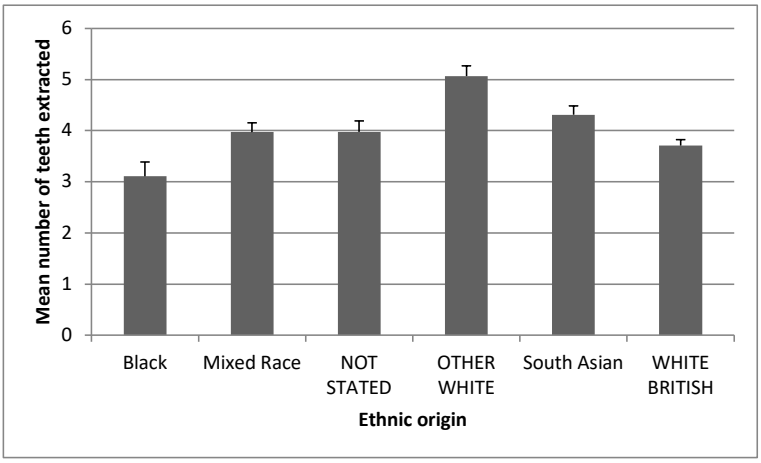

Figure 2b. Number of teeth extracted by ethnic origin. Values are means and standard errors.

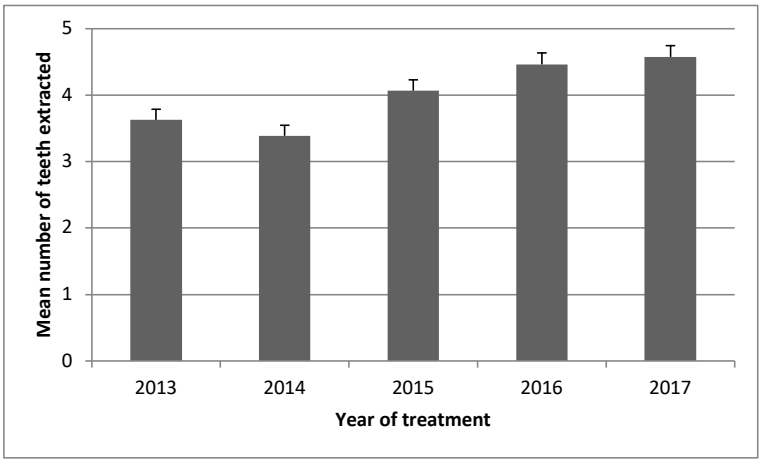

Figure 2c. Number of teeth extracted by the year of treatment. Values are means and standard errors.

(PHE, 2014 b) also provides guidance for primary care on oral health assessments and age-appropriate preventive advice including the importance of regular tooth brushing with fluoride toothpaste. These measures could be especially appropriate for use with 0-5-year-olds from deprived communities and some ethnic groups including Other Whites. Dental Commissioners are also being encouraged to support the commissioning of the "Dental Check by one" (DCby1) national campaign launched by the British Society of Paediatric Dentistry (2019), which aims to improve dental attendance of children under one year. Other programmes that could have a positive impact on oral health include Public Health England's "Sugar Smart" and more recent "Food Smart" campaigns

Table 2. Multi-level model of predictors of the number of teeth extracted in 1911 0-17-year-olds having extractions in Wolverhampton

	RR = exp(β) (95% CI)
Constant intercept	2.74 (2.43 – 3.08)
β_2 Age 6 to 11 yrs	1.28 (1.14 – 1.43)
β_3 Age 0-5 yrs	1.39 (1.24 – 1.56)
β_4 NOT STATED	1.06 (0.98 – 1.16)
β_5OTHER WHITE	1.34 (1.25 – 1.43)
β_6 South Asian	1.15 (1.08 – 1.23)
β_7 Mixed Race	1.07 (1.00 – 1.14)
β_8 Black	0.85 (0.76 – 0.95)
β_9 Year treated 2014	0.94 (0.87 – 1.01)
β_{10} Year treated 2015	1.12 (1.04 – 1.20)
β_{11} Year treated 2016	1.22 (1.13 – 1.31)
β_{12} Year treated 2017	1.25 (1.16 – 1.34)
β_{13} IMD (Deciles)	0.98 (0.97 – 0.99)

RRs & 95% CIs were calculated from log transformed relative-risk parameter estimates using (MLwiN) software assuming a Poisson distribution and a log-link function. The constant intercept parameter estimates the number of teeth extracted for the reference group, i.e. British white children, aged 12 to 17 years who were treated in 2013 and had the mean index of deprivation found to be 2.408 deciles.

aimed at reducing sugar consumption in childhood to reduce tooth decay and the government's sugar-levy aimed primarily to target obesity and overweight by reductions in sugar consumption, which could also help reduce the levels of tooth decay. There are also wider initiatives to tackle socioeconomic determinants that shape inequalities including research into common risk factors such as oral disease through actions on the common social determinants of oral health inequalities rather than a fixation on changing oral health behaviour alone (Watt, 2007). Collaborative working between organisations including local authority commissioners and healthcare professionals on preventive measures would be helpful in this respect.

Some limitations of this study need to be discussed. The sample of children receiving DGA is highly selective and caries experience in this group does not reflect the overall distribution of oral disease in the community. In addition, the sample was relatively small. Unfortunately, there are no data on the overall number of referrals made over the 5 years including those referred for alternative treatments such as extractions under local anaesthesia or sedation. In addition, this study did not identify any patients who may have received more than one DGA over the five years, which could have an impact on the child and resources used, although it is thought that repeat DGAs do not not happen often. We have limited knowledge of the dental care these children received in primary care before their DGA although many referrals were from a relatively small number of dental practices in deprived areas. No data were recorded on the immigrant status of any of the children in this study who may have presented with pre-existing caries.

In summary, our study has identified inequalities in DGA for young children with high levels of deprivation and from some ethnic minority groups. As far as we know, it is the first to report inequalities among children treated in the children's DGA service in a deprived area with a high level BME and EU white immigrant population using statistical software MLwiN. In order to be effective, it is important that commissioners of services receive appropriate public health advice to ensure support of strategies which address health inequalities and ensure that oral health is included. Both Public Health England (PHE, 2014 a) and the National Institute of Clinical Excellence (NICE, 2014) have produced toolkits about commissioning oral health improvement programmes. There is a need to focus on the most vulnerable groups including disadvantaged socioeconomic and ethnic minority groups which are less likely to visit the dentist unless they have problems with their teeth.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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