Area-level deprivation, childhood dental ambulatory sensitive hospitalisations, and community water fluoridation: evidence from New Zealand

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Abstract

Background:
We examined the association between area-level deprivation and dental ambulatory sensitive hospitalisations (ASH), and considered the moderating effect of community water fluoridation (CWF). The hypothesis was that higher levels of deprivation are associated with higher dental ASH rates, and that CWF will moderate this association such that children living in the most deprived areas have greater health gain from CWF.

Methods:
Dental ASH conditions (dental caries and diseases of pulp/periapical tissues), age, gender and home address identifier (meshblock) were extracted from pooled cross-sectional data (Q3, 2011 to Q2, 2017) on children aged 0-4 and 5-12 from the National Minimum Dataset, New Zealand (NZ) Ministry of Health. CWF was obtained for 2011 and 2016 from the NZ Institute of Environmental Science and Research. Dental ASH rates for children aged 0-4 and 5-12 (/1000) were calculated for census area units (CAU). Multilevel negative binomial models investigated associations between area-level deprivation, dental ASH rate, and moderation by CWF status.

Results:
Relative to CWF (2011 and 2016), no CWF (2011 and 2016) was associated with increased dental ASH rates in children aged 0-4 (Incidence Rate Ratio (IRR)=1.171 [95%CI 1.064-1.288]; and aged 5-12 (IRR=1.181 [1.084-1.286]). An interaction between area-level deprivation and CWF showed that the association between CWF and dental ASH rates was greatest within the most deprived quintile of children aged 0-4 (IRR=1.316 [1.052-1.645]).

Conclusion:
CWF was associated with reduced dental ASH rate for children aged 0-4 and 5-12 years. Children living in the most deprived areas showed the greatest effect of CWF on dental ASH rates indicating that the greater health gain from CWF occurred for those with highest socioeconomic disadvantage. Variation in CWF contributes to structural inequities in oral health outcomes for children.

Key words: Community Water Fluoridation (CWF), dental ambulatory sensitive hospitalisation (ASH) rates, area-level deprivation, moderation, children, dentist.

Key messages

- Ambulatory sensitive hospitalisations (ASH) account for approximately 30 percent of all acute and arranged medical and surgical discharges in New Zealand.
- Dental ASH are a leading cause of potentially avoidable admission to hospital with a strong social gradient according to deprivation.
- The effect of community water fluoridation in moderating the association between deprivation and dental ASH has not been studied previously.
- Using pooled data from National Minimum Dataset, we found that area-level deprivation was related to higher dental ASH rates in children aged 0-4 and 5-12 and that community water fluoridation moderated this association in children aged 0-4.
- The greatest absolute benefit from community water fluoridation for dental ASH occurs in the most deprived areas.

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1. Introduction

Many health indicators show a social gradient in population health related to inequity in social and economic status [1-4]; groups at the top of the social hierarchy have better health than those immediately below them in a continuous gradient of deteriorating health [5]. Such differences are considered unfair, unjust, and avoidable [6]. Disparity in oral health status by socioeconomic status has been observed in several countries [5, 7]. The most recent New Zealand (NZ) oral health survey showed that people living in areas of high deprivation were almost three times as likely to have completely lost their teeth compared with people in areas of low deprivation [8]. While child oral health has improved notably in the past decades [9], estimates suggest that 20% of NZ children aged 2-4 are affected by dental decay [8]. Globally, and in NZ, the persistent nature of oral health inequities present a significant challenge to policy makers [5].

Studies in Canada [10], England [11] and in NZ [12] have reported high rates of children admitted to hospital for oral health (dental) conditions. Ambulatory Sensitive Hospitalisations (ASH) are hospital admissions for conditions which could be prevented or treated in primary care [13]. In NZ, childhood ASH accounts for approximately 30 percent of all acute and arranged medical and surgical discharges [14]. ASH conditions include dental caries and diseases of pulp and periapical tissues. In NZ, community oral health services are provided free of charge to all children aged under 18 years in district hospitals and by outreach services. Simple procedures can be provided in mobile clinics, but procedures requiring a general anaesthetic are only provided in hospital and are counted as dental ASH.

Preventative public health measures coupled with early diagnosis and management in community settings have the potential to reduce health loss and the burden on the health system. Community water fluoridation (CWF) is a preventative measure that has received little attention as a way of addressing dental ASH in the context of the social gradient of health [10]. It is a public health intervention that involves the controlled addition of a fluoride compound to a public drinking water system [9]. CWF prevents dental decay [9]; a recent systematic review showed some evidence that dental caries increased post-CWF cessation [15]. While US [16], Brazilian [17], Australian [18], and UK [19] research in large samples of children highlights that CWF is associated with reduced dental caries, less is known about dental-related hospital admission rates. A UK study showed 45% fewer hospital admissions for tooth extractions in children aged 1-4 in fluoridated, compared to non-fluoridated areas [19]. Research is needed to examine the associations between area-level deprivation, dental ASH, and CWF [15]. In NZ, the decision to add fluoride to water supplies is made by elected local district council boards leading to variation between areas and over time in CWF.

Internationally, studies on CWF and dental ASH have been limited by small sample size, single time point measures of CWF, and use of proxy measures for CWF. The increased prevalence of dental decay among children living in the most deprived areas suggests there may be a greater absolute benefit from CWF in those deprived areas [9]. Our study investigates the relationship between CWF and dental ASH rates and examines the moderating effect of CWF on the association between deprivation and dental ASH. The hypothesis is that higher levels of deprivation will be associated with higher dental ASH rates; and CWF will moderate this association such that those who reside in the most deprived areas have the most to gain from CWF.

2. Methods

2.1 Participants and settings

Individual-level data were obtained from the National Minimum Dataset (NMDS) for children aged 0-12 across New Zealand. Data from six years (Q3, 2011 – Q2, 2017) were pooled. Access to data used in this study was provided by the New Zealand Ministry of Health under conditions designed to keep individual information confidential and secure in accordance with requirements of the Health Information Privacy Code 1994 and the Privacy Act 1993. Anonymised age, gender, meshblock identifier (ID) as identifier of residential address, and ASH rates were provided. The ASH conditions included were based on the ICD-10 (International Statistical Classification of Diseases and Related Health Problems [10th edition]) from the New Zealand ASH code lists for dental conditions, including category codes KO2 (dental caries) and KO4 (diseases of pulp and periapical tissues). Data from individuals aged 0-12 (n=1 115 954) were extracted from the National Minimum Dataset. Data with no valid geographic identifier were excluded (n=28 389) resulting in 1 087 565 records. Only dental-related admissions were extracted (n=47 552). Further records were removed due to missing age bands (n=6074) resulting in a final analytical sample of 41 478 children. Age-group categories of 0-4 and 5-12 were then created. These were attached to 2013 census data and geographical areas to calculate ASH rates (per 1000) for children aged 0-4 and 5-12 years. Rural/urban classification was defined as: main urban areas, secondary urban areas, minor urban areas and rural. Main urban areas (large towns and cities) have a minimum population of 30,000, secondary urban areas have a population of 10,000 to 29,999 and minor urban areas are small towns with 1,000 to 9,999 people.

2.2 Access to community oral health services

The location of community oral health services (not including private dentists) were obtained from the Ministry of Health. Community oral healthcare services relate to publicly funded District Health Board (DHB) provided services. This geospatial data allowed the research to control for community oral healthcare services availability. Estimated travel time by motor vehicle from population weighted centroids to closest facility for community oral health services via road network was calculated at 0-29 minutes, 30 to 59 minutes, and >59 minutes. Accessibility analysis was computed using the tool “service area networks” in ArcGIS 10.4.1 (©ESRI Inc.).

2.3 Change in water fluoridation

Water fluoridation data for 2011 and 2016 were extracted by ESR (NZ Institute of Environmental Science and Research) from a drinking water database archive maintained on behalf of the Ministry of Health. Geospatial data was not included in the database holdings. Water supplies listed as fluoridated were mapped spatially based on supply name and joined to city and locality shapefiles by the GeoHealth Laboratory. This provided geographical boundaries for areas in NZ that were fluoridated or not at the two time points. Meshblocks were identified in ArcGIS if they intersected with the localities that were listed as fluoridated. Meshblocks were defined as four categories of: (1) fluoridated (both 2011 and 2016); (2) fluoridated in 2011 but not in 2016 (3) fluoridated in 2016 but not in 2011; (4) not fluoridated in either 2011 or 2016. Due to low numbers, categories two and three were amalgamated and called partially fluoridated (partial CWF). Population weighted centroids for meshblocks were identified within the fluoridated areas and joined to census area units (CAUs) if the centroid was completely within the CAUs in ArcGIS. This resulted in 801 CAUs defined as fluoridated, 47 partially fluoridated and 1,064 not fluoridated.

2.4 Statistical analysis

Age-adjusted hospitalization rates were calculated using a direct method. Age specific (0-4 and 5-12 years) hospitalisation rates were calculated using as numerator the total number of hospitalizations and as denominator the resident population in each age group. To allow comparison between districts (DHB resident populations) age-adjusted rates were also calculated. A one-way analysis of variance (ANOVA) tested for differences between groups (fluoridated, partially fluoridated, not fluoridated) with a Tukey post hoc test (equal variances were confirmed). Due to clustering within space we used a two-level hierarchical multilevel model with CAUs nested within DHBs [20]. To control for important influences on dental ASH rate, the proportions of the age-specific population were derived for each CAU according to: Māori, male, rural/urban classification, New Zealand Deprivation index (NZDep2013) and accessibility to community oral health services. The variance of the dental ASH rates were large relative to the mean, indicating overdispersion. A multilevel negative binomial model was therefore used to investigate the association between dental ASH rate and CWF due to the overdispersed outcome variables and multilevel nature of the data. Following the initial model an interaction term was then added between area-level deprivation and CWF to investigate the moderating effect of CWF for each age group of children. We checked interaction terms and assessed if the model fit improved. Analyses were conducted within STATA V15 and data are presented as incidence rate ratio [95% confidence intervals].

3. Results

3.1 Descriptive statistics and age specific dental ASH rate

Table 1 summarises age specific dental ASH rate at the census area unit (CAU) level. Overall, dental ASH rate was 10.22/1000 among those children aged 0-4 and 5.74/1000 for those aged 5-12. Children residing in the most deprived areas (Quintile 5) had the highest dental ASH rate (0-4: 18.85/1000; 5-12: 8.86/1000).

INSERT TABLE 1 HERE

3.2 Change in community water fluoridation status and dental ASH rates

Dental ASH rate (per 1000) was highest in those CAUs that were not fluoridated at both time points (2011 and 2016) for both age bands of children (Figure 1). In children aged 0-4 years dental ASH rates were lower in fluoridated compared with non-fluoridated CAUs (-3.22 [-4.47, -1.97], p<0.000). For children aged 5-12 years dental ASH rates were also lower in fluoridated versus non-fluoridated CAUs (-1.62 [-2.20, -1.04], p<0.000). There was no difference in either age band between CAUs fully fluoridated compared with partial CWF (p>0.05) or between CAUs with partial CWF compared with no CWF (p>0.05). There were marked differences in dental ASH rates by area-level deprivation and by age group (Figures 2A and 2B), being highest in the CAUs classified as most deprived (Quintile 5, Q5) for both age groups. For children aged 0-4 (Figure 2A) the difference between dental ASH rates in CAUs with CWF those without was more marked in the most deprived areas.

3.3 Multilevel models

After adjusting for covariates there was an association between CWF and dental ASH rate (Table 2). Compared to fully fluoridated CAUs , unfluoridated CAUs had higher dental ASH for children aged 0-4 (Incidence Rate Ratio (IRR) = 1.171 [95% CI 1.064, 1.288]) and aged 5-12 (IRR = 1.181 [95% CI 1.084, 1.286]). There was no association by partial fluoridation for children aged 0-4 (IRR = 0.943 [95% CI 0.756, 1.174]) or children aged 5-12 (IRR = 0.946 [95% CI 0.776, 1.153]). We fitted interaction terms between area-level deprivation (quintiles) and CWF (fluoridated, partial, not fluoridated) to investigate the hypothesis that CWF moderates the association between area-level deprivation and dental ASH rate. Separate multilevel negative binomial regression models revealed an interaction for children aged 0-4 but not for children aged 5-12. Table 3 shows that the association between change in CWF status and dental ASH rates was more pronounced for children within the most deprived quintile in children aged 0-4 (IRR = 1.316 [95% CI 1.052, 1.645]). Models using age-adjusted rates exhibited the same effects (supplementary material Table S1 and Table S2). Access to services and rurality had inconsistent effects on dental ASH (Table 2). Higher dental ASH rates were seen in children living in minor urban areas compared with main urban areas for both 0-4 years (IRR 1.207 [95%CI 1.079-1.350]) and 5-12 years (IRR=1.115 [95% CI 1.008-1.233). Children in both age bands who had a 30-59 minute drive to oral health services had lower dental ASH than those who had either a 0-29 minute drive or a greater than one hour drive (IRR 0-4 years 0.761 [0.645, 0.899], 5-12 years 0.789 [0.690, 0.917]). The numbers of individuals within each cell for the final model are shown within supplementary Table S3.

INSERT TABLE 2 HERE

INSERT TABLE 3 HERE

4. Discussion

This study investigated whether CWF improves oral health in children and reduces inequity using a population health approach. We found strong evidence that CWF was related to lower dental ASH rates in children aged 0-4 and 5-12. We also found important disparities in the effect of area-level deprivation on dental ASH rates in children by CWF status. CWF moderated this association in children aged 0-4. The key implication is that while CWF was beneficial for CAUs defined as fluoridated at both time points, the highest absolute benefit of CWF was seen in the most deprived CAUs that have the highest dental ASH rate and poorest oral health. This study adds to knowledge by using a pooled sample of nationwide child hospitalisations, measuring change in CWF over time, and investigating moderating effects by different levels of deprivation [15].

Childhood ASH accounts for approximately 30 percent of all acute and arranged medical and surgical discharges in NZ [14]. CWF is one of the ten greatest public health achievements of the 20th century but the association between CWF and dental ASH rates has not been studied extensively [21]. A Public Health England report showed 45% fewer dental-related hospital admissions for tooth extractions in children aged 1-4 in fluoridated compared to non-fluoridated areas [19]. In Australia, children residing in postcodes without CWF had 59% higher rates of potentially preventable dental hospitalizations than those with CWF [10]. A causal relationship between CWF and potentially preventable dental hospitalizations is posited by Rogers (26). Trend data for potentially preventable dental hospitalization rates of 0-4 year olds between 2001–2002 and 2012–2013 progressively reduced by 52% [22] which coincided with an increase in the proportion of the population able to access CWF (76% to 90%) [23].

Globally the persistence of oral health inequities presents a significant challenge to policy makers [5]. A systematic review found that the beneficial effects of CWF may not be the same across different population groups, but the evidence was inconclusive [15]. A recent national-level UK study showed that the greatest impact of CWF was seen among the most deprived children and those from an Asian or Asian British ethnic group [24]. The York report, a key meta-analysis found mixed results for the absolute and relative impacts of CWF by deprivation [25], due to a low number of studies and low data quality. We show a tangible and important reduction in dental ASH, especially in those living in the most deprived CAUs. Interestingly, other than for minor urban areas, rurality and distance to services did not show a consistent gradient with dental ASH. CWF offers affordability and ease of implementation to many of New Zealand's children to reduce dental ASH rates. The expansion of CWF would reduce the economic and societal burden of preventable acute dental admissions for New Zealand's hospitals. For every $1 spent on CWF in New Zealand it is estimated that $9 are saved on dental care costs [9]. Contemporary evidence shows that CWF also reduces dental caries [26]. It is therefore plausible that the overall burden of poor dental health including both dental caries and dental ASH in children could be reduced by CWF. Moreover, better oral health and reduced ASH also has wider benefits for instance, reducing school absences, improving childhood educational attainment [27] and improved psychosocial wellbeing [28].

CWF is a contentious issue with strong anti-fluoride lobby groups that can influence locally elected bodies. During the study period, decisions about CWF in NZ were devolved to local district councils. The resulting differences in CWF between districts and over time contributed to oral health related inequity. Recent policy change proposes control of CWF sits with District Health Boards, which are comprised of government appointed and locally elected members. The potential for continued variation in CWF persists in New Zealand in the absence of regulation at the national level.

Links between CWF and adverse health outcomes have been extensively investigated by the Royal Society of New Zealand, Chief Science Advisor in 2014 and others including the World Health Organisation [29, 30]. All have concluded that CWF at the recommended concentration of 0.7-1ppm demonstrates no adverse health risks. There is a very low risk of mild fluorosis in infants fed with formula milk made with fluoridated water. The cosmetic significance is minimal, often only detected by a dental professional at a formal clinical examination [29]. Fluorosis remains only a risk when the teeth are developing up to approximately 8 years of age [29]. The 2009 New Zealand Oral Health Survey indicated that the prevalence of fluorosis is similar between fluoridated and non-fluoridated areas, and of these cases none were classed as severe [8].

Limitations of this study include a cross-sectional design; and being an ecological-level analysis, which provides results at a population-level rather than at the individual-level. Only associations can be identified, and no causal relationships can be inferred. Additional factors such as fluoride toothpaste use and oral health behaviours would have increased the accuracy of the models, however these data are not available at the CAU level. These could partially explain the social gradient as health behaviours are socially patterned. For instance, higher socioeconomic status parents are more likely to get their children to brush with fluoride toothpaste [8]. CWF is a surrogate measure for fluoride exposure, and a strength of the study is the use of data at two time points. While the CWF data was originally intended to give a DHB-level comparison rather than a full detail at the supply or distribution zone level, we estimated CWF by joining locality shapefiles to provide an estimate of CWF. Further work would be required to give a more accurate detailed view on actual supplies, although it would be difficult to estimate actual fluoride exposure in children accurately at the population level.

5. Conclusion

This study shows that CWF was associated with a lower dental ASH rate. We showed how CWF moderated the association between area-level deprivation and dental ASH in children aged 0-4. An increased dental ASH rate was most apparent in children aged 0-4 years in those areas with no CWF at both time points and were most deprived (quintile 5). As deprived areas have the highest incidence of dental ASH, caries and poor oral health, those who live in the most deprived areas have the most to gain from CWF. In summary, our study supports evidence linking CWF to better health in children. Variation in CWF contributes to structural inequities in oral health outcomes for children.

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Author contributions

All named authors contributed substantially to the manuscript. Specifically, Dr Matthew Hobbs led the manuscript from conception and development of idea, to data analysis, interpretation of results, editing of manuscript and refinement of manuscript following peer review. Dr Peter Jones and Dr Alicia Wade contributed substantially to the initial writing of the manuscript and editing following peer review. Dr Lukas Marek, Dr Melanie Tomintz, and Dr John McCarthy provided advice on the manuscript and various aspects of data analysis. Kanchan Sharma was instrumental from the conception of idea to submission while Dr Malcolm Campbell and Prof Simon Kingham contributed to the conception of idea and editing of manuscript.

Conflict of interest

None to declare.

References

1. Kosteniuk JG, Dickinson HD. Tracing the social gradient in the health of Canadians: primary and secondary determinants. *Social science & medicine* 2003; **57**: 263-76.
2. Marmot MG. Understanding social inequalities in health. *Perspectives in biology and medicine* 2003; **46**: S9-23.
3. Marmot M. Social determinants of health inequalities. *The Lancet* 2005; **365**: 1099-104.
4. Marmot M. The Health Gap: The Challenge of an Unequal World: the argument. *International journal of epidemiology* 2017; **46**: 1312-8.
5. Watt RG. From victim blaming to upstream action: tackling the social determinants of oral health inequalities. *Community dentistry and oral epidemiology* 2007; **35**: 1-11.
6. Whitehead M. The concepts and principles of equity and health. *International journal of health services : planning, administration, evaluation* 1992; **22**: 429-45.
7. Carter KN, Blakely T, Soeberg M. Trends in survival and life expectancy by ethnicity, income and smoking in New Zealand: 1980s to 2000s. *N Z Med J* 2010; **123**: 13-24.
8. Ministry of Health. *Our Oral Health*. Wellington; 2010.
9. Sapere Research Group. *Review of the benefits and costs of water fluoridation in New Zealand* Wellington: Ministry of Health; 2015.
10. Rogers JG, Adams GG, Wright FAC, Roberts-Thomson K, Morgan MV. Reducing Potentially Preventable Dental Hospitalizations of Young Children: A Community-Level Analysis. *JDR Clinical & Translational Research* 2018; **3**: 272-8.
11. Deery C, Owen J, Welbury R, Chadwick B. Dental caries in children and the level of repeat general anaesthetics for dental extractions. a national disgrace. *Dental Update* 2015; **42**: 305-6.
12. Whyman RA, Mahoney EK, Morrison D, Stanley J. Potentially preventable admissions to New Zealand public hospitals for dental care: a 20-year review. *Community dentistry and oral epidemiology* 2014; **42**: 234-44.
13. Barker C, Crengle S, Bramley D, et al. Pathways to ambulatory sensitive hospitalisations for Maori in the Auckland and Waitemata regions. *N Z Med J* 2016; **129**: 15-34.
14. Health Quality and Safety Commission New Zealand. *Childhood ambulatory sensitive hospitalisations*. 2015 [cited 12th December 2019]; Available from: http://www.hqsc.govt.nz/our-programmes/health-quality-evaluation/projects/atlas-of-healthcarevariation/childhood-ambulatory-sensitive-hospitalisations/
15. McLaren L, Singhal S. Does cessation of community water fluoridation lead to an increase in tooth decay? A systematic review of published studies. *Journal of Epidemiology and Community Health* 2016; **70**: 934.
16. Slade GD, Grider WB, Maas WR, Sanders AE. Water Fluoridation and Dental Caries in U.S. Children and Adolescents. *Journal of dental research* 2018; **97**: 1122-8.
17. Firmino RT, Bueno AX, Martins CC, Ferreira FM, Granville-Garcia AF, Paiva SM. Dental caries and dental fluorosis according to water fluoridation among 12-year-old Brazilian schoolchildren: a nation-wide study comparing different municipalities. *Journal of Public Health* 2018; **26**: 501-7.
18. Spencer AJ, Do LG, Ha DH. Contemporary evidence on the effectiveness of water fluoridation in the prevention of childhood caries. *Community dentistry and oral epidemiology* 2018; **46**: 407-15.
19. Public Health England. *Water fluoridation: health monitoring report for England 2014*. London: PHE; 2014.
20. Xu H. Comparing Spatial and Multilevel Regression Models for Binary Outcomes in Neighborhood Studies. *Sociol Methodol* 2014; **44**: 229-72.
21. Ajiboye AS, Dawson DR, Fox CH. American Association for Dental Research Policy Statement on Community Water Fluoridation. *Journal of dental research* 2018; **97**: 1293-6.
22. Department of Health and Human Services. *Victorian Health Information Surveillance System (VHISS)*. Melbourne: DHHS; 2017.

23. Neil A. The extent of water fluoridation coverage in Australia. *Australian and New Zealand journal of public health* 2011; **35**: 392-3.
24. Weston-Price S, Copley V, Smith H, Davies GM. A multi-variable analysis of four factors affecting caries levels among five-year-old children; deprivation, ethnicity, exposure to fluoridated water and geographic region. *Community dental health* 2018; **35**: 217-22.
25. McDonagh MS, Whiting PF, Wilson PM, et al. Systematic review of water fluoridation. *BMJ (Clinical research ed)* 2000; **321**: 855-9.
26. Lee M, Dennison PJ. Water fluoridation and dental caries in 5- and 12-year-old children from Canterbury and Wellington. *The New Zealand dental journal* 2004; **100**: 10-5.
27. Jackson SL, Vann WF, Jr., Kotch JB, Pahel BT, Lee JY. Impact of poor oral health on children's school attendance and performance. *American journal of public health* 2011; **101**: 1900-6.
28. Eccleston C, Malleson P. Managing chronic pain in children and adolescents. We need to address the embarrassing lack of data for this common problem. *Bmj* 2003; **326**: 1408-9.
29. Bardsley A. *Health effects of water fluoridation: a review of the scientific evidence*. Wellington: Office of the Prime Minister's Chief Science Advisor and Royal Society of New Zealand; 2014.
30. World Health Organisation. *Guidelines for drinking-water quality*. Geneva: World Health Organisation; 2004.