

Dental caries trends among indigenous and non-indigenous Australian children

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Objective To examine trends in dental caries among indigenous and non-indigenous children in an Australian territory. **Basic Research Design** Routinely-collected data from a random selection of 6- and 12-year-old indigenous and non-indigenous children enrolled in the Northern Territory School Dental Service from 1989–2000 were obtained. The association of indigenous status with caries prevalence (percent dmft or DMFT >0 and percent dmft >3 or DMFT >1), caries severity (mean dmft or DMFT) and treatment need (percent d/dmft or D/DMFT) was examined. **Results** Results were obtained for 10,687 6- and 12-year old indigenous children and 21,777 6- and 12-year-old non-indigenous children from 1989–2000. Across all years, indigenous 6-year-olds had higher caries prevalence in the deciduous dentition, greater mean dmft and percent d/dmft, and indigenous 12-year-olds had greater percent D/DMFT than their non-indigenous counterparts ($p < 0.05$). From 1996–2000 the mean dmft and percent d/dmft for indigenous 6-year-olds and mean DMFT and percent D/DMFT for indigenous 12-year-olds increased, yet remained relatively constant for their non-indigenous counterparts ($p < 0.05$). From 1997–2000, the percent dmft >3 for 6-year-old indigenous children was more than double that of non-indigenous children, while across the period 1994–2000, indigenous 6-year-old mean dmft was more than double that of their non-indigenous counterparts ($p < 0.05$). **Conclusions** Indigenous children in our study experienced consistently poorer oral health than non-indigenous children. The severity of dental caries among indigenous children, particularly in the deciduous dentition, appears to be increasing while that of non-indigenous children has remained constant. Our findings suggest that indigenous children carry a disproportionate amount of the dental caries burden among Northern Territory 6- and 12-year-olds.

Key words: Children, dental caries, indigenous, trends

Introduction

Indigenous Australian children are those who identify as Aboriginals, Torres Strait Islanders or both (ABS, 2003). They represent 4.7 percent of the total Australian child population aged 0–14 years and 39.8 percent of 0–14-year-old children in the Northern Territory (one of the eight major Australian states and territories) (ABS, 2001). Some 62.2 percent of Northern Territory indigenous children live in very remote areas (census collection districts with an accessibility/remoteness index of Australia (ARIA) value greater than 10.53, with ARIA being a measure of the remoteness of a point based on the road distances to the nearest service centre), where they constitute 82.7 percent of the total very remote area child population (ABS, 2001). In contrast, 67.6 percent of non-indigenous Northern Territory children live in regional areas (census collection districts with an ARIA value of 0.2 to 5.92) where they constitute 83.8 percent of the total Northern Territory regional area child population (ABS, 2001a). Indigenous children in the Northern Territory speak a multitude of languages and belong to many distinct descent groups (AIHW, 2004). While this paper focuses on indigenous children as a group, it is important to acknowledge this diversity. Indigenous children are at higher risk of disease and injury than other Australian children, and more likely to be hospitalised for most diseases and conditions (AIHW, 2004). They

experience greater disability and poorer quality of life due to ill health, partake in higher levels of health risk behaviours (for example, petrol sniffing) and are more exposed to violence in the home (ABS, 2003). In 2002, indigenous child mortality rates were 2.7 times those of non-indigenous children (AIHW, 2004). Indigenous children also have over twice the odds of being born underweight than other Australian children (AIHW, 2004). Low birth weight babies are more prone to ill health, including dental ill-health, in later life (Nicolau *et al.*, 2003).

Prior to the 1980s, indigenous Australian children were recognised as having better oral health than their non-indigenous counterparts (Barrett and Williamson, 1972). Recent evidence suggests, however, that indigenous children experience worse oral health than non-indigenous children, with some having up to five times the dental disease experience of their non-indigenous counterparts (Endean *et al.*, 2004). In one study of remote indigenous children, more than 90 percent of dmfs (sum of decayed, missing or filled deciduous tooth surfaces) was made up of either decayed or missing surfaces, and fewer than 10 percent of tooth surfaces with experience of decay had been treated with a filling (Bourke *et al.*, 1999). This is consistent with literature showing that indigenous children in developed countries such as New Zealand, Canada and the United States experience poorer oral health than their non-indigenous counterparts (Peressini *et al.*, 2004; Niendorff and Jones, 2000; Thomson, 1993).

Although there is some research examining indigenous children's oral health status, there is a paucity of data pertaining to changes in caries levels in indigenous and non-indigenous children over time. The aim of this study was to describe dental caries trends among indigenous and non-indigenous children in an Australian Territory from 1989–2000. We hypothesised that disparities in caries levels between indigenous and non-indigenous children would increase over time, with indigenous child caries levels becoming worse relative to non-indigenous children.

Methods

Data were obtained from random samples of children enrolled in the Northern Territory School Dental Service (SDS) for the years 1989–2000. The random sampling procedure involved selecting approximately one in two (1:1.9) children residing in the capital city of Darwin (achieved by selecting children whose birthday was between the 1st and 16th inclusive of any given month). Due to their small numbers, all children residing outside Darwin were included. Children were enrolled from public and private schools (the SDS provides care to all school-aged children irrespective of school type) and examinations were conducted by dental health professionals employed by the SDS. The proportion of indigenous and non-indigenous children by school type was similar during each examination period. Dental examiners were not calibrated, but had received similar training and used standardised procedures.

Data were collected over a 12-month period each year. When more than one examination occurred during a given 12-month period, information from the first examination only was included. Data were weighted each year on the basis of 'area of sampling' and 'sampling fraction' to provide a more representative result, and by 'time since last dental examination' so children on shorter recall intervals were not over-represented. Unit records were also weighted each year to reflect the estimated resident population (ERP) of children in the Northern Territory according to the Australian Bureau of Statistics (ABS). Children aged 6- and 12-years were analysed so findings could be compared at national and international levels.

Dental disease experience was measured by the number of teeth that were decayed, missing because of dental caries or filled because of dental caries. Caries was defined as 'any lesion with a softened floor or wall, or undermined enamel' based on WHO guidelines (WHO, 1997). Explorers were used in examinations but cavitated lesions were not probed. Radiographs were not used. Illumination was by standard lights attached to examination dental chairs.

The dmft and DMFT indices were used to assess oral health outcomes. The indices are a cumulative measure of caries experience. Percent dmft or DMFT>0 was used to determine the prevalence of dental caries experience, while mean dmft or DMFT values were used to ascertain the severity of dental caries experience within the deciduous and permanent dentition respectively. The proportion of decayed teeth in overall dmft or DMFT was measured to indicate levels of unmet treatment need. Upper quintile

splits were performed to determine the characteristics of children over-represented in the tail of the dmft or DMFT distribution over time. Six-year-old children in the highest dmft quintile had a dmft>3, while 12-year-old children in the highest DMFT quintile had a DMFT>1.

Data were analysed using Intercooled Stata 8.0. The Pearson Chi-square test was used to compare differences in proportions of categorical variables and analysis of variance (ANOVA) when the dependent variable was continuous. The standard error formula for ratios was used to derive standard errors and consequent 95% confidence intervals for the percent d/dmft or D/DMFT variables respectively. Differences in proportions, means and ratios were tested between Indigenous and non-Indigenous children for each year. Logistic regression was used to test for trends in dental prevalence outcomes, linear regression when the dental outcomes were continuous and Poisson regression when the dental outcomes were ratios. Dental outcomes were entered as dependant variables in the multivariate models, year entered as an independent variable and each model run separately for indigenous and non-indigenous children. The level of significance was set at $p<0.05$. Ethical approval for the study was obtained from the Australian Institute of Health and Welfare and the University of Adelaide.

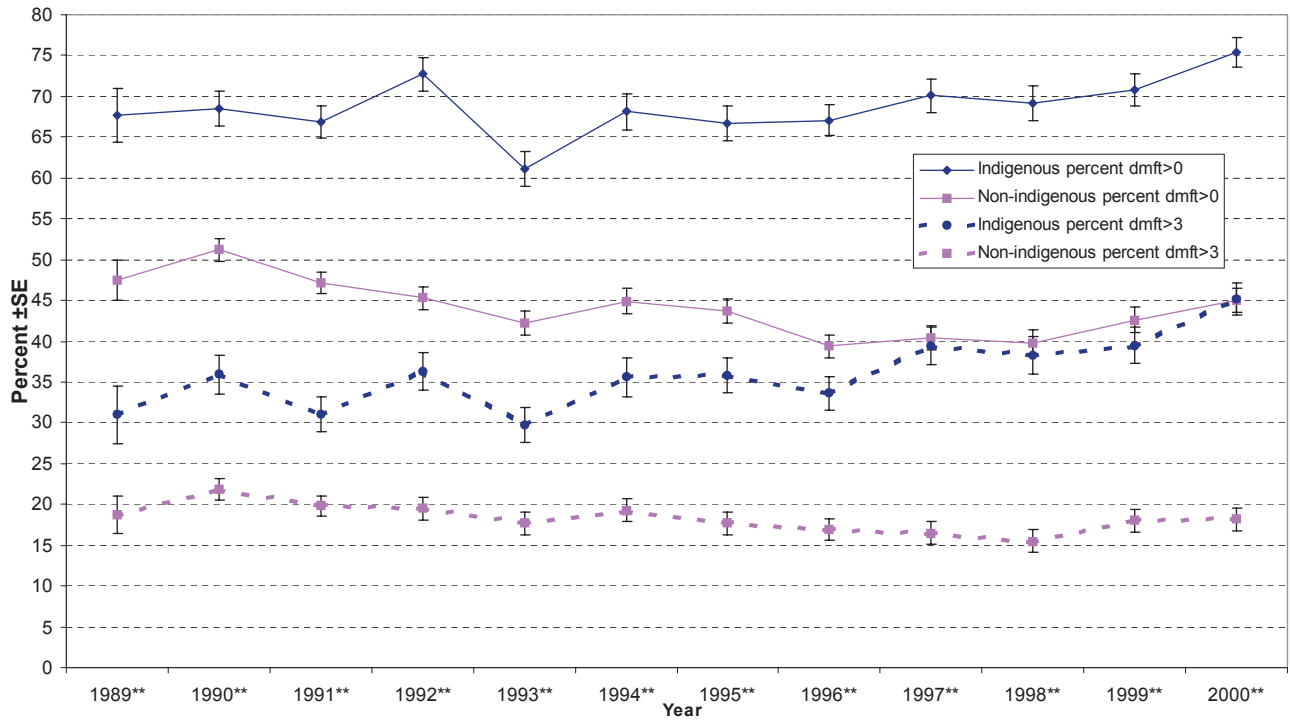
Results

Male and female children were generally equally represented across all years for both age-groups (Table 1). The proportion of 6-year-old indigenous children ranged from 25.8 percent (1990) to 33.1 percent (2000) while the proportion of 12-year-old indigenous children ranged from 30.7 percent (1991) to 43.6 percent (1995). The proportion of 6-year-old indigenous children enrolled in private schools ranged from 3.0 percent (1989) to 9.9 percent (1990), while the proportion of 6-year-old non-indigenous children ranged from 16.3 percent (1995) to 25.6 percent (1989). The proportion of 12-year-old indigenous children enrolled in private schools ranged from 13.4 percent (1994) to 17.1 percent (1995), while the proportion of 12-year-old non-indigenous children ranged from 14.8 percent (1992) to 24.2 (1990).

Across all years, the proportion of children with evidence of dental caries experience was greater among indigenous than non-indigenous children, with the differences increasing from 1994 (Figure 1). From 1997–2000, the percent of indigenous children with dmft>3 was more than double that of non-indigenous children. The greatest difference was observed in 2000, with the proportion of indigenous and non-indigenous children with dmft>1 being 75.4 and 45.0 percent respectively, and the proportion of indigenous and non-indigenous children with dmft>3 being 45.0 and 18.2 percent respectively. The proportion of indigenous children with deciduous caries experience increased between 1989 and 2000 (67.7 to 75.4 percent; $p=0.003$), with a peak occurring in 1992 (73.4 percent). The proportion of non-indigenous children with experience of dental caries decreased from 1989 to 2000 (47.5 to 45.0 percent; $p<0.001$), with a peak in 1990 (51.9 percent). The proportion of indigenous children with dmft>3 increased between 1989 and 2000 (32.3 to 45.0 percent; $p<0.001$) while in the same period

Table 1. Socio-demographic characteristics of 6- and 12-year-old Northern Territory children enrolled in the School Dental Service, 1989–2000 (percentages in brackets)

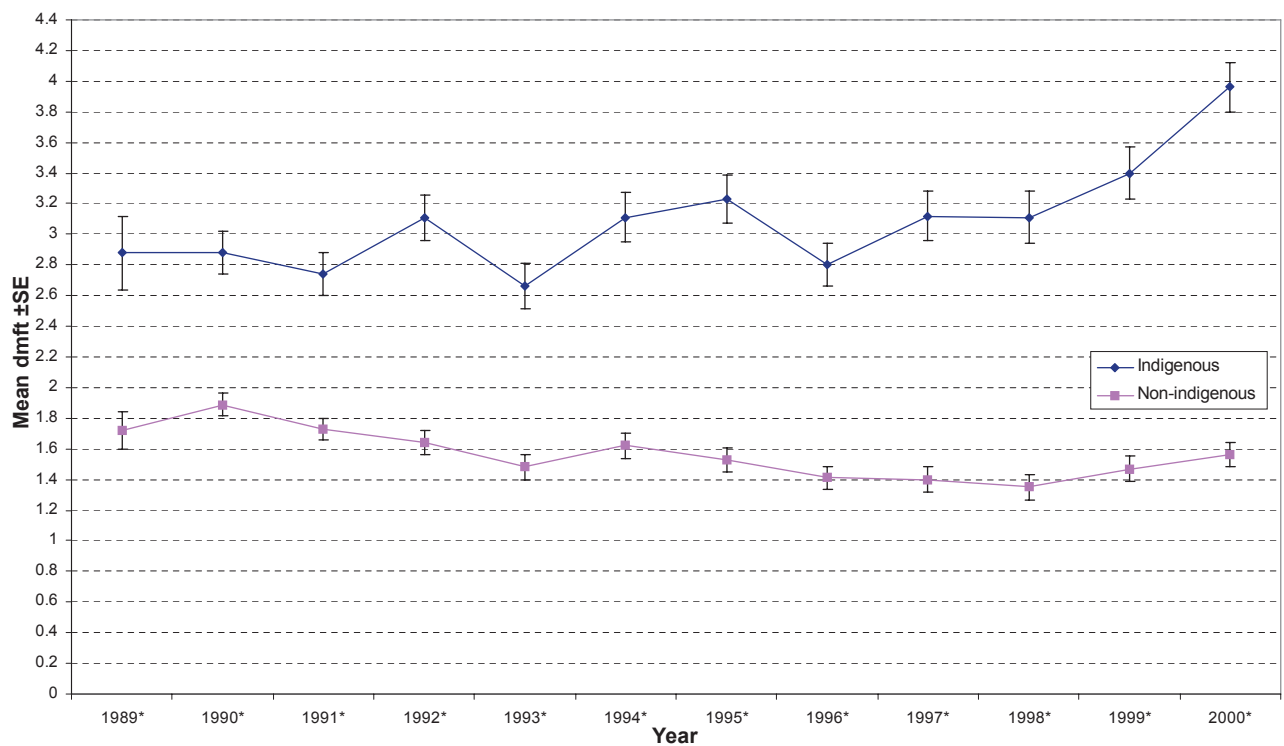
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
<i>6-year-olds</i>												
Total	597	1796	2057	1713	1741	1542	1715	1819	1659	1471	1544	1655
<i>Gender</i>												
Male	296 (49.5)	874 (48.7)	1034 (50.3)	852 (49.7)	895 (51.4)	797 (51.7)	870 (50.7)	890 (48.9)	844 (50.9)	744 (50.6)	763 (49.4)	831 (50.2)
Female	301 (50.5)	922 (51.3)	1023 (49.7)	861 (50.3)	846 (48.6)	745 (48.3)	845 (49.3)	929 (51.1)	815 (49.1)	727 (49.4)	781 (50.6)	824 (49.8)
<i>Indigenous status</i>												
Indigenous	196 (32.9)	463 (25.8)	550 (26.7)	465 (27.1)	543 (31.2)	450 (29.2)	509 (29.7)	574 (31.6)	467 (28.1)	463 (31.5)	494 (32.0)	547 (33.1)
Non-indigenous	401 (67.1)	1333 (74.2)	1507 (73.3)	1248 (72.9)	1198 (68.8)	1092 (70.8)	1206 (70.3)	1245 (68.4)	1192 (71.9)	1008 (68.5)	1050 (68.0)	1108 (66.9)
<i>Private school</i>												
Indigenous	6 (3.0)	46 (9.9)	32 (5.8)	33 (7.1)	26 (4.8)	33 (7.3)	34 (6.7)	42 (7.3)	25 (5.4)	29 (6.3)	28 (5.7)	21 (3.8)
Non-indigenous	103 (25.6)	223 (16.7)	254 (16.9)	212 (17.0)	240 (20.0)	267 (24.5)	197 (16.3)	280 (22.5)	292 (24.5)	249 (24.7)	186 (17.7)	207 (18.7)
<i>12-year-olds</i>												
Total	599	1319	1516	1188	1164	957	1143	1220	1007	924	1032	1086
<i>Gender</i>												
Male	308 (51.3)	652 (49.4)	802 (52.9)	582 (49.0)	611 (52.5)	490 (51.2)	572 (50.0)	630 (51.6)	482 (47.9)	470 (50.9)	516 (50.0)	562 (51.7)
Female	292 (48.7)	667 (50.6)	714 (47.1)	606 (51.0)	553 (47.5)	467 (48.8)	571 (50.0)	590 (48.4)	525 (52.1)	454 (49.1)	516 (50.0)	524 (48.3)
<i>Indigenous status</i>												
Indigenous	200 (33.4)	485 (36.8)	466 (30.7)	444 (37.4)	423 (36.3)	322 (33.6)	498 (43.6)	514 (42.1)	386 (38.3)	341 (36.0)	445 (43.1)	442 (40.7)
Non-indigenous	399 (66.6)	834 (63.2)	1050 (69.3)	744 (62.6)	741 (63.7)	635 (66.4)	645 (56.4)	706 (57.9)	621 (61.7)	583 (63.1)	587 (56.9)	644 (59.3)
<i>Private school</i>												
Indigenous	31 (15.3)	79 (17.0)	71 (15.2)	74 (16.7)	64 (15.1)	43 (13.4)	85 (17.1)	82 (16.0)	60 (15.5)	47 (13.8)	73 (16.4)	64 (14.5)
Non-indigenous	103 (24.0)	202 (24.2)	224 (21.3)	110 (14.8)	118 (15.9)	135 (21.3)	114 (17.7)	116 (16.4)	135 (21.7)	116 (19.9)	119 (20.3)	115 (17.9)



** $p < 0.05$; Chi-square (difference between indigenous and non-indigenous percent dmft >0, and indigenous and non-indigenous percent dmft >3 each year)

Test for trend 1989-2000 (logistic regression):
 Indigenous percent dmft >0; $B = 0.026, p = 0.003$
 Non-indigenous percent dmft >0; $B = -0.019, p < 0.001$
 Indigenous percent dmft >3; $B = 0.042, p < 0.001$
 Non-indigenous percent dmft >3; $B = -0.024, p < 0.001$

Figure 1. Percent dmft >0 and dmft >3 for 6-year-old Northern Territory indigenous and non-indigenous children, 1989–2000



* $p < 0.05$; ANOVA (difference between indigenous and non-indigenous mean dmft each year)

Test for trend 1989-2000 (linear regression):
 Indigenous; $B = 0.081, p < 0.001$
 Non-indigenous; $B = -0.021, p = 0.003$

Figure 2. Mean dmft for 6-year-old Northern Territory indigenous and non-indigenous children, 1989–2000

the proportion of non-indigenous children with $dmft > 3$ decreased (19.1 to 18.7 percent; $p < 0.001$). The prevalence of dental caries in the deciduous dentition (both $dmft > 0$ and $dmft > 3$) of indigenous and non-indigenous children has been increasing since 1998.

Across all years, the mean $dmft$ of indigenous children was higher than that of non-indigenous children with indigenous children having more than double the mean $dmft$ of their non-indigenous counterparts across the period 1994–2000 (Figure 2). The mean $dmft$ of indigenous children increased from 2.88 in 1989 to 3.96 in 2000 ($p < 0.001$), although slight decreases occurred from 1992–1993 and 1995–1996. There has been an increase in mean $dmft$ for indigenous children since 1998. The mean $dmft$ of non-indigenous children decreased from 1989–2000 ($p = 0.003$); the highest peak was reached in 1990 (1.89) and the lowest in 1998 (1.35). The mean $dmft$ of non-indigenous children has been increasing since 1998, although not to the extent observed for indigenous children. The difference in mean $dmft$ between indigenous and non-indigenous children was least in 1990 and greatest in 2000, and has been increasing since 1996.

Across all years, the percent $d/dmft$ was higher for indigenous than non-indigenous children. The percent $d/dmft$ for indigenous children never dropped below 71 percent (1997) and never rose above 59 percent (1990) for non-indigenous children (Figure 3). There was no significant difference in percent $d/dmft$ for indigenous children between 1989 and 2000 ($p > 0.05$), although fluctuations did occur in the intervening years. The proportion of the decayed component in overall $dmft$ has been increasing among indigenous children since 1997. The percent $d/dmft$ increased among non-indigenous children between 1989 and 2000 ($p < 0.001$), with the sharpest increase occurring from 1999–2000. The difference in percent $d/dmft$ between indigenous and non-indigenous children was least in 1990 and greatest in 1999.

Across all years, the proportion of children with evidence of dental caries experience in the permanent dentition was greater among indigenous than non-indigenous children (Figure 4). The greatest difference was observed in 1999, with the proportion of indigenous and non-indigenous children with $DMFT > 0$ being 47.2 and 29.5 percent respectively, and the proportion of indigenous and non-indigenous children with $DMFT > 1$ being 29.6 and 15.1 percent respectively. The proportion of indigenous children with caries experience in the permanent dentition decreased between 1989 and 2000 (52.1 to 46.9 percent; $p = 0.009$), as did the proportion of non-indigenous children (43.1 to 32.2 percent; $p < 0.001$). The proportion of both indigenous and non-indigenous children with $DMFT > 1$ decreased between 1989 and 2000 (35.0 to 27.5 percent for indigenous children; $p = 0.002$ and 25.2 to 17.8 percent for non-indigenous children; $p < 0.001$).

The mean $DMFT$ of indigenous children was higher across all years than for non-indigenous children, with the difference in mean $DMFT$ between indigenous and non-indigenous children being least in 1990 and largest in 1998 (Figure 5). In 1998 and 1999, the mean $DMFT$ of indigenous children was over twice that of non-indigenous children. The mean $DMFT$ of indigenous children in 1989 and 2000 were not significantly different ($p > 0.05$), although fluctuations occurred in the interim

years; the lowest mean $DMFT$ score was observed in 1996 (0.85) and the highest in 1991 (1.38). The mean $DMFT$ of non-indigenous children decreased overall from 1989–2000 ($p < 0.001$), with the highest peak occurring in 1991 (1.24) and the lowest peak in 1998 (0.51). Since 1998, the mean $DMFT$ for non-indigenous children has been increasing, although is still less than the values observed in 1989–1991.

Across all years the percent $D/DMFT$ was higher for indigenous children than for non-indigenous children, with the difference being most marked in 1992 (50.2 percent compared to 21.4 percent respectively; (Figure 6). The difference was least marked in 1996. The lowest percent $D/DMFT$ for indigenous children was noted in 1989 (32.1 percent) and the highest in 2000 (66.5 percent). For non-indigenous children, the proportion of permanent decay in overall $DMFT$ was highest in 1999 (35.5 percent) and lowest in 1991 (18.7 percent). The percent $D/DMFT$ was lower in 1989 than 2000 for both indigenous and non-indigenous groups ($p < 0.001$). The proportion of $DMFT$ index attributed to the decayed component for indigenous children has been increasing since 1996, but there have been little percent $D/DMFT$ changes among non-indigenous children since 1995.

Discussion

Our analyses of routinely-collected Northern Territory SDS data between 1989–2000 show that, from 1996–2000, the mean $dmft$ and percent $d/dmft$ for indigenous 6-year-olds and mean $DMFT$ and percent $D/DMFT$ for indigenous 12-year-olds increased, yet remained relatively constant (and considerably less) for 6- and 12-year-old non-indigenous children respectively. It is clear from the percent $d/dmft$ and percent $D/DMFT$ findings that a substantial number of indigenous children in our study, for whatever reason, are not receiving the dental care they require, which is likely to have long term impacts on their future dental health and general health and well-being.

Our findings can be contrasted to those of Armfield and colleagues (2003), who examined oral health trends in the general Australian child population from 1990–1999. In their report, the mean $dmft$ for 6-year-olds increased slightly from 1996–1999, but the percentage of caries experience accounted for by the decayed component remained relatively constant in the same period. The reverse occurred among 11–12-year-olds, with mean $DMFT$ remaining relatively constant between 1996–1999 but the percentage of $DMFT$ scores accounted for by decay increasing in the same period (although not to the extent of that observed by indigenous 12-year-olds in our study; (Figure 6). It is clear that the oral health disparities observed in our study are not merely part of national child oral health trends.

It is difficult to make comparisons between our findings and those of indigenous child groups in other developed countries due to the limited amount of indigenous child oral health trend data in the literature. A comparison of two national oral health surveys of indigenous Canadian children conducted in 1990–91 and 1996–97 respectively showed that mean $deft$ (decayed, extracted, filled deciduous teeth) scores for 6-year old

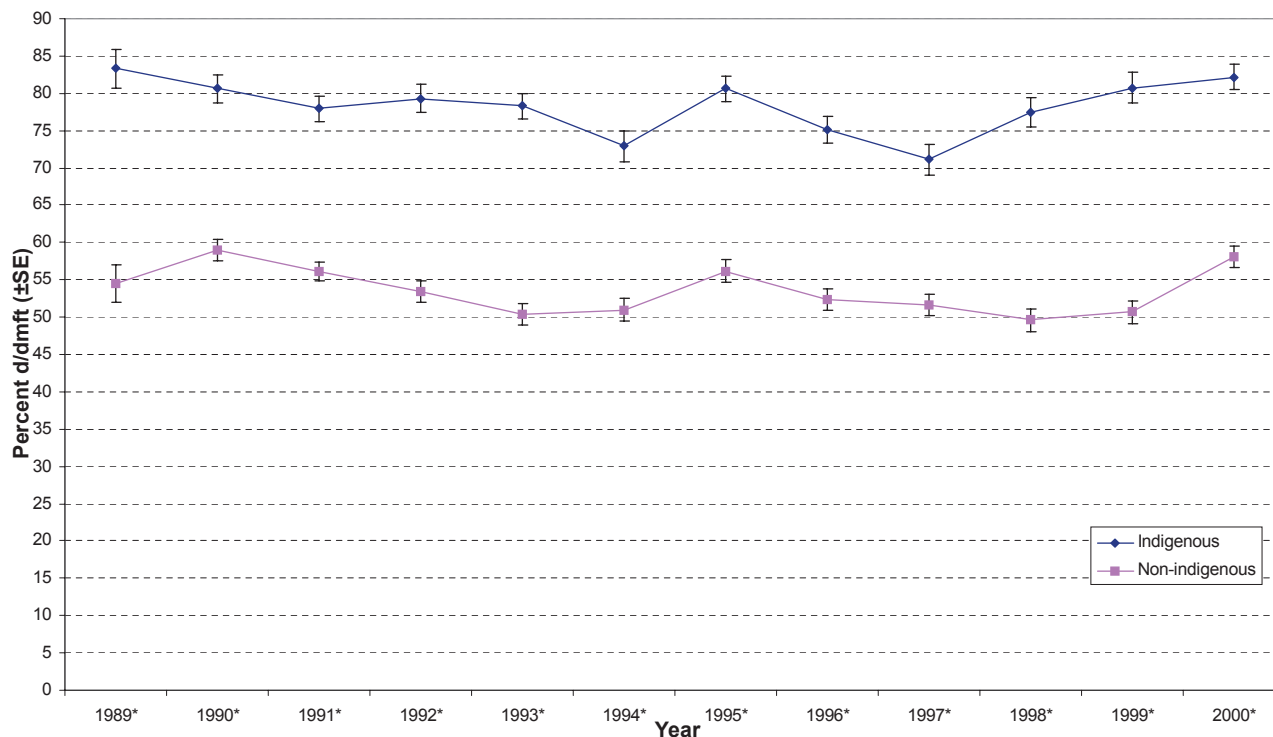


Figure 3. Percent d/dmft for 6-year-old Northern Territory indigenous and non-indigenous children, 1989–2000
 * $p < 0.05$; 95% CI using SE formula for ratios (difference between indigenous and non-indigenous percent d/dmft each year)

Test for trend 1989–2000 (Poisson regression): Indigenous; $B = -0.009$, $p > 0.050$
 Non-indigenous; $B = 0.013$, $p < 0.001$

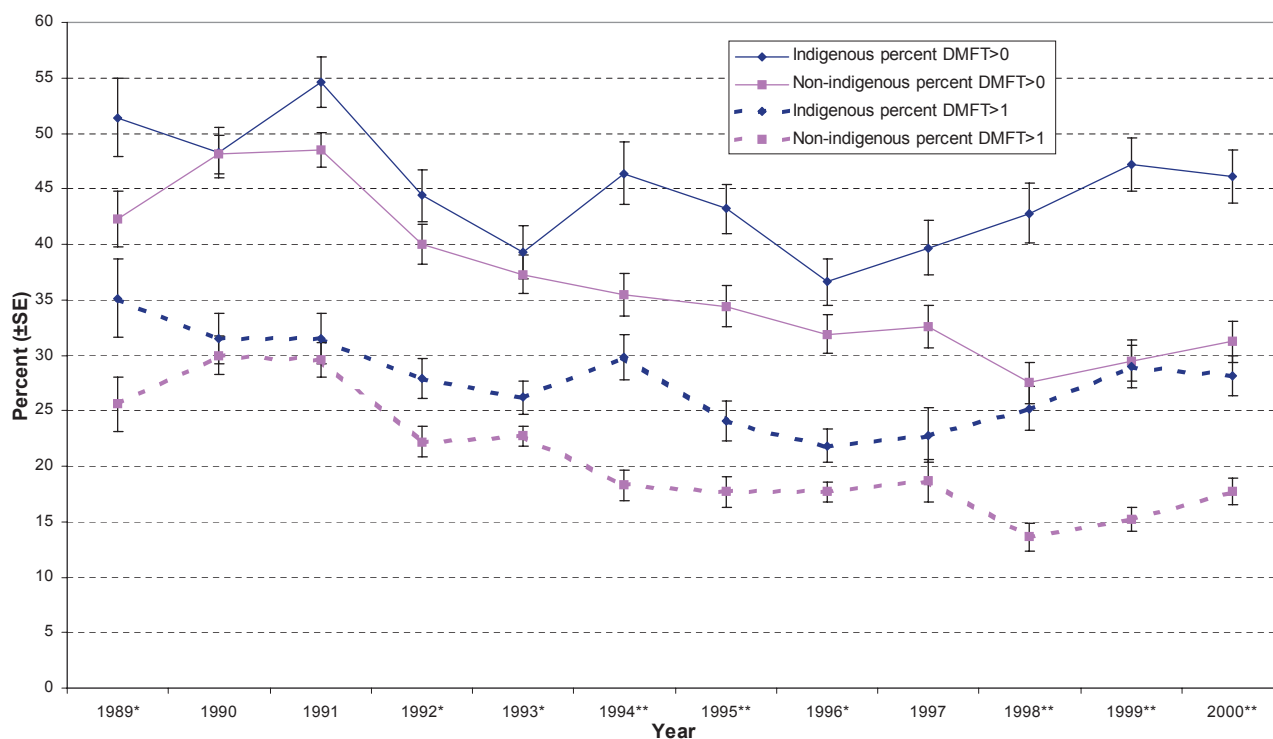


Figure 4. Percent DMFT > 0 and DMFT > 1 for 12-year-old Northern Territory indigenous and non-indigenous children, 1989–2000
 ** $p < 0.05$; Chi-square (difference between indigenous and non-indigenous percent DMFT > 0, and indigenous and non-indigenous percent DMFT > 1 each year)

* $p < 0.05$; Chi-square (difference between indigenous and non-indigenous percent DMFT > 1 each year)

Test for trend 1989–2000 (logistic regression): Indigenous percent DMFT > 0; $B = -0.022$, $p = 0.009$
 Non-indigenous percent DMFT > 0; $B = -0.076$, $p < 0.001$
 Indigenous percent DMFT > 1; $B = -0.029$, $p = 0.002$
 Non-indigenous percent DMFT > 1; $B = -0.085$, $p < 0.001$



* $p < 0.05$; ANOVA (difference between indigenous and non-indigenous mean DMFT each year)

Test for trend 1989-2000 (linear regression): Indigenous; $B = 0.011$, $p > 0.050$
 Non-indigenous; $B = -0.050$, $p < 0.001$

Figure 5. Mean DMFT for 12-year-old Northern Territory indigenous and non-indigenous children, 1989–2000



* $p < 0.05$; 95% CI using SE formula for ratios (difference between indigenous and non-indigenous percent D/DMFT each year)

Test for trend 1989-2000 (Poisson regression): Indigenous; $B = 0.030$, $p < 0.001$
 Non-indigenous; $B = 0.050$, $p < 0.001$

Figure 6. Percent D/DMFT for 12-year-old Northern Territory indigenous and non-indigenous children, 1989–2000

children had increased from 8.2 to 8.7, while mean DMFT scores had increased from 0.7 to 0.8. This was in contrast to the over-all Canadian child population in this age-group, where a decrease in dental caries experience was noted (Peressini *et al.*, 2004). Other regional reports of indigenous Canadian child oral health show similar trends. In the United States, Niendorff and Jones (2000) found that while the caries prevalence of Native American children was higher than that of the general American child population, it has been steadily decreasing since 1984. However, Douglass and colleagues (1996) reported that the prevalence and severity of caries did not differ among samples of 4-year-old Apache children between 1978–79 and 1993 in the United States, despite there being an increase in the level of treatment received in 1993 compared to 1978–79.

Reasons for our findings are likely to be complex and inter-related. Factors such as access to services, availability of fluoride in water and dentrifices, socio-economic status, residential location, oral self-care habits and care-giver dental disease experience are known to influence child oral health outcomes. However, between 1989 and 2000, these would be expected to have remained relatively constant for the children involved.

One of the more plausible explanations for our findings may relate to ongoing dietary changes. The food intake of indigenous Australian children has undergone rapid modification in the last decade, with a diet that was rich in fiber, protein and low saturated fat diet being replaced by one in which refined carbohydrates and saturated fats predominate (ABS, 2003). Access to cariogenic food and beverage products has increased, with vending machines containing such products now existing in many schools and areas in the community (Bell and Swinburn, 2004). The emergence of 24-hour convenience stores and increased operating hours of supermarkets has additionally improved access to cariogenic food and beverages. Such dietary changes, together with an increasingly sedentary life-style, have had a grave impact on the general health of indigenous children, with the prevalence of Type II diabetes and obesity among such children escalating in recent years (Irvine *et al.*, 2003). Living in a remote location may compromise access to fresh food produce for some indigenous families, although even when healthy food is available, lack of education and limited access to income may support decisions being made that are not conducive to oral health (Altman, 2003). In addition, the ability to store and prepare fresh food may be constrained by lack of adequate facilities such as kitchens, storage areas and reliable electricity sources (ABS, 2003). Findings from a survey of food-purchasing behaviour in a central Australian Aboriginal community have also revealed that children now have sufficient disposable income to purchase their own nourishment from food outlets, meaning that much of their food consumption is not determined by adult family members (Rowse *et al.*, 1994). If more indigenous children were responsible for their nourishment than non-indigenous children, and if the range of food options from 1989–2000 increasingly included cariogenic food and beverages, it is perhaps unsurprising that the prevalence of dental caries among indigenous children in our study increased.

It has been documented that increases in the dental caries experience of indigenous children may also arise from economic and social policy changes. For example, the caries severity of 5-year-old Maori children in a New Zealand region increased relative to non-Maori 5-year-olds in the 1995–2000 period, which Thomson *et al.* (2002) attributed to changes in the government's social and economic policies in 1990–91 that were disadvantageous to socially-deprived groups or ethnic minorities. Although the social and economic policy changes made by respective Australian governments in the last decade have not been on the scale of those observed in New Zealand in the early 1990s, it is possible that the widening oral health disparities between indigenous and non-indigenous children in our study may be an indirect result of the increasing socio-economic inequalities among indigenous and non-indigenous Australian groups. It has been asserted that the increasingly inferior health status of indigenous Australians is inextricably linked to their historical legacy, their ongoing social and economic disadvantage, and psychosocial trauma; factors not experienced by the majority of non-indigenous Australians (McIntyre and Menzies, 2005). It may be that before indigenous and non-indigenous child oral health parity is reached, fundamental shifts in the political and societal paradigms that determine social capital are necessary.

In summary, our findings show that across the period 1989–2000, 6- and 12-year-old Northern Territory indigenous children had consistently higher prevalence, severity and untreated dental caries than their non-indigenous counterparts, and the disparities appear to be widening. More research in this area is required to better understand the complex relationship between indigenous status and child oral health.

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References

- Armfield, J.M., Roberts-Thomson, K.F. and Spencer, A.J. (2003): *The Child Dental Health Survey, Australia 1999: Trends across the 1990s*. AIHW Cat. No. DEN 95. Adelaide: The University of Adelaide.
- Australian Bureau of Statistics. (2001): *Indigenous Profile 2001 Census of Population and Housing*. Canberra: Australian Government.
- Australian Bureau of Statistics. (2001a): *Census of Population and Housing 2001; Basic Community Profile*. Canberra: Australian Government.
- Australian Bureau of Statistics. (2003): *The Health and Welfare of Australia's Aboriginal and Torres Strait Islander Peoples, 2003*. Canberra: Australian Government.
- Australian Institute of Health and Welfare. (2004): *Australia's Health 2004*. Canberra: AIHW.
- Barrett, M.J. and Williamson, J.J. (1972): Oral health of Australian Aborigines: Survey methods and prevalence of dental caries. *Australian Dental Journal* **32**, 37–50.
- Bell, A.C and Swinburn, B.A. (2004): What are the key food groups to target for preventing obesity and improving nutrition in schools? *European Journal of Clinical Nutrition* **58**, 258–263.

- Bourke, C., Baima, D., Allister, J. and Spencer, A.J. (1999): Caries experience of aboriginal children in South Australia. *Journal of Dental Research* **78**, 951.
- Douglass, J.M., O'Sullivan, D.M. and Tinanoff, N. (1996): Temporal changes in dental caries levels and patterns in a Native American preschool population. *Journal of Public Health Dentistry* **56**, 171–175.
- Endean, C., Roberts-Thomson, K. and Wooley, S. (2004): Anangu oral health: the status of the Indigenous population of the Anangu Pitjantjatjara lands. *Australian Journal of Rural Health*. **12**, 99–103.
- Irvine, J., Kirov, E. and Thomson, N. (2003): Diabetes. In: *The Health of Indigenous Australians*, ed. Thomson, N. pp93–126. Victoria: Oxford University Press.
- McIntyre, P.B. and Menzies, R.I. (2005): Immunisation: reducing health inequality for Indigenous Australians. *Medical Journal of Australia* **182**, 207–208.
- Niendorff, W.J. and Jones, C.M. (2000): Prevalence and severity of dental caries among American Indians and Alaska Natives. *Journal of Public Health Dentistry* **60**, 243–249.
- Nicolau, B., Marcenes, W., Bartley, M. and Sheiham, A. (2003): A life course approach to assessing causes of dental caries experience: the relationship between biological, behavioural, socio-economic and psychological conditions and caries in adolescents. *Caries Research* **37**, 319–326.
- Peressini, S., Leake, J.L., Mayhall, J.T., Maar, M. and Trudeau, R. (2004): Prevalence of early childhood caries among First Nations children, District of Manitoulin, Ontario. *International Journal of Paediatric Dentistry* **14**, 101–110.
- Rowse, T., Scrimgeour, D., Knight, S. and Thomas, D. (1994): Food-purchasing behaviour in an Aboriginal community. 1. Results of a survey. *Australian Journal of Public Health* **18**, 63–67.
- Thomson, W.M. (1993): Ethnicity and child dental health status in the Manuwatu-Wanganui Area Health Board. *New Zealand Dental Journal* **89**, 12–14.
- Thomson, W.M., Williams, S.M., Dennison, P.J. and Peacock, D.W. (2002): Were NZ's structural changes to the welfare state in the early 1990s associated with a measurable increase in oral health inequalities among children? *Australia and New Zealand Journal of Public Health*. **26**, 525–530.
- World Health Organisation. (1997): Oral Health Surveys – basic methods. 4th ed. Geneva: WHO.