An alternative marker for the effectiveness of water fluoridation: hospital extraction rates for dental decay, a two-region study

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IN BRIEF

- Demonstrates the usefulness of routinely collected hospital episodes data in assessing child oral health.
- Suggests a method that can be readily and inexpensively replicated.
- Highlights that even when deprivation is taken into account, when comparing West Midlands with the North West, 0-19-year-olds in unfluoridated areas appear to experience a greater rate of extractions than those in fluoridated areas.

RESEARCH

Background Contemporary evidence for the effectiveness of water fluoridation schemes in the UK is sparse. The utility of routinely collected data in providing evidence warrants further research. **Objectives** To examine inpatient hospital episodes statistics for dental extractions as an alternative population marker for the effectiveness of water fluoridation by comparing hospital admissions between two major strategic health authority (SHA) areas, the West Midlands SHA – largely fluoridated – and the North West SHA – largely unfluoridated. **Method** Hospital episodes statistics (HES) were interrogated to provide data on admissions for simple and surgical dental extractions, which had a primary diagnostic code of either dental caries or diseases of pulp and periapical tissues for financial years 2006/7, 2007/8 and 2008/9. Data was aggregated by SHA area and quinary age group. Directly standardised rates (DSR) of admissions purchased for each primary care trust (PCT) were calculated and ranked by index of multiple deprivation (IMD). **Results** A significant difference in DSRs of admission between PCTs in the West Midlands and North West was observed (Mann-Whitney U test [p <0.0001]) irrespective of IMD ranking. The difference in rates between the two most deprived PCTs was 27-fold. **Conclusions** After ranking by IMD, DSRs of hospital admissions for the extraction of decayed or pulpally/periapically involved teeth is lower in areas with a fluoridated water supply. The analysis of routinely collected HES data may help identify the impact of water fluoridation schemes.

INTRODUCTION

The recent passage of the Health and Social Care Act 2012 gives each unitary and upper tier local authority the duty to: 'take such steps as it considers appropriate for improving the health of the people in its area'.[1] The publication of *Healthy lives, healthy people* in January 2012 by the Department of Health identified a number of public health outcome indicators that local authorities could influence, including one for improving the level of tooth decay in five-year-old children.[2]

Artificial water fluoridation has been used as an effective method of improving oral health in some areas of the UK for several decades. The West Midlands has the most extensive and longstanding number of fluoridation schemes, covering some 3.4 million people, with many schemes dating from the mid 1960s, introduced by local authorities.

While literature on the effectiveness of water fluoridation continues to be published,[3] contemporary UK specific reports of clinical trials on the efficacy of water fluoridation remain understandably absent; it is methodologically very challenging to design and execute a randomised control trial that examines the effect of water fluoridation. Traditionally, the NHS Dental Epidemiology Programme has been used to provide regular, contemporaneous data demonstrating the effects of water fluoridation on dental health in a particular region through the examination of schoolchildren across England and Wales.

Despite being a largely preventable disease, dental decay in children and adolescents remains extremely common,[4–6] although there are wide variations in the extent to which it affects this population group across the UK. Left unchecked, the progress of dental decay can be inexorable, leading to pain and suffering for the individual, with often no alternative treatment option other than removal of the tooth.

Dental extractions in children can be stressful for the patient, the child's parent and the practitioner. This often leads to the utilisation of general anaesthetic services in a hospital environment to effect the extraction of the tooth or teeth. There is evidence that this intervention remains stressful for the child and their parent and can act as a predictor for future dental anxiety and avoidance of dental service.[7,8]

The uptake of hospital services for the extraction of teeth that are decayed or infected may act as a marker for both the prevalence of dental decay and its severity within the population. In order to gain a picture of the possible contributory effects of water fluoridation in preventing the initiation and sequelae of dental decay, a retrospective review of admissions to hospital purchased by primary care trusts (PCTs) in the West Midlands' Strategic Health Authority (SHA), which is largely fluoridated and the North West SHA (largely unfluoridated) for the extraction of decayed or pulp/periapically involved teeth in the 0-19 year age group

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for the period financial years (FY) 2006/7 to 2008/9 was undertaken.

This paper aims to provide contemporary ecological evidence for the beneficial effects of water fluoridation on dental health using routinely collected hospital data as an alternative population marker.

METHOD

Inpatient hospital episodes statistics (HES) were interrogated to provide data on admissions for simple and surgical dental extractions (procedure codes F09 and F10), which had a primary diagnosis code of either K02 (dental caries) or K04 (diseases of pulp and periapical tissues) during FY 2006/7, 2007/8 and 2008/9 in patients aged 0-19. Data were extracted by one person and only cleaned HES data sets from complete FYs were interrogated. Data was included for patients registered with a general medical practitioner in that PCT and for each FY the data was grouped by quinary age group (0-19 years) and PCT for both the West Midlands SHA and North West SHA areas.

Population estimates for each age group by PCT were obtained from the Office for National Statistics Primary Care Organisation mid-year population estimates for 2007, 2008 and 2009. Using the European Standard Population, directly standardised rates (DSR) of admissions purchased for each PCT were calculated and plotted to show any changing trends over the three year period. This gave regional but separate pictures of admission activity purchased.

Ranked indices of multiple deprivation (IMD) reflecting the area served by each PCT were only available for 2007.[9] Using the data for 2007/8, each PCT was arranged in rank order of its IMD with the corresponding DSRs for hospital admissions purchased in FY 2007-8. Relative rates of DSR for each PCT were calculated using the DSR in Heart of Birmingham PCT, the PCT ranked as being the most deprived PCT in England in 2007, as the reference.

In addition to this, for each FY the DSR data for each PCT identified by SHA region and was input to STATA (STATA 11. StataCorp, 4905 Lakeway Drive, College Station, Texas 77845 USA) and a Mann-Whitney U test performed to establish if a statistically significant difference existed between the DSRs of each SHA region.

RESULTS

Comparison of West Midlands and North West PCTs

Assembling the data for the West Midlands and the North West over this three-year

Table 1 Relative standardised rates of admissions purchased by IMD ranking, NW/WM for FY 2007–8. NB: NW PCTs in bold

PCT name	PCT Ranking of Average IMD Score 2007	DSR admissions per 10000 FY 2007–8	Relative rates of DSR compared to HOB	
Heart of Birmingham Teaching (HOB)	1	4.17	1.00 (reference)	Most deprived
Liverpool	2	112.58	27.00	
Manchester	5	92.27	22.13	
Knowsley	6	51.51	12.35	
Birmingham East and North	10	4.84	1.16	
Blackpool	12	106.20	25.47	
Sandwell	14	4.91	1.18	
Salford	15	61.37	14.72	
Blackburn with Darwen	16	101.96	24.45	
Stoke on Trent	18	4.88	1.17	
Heywood, Middleton and Rochdale	24	82.00	19.66	
Wolverhampton City	27	53.66	12.87	
Halton and St Helens	33	19.68	4.72	
South Birmingham	34	4.75	1.14	
Oldham	36	22.47	5.39	
Walsall Teaching	38	14.00	3.36	
Bolton	40	22.51	5.40	
Wirral	46	8.30	1.99	
Coventry Teaching	47	11.94	2.86	
East Lancashire Teaching	50	46.26	11.09	
Tameside and Glossop	51	20.56	4.93	
Ashton, Leigh and Wigan	54	84.78	20.33	
Sefton	63	47.46	11.38	
Dudley	76	5.42	1.30	
Telford and Wrekin	81	5.95	1.43	
Bury	83	72.42	17.37	
Cumbria Teaching	85	12.42	2.98	
Central Lancashire	88	62.99	15.10	
North Lancashire Teaching	100	42.83	10.27	
North Staffordshire	101	4.35	1.04	
Stockport	102	37.02	8.88	
Warrington	104	12.63	3.03	
Herefordshire	105	7.60	1.82	
Trafford	107	57.03	13.68	
Western Cheshire	109	11.59	2.78	
Shropshire County	112	5.05	1.21	
Solihull	114	3.27	0.78	
South Staffordshire	119	3.88	0.93	
Worcestershire	121	3.38	0.81	
Warwickshire	125	8.88	2.13	
Central and Eastern Cheshire	132	7.91	1.90	Least deprived

Mann-Whitney U test: z = -4.869, p <0.0001

period reveals that although individual PCTs experience minor changes of position within the 'league table', there is a very definite and persistent divide in the DSRs for admissions between the North West and the West Midlands. Although 2007/8 has been described in detail, repeating the analysis for each year shows a similar pattern.

The Mann Whitney U test revealed a statistically significant difference between the DSRs of the PCTs in the West Midlands and the North West for each year under examination, ($p < 0.0001$).

Relative rates of admission by deprivation

The PCT serving the most deprived area in England was Heart of Birmingham, with the second most deprived being Liverpool. Although separated by only one place in the IMD ranking, the DSR of admissions purchased by Liverpool PCT in 2007/8 for extractions due to dental decay, pulp or periapical disease was 27 times greater than in Heart of Birmingham PCT.

Of the 11 PCTs in the two regions serving the most deprived areas, (ranked between 1 and 24), four were from the West Midlands. The directly standardised rates of admissions in these West Midlands PCTs varied between 4.17 and 4.91 per 10,000 while the PCTs serving similarly deprived areas of the North West had rates between 51.51 and 112.58 per 10,000. As IMD rank increased and deprivation decreased, the rates of admissions purchased by West Midlands PCTs were consistently lower than their North West counterparts ranked close to them, with the exception of Wolverhampton PCT (Table 1).

DISCUSSION

Both of these SHA areas encompass major industrial conurbations with a wide spread of IMD from the severest areas of deprivation to relative affluence. It would appear from this data that children and adolescents in the largely unfluoridated North West experience a greater prevalence of dental decay that is sufficiently severe to warrant admission to hospital for the removal of the tooth/teeth compared to the largely fluoridated West Midlands, even when deprivation is taken into account. Not only do these admissions necessarily result in the loss of teeth but there may also be psychological impacts upon these patients, resulting in greater anxiety and possible avoidance of dental visits in the future.

Previous research has compared the cost of dental treatment needed by children in fluoridated and non-fluoridated communities but used costs based on the British National Health Service scale of fees for general dental practitioners in effect at the time.[10,11] The financial cost of performing even a simple extraction in a hospital theatre is significant: under the 2008/9 payment by results tariff, the cost of performing such a procedure was £558.[12] Although the 0-19 year population in the North West (1.7million) is 31% larger than the West Midlands (1.3 million) some 742% more hospital admissions (approximately 6,000) took place each year in the North West for dental extractions through decay, pulp or periapical disease. This incurred an additional cost of approximately four million pounds.

In addition to the financial and service impacts of dental caries described, there will also be impacts at an individual and family level for those people undergoing extraction. These may include pain, sepsis, time lost from work or school or sleepless nights, although no attempt has been made to quantify these in this study.

The clinical burden of performing these extraction services falls mainly to hospital oral and maxillofacial surgery departments with a commensurate increase in clinical caseload. Arguably this is not the most apposite use of an expensive and highly trained resource and it may impede or delay access to these services for patients with greater degree of need. There is also a significant but unquantified opportunity cost in relation to the utilisation of hospital anaesthetic services.

Before ascribing these results to the benefits of water fluoridation, other possible explanations need to be explored.

HES data is compiled as a result of coding clerks in hospitals transposing the notes from discharge records of patients. It follows that if there were systematically different practices in the recording of procedures between all hospitals in the North West and the West Midlands then a differential would be observed. It does, however, seem unlikely that this practice would occur, especially as hospital income is derived via the correct annotation of procedure through the Healthcare Resource Group/payment by results system.

It is also possible that there is hospital-based extraction activity taking place that is not recorded on HES, for example by some NHS trust primary care dental services undertaking dental extractions using hospital facilities. It is unclear how many of these admissions are recorded on HES, or how recording these episodes varies from hospital to hospital. This area needs further investigation but seems unlikely to account for the magnitude of the observed differences between the two regions.

Water fluoridation may be a significant contributor to the differential observed. In both regions are PCTs whose fluoridation status diverges from the regional 'norm'. North Staffordshire, Herefordshire and Shropshire are all unfluoridated yet have lower rates of admission than PCTs in the North West with similar IMD rankings. This may be a result of the halo effect[13] of living adjacent to a fluoridated area. Eastern Cheshire and Cumbria PCTs both perform better on this indicator than the majority of PCTs in North West region. Both have fluoridation schemes, although these do not reach all of the population of the PCT.

There are intrinsic limitations to this study: it is an ecological study that only examines two SHA areas and the population group studied is confined to the 0-19-year-old age group. The data records only admissions and does not give details of the number of teeth extracted during each admission. No attempt has been made to establish lifetime exposure to fluoridated water of those who experienced extractions. Equally, this method offers a straightforward and easily accessible method of examining and quantifying some of the benefits of water fluoridation.

CONCLUSION

Analysis of the West Midlands and North West data shows a clear and consistent pattern that endures on an annual basis. After age standardisation of admission rates and ranking by deprivation, PCTs in the West Midlands have a significantly lower rate of admission to hospitals in 0-19-year-olds for the extraction of teeth that are decayed or pulp/periapically involved compared to the North West. Analysis of routinely collected HES shows potential utility as a tool for demonstrating the impact of water fluoridation schemes.

1. Health and Social Care Act 2012. *Duties as to improvement of public health. Chapter 7, Part 1, Section 12.* Online information available at http://www.legislation.gov.uk/ukpga/2012/7 (accessed February 2014).
2. Department of Health. *Healthy lives, healthy people. Improving outcomes and supporting transparency.* London: DH, 2012.
3. Rugg-Gunn A J, Do L. Effectiveness of water fluoridation in caries prevention. *Community Dent Oral Epidemiol* 2012; **40(Suppl 2):** 55–64.
4. Office for National Statistics. *Children's dental health in the United Kingdom, 2003.* London: ONS, 2003. Online information available at http://www.ons.gov.uk/ons/guide-method/method-quality/specific/health-methodology/dental-health/dental-health-of-children/index.html (accessed February 2014).
5. NHS Dental Epidemiology Programme for England. *Oral health survey of 5-year-old Children 2007/8.* NHS Dental Epidemiology Programme for England, 2009. Online information available at http://www.nwph.net/dentalhealth/reports/NHS_DEP_for_England_OH_Survey_5yr_2007-08_Report.pdf (accessed February 2014).
6. NHS Dental Epidemiology Programme for England.

Oral health survey of 12-year-old children 2008/9. NHS Dental Epidemiology Programme for England, 2010. Online information available at http://www.nwph.net/dentalhealth/reports/Report_NHS_DEP_for_England_OH_Survey_12yr_2008-09.pdf (accessed February 2014).
7. Karjalainen S, Olak J, Söderling E, Pienihäkkinen K, Simell O. Frequent exposure to invasive medical care in early childhood and operative dental treatment associated with dental apprehension of children at 9 years of age. *Eur J Paediatr Dent* 2003; **4:** 186–190.
8. Gazal G, Mackie I C. Distress related to dental extraction for children under general anaesthesia and their parents. *Eur J Paediatr Dent* 2007; **8:** 7–12.
9. The National Archives. *Indices of deprivation 2007*. Online information available at: http://webarchive.nationalarchives.gov.uk/+/http://www.communities.gov.uk/communities/neighbourhoodrenewal/deprivation/deprivation07/ (accessed February 2014).
10. Downer M C, Blinkhorn A S, Attwood D. Effect of fluoridation on the cost of dental treatment among urban Scottish schoolchildren. *Community Dent Oral Epidemiol* 1981; **9:** 112–116.
11. Attwood D, Blinkhorn A S. Reassessment of the effect of fluoridation on cost of dental treatment among Scottish schoolchildren. *Community Dent Oral Epidemiol* 1989; **17:** 79–82.
12. Department of Health. *Payment by results: guidance and tariff for 2008–2009*. London: DH, 2007. Online information available at: http://webarchive.nationalarchives.gov.uk/+/www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_081096 (accessed February 2014).
13. Griffin S O, Gooch B F, Lockwood S A, Tomar S L. Quantifying the diffused benefit from water fluoridation in the United States. *Community Dent Oral Epidemiol* 2001; **29:** 120–129.