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Public health intervention over four decades for the children in the Australian Capital Territory: Have we reached the point of diminishing returns?

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Background: Most of the developed world has seen some substantial improvements in the dental health of children over the past four decades owing to advances in service access, fluoride exposure, socio-economic development and improved diets, with the DMFT score of 12 year-olds dropping from well over 10 down to around one. ***Aim:*** To examine the question of advancing dental health for children even further using the same set of tools as we have to date by asking the question: Have we come to a point of diminishing returns? The study examines the long-term, near optimum settings of the known public dental health variables in the Australian Capital Territory. ***Results:*** Despite having the most ideal and persistent dental health optimised situation, there remains underlying dental caries at a severity level of just below 1 DMFT (12 year olds), and over the last decade the rate of diminishing incidence and prevalence of decay has slowed and arguably stopped. ***Conclusion:*** This suggests that rather than toiling to eliminate dental decay completely, the focus might usefully be reoriented towards those small known pockets of society with persistent higher levels of disease and looking for new ways to address these difficult clusters, while simultaneously advancing the understanding that a small residual level of decay will always exist in society.

Key words: *oral health, dental health, intervention, socioeconomics, geographic information system, Australia*

Introduction

Globally, the dental health of children in developed countries has seen a rapid and substantial improvement over the last half-century. This improvement has been seen as a composite outcome of several advances in population health, including water fluoridation, increased access to fluoridated dentifrices, health promotion and dental services, improved focus on general personal hygiene and better diets (Armfield, 2010; Petersson and Bratthall 1996). At a population level, the children of the wealthy have substantially better dental health than the poor (Anikeeva *et al*., 2013). Arguably, three elements: socio-economics, fluoride and access, can be put at the top of the list of public health initiatives leading to better oral health (Marthaler 2004; Petersson and Bratthall 1996). We have seen the benchmark 12 year olds' DMFT fall in many countries to around one (ranges from 0.5 to 3) then, in many highly developed regions of the world, for the last decade it seems to have levelled off at around one. This plateauing around a mean DMFT of one appears irrespective of some of the core variables of dental public health and across countries with widely differing societal and cultural bases. Similarly, prevalence values level off at 40 to 50% in highly developed regions (Mejia *et al*., 2012). There are locations where this is not the case, for example Southwark, London (PHE, 2012) but these are somewhat special cases. In this study we discuss whether this levelling off in improvement could be overcome by pressing for improving the focus of key dental public health resources. To that end we identified a substantial-sized isolated community with good data on the variables for a substantial length of time in order to test the hypothesis that DMFT of one and a prevalence of about 50% is the best possible dental outcome that can be achieved by optimisation of the key dental public health variables of socio-economics, fluoride exposure and service access.

Materials and Methods

After searching the socio-geographic peer-review and grey literature for an experimental site that fitted the inclusion criteria; a relatively wealthy community of 100,000s of people, relatively isolated, with robust long-standing data sets, dentally optimal water fluoride and good access to dental services, it was concluded that Canberra in Australia met these criteria, and thus it became the basis for the study. Canberra is the capital of Australia that is within its own jurisdiction, the Australian Capital Territory, ACT, with a population is close to 400,000. Its nearest major cities are Sydney and Melbourne, both about 500km away. The ACT is a self-governed autonomous region in Australia that is a "designed" city, some 100 years old, planned out in detail from the ground up with good road access throughout.

Population data from the most recent census (2011) was collected from the Australian Bureau of Statistics,

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ABS, and used at its highest geographic resolution (SA1). These data were geographically linked to other ABS mapping data using QGIS (Quantum Geographic Information Sysytem, v.Lisboa 1.8). The addresses of all public dental clinics were collected from the web and cross-correlated with mid-2015 telephone directories. The addresses were geocoded using Google maps for correlation with population data. Circular zones of radius 2½km and 5km around each clinic were added. Using the centroid of each SA1 area, the population within each buffer (and outside) was estimated. The ABS build an index of socio-economic status called SEIFA (Socio-Economic Indexes for Areas) which integrates a series of other indices to rank geographic areas. The ranks are clustered into deciles to form a categorical variable with decile 1 being the least affluent areas and 10 the mist advantaged (ABS, 2011).

The most recent annual report of the local water department (Icon Water, 2014) reported that all ACT residents had access to water optimally fluoridated (for dental health) since the early 1960s (Armfield, 2006). No further analysis of this was undertaken in the study.

All data used in this study are from open sources and therefore no ethical approval was required for the study. All databases were stored in Excel (v.14 Microsoft Redmount, USA).

Results

The study population were 351,158 people living in the Australian Capital Territory in SA1 areas with available valid SEIFA indices, excluding 6,060 from areas with no SEIFA index. Of the whole study population 19% (66,246) were aged 0 to 14 years inclusive, and 25% (88,958) were 0-19 years old (Table 1). Across all ages, 2% (7,182) were from the lowest three decile areas (poorest) while 73% (256,459) were from the highest three. For 0-14 year olds these percentages were practically identical at 1.7% (1,131) and 73% (48,549) while for 0-19 year olds, 1.7% (1,493) and 74% (65,616).

Mapped to specific locations across the Australian Capital Territory were 153 government and private clinics, each with 2.5km and 5km zones marked around them together with their road access (Figure 1). Of 0-14 year olds, 12% (7,896) lived more than 2.5km from a clinic and just 0.1% (84) were classified as in the poorest 30% of SEIFA SA1 areas (Figure 2). For the same age group, 0.2% (128) lived more than 5km from a clinic and none from the poorest three SEIFA decile SA1 areas lived more than 5km from a dental clinic.

Discussion

All children of the Australian Capital Territory have had dentally-optimal fluoridated water coverage and three quarters are from the most advantaged 30% of the Australian population with just 2% from the most disadvantaged 30%.

Supplementing these near optimal population health variables, just 128 children (including zero of the least advantaged 30% of the population) live more than 5km from a dental practice. As a sustained cohort of children, they would arguably be one of the most dental health advantaged geographic clusters (of greater than 50,000) of children in the developed world. Throughout Australia (including the ACT), dental care for children is provided by three pathways, two of which are highly subsidised by state and federal governments besides private fee-for-service options.

Over the past four decades, the oral health of Australian children has substantially improved, as evidenced by declines in the prevalence (the proportion of children with any caries present) and severity (the mean dmft/DMFT) of dental caries. The mean number of decayed, missing and filled deciduous teeth in 6-year-olds was 37% lower in 2002 than in 1977, while the corresponding figure for the permanent dentition of 12-year-olds was 79% (Armfield and Spencer, 2008). The role of water fluoridation,

Table 1. Numbers and percentages of people living in the Australian Capital Territory classified by socio-economic status.

	Lowest	*Socio-Economic Indexes for Areas (SEIFA) decile*								*Highest*	
Age group	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
0 to 14 years old	210	140	781	1,466	2,898	4,718	7,484	11,036	13,758	23,755	66,246
0 to 19 years old	282	172	1,039	1,997	3,856	6,069	9,927	14,665	18,598	32,353	88,958
Over 14 years old	1763	667	3,621	8,045	13,344	18,246	31,316	46,627	62,176	99,107	284,912
Over 19 years old	1,691	635	3,363	7,514	12,386	16,895	28,873	42,998	57,336	90,509	262,200
Overall	1,973	807	4,402	9,511	16,242	22,964	38,800	57,663	75,934	122,862	351,158
					Percent						
0 to 14 years old	0.3%	0.2%	1.2%	2.2%	4.4%	7.1%	11.3%	16.7%	20.8%	35.9%	100%
0 to 19 years old	0.3%	0.2%	1.2%	2.2%	4.3%	6.8%	11.2%	16.5%	20.9%	36.4%	100%
Over 14 years old	0.6%	0.2%	1.3%	2.8%	4.7%	6.4%	11.0%	16.4%	21.8%	34.8%	100%
Over 19 years old	0.6%	0.2%	1.3%	2.9%	4.7%	6.4%	11.0%	16.4%	21.9%	34.5%	100%
Overall	0.6%	0.2%	1.3%	2.7%	4.6%	6.5%	11.0%	16.4%	21.6%	35.0%	100%
					Cumulative Percent						
0 to 14 years old	0.3%	0.5%	1.7%	3.9%	8.3%	15.4%	26.7%	43.4%	64.1%	100%	
0 to 19 years old	0.3%	0.5%	1.7%	3.9%	8.3%	15.1%	26.2%	42.7%	63.6%	100%	
Over 14 years old	0.6%	0.9%	2.1%	4.9%	9.6%	16.0%	27.0%	43.4%	65.2%	100%	
Over 19 years old	0.6%	0.9%	2.2%	5.0%	9.8%	16.2%	27.2%	43.6%	65.5%	100%	
Overall	0.6%	0.8%	2.0%	4.8%	9.4%	15.9%	27.0%	43.4%	65.0%	100%	

Note: The small number of SA1 areas lacking a SEIFA decile are excluded from these data.

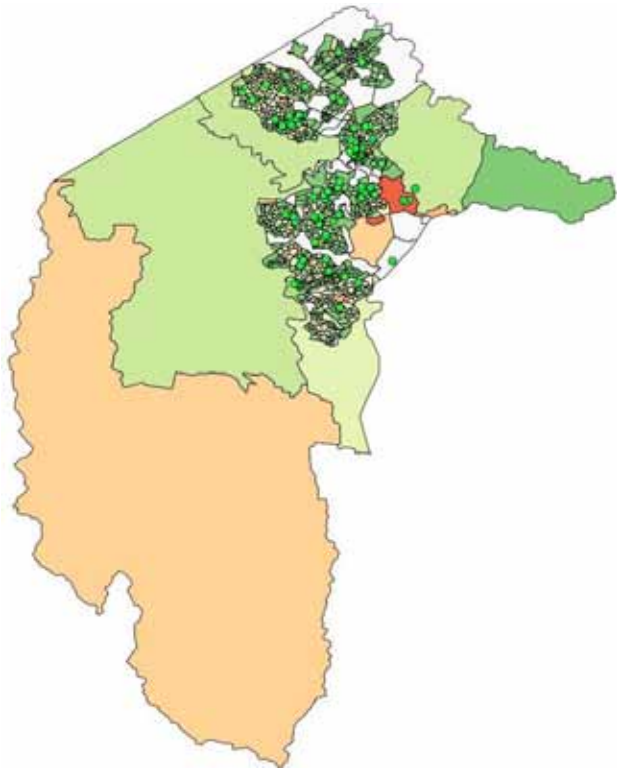

Figure 1a. *SA1 areas colour-coded from red (lowest socio-economic decile) to green (highest) for the Australian Capital Territory overlayed with all dental clinics (green dots)*

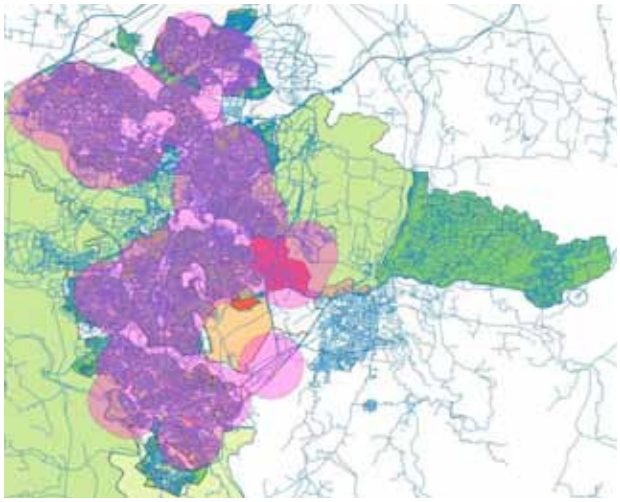

Figure 1b. *A higher magnification view of the SA1 areas colour-coded for socio-economic status from red (lowest decile) to green (highest) for the core of the Australian Capital Territory overlayed with 2.5km areas (purple) around all dental clinics for scale and with the road network shown in blue*

access to services and increasing overall wealth have been identified as important factors contributing to the decline in caries levels (Armfield and Spencer, 2008). In the ACT, it is reported that 96% of children aged 5–14 years had no deciduous or permanent teeth missing due to caries, with little variation by age. The ACT reported the mean number of decayed teeth per child as 0.23 amongst the 12-year-olds, significantly lower than other states. However, as a composite of decayed, missing and filled teeth, the score for the ACT was 0.8, which was not significantly different from some other states.

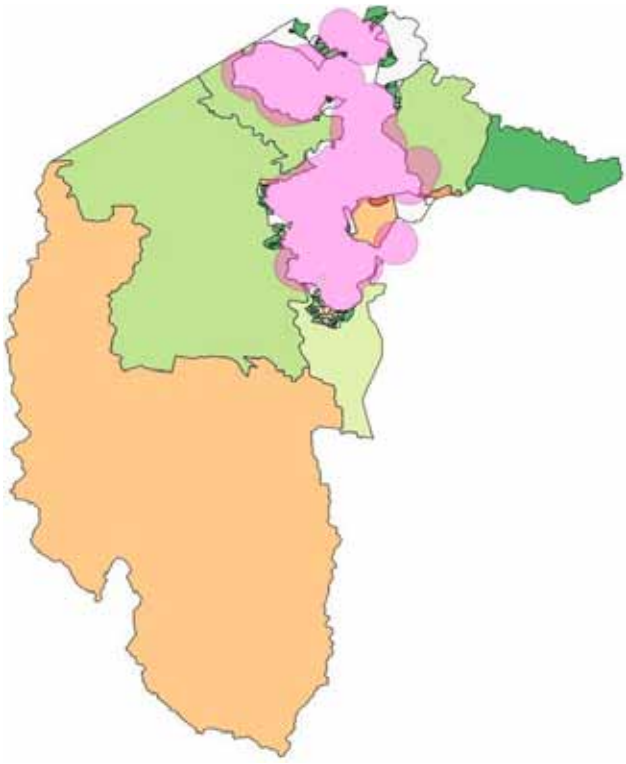

Figure 2. *SA1 areas more than 2.5km from a dental clinic colour-coded for socio-economic status from red (lowest decile) to green (highest) for the Australian Capital Territory*

The overall national DMFT for 12 year olds was, in 2007, reported as 0.95 (95%CI 0.85,1.05) (Armfield and Spencer, 2008).

There remains a level of dental decay in ACT children despite having intensive large scale sustained optimal public dental health conditions. The severity of caries experience has fallen to below 1 (DMFT) for 12 year olds, with a prevalence of 60%, and remains at that level. Nationally, the decayed component of DMFT has remained stable since the mid-1980s at around 0.5 per child with the overall level of decay in deciduous teeth being low in the ACT and similar to the rest of the nation (Armfield and Slade, 2002). Notwithstanding this, recent research has shown that in pockets of society, substantial levels of decay remain an issue (Roberts-Thomson *et al*., 2008). Nationally, the 30% of 12-year-olds with the most caries experience had a mean DMFT of almost 2.5 and the worst 10% averaged more than 4.5 DMF teeth. Among younger children these figures were even higher with the 10% of 6 year olds with the most extensive deciduous caries experience having a mean dmft of 9.1 in 2002 (Armfield and Spencer, 2008).

This points to the important issue of what the optimal measures for dental decay incidence and prevalence in a highly skewed situation should be. We have argued elsewhere (Tennant and Kruger 2016) that under these conditions the use of significant caries index (SiC) or DMFT being non-zero would be far better measures. Importantly, these measures would also direct resources towards those with more specific needs. The role of health professionals in strengthening prevention programs for dental decay is not diminished by this principle but are better targeted on “at risk” groups – especially where resources are limited.

Clearly, one factor that may influence this discussion is the remaining high levels of sugar consumption. It will be interesting to see if there will be a further reduction in decay as public health efforts strive to reduce this at a population level (Encarnação *et al*., 2016).

This study argues than even under near optimal conditions, a base-line level of decay will remain in a population. Instead of aspiring to achieve zero decay in the population, dental policy makers should aim for a more realistic and achievable target – one accepting a small but persistent residual level of decay in the population – and instead concentrate resources on those groups with the greatest caries experience.

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