

Inequalities in orthodontic outcomes in England: treatment utilisation, subjective and normative need

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Objective: To investigate inequalities in three aspects of access to orthodontic care: uptake of orthodontic treatment, normative need and subjective need in England. **Methods:** We used data from two surveys in England: 12 and 15-year-olds from the 2013 Child Dental Health Survey (CDHS 2013) and 12-year-olds from the 2008/2009 NHS Dental Epidemiology Programme for England (NDEP 2008/2009). Summary variables representing orthodontic status were calculated. Two regression-based summary measures of inequalities were used to investigate the relationship between deprivation level and orthodontic outcomes: Slope and Relative indices of Inequality. **Results:** There were significant absolute and relative inequalities in uptake of orthodontic treatment. The least deprived were 1.9 times more likely to have received orthodontic treatment compared to the most deprived in both surveys. Normative need was not associated with deprivation in either the analyses of CDHS 2013 (SII= 0.03, 95% CI: -0.04, 0.1; RII=1.06, 95% CI: 0.91, 1.24) or the NDEP 2007/2008 (SII= 0.03, 95% CI: -0.02, 0.07; RII=1.06, 95% CI: 0.96, 1.18). There was greater willingness to have teeth straightened in more deprived children from CDHS 2013 (SII=-0.09, 95% CI: -0.16, -0.03; RII=0.85, 95% CI: 0.75, 0.96) but not in NDEP 2007/2008 (SII=0.03, 95% CI: 0, 0.06; RII=1.07, 95% CI: 0.99, 1.15). **Conclusions:** Being deprived was associated with lower uptake of orthodontic treatment. Normative need was not related to deprivation. The association between deprivation and subjective need was only partly established, with poorer children showing a greater desire to have their teeth straightened in one survey.

Keywords: Inequalities, orthodontics, IOTN, normative need and subjective need

Introduction

Malocclusion has been linked to poorer oral health related quality of life (OHRQoL) (Liu *et al.*, 2009). One meta-analysis estimated that children with a malocclusion were 1.74 times more likely to report an impact on their quality of life (Kragt *et al.*, 2016). In the absence of strong evidence to link malocclusion to dental caries (Hafez *et al.*, 2012) and other clinical conditions such as temporomandibular joint problems (Luther *et al.*, 2010) the rationale for orthodontic treatment relies mainly on improving psychological and subjective well-being (Benson *et al.*, 2015). A recent review found some aspects of OHRQoL such as emotional and social well-being ‘moderately’ improved as a result of orthodontic treatment (Javidi *et al.*, 2017).

In England, the National Health Service (NHS) commissions or provides orthodontic treatment for children and adults. Since 2006 this has been subject to eligibility criteria, under which treatment is normally offered to those with a certain level of need only, as determined by the Index of Orthodontic Treatment Need (Brook *et al.*, 1989). This restriction does not apply to private provision.

Previous surveys of children in England showed some variations in orthodontic treatment uptake. Analyses of local data, collected before the introduction of new NHS dental contracts in 2006, demonstrated deprivation-related inequalities in uptake of orthodontic treatment in North East (Morris *et al.*, 2006) and South East England (Drugan

et al., 2007). More recently, a 2013 national dental health survey found greater ‘unmet orthodontic treatment need’ among children eligible for free school meals (an indicator of family deprivation) (Rolland *et al.*, 2016). The inequality in ‘unmet orthodontic treatment need’ is likely to be the outcome of interaction between several factors such as differences in normative and subjective need and factors related to health services. While reporting unmet orthodontic treatment need could be useful for planning health services, it does not provide information about variation in normative or subjective need. For example, it may be that variation in uptake is due to variation in need, rather than inequality in access to services. This study aims address this gap in the evidence by investigating inequalities in normative and subjective need and uptake of orthodontic treatment in England using both individual and aggregate data.

Methods

We used data from two studies: the 2013 Child Dental Health Survey (Health & Social Care Information Centre, 2015) and 2008/2009 NHS Dental Epidemiology Programme for England (NHS Dental Epidemiology Programme for England, 2010). CDHS 2013 reported individual-level data on orthodontic components whereas NDEP 2008/2009 provided aggregate data at local level for the NHS commissioning organisations in existence at the time of data collection (Primary Care Trusts, PCTs).

Both surveys involved clinical examination of subjects to identify orthodontic need using the modified-Index of Orthodontic Treatment Need (IOTN) (Burden *et al.*, 2001) and self-reported information obtained through a questionnaire.

CDHS 2013 sampled 9,866 children aged 5, 8, 12 and 15 years attending state and independent schools. Children aged 12 & 15 underwent clinical examination and reported information on aspects of orthodontic status. The overall response rates were 83% and 74% for 12 and 15-year-olds, respectively. For this study, we used the data from England only. The NDEP 2008/2009 sampled 88,993 children aged 12 years from 140 participating PCTs. All children underwent clinical orthodontic examination and were administered a questionnaire. The complete methods for both surveys were described in the original reports (Health & Social Care Information Centre 2015; NHS Dental Epidemiology Programme for England 2010).

Both surveys measured orthodontic treatment need in children who were not undergoing treatment at the time, based upon a simplified IOTN (Burden *et al.*, 2001). This index has a dental health (DHC) and an aesthetic component (AC). DHC assesses five aspects, missing/impacted teeth, overjet, crossbite, displacement of contact points and overbite. The AC score is based on an assessment of the participant against ten photographs showing different levels of dental appearance. Those with definite need were identified using both components (DHC ≥ 4 or AC ≥ 8).

Both surveys also used questionnaires to assess the children's desire to have their teeth straightened; this desire was described as willingness and we have retained the phrase for consistency. CDHS 2013 asked children 'at the moment, do you think that your teeth are all right as they are or would you prefer to have them straightened?' NDEP 2007/2008 used two questions: (a) 'Do you think your teeth need straightening?' and (b) 'Would you be prepared to have treatment and wear a brace if it were necessary?'; only those who answered 'yes' to both questions were considered willing to have orthodontic treatment.

Three orthodontic variables were assessed in this study: (1) uptake of orthodontic treatment, (2) normative need and (3) subjective need. For all outcomes, both present and previous experience was calculated (See Table 1 for details). This allowed us to evaluate the cumulative experience of orthodontic treatment, normative need and subjective need. Uptake of orthodontic treatment for CDHS 2013, for instance, was defined as both those who reported past orthodontic treatment or were currently undergoing treatment. However, for the NDEP 2008/2009, past treatment was not reported, so the uptake of orthodontic treatment was ascertained by those undergoing orthodontic treatment at the time of survey. Normative need was defined as the state in which the child had been defined at some point as having a need for treatment. Therefore, to calculate normative need for NDEP 2008/2009, we included those who had definite need for orthodontic treatment at the time of the survey. For the CDHS 2013, in addition to those who were undergoing orthodontic treatment at the time of survey, those who reported past treatment were

included in the calculation of normative need. Similarly, subjective need was also defined as historical willingness to undergo orthodontic treatment whether in the past or present. Subjective need, therefore, was calculated based on present and past willingness to have teeth straightened, so those who had received orthodontic treatment at any point were included in this category.

Table 1. Definition of orthodontic outcomes

<p><i>Uptake of orthodontic treatment:</i></p> <ul style="list-style-type: none"> • Wearing appliances at the time of survey and/or • Past orthodontic treatment reported (CDHS 2013 only) <p><i>Normative need:</i></p> <ul style="list-style-type: none"> • IOTN (DHC=4/5 OR AC=8/10) and/ or • Wearing appliances at the time of the survey and/or • Past orthodontic treatment completed (CDHS 2013 only) <p><i>Subjective need:</i></p> <ul style="list-style-type: none"> • Willingness among those who had not received treatment and/or • Wearing appliances at the time of the survey and/ or • Past orthodontic treatment reported (CDHS 2013 only)

We reported the prevalence of orthodontic variables across deprivation quintiles. For assessing overall inequalities, we used two regression-based summary measures of inequalities: Slope Index of Inequality (SII) and Relative Index of Inequality (RII), which have been recommended by the World Health Organisation for monitoring health inequalities (WHO, 2013). The values of SII & RII are interpreted as the hypothetical absolute and relative difference between the least and most deprived. These are preferred to simpler inequality indicators as they take into account the distribution of outcome across categories of deprivation rather than comparing the extreme ends of deprivation spectrum; they also account for the number of individuals in each category of socioeconomic status. In addition to methodological appropriateness, these indices are also relatively easy to interpret. For example, for uptake of orthodontic treatment, an SII of 0.10 indicates a 10-percentage point difference between the bottom and top of deprivation distribution. The negative and positive values of the SII show the direction of the relationship, i.e. whether the outcome increases or decreases with deprivation. The interpretation of the RII is similar to relative risk; a value of 1.5 for uptake of orthodontic treatment, for instance, indicates that the treatment use at the top of the deprivation distribution is 1.5 times greater than the bottom of the deprivation distribution.

For CDHS 2013, summary measures were calculated based on the distribution of the sample across quintiles of 2010 IMD deprivation, which was based on household postcodes in the survey. For NDEP 2007/2008, summary measures were calculated using PCT average IMD (2007) using data from the Office for National Statistics (ONS). The number of individuals in each PCT was reported in the survey based on available mid-year population data. Statistical significance was set at 0.05. Analysis was carried out using Stata 13.

Results

In CHDS (12 and 15 year olds) the prevalence of uptake of orthodontic treatment, normative need and subjective need were 22.9%, 44.8% and 56.9% respectively. In NDEP 2007/2008 (12 year olds) the values were 7.9%, 39.6%, and 43.3% respectively.

Tables 2 and 3 summarise the distribution of orthodontic variables across the quintiles of IMD for the CDHS 2013 and NDEP 2007/2008, respectively (the prevalence of orthodontic variables for each PCT in the NDEP 2007/2008 is available upon request from the authors).

There was an inverse relationship between deprivation and the uptake of orthodontic treatment in both surveys. The SII values for NDEP 2007/2008 and CDHS 2013 were 0.05 (95% CI: 0.03, 0.07) and 0.14 (95% CI: 0.08, 0.19) respectively. These indicate 5% and 14% higher prevalence of uptake of orthodontic treatment between children from the least and most deprived areas. In terms of relative difference (RII), the uptake of orthodontic treatment in the least deprived was 1.9 times greater than the most deprived areas in both surveys (CDHS 2013: RII=1.87, 95% CI: 1.44, 2.43); (NDEP 2007/2008: RII=1.90, 95% CI: 1.5, 2.42). Normative need was not associated with deprivation in either survey (CDHS 2013: SII= 0.03, 95% CI: -0.04, 0.1; RII=1.06, 95% CI: 0.91, 1.24); (NDEP 2007/2008: SII= 0.03, 95% CI: -0.02, 0.07; RII=1.06, 95% CI: 0.96, 1.18).

There was greater willingness to straighten teeth in more deprived 12 and 15-year-olds in CHDS 2013 (SII=-0.09, 95% CI: -0.16, -0.03; RII=0.85, 95% CI: 0.75, 0.96). The aggregate data from the NDEP 2007/2008 did not show significant variation by deprivation in willingness for treatment (SII=0.03, 95% CI: 0, 0.06; RII=1.07, 95% CI: 0.99, 1.15).

Age stratified analyses of the CDHS 2013 data replicated the overall findings for uptake of orthodontic treatment and normative need in both age groups. However, deprivation was associated with greater willingness to straighten teeth in 12 year old children but not in 15 year olds.

Discussion

We used data from two national surveys to investigate normative and subjective need and uptake of orthodontic treatment and found no significant variation in normative need by deprivation but significant variation in the receipt of orthodontic treatment. The least deprived had 1.9 times greater chance of receiving treatment compared to the most deprived. There was evidence of greater subjective need among the more deprived children from CDHS 2013 but not in NDEP 2007/2008.

In theory, inequalities in the uptake of orthodontic treatment could be due to greater normative need in more affluent children, but our analyses do not support this hypothesis. Equally, it could be argued that lower subjective need in more deprived communities explains lower receipt of care; again our analysis does not support this assumption. On the contrary, subjective need was more pronounced among deprived children in the CDHS 2013. In summary, it is unlikely that the greater uptake of orthodontic treatment among the better-off is related to variation in normative or subjective need.

Table 2. Distribution of orthodontic outcomes in CDHS 2013 by IMD categories

IMD	12 & 15 year Olds (n=2636)			12 year olds (n=1376)			15 year olds (n=1260)					
	Number	Uptake of orthodontic treatment	Normative need	Subjective need	Number	Uptake of orthodontic treatment	Normative need	Subjective need	Number	Uptake of orthodontic treatment	Normative need	Subjective need
Least Deprived	313	26.6%	45.8%	51.9%	157	14.8%	46.3%	47.2%	156	37.9%	45.3%	56.5%
2	365	23.3%	42.0%	52.9%	193	15.5%	45.0%	55.8%	172	31.3%	38.9%	50.0%
3	326	25.6%	43.5%	47.8%	169	10.3%	37.8%	41.1%	157	37.4%	47.9%	53.0%
4	504	22.1%	44.9%	61.4%	260	10.7%	42.3%	60.4%	244	32.5%	47.4%	62.3%
Most Deprived	1128	19.4%	45.8%	59.7%	597	12.6%	42.3%	63.1%	531	26.6%	49.5%	56.1%
Total	2636	22.9%	44.8%	56.9%	1,376	12.9%	42.8%	56.4%	1,260	32.3%	46.6%	57.3%
SII		0.14 (0.08, 0.19)	0.03 (-0.04, 0.1)	-0.09 (-0.16, -0.03)		0.08 (0.02, 0.14)	0.07 (-0.02, 0.17)	-0.14 (-0.23, -0.04)		0.19 (0.1, 0.28)	-0.02 (-0.12, 0.08)	-0.05 (-0.15, 0.05)
P Values		<0.001	0.447	0.007		0.014	0.144	0.005		<0.001	0.645	0.3
RII		1.87 (1.44, 2.43)	1.06 (0.91, 1.24)	0.85 (0.75, 0.96)		1.94 (1.16, 3.23)	1.18 (0.95, 1.48)	0.78 (0.65, 0.93)		1.78 (1.33, 2.37)	0.95 (0.77, 1.18)	0.92 (0.77, 1.08)
P Values		<0.001	0.447	0.008		0.011	0.139	0.006		<0.001	0.65	0.307

SII: Slope Index of Inequality RII: Relative Index of Inequality **Bolded estimates:** significant values at confidence level of 95% are bolded

Table 3. Distribution of orthodontic outcomes in the NDEP 2007/2008 by IMD categories

IMD	Number	Uptake of orthodontic treatment	Normative need	Subjective need
Least Deprived	24003	10.5%	39.8%	45.1%
2	21037	7.5%	39.3%	43.3%
3	12841	6.9%	39.6%	41.0%
4	14680	6.9%	36.7%	41.7%
Most Deprived	16432	6.5%	41.9%	44.1%
Total	88993	7.9%	39.6%	43.3%
SII		0.05 (0.03, 0.07)	0.03 (-0.02, 0.07)	0.03 (0, 0.06)
P Values		<0.001	0.236	0.093
RII		1.9 (1.5, 2.42)	1.06 (0.96, 1.18)	1.07 (0.99, 1.15)
P Values		<0.001	0.236	0.091

SII: Slope Index of Inequality

RII: Relative Index of Inequality

Bolded estimates: significant values at confidence level of 95% are bolded

A plausible explanation for the observed inequality may be variation in uptake of routine dental care which is the main gateway to specialist referral. For example, two thirds of 12 year children in CDHS who were eligible for free school meals reported visiting for check-ups compared to 86% of those non-eligible (Health & Social Care Information Centre 2015). Lower uptake of orthodontic treatment in deprived areas and among more deprived children could be also linked to other barriers to health services such as long waiting lists or poor transport links. Accessing specialist dental services may require greater travelling distances than for routine care and, if provided in non-hospital settings, does not attract NHS support for travel costs.

Caution should be practiced when comparing our findings with those of other studies due to differing definitions of normative and subjective need. For example, Rolland and colleagues (2016), using CDHS 2013 data reported inequalities in 'unmet orthodontic] treatment need' which, would not account for those with a previous need, since met with orthodontic treatment, unlike the previous or present normative need in our study. Analysis of CHDS 2003 data by Price (2016) did account for children who had received treatment, finding no social inequalities in normative need.

The link between deprivation and subjective need was inconsistent in our analysis. Subjective need for orthodontic treatment arises from a complex interaction between a wide range of social and psychological factors, including the impact on quality of life. For example, our recent analyses of British data show that the association between malocclusion and OHRQoL varies by SES groups, with children eligible for free school meals (an indicator of family deprivation) reporting higher impact of malocclusion (Ravaghi *et al.* 2019). Other studies have investigated the moderating effect of self-esteem in the association between malocclusion and OHRQoL with inconsistent findings (Agou *et al.*, 2008; De Baets *et al.*, 2012).

Efforts were made to identify and create comparable variables from two surveys for this study. The aggregate nature of the NDEP 2007/2008 as compared to individual level data from CDHS 2003 should, however, be noted when interpreting the findings. All conclusions drawn regarding inequalities based on the NDEP 2007/2008

relates to differences between English areas (i.e. PCTs) whereas the findings of the CDHS 2013 describes inequalities in children.

The NHS commissioning guide for orthodontics advises that one out of three child in any given population will require treatment (NHS England, 2015). Our calculations, which have taken into account those already in treatment produced a slightly larger estimate, ranging from 40% in NDEP 2007/2008 to 46% among 12 year olds in the CDHS 2013. We cannot, however, be certain that those who reported past treatment or were receiving treatment at the time would have met the survey criteria for unmet need before their treatment. Nevertheless, our findings suggest that planners of dental care programmes should consider how ensuring that access to orthodontic care is equitable.

Conclusion

There were inequalities in receiving orthodontic treatment among children with a lower uptake of treatment among more deprived groups. We found no evidence of inequalities in normative need and some evidence of greater present subjective need in more deprived groups. Our findings suggest inequalities in access to services.

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