The Role of Location in Indigenous and Non-Indigenous Child Oral Health

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Abstract

Objective: *To examine the role of location in Indigenous and non-Indigenous child oral health in three Australian states and territories. The association of Indigenous status and residential location with caries prevalence, severity and unmet treatment need was examined.* ***Methods:*** *Data were collected as part of a national monitoring survey of 4–14-year-old children enrolled in school dental services in New South Wales, South Australia and the Northern Territory, Australia.* ***Results:*** *Of the 326,099 children examined, 10,473 (3.2%) were Indigenous. Fewer 4–10-year-old rural Indigenous children were caries-free in the deciduous dentition than their non-Indigenous counterparts and rural Indigenous children had almost twice the mean number of decayed, missing and filled teeth (dmft) of rural non-Indigenous children. The % d/dmft was higher among rural Indigenous children than rural non-Indigenous children. Fewer 6–14-year-old rural Indigenous children were caries-free in the permanent dentition than their non-Indigenous counterparts and rural Indigenous children had almost twice the mean DMFT of rural non-Indigenous children. The % D/DMFT was higher in rural Indigenous than rural non-Indigenous children. Living in a rural location was the strongest indicator of caries prevalence, severity and unmet treatment need in the deciduous dentition of Indigenous 4–10-year-olds while being socially disadvantaged was the strongest indicator of poor oral health outcomes among older Indigenous and all non-Indigenous children.* ***Conclusions:*** *Living in a rural location exhibited the strongest association with poor oral health outcomes for young Indigenous children but was also associated with poorer oral health among older Indigenous and non-Indigenous children.*

Key Words: Indigenous, children, location, dental caries

Introduction

Indigenous children in Australia are those who identify as Aboriginal, Torres Strait Islander or both. Such children represent 4.7% of the child population of Australia, a country comprising 6 states and 2 principal territories of note (1). The demographic distribution of the Indigenous child population differs across states and territories. For example, almost 30% of Indigenous 4–14-year-olds live in New South Wales while only 1% live in the Australian Capital Territory (1). Indigenous children comprise 3.9, 3.3 and 40.1% of 4–14-year-old children in New South Wales, South Australia and the Northern Territory respectively, and 60.1, 52.5 and 80.1% of such children respectively live in rural or remote areas (1).

Information from the Australian 2001 Census of Population and Housing indicated that almost 3 times as many Indigenous than non-Indigenous adults were not in the paid labor force, with unemployment levels among rural-dwelling Indigenous Australians being almost 70% in some communities (1). In the same Census, Indigenous Australians were 1½ times more likely to have an income of less than $200 per week, 3 times more likely to be employed as unskilled laborers, 2 ½ times more likely to not own their homes and five times more likely to have not gone to school than their non-Indigenous counterparts (1). The average number of occupants in Indigenous households was 5 compared with 2 for non-Indigenous residences. Fifteen percent of Indigenous households were overcrowded, with 19% of houses requiring major repairs and 10% needing to be replaced (2).

The lifestyle upheavals experienced by Indigenous Australians since European colonization in 1788 have had marked impacts on Indigenous health, particularly Indigenous child health. Indigenous children are at higher risk of disease and injury (2, 3) and more likely to be hospitalized for most conditions than other Australian children. They experience greater disability and reduced quality of life due to ill health, partake in higher levels of health risk behaviors and are more exposed to violence in the home. In 2002, Indigenous child mortality rates were 2.7 times those of non-Indigenous children (2). Indigenous children are also more than twice as likely to have been born underweight than other Australian children (2), with low birth weight infants being more prone to ill health, including dental ill health, in later life (4, 5).

Increasing exposure to non-Indigenous lifestyles has also impacted on Indigenous child oral health. Recent evidence from localized investigations suggest that Indigenous children now have, on average, twice as much (and in some communities, up to 5 times as much) tooth decay as non-Indigenous children (7). This change has largely been attributed to the increased availability and consumption of cariogenic food and beverage products (8). The literature suggests that

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the poor oral health status of Indigenous children relative to their non-Indigenous counterparts is a global phenomenon (9–11). Today, many Indigenous people are unfamiliar with their origins and this, together with the ongoing effects of poverty, discrimination and racism, has contributed to the rapid unraveling of once robust societies; the downstream effects of which may manifest as certain health outcomes including poor child oral health (3).

Although there is an established relationship between residential location and Indigenous child general health, with general health deteriorating with increasing remoteness (3), the role of location in Indigenous child oral health is a less clear. The purpose of this study is to explore the role of location in the oral health of Indigenous and non-Indigenous children in three Australian states and territories. To the best of the authors' knowledge, the paper is the first to provide population-based estimates of dental disease prevalence, severity and unmet treatment need of Indigenous and non-Indigenous child populations in relation to residential location.

Methods

Data were obtained from the Child Dental Health Survey, a collection of cross-sectional national oral health data of children enrolled in the school dental service in each Australian state and territory. Children were enrolled from government and non-government schools, and dental health professionals employed by school dental services conducted examinations. Dental examiners were not calibrated, but received similar training and used standardized procedures.

For the purposes of this investigation, analyses of Indigenous and non-Indigenous child oral health outcomes were confined to collections from New South Wales, South Australia and the Northern Territory only (due to poor compliance or lack of Indigenous data collection from the other states and territories). A full enumeration of children presenting for examinations in New South Wales, South Australia and areas in the Northern Territory outside the capital city of Darwin were included, and a random sampling procedure was used to select approximately 1 in 2 (1:1.9) school dental service-enrolled children residing in Darwin (achieved by selecting children whose birthday was between the 1st and 16th (inclusive) of any given month).

Data at the state/territory level were weighted so that the number of study participants in a given jurisdiction reflected the proportion of children in the estimated resident population of the same jurisdiction. To ensure children on longer recall intervals were not under-represented (children with good oral health may be placed on longer recall intervals than children with poorer oral health), participants seen more frequently in a given year were weighted down while their counterparts seen less often were weighted up. Once state/territory level data had been aggregated, data were post-stratified and weighted by age and sex to ensure that the data more accurately represented the child population at a national level as estimated by the Australian Bureau of Statistics. Ethical approval for the study was obtained from the Australian Institute of Health and Welfare and the University of Adelaide.

Location index. The Rural, Remote and Metropolitan Areas classification was used to measure location. The classification is based on Statistical Local Areas and allocates each such area in Australia to a category based primarily on population numbers and an index of remoteness. The then Commonwealth Department of Primary Industry and Energy defined the classification, and Human Services and Health in 1994 based on 1991 Census data. "Metropolitan" is defined as any capital city or other metropolitan area with a population of >100,000, "rural" zones are those with a population ranging from 10–99,000 and "remote" areas those with a population of <10,000. For the purposes of this study, "rural" and "remote"' zones were combined.

Socio-economic status index. The Socio-Economic Indexes For Areas (12) were used to determine socio-economic status (SES). The Australian Bureau of Statistics developed the indices and use data derived from the 2001 Census of Population and Housing to employ a range of measures to rank areas based on their relative social and economic well being. For the purposes of this report, the Socio-Economic Indexes For Areas Index of Disadvantage (category 2) was used. This index takes into account 20 different variables including income, educational attainment, unemployment and dwellings without motor vehicles. In particular it focuses on low-income earners, relatively lower educational attainment and high unemployment. The Socio-Economic Indexes For Areas have been validated against household measures of SES (12), are perceived by the general public as containing important measures of area-based disadvantage (13) and are standardized instruments frequently used in the measurement of SES at a population level in Australia.

Oral health index. The dmft (sum of decayed, missing and filled teeth in the deciduous dentition) and DMFT (sum of decayed, missing and filled teeth in the permanent dentition) indices were used to assess oral health outcomes. Percent dmft/DMFT>0 was used to determine the prevalence of dental disease experience within the deciduous and permanent dentition respectively, while mean dmft/DMFT values were used to ascertain the severity of dental disease experience. The proportion of decayed teeth in overall dmft/DMFT (percent d/dmft and percent D/DMFT) was calculated to indicate levels of unmet treatment need. Both dmft and DMFT measures were used for children aged 6–10 years because in such age groups children have a mixed dentition (both primary and permanent teeth are present).

Caries prevalence, severity and unmet treatment need were calculated from data collected over three 12-month periods; 2000 for New South Wales, 2002 for the Northern Terri-

TABLE 1
Sociodemographic and dental characteristics by Indigenous status and location (column % in brackets unless indicated otherwise)

	Indigenous			Non-Indigenous		
	Metropolitan n (%)	Rural n (%)	Sig	Metropolitan n (%)	Rural n (%)	Sig.
Age[a]			P<0.001			P<0.001
4-7 years	1,351 (39.2)	2,811 (40.0)		96,231 (41.8)	33,772 (39.4)	
8-11 years	1,534 (44.5)	3,293 (46.9)		92,855 (40.4)	37,140 (43.4)	
12-14 years	565 (16.4)	919 (13.1)		40,878 (17.8)	14,750 (17.2)	
Sex[a]			P=0.438			P<0.001
Male	1,678 (48.7)	3,402 (48.5)		105,348 (45.8)	41,846 (48.9)	
Female	1,771 (51.3)	3,617 (51.5)		124,538 (54.2)	43,748 (51.1)	
Index of Disadvantage[a]			P<0.001			P<0.001
1 (most disadv)	1,219 (35.4)	3,701 (52.9)		58,985 (25.8)	16,025 (19.0)	
2	1,007 (29.3)	2,206 (31.5)		61,478 (26.9)	48,833 (58.0)	
3	690 (20.1)	1,079 (15.4)		44,144 (19.3)	17,302 (20.6)	
4 (least disadv)	523 (15.2)	9 (0.1)		64,015 (28.0)	1980 (2.4)	
4–10-year-old						
dmft=0[a]	1,158 (47.8)	1,729 (32.8)	P<0.001	104,246 (65.0)	34,321 (56.9)	P<0.001
Mean dmft (sd)[b]	2.27 (2.30)	3.19 (3.40)	P<0.001	1.30 (1.84)	1.64 (2.13)	P<0.001
Percent d/dmft[a]	52.8	65.6	P<0.001	46.1	42.5	P<0.001
6–14-year-old						
DMFT=0[a]	2,158 (74.1)	3,955 (69.1)	P<0.001	151,041 (81.3)	57,780 (81.1)	P=0.172
Mean DMFT (sd)[b]	0.81 (1.48)	1.02 (1.67)	P<0.001	0.54 (1.18)	0.53 (1.20)	P<0.010
Percent D/DMFT[a]	51.9	64.2	P<0.001	44.6	42.8	P<0.050
Total (row %)	3,450 (32.9)	7,023 (67.1)		229,964 (72.9)	85,662 (27.1)	

[a]Chi-square Test
[b]Mann-Whitney U Test

tory and 2003 for South Australia. When children received more than one examination during any given year, information derived from the first examination only was included. There was no measure of exposure to fluoridated water due to incomplete data on water fluoride levels in many rural and remote areas.

The Pearson Chi-square test was used to compare differences in proportions and analysis of variance (ANOVA) when the dependent variable was continuous. Non-parametric tests were used if data were not normally distributed; the Mann-Whitney U Test for two independent variables and the Kruskal Wallis Test for more than two comparison groups.

Independent variables that were significant at a bivariate level were entered as explanatory factors in multivariate models. All variables were checked for multicollinearity. Categorical dependent variables were modeled using logistic regression while linear regression was used for dependent variables that were continuous. Dummy variables were created that included: 4–7 years (4–7 years = 1, other age-groups = 0), 8–11 years (8–11 years = 1, other age-groups = 0), male (male = 1, female = 0), rural living (rural/remote living = 1, metropolitan living = 0) and low SES area (living in the most disadvantaged area = 1, living in other areas = 0). The R^2 statistic was used to measure the proportion of variation that each factor contributed to the models. Analyses of data were completed using SPSS 13.0.

Results

Some 326,099 children were included in this sample, of which 10,473 (3.2%) were Indigenous. Over two-thirds of Indigenous children lived in rural locations, compared with 27.1% of non-Indigenous children (Table 1). Approximately 47 % of rural Indigenous children were aged 8–11 years, while 43.4% of non-Indigenous rural children were in the same age group. Indigenous children were equally distributed by sex in metropolitan and rural areas, but there were proportionally more non-Indigenous females residing in metropolitan as opposed to rural areas. Over half the rural Indigenous children were in the most socially disadvantaged category compared with less than one-fifth of their non-Indigenous counterparts. Less than one-third of 4–10-year-old rural Indigenous children were caries-free in the deciduous dentition compared with 57.9% of rural non-Indigenous children and the mean dmft of rural Indigenous children was almost twice that of rural non-Indigenous children. The proportion of the decayed component in overall dmft was 65.6% for rural Indigenous children compared with 42.5% for rural non-Indigenous children. Almost 70% of 6–14-year-old rural Indigenous children were caries-free in the permanent dentition compared with 81.1% of their non-Indigenous counterparts, and the mean DMFT of rural Indigenous children was almost twice that of rural non-Indigenous children.

FIGURE 1
Percent dmft=0 for 4- 10-year-old indigenous and non-indigenous children by residential location

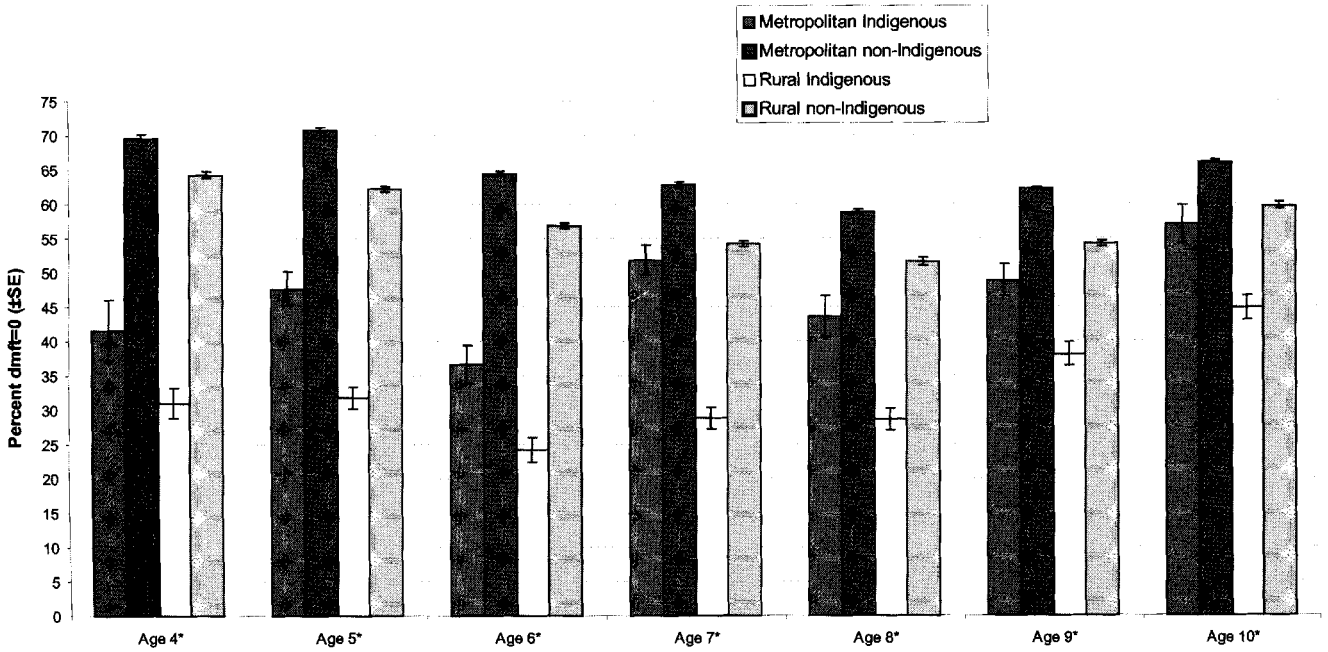
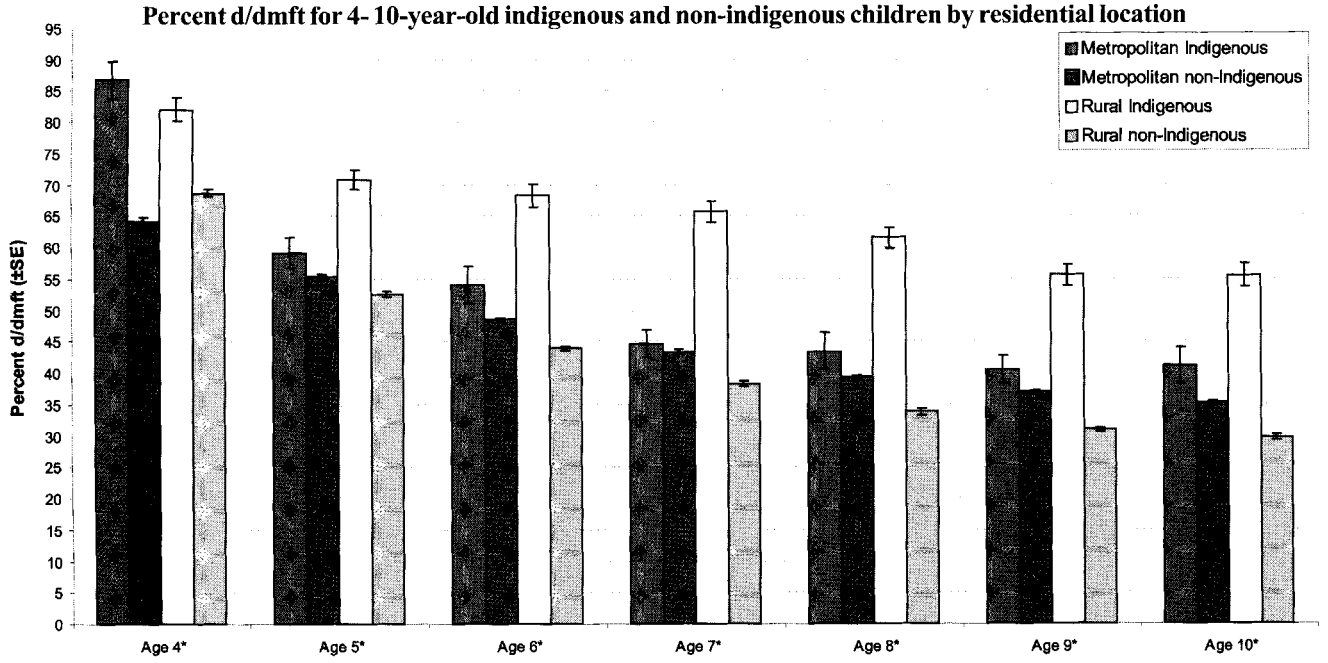


FIGURE 2
Percent d/dmft for 4- 10-year-old indigenous and non-indigenous children by residential location



The proportion of untreated decay in overall DMFT was 64.2 and 42.8 % for rural Indigenous and non-Indigenous children respectively.

Across all age-groups, a higher

ure 1). Metropolitan non-Indigenous children aged 5 years had the highest percent dmft=0 and this was 1.5 times that of similarly aged metropolitan Indigenous children. The greatest per-

Indigenous children had higher levels of untreated decay as a percentage of deciduous dmft than non-Indigenous children across all age groups, with the difference between

FIGURE 3

Percent DMFT=0 for 6- 14-year-old indigenous and non-indigenous children by residential location

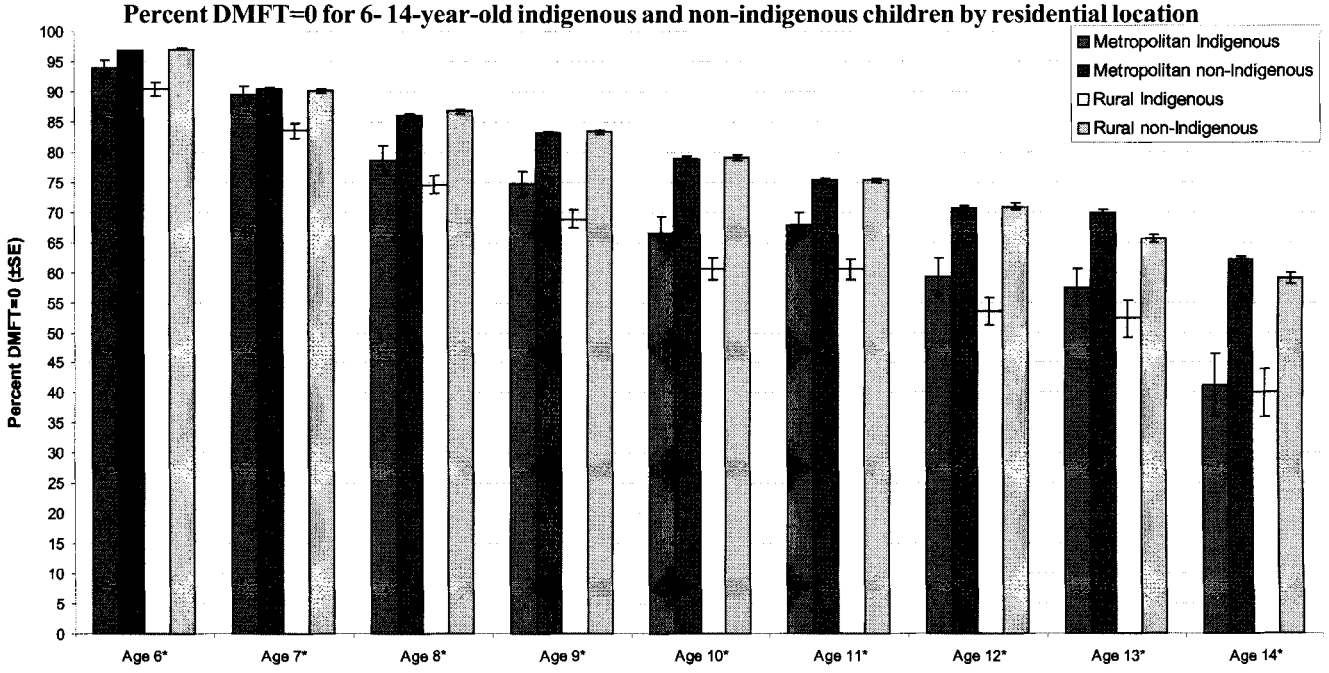
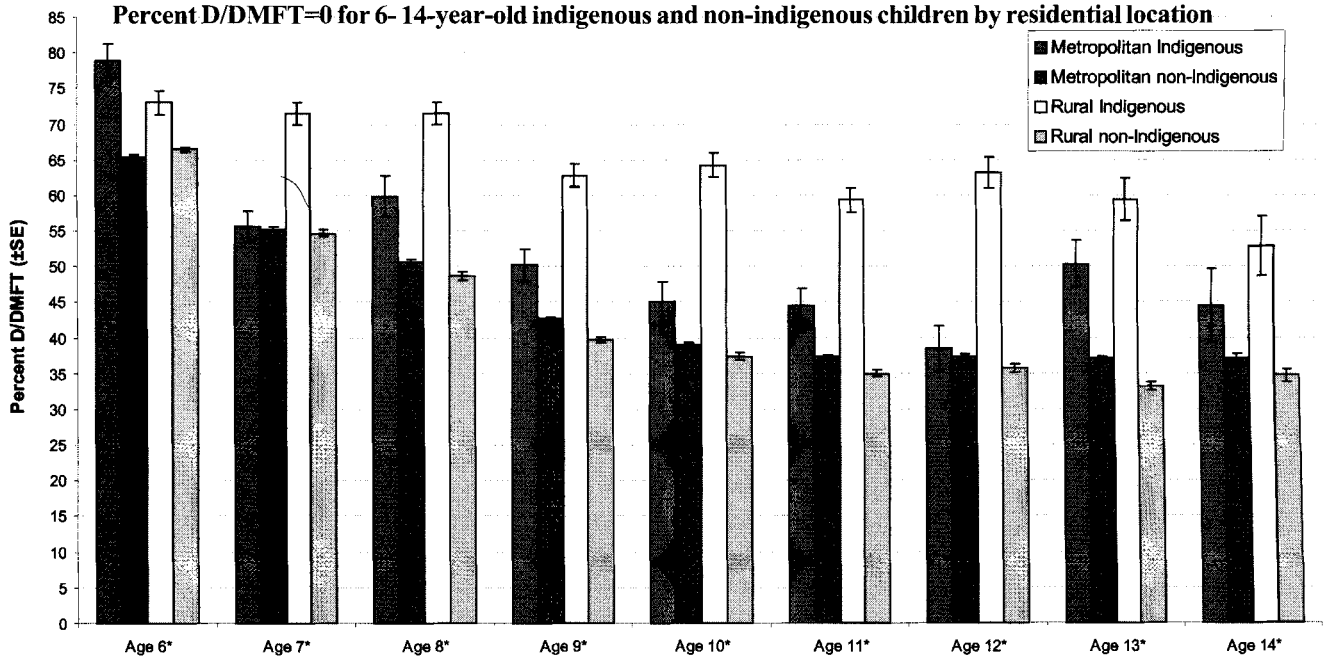


FIGURE 4

Percent D/DMFT=0 for 6- 14-year-old indigenous and non-indigenous children by residential location



tan and non-Indigenous counterparts. The highest percent d/dmft in rural Indigenous children was observed among 4-year-olds and this was 1.2 times that of rural non-Indigenous 4-year-olds. The greatest difference in percent d/dmft between rural Indigenous and non-Indigenous children was observed among 10-year-olds, with rural Indigenous children having 1.9 times the percent d/dmft of rural non-Indigenous children. The percent d/dmft decreased with increasing age for all children.

Across all age groups, the proportion of children with no evidence of dental disease experience in the permanent dentition was highest among metropolitan and rural non-Indigenous groups, followed by metropolitan Indigenous children and rural Indigenous children respectively (Figure 3). The highest proportion of children who were caries-free in the permanent dentition were metropolitan and rural living non-Indigenous children aged 6 years. The greatest percent DMFT=0 difference between rural Indigenous and non-Indigenous children was observed among 14-year-olds, with rural non-Indigenous children having 1.5 times the percent DMFT=0 of rural Indigenous children in this age group. The percent DMFT=0 generally decreased with increasing age across Indig-

enous and non-Indigenous groups with the trend being most marked among rural and metropolitan Indigenous children.

Indigenous children across all ages had higher levels of untreated decay in the permanent dentition as expressed by percent D/DMFT than non-Indigenous children (Figure 4). Across all age groups, with the exception of 6-year-olds, rural Indigenous children had higher percent D/DMFT than their metropolitan counterparts. There were no significant differences between metropolitan and rural non-Indigenous percent D/DMFT levels across all ages, except age 13 (metropolitan non-Indigenous children had slightly higher percent D/DMFT levels than their rural counterparts). The highest proportion of unmet treatment need in the permanent dentition among rural Indigenous children was observed among 6-year-olds. The greatest difference in percent D/DMFT between rural Indigenous and non-Indigenous children was observed among 12- and 13-year-olds, with rural Indigenous children in these age groups having 1.8 times the percent D/DMFT of their similarly-aged rural non-Indigenous counterparts.

Regression modeling for caries prevalence, unmet treatment need and caries severity for Indigenous and non-Indigenous children was carried out to test for the independent effects of age, sex, residential location and area-based SES (Table 2). Living in a rural area was the strongest indicator of caries prevalence and unmet dental need in the deciduous dentition of Indigenous children, with rural Indigenous children being 1.7 times more likely to have experienced dental disease in the primary dentition than their counterparts residing in metropolitan areas and 1.9 times more likely to have one or more teeth with untreated decay. Being female was the strongest indicator of having one or more permanent teeth with experience of past or present dental disease for Indigenous children, while living in a socially disadvantaged area was the strongest indicator of unmet treatment need in the permanent dentition. Living in a low SES area was the strongest indicator of caries prevalence and unmet dental need in the deciduous and permanent dentitions of non-Indigenous children. Living in a rural location contributed to most of the variance for caries severity in the deciduous dentition among Indigenous children while living in a low SES area was the strongest indicator of caries severity in the permanent dentition of such children. Living in a low SES area was the strongest indicator of caries severity in the deciduous and permanent dentition of non-Indigenous children.

TABLE 2
Regression analyses of Indigenous and non-Indigenous child caries prevalence, untreated decay and caries severity

	Indigenous		Non-Indigenous	
	OR (95% CI)	Nagelkerke R^2 contribution	OR (95% CI)	Nagelkerke R^2 contribution
dmft=0 (4-10-year-olds)				
4–7 years	1.35 (1.23, 1.48)*	0.006	0.84 (0.82, 0.85)*	0.003
Male	1.14 (1.04, 1.25)*	0.001	1.14 (1.12, 1.15)*	0.001
Rural	1.75 (1.58, 1.93)*	0.027	1.43 (1.41, 1.46)*	0.007
Low SES area	1.59 (1.45, 1.75)*	0.016	1.43 (1.40, 1.46)*	0.008
Percent d/dmft (4-10-year-olds)				
4–7 years	1.74 (1.58, 1.90)*	0.021	1.21 (1.18, 1.23)*	0.002
Male	1.09 (0.98, 1.20)	0.000	1.16 (1.13, 1.18)*	0.002
Rural	1.94 (1.76, 2.15)*	0.037	1.22 (1.21, 1.26)*	0.002
Low SES area	1.72 (1.57, 1.89)*	0.022	1.45 (1.42, 1.48)*	0.007
DMFT=0 (8–14-year-olds)				
8–11 years	1.36 (1.24, 1.50)*	0.007	1.08 (1.06, 1.11)*	0.000
Male	0.71 (0.65, 0.78)*	0.009	0.89 (0.88, 0.91)*	0.001
Rural	1.18 (1.06, 1.30)*	0.003	1.04 (1.02, 1.06)*	0.000
Low SES area	1.40 (1.28, 1.54)*	0.008	1.33 (1.30, 1.36)*	0.004
Percent D/DMFT (8–14-year-olds)				
8–11 years	1.28 (1.16, 1.42)*	0.004	1.02 (1.00, 1.05)*	0.000
Male	0.69 (0.62, 0.76)*	0.009	0.89 (0.87, 0.92)*	0.001
Rural	1.32 (1.18, 1.48)*	0.007	0.92 (0.90, 0.95)*	0.000
Low SES area	1.55 (1.39, 1.72)*	0.012	1.37 (1.33, 1.41)*	0.004
	B (SE)	Adjusted R^2 contribution	B (SE)	Adjusted R^2 contribution
Mean dmft (4-10-year-olds)				
4–7 years	0.80 (0.08)*	0.015	0.10 (0.01)*	0.000
Male	0.25 (0.08)*	0.001	0.19 (0.01)*	0.002
Rural	0.81 (0.08)*	0.017	0.41 (0.01)*	0.004
Low SES area	0.80 (0.08)*	0.013	0.49 (0.01)*	0.007
Mean DMFT (8–14-year-olds)				
8–11 years	0.02 (0.03)	0.000	-0.05 (0.01)*	0.000
Male	-0.23 (0.03)*	0.005	-0.06 (0.01)*	0.001
Rural	0.08 (0.04)*	0.001	-0.01 (0.01)	0.000
Low SES area	0.24 (0.04)*	0.006	0.14 (0.01)*	0.002

* $P<0.05$

Discussion

This cross-sectional investigation of a child sample from three of Australia's states and territories showed that living in a rural location was the strongest indicator of caries prevalence, severity and unmet treatment need in the deciduous dentition of Indigenous children, while living in a socially disadvantaged area had the most influence on poor oral health outcomes in the permanent dentition of Indigenous children and in both dentitions of non-Indigenous children. The findings suggest that while there may be factors concerned with rural living that influence dental disease experience in young Indigenous children, the same factors do not ap-

pear to affect older Indigenous and non-Indigenous child oral health to the same extent.

In general, the items used in the multivariate analyses explained comparatively little of the variance in caries prevalence, severity and unmet treatment need (Table 2), indicating that other factors or paradigms, not accounted for, were impacting the findings of the study. Such paradigms may include exposure to fluoride, diet, access to care, historical legacy, culturally insensitive oral health services, dental fear, intergenerational issues, social capital, community cohesion or neighborhood trust (14). It is not uncommon in dental epidemiology to have relatively small R^2 values due to the complexity of the relations between factors that influence oral health outcomes (15, 16).

There are important differences between rural- and urban-dwelling Indigenous Australians in terms of community capital, and general health and well being that may impact on Indigenous child oral health. Rural-living Indigenous Australians are generally more dislocated from mainstream life than their urban counterparts, with McIntyre and Menzies (17) asserting that many rural-living Indigenous people experience a greater sense of "hopelessness" because of their perception that most major life decisions (livelihood, health) are out of their control. In recent times, the social capital at a community level of rural Indigenous Australians is believed to have deteriorated, with increasing substance and drug abuse, domestic violence and suicides leading to stronger feelings of despondency and cultural defragmentation (18). In contrast, urban-dwelling Indigenous Australians are generally more integrated with their non-Indigenous counterparts, have attained higher levels of formal education, are more familiar with mainstream health and social services, more likely to be employed, more exposed to health education messages and, in general, more empowered to accept health, including oral health, as their responsibility (19). These are all factors that may contribute to positive child oral health outcomes.

Another factor that may influence the poor oral health of rural Indigenous children is the relative autonomy of such children in comparison with their non-Indigenous counterparts (20). A food purchasing survey by Rowse *et al.* (21), for example, revealed that Indigenous rural children have sufficient disposable income to purchase their own nourishment, meaning much of their cariogenic intake is not monitored by adult family members. Similar freedom is also experienced in terms of lifestyle, with many rural-living Indigenous children residing in a number of different houses within a community, having limited pressure to attend school and often living in houses with no fixed meal or bedtimes (22). In these same communities, child ownership of toothbrushes may be low (23).

Access to dental services in rural communities may help explain the higher unmet dental needs of rural-living Indigenous children, with dental service provision in such areas being constrained by logistical challenges such as staffing shortages, geographic distance and equipment failure. Indigenous children in some rural communities are visited by the school dental service less than once every two years, whereas their urban counterparts may receive dental care twice yearly (24). Even when dental services to rural-living Indigenous children are available, certain cultural issues and community events, such as initiation ceremonies, funerals, community meetings and football games, may preclude completion of dental care (23). Indigenous children in rural communities have the highest referral rates for dental care received under a hospital general anesthetic, largely due to their late presentation with dental problems and limited availability of personnel trained to deal with such scenarios (25).

Welfare dependence is high among rural-living Indigenous Australians and is recognized as contributing – some would argue fundamentally – to their disempowerment (26). Following the tenet that it is not poverty in absolute terms that contributes to health inequalities, but *relative* poverty, that is, poverty in relation to other societal members, it is not because Indigenous Australians are materially poor that they have poor health, but because they are a socially-excluded minority within their own country (27). McIntyre and Menzies (17) assert that the inferior health status of Indigenous Australians is inextricably linked to their historical legacy, their ongoing social and economic disadvantage (including displacement from their homes, land and lifestyle) and psychosocial trauma (particularly in regards to child separation from their families; an official government policy for much of the 20th Century); factors not experienced by the majority of non-Indigenous Australians. Nowhere is this felt more than in rural Indigenous communities. It may be that before rural Indigenous and non-Indigenous child oral health parity is reached, fundamental shifts in the political and societal paradigms that determine Indigenous social capital and empowerment are necessary.

The findings of the study indicate a need for policy makers to implement more effective and relevant rural Indigenous child oral health strategies in the states and territories involved in our study. Initiatives that address upstream factors as well as those more directly related to dental service provision and oral health behaviors appear to be warranted. Dental workforce issues need to be addressed, including implementation of strategies to encourage rural Indigenous students into dental training programs and improved incentives to work in rural areas.

The oral health of rural Indigenous children is a public health issue that deserves to have its profile raised. Although the findings add to the collective knowledge of Indigenous child oral health, more research is required to better understand the complexity of the relationship between Indigenous status, location and child oral health.

Acknowledgements

The authors are grateful to the New South Wales, South Australia and Northern Territory School Dental Services for their assistance and support in the collection of these data.

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