Dental caries and previous hospitalisations among preschool children: findings from a population-based study in New Zealand

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ABSTRACT

BACKGROUND: Early childhood caries (ECC) is a significant public health problem, and may be associated with other health conditions.

AIM: To investigate whether an association exists between ECC and previous hospitalisations due to avoidable medical conditions, including injury-related admissions among preschool children.

METHODS: This population-based retrospective study involves all five-year old children who resided in one of the two contiguous regions in northern New Zealand (Northland and Auckland) and received school entry dental examinations between 1 January 2014 and 31 December 2015. Eligible children were identified from the regional dental datasets (Titanium® software), and their ECC status was determined by using decayed missing filled teeth (dmft) scores. Information on hospitalisations for avoidable medical conditions, which occurred during the first six years of life, was obtained through linkage to hospital discharge data. Logistic regression analysis was performed to assess the associations between ECC and previous hospitalisations.

RESULTS: 11,173 of the 27,333 eligible children (40.9%) had ECC (dmft ≥1). Children from non-European ethnic origins (Māori, Pacific and Asian groups) and those from the Northland, areas without community water fluoridation or deprived neighbourhoods, were more likely to have ECC. ECC was significantly associated with injury-related admissions (adjusted odds ratio: 1.17; 95% CI: 1.07, 1.27), but not with admissions for other medical and respiratory conditions.

CONCLUSION: ECC was highly prevalent in New Zealand children, and associated with injury-related hospital admissions. The findings underscore more efforts to tackle ECC and associated health conditions.

Early childhood caries (ECC) is a global public health problem and its estimated prevalence in the preschool population varies from 17% to 94%.[1] Likewise in New Zealand, dental caries is the commonest chronic disease in children. The most recent data from the Community Oral Health Service showed that 38% of five-year old children had caries in 2017, with a higher prevalence observed among Māori and Pacific children compared to children of other ethnicities.[2] Over the past decade, there has been little reduction in the prevalence or severity of ECC among preschool children.[2,3]

Previous studies showed that several childhood medical conditions and infectious diseases, particularly respiratory tract diseases, such as asthma and middle ear infections, were associated with an increased risk of ECC.[4–8] Possible mechanisms include: altered salivary flow and quality in children with respiratory diseases, high sugar content of medications used to treat infectious diseases and altered diet in relation to frequent sickness.[8]

It is also possible that the oral cavity can act as a site of microorganism colonisation, disseminate pathogenic organisms to distant

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body sites and cause damage to the remote parts of the body.[9,10] Cytokines released from the diseased periodontal tissues may also be circulated, and stimulate inflammatory processes in other body parts.[11] These may contribute to acute and severe lung diseases including pneumonia[10–12] and may also affect skin,[13] cardiovascular systems, gastrointestinal organs[10] and the genitourinary system.[12]

It is possible that injuries (including poisoning) may also be associated with preschool dental health due to common factors relating to wider issues of social inequities and environmental factors [3,14–16]. However, this area has received scant research attention.

Our study aims to examine the associations between ECC and previous hospitalisations due to avoidable conditions including injuries among preschool children living in northern New Zealand. For this study, northern New Zealand is defined as the two contiguous northern-most regions; Auckland and Northland. For the Auckland Region, which comprises three district health boards (Counties Manukau, Auckland, Waitemata), there is a single regional service, while dental health services of Northland Region are managed separately by Northland District Health Board (DHB).

Methods

Study population

This population-based retrospective study involves all five-year old children, who resided in the study region where two-fifths of the country's population reside,[17] and who had received school entry dental examination between 1 January 2014 and 31 December 2015.

Data sources

Eligible children were identified from the Titanium® dataset, a population-based information management system which records clinical data related to free dental examinations conducted by trained dental therapists or dentists. In New Zealand, all children up to their 18th birthday are eligible for free dental care, except for orthodontic treatment. Up to and including Year 8, they are seen by the Community Oral Health Service. The dataset contains information on dental health information of children, fluoridation status of individual children's homes and schools, child's date of birth and demographic variables including gender, ethnicity, school decile and domicile.

The data were linked to the National Minimum Dataset (NMDS) using the National Health Index (NHI) number, which is assigned to every New Zealander who uses health and disability services.[18] The NMDS contains information about all day-patients and inpatients discharged from all public hospitals and over 90% of private hospitals in New Zealand. Diagnoses and diagnostic and therapeutic procedures undertaken in each hospital visit are coded with ICD-10-AM.

Variables of interest

The main outcome of interest was ECC, is defined as 'the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries) or filled tooth surfaces, ie, dmft (decayed, missing, filled, teeth) score of one or more in any primary tooth[19,20] measured at school entry. The outcome status was determined using the dmft scores recorded in the Titanium® dataset.

The exposure of interest in this analysis was hospitalisation(s) for avoidable medical conditions, including injury-related admissions that occurred during the first six years of life. Avoidable medical conditions were identified using a tool developed previously.[21] Dental admissions (K02, K04 and K05) were excluded, but wheezing (R062) and unspecified acute lower respiratory infection (J22) were added to the list as these were found to be the common causes of hospitalisation and relevant to respiratory diseases. Injury-related admissions were identified using the principal diagnosis of injury, poisoning and other external causes (S00-T98) as well as a primary external cause code of morbidity (Primary E-code V01 to Y98) as in previous studies.[22–24] Dental injuries (S02.50 and S02.51) (2% of all injury admissions) were included in the analysis. The admissions related to "complications of medical and surgical care" (primary diagnosis code T80-T98; primary E-code Y40-Y84) were excluded. Admissions that occurred within one month of the previous admission were regarded as readmissions and were excluded. Table 1 lists the potentially avoidable hospitalisations, non-dental (PAHND) included in this analysis and respective ICD-10-AM codes.

Table 1: List of potentially avoidable hospitalisations, non-dental (PAHND) for New Zealand children used in the study.

Conditions of potentially avoidable hospitalisations, non-dental (PAHND)	ICD-10-AM PDx Code
Acute bronchiolitis	J21
Acute rheumatic fever	I00-I02
Acute upper respiratory tract infection excluding croup	J00-J03, J06
Asthma, wheezing	J45, J46, R062
Bronchiectasis	J47
Bacterial meningitis	G00,G01
Bacterial/unspecified pneumonia, unspecified acute lower respiratory infection	J13-J16, J18, J22
Constipation	K590
Chronic rheumatic heart disease	I05-I09
Croup, acute laryngitis, tracheitis	J04 J050
Dermatitis/eczema	L20-L30
Febrile convulsions	R560
Gastroenteritis	A00-A09, R11, K529
Gastro oesophageal reflux	K21
Meningococcal disease	A39
Nutritional deficiency	E40-E64, D50-D53
Otitis media	H65-H67
Osteomyelitis	M86
Vaccine preventable diseases tetanus neonatorum congenital rubella tetanus, diphtheria, pertussis, polio, hepatitis B, measles, rubella, mumps	P350, A33, A34 A35, A36, A37, A80, B16, B180, B181 B05, B06, B26, M014
Skin infection	L00-L05, L08, L980, J340, H010, H000
Tuberculosis	A15-A19
Urinary tract infection ≥5 years	N10, N12, N300, N390, N136, N309
Viral pneumonia	J12, J100, J110
Viral/other/unspecified meningitis	A87, G02, G03
Viral infection of unspecified site	B34
Injuries and poisoning	S00-T79 with Primary E-codes of V01-Y39 or Y85-Y98

Source: modified from[21]

Statistical analysis

Descriptive and regression analyses were performed using the Epi Info software tool (version 7). Unconditional logistic regression was used to examine the association between ECC and previous hospitalisations. The multivariate model adjusted for demographic variables such as gender, ethnicity, region, neighbourhood deprivation and community water fluoridation. The degree of neighbourhood deprivation was assessed using the 2013 New Zealand Deprivation Index (NZDep) (census-based small-area index of relative socio-economic deprivation) with decile ten the most deprived and decile one the least.[25] This variable was re-categorised into three levels: low (NZDep 1 to 4), medium (NZDep 5 to 8) and high deprivation (NZDep 9 and 10). Analyses were undertaken separately for respiratory admissions and injuries as the former is likely to occur through the biomedical pathway and the latter is significantly influenced by physical and social environmental factors. A two-sided level for statistical significance was set at 0.05 for all analyses.

Results

Of the 27,333 five-year-old children included in the analysis, 40.9% had ECC (dmft≥1). There were significant differences by ethnicity, with the greatest prevalence of ECC among Māori and Pacific children. Children who lived in Northland, areas without community water fluoridation and the most deprived neighbourhoods had a higher prevalence of ECC than those living in Auckland, areas where the community water supply is fluoridated and least deprived neighbourhoods, respectively (Table 2).

Table 2: Prevalence of ECC (dmft≥1) in five-year-old children in northern New Zealand by demographic characteristics.

	Total participants	**With ECC**	**p-value**
	N (column %)	**N (row %)**	**(Chi-square)**
Total	27,333	11,173 (40.9)	
Gender			
Girls	13,464 (49.3)	5,420 (40.3)	0.039
Boys	13,869 (50.7)	5,733 (41.3)	
Region			
Auckland	24,700 (90.4)	9,765 (39.5)	<0.001
Northland	2,633 (9.6)	1,408 (53.5)	
Ethnicity			
European	12,134 (44.4)	2,820 (23.2)	<0.001
Māori	4,526 (16.6)	2,669 (59.0)	
Pacific	4,941 (18.1)	3,186 (64.5)	
Asian	4,914 (18.0)	2,164 (44.0)	
Other	818 (3.0)	334 (40.8)	
Community water fluoridation			
Yes	21,893 (80.1)	8,776 (40.1)	<0.001
No	4,352 (15.9)	2,045 (47.0)	
Unknown	1,088 (4.0)	352 (32.4)	
NZDep 2013			
Low (NZDep 1–4)	9,758 (35.7)	2,656 (27.2)	<0.001
Medium (NZDep 5–8)	10,145 (37.1)	4,081 (40.2)	
High (NZDep 9–10)	7,266 (26.6)	4,378 (60.3)	
Unknown	164 (0.6)	58 (35.4)	

Table 3: Logistic regression analyses for the association between ECC and PAHND.

	Total participants N (column %)	With ECC N (row %)	p-value (Chi-square)	Crude OR (95%CI)	p-value	Adjusted OR* (95%CI)	p-value
No PAHND	17,621 (64.5)	6,798 (38.6)	<0.001	Reference		Reference	
PAHND 1 time	6,322 (23.1)	2,728 (43.2)		1.21 (1.14, 1.28)	<0.001	1.04 (0.98, 1.11)	0.20
PAHND 2 times	2,071 (7.6)	983 (47.5)		1.44 (1.31,1.58)	<0.001	1.07 (0.97, 1.18)	0.17
PAHND ≥3 times	1,319 (4.8)	664 (50.3)		1.61 (1.44, 1.81)	<0.001	1.04 (0.92, 1.17)	0.54

*Model adjusted for the demographic variables (gender, ethnicity, region, socioeconomic status and community water fluoridation).

The dmft scores in our study population ranged from 0 to 20. About 40.9% of study population had ECC; 20.05% (n=5,480) had 1–3 teeth affected and 20.83% (n=5,693) had more than three teeth affected with dental decay.

The number of PAHND events (including injury admissions) experienced during the first six years of life ranged from 0–18 per child. Among them, 23.1% of children had one PAHND event; 7.6% had two events; and 4.8% had three or more events (Table 3). The prevalence of ECC appeared to be higher among those with a past history of PAHND events but the association was not statistically significant after adjusting for demographic variables.

Nineteen percent of children had been hospitalised for a respiratory illness. Among them, 13.2% had a single event and 5.5% had two or more events (Table 4). There was a significant association between respiratory admissions and an increased risk of ECC in the univariate analysis but not in the multivariate models adjusting for the demographic variables.

Only 10.1% of the sample population had been hospitalised for injury or poisoning during their first six years (Table 5). There was a significant association between injury admissions and ECC (adjusted OR: 1.17; 95% CI: 1.07, 1.27).

Discussion

In this study, 40.9% of the five-year old children who lived in northern New Zealand had ECC. ECC was significantly associated with injury admissions in the first six years of life but not with admissions for other avoidable medical conditions.

Strengths and limitations

This population-based retrospective study examined how ECC may be associated with avoidable hospital admissions especially those for injuries, an aspect that has not been explored in previous research. The study used routinely collected data, including dental health assessments linked by unique person index to hospital discharges. Dental caries was assessed objectively by dental therapists who undertook clinical oral examinations.

The limitations of the study should be considered in interpreting the findings. The data routinely collected in the Titanium® dataset and the NMDS is limited. For example, the dmft score recorded may be subjected to inaccuracies due to potential inter-observer bias and variability.[26] The data also lacks details about why a tooth was missing or a dental restoration placed (ie, due to caries, trauma or other reasons). About 10–20% of the eligible children, particularly of Māori and Pacific ethnicity,[27]

Table 4: Logistic regression analyses for association between ECC and respiratory admissions (RA).

	Total participants N (column %)	With ECC N (row %)	p-value (Chi-square)	Crude OR (95%CI)	p-value	Adjusted OR* (95%CI)	p-value
No RA	22,222 (81.3)	8,794 (39.6)	<0.001	Reference		Reference	
RA 1 time	3,596 (13.2)	1,627 (45.2)		1.26 (1.18, 1.35)	<0.001	1.00 (0.92, 1.08)	0.97
RA ≥2 times	1,515 (5.5)	752 (49.6)		1.50 (1.36, 1.67)	<0.001	1.03 (0.92, 1.16)	0.56

*Model adjusted for the demographic variables (gender, ethnicity, region, socioeconomic status and community water fluoridation).

Table 5: Logistic regression analyses for association between ECC and injury admissions.

	Total Participants N (column %)	With ECC N (row %)	p-value (Chi-square)	Crude OR (95%CI)	p-value	Adjusted OR* (95%CI)	p-value
Injury admission=0	24,566 (89.9)	9,887 (40.2)	<0.001	Reference		Reference	
Injury admission≥1	2,767 (10.1)	1,286 (46.5)		1.29 (1.19, 1.40)	<0.001	1.17 (1.07, 1.27)	<0.001

*Model adjusted for the demographic variables (gender, ethnicity, region, socioeconomic status and community water fluoridation).

were not enrolled for a dental examination, and therefore not recorded in the Titanium® dataset and not included in this analysis. Similarly, children who had moved out of the region or were deceased prior to dental examination were not included in the analysis. As access to routine dental care could be lower among Māori and Pacific children than other ethnic groups,[27,28] our sample may also be biased toward children with less exposure to ECC with a potential underestimation of the associations. For overseas-born children who resided in the study regions at the time of dental examination and were included in this analysis, their prior hospital admissions may have been undercounted as the NMDS does not capture overseas admissions. Moreover, overseas-born children were likely to have lower access to healthcare due to cultural, language or transport barriers despite their eligibility for public health services as New Zealand-born children.[29,30] However, based on the birth events recorded in the NMDS, we found that about 90% of the sample (24,492 out of 27,333) was born in New Zealand. Hence, the impact of immigration on the findings is not likely to be substantial. Overall, the study sample is reasonably representative of the preschool population in the two study regions.

There may be inaccuracies in coding of the hospital discharge events in the NMDS, for example, a previous study reported that about 14% of principal injury diagnosis (PDx) and 26% of external causes (E-code) were not accurate for injury admissions.[22] There may also be misclassification of ethnicity, community water fluoridation and socioeconomic status. Ethnicity was self-reported by parents[31] and may be misclassified, as reported previously.[32,33] Internal migration may result in misclassification of community water fluoridation status if the child moved from non-fluoridated areas to fluoridated areas at the time of their dental examination (or vice versa). The socioeconomic status was measured using the NZDep, which is a small area-based measure and may not reflect the individual socioeconomic status. It was also not possible to assess changes in the socioeconomic status over time in this cross-sectional analysis. As this was an exploratory analysis of the available data from the Regional Dental Services and Ministry of Health, it was not possible to consider other important confounders, such as frequency of tooth brushing, sugar intake, maternal caries status, maternal smoking and access to/utilisation of dental health service.

Interpretations

In this study involving five-year-old children from northern New Zealand, the prevalence of ECC was 40.9%, which is similar to the national figure (40.4%) in 2015[2] but is higher than the prevalence observed in other high-income countries. The national prevalence of ECC in five-year-old children in England was 24.7%,[34] with the prevalence of 35.4% in Wales and 31.8% in Scotland during 2013–2015.[35,36] In 2000, the caries prevalence among 4–6 year-old children in Queensland, Australia was 33.7%.[37] Importantly, inequalities exist in New Zealand children with a higher prevalence of ECC observed among Pacific (64.5%) and Māori (59.0%) children and those from the most deprived areas (60.3%) and from Northland (53.5%). The high prevalence of ECC in Northland may be attributable in part to the lack of community water fluoridation in the region.[38,39] There is also a shortage of dentists and financial resources for dental care to meet oral health needs of the population.[40] A poorer beverage environment may also be a contributory factor.[41] There is minimal regulation on the availability and promotion of sugary foods and drinks in New Zealand.[42]

Our study showed a significant association between ECC and injury admissions. This may be due to common factors relating to wider issues of social inequities and environmental factors such as children being from disadvantaged socioeconomic groups, poor physical environment, large families or young mothers.[3,14–16] Residual confounding is likely. This relates to the socioeconomic gradient seen with childhood injuries in New Zealand. Our analyses adjusted for neighbourhood deprivation but not individual level socioeconomic status. Prospective cohort studies would be required to confirm findings from this exploratory analysis and to further explore likely mechanisms.

In the bivariate analyses, we found a dose-response association between ECC and PAHND in general and respiratory admissions in particular. The findings are consistent with previous studies which did not account for demographic characteristics. They reported significant associations of early childhood dental health problems to skin infections[13] and respiratory and urinary tract infections.[12] However, we did not find any significant association after adjusting for demographic characteristics such as gender, ethnicity, region, neighbourhood deprivation and community water fluoridation.

The findings from this exploratory analysis suggest that the history of an injury admission may be used as a marker to prompt additional attention to oral health status. When such children are identified, for example, at Well Child Tamariki Ora Visits or through emergency care services, clinicians should ensure that these children are receiving oral health examination and treatment. Health providers should also support their families with effective preventative oral health advice.

Overall, more effort is necessary to reduce the burden of ECC in Auckland and Northland. Healthy public policies, such as community water fluoridation, and strategies to reduce sugary drink consumption, such as the implementation of a sugar-sweetened beverage tax, regulating the promotion of sugary foods and drinks, and health warnings on product labels similar to tobacco products, are necessary to address oral health problems in New Zealand children. Innovative health promotion, such as health messaging through culturally relevant and interactive platforms of videos, songs, television and tooth brushing demonstration, may also be considered. Interventions targeted to high-risk groups, for example, delivering toothbrush kits and communication materials may help reduce disparities. Given potential associations between children's general and dental health, oral health care services should also be integrated into the wider paediatric health care system. Some programmes are already in place in Northland such as the supervised tooth brushing programme in schools and a project undertaken in Whangarei Hospital, which aimed to improve oral health care coverage by providing service by oral health professionals and health promotion material to children, siblings and mothers directly in the hospital wards.[43,44] The association of ECC with childhood injury observed in this study suggests a similar opportunistic provision of oral health care would be worth considering in Emergency Care Settings. However, caution should be taken to ensure that such activities do not widen inequalities as those with fewer resources are less able to act on the advice given.

Conclusion

To conclude, the prevalence of ECC is high in New Zealand children, particularly among Māori, Pacific and children from the most deprived neighbourhoods. ECC is also significantly associated with previous injury admissions. The findings underscore the need for more efforts to understand mechanisms underlying the co-occurrence of ECC and other health problems in New Zealand children, and to develop policies and programmes targeted to high-risk groups.

Competing interests:

Nil.

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