

Outcomes of a co-designed, community-led oral health promotion program for Aboriginal children in rural and remote communities in New South Wales, Australia

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Objective: Improving the oral health of Aboriginal children is an Australian priority. Public policy recommends the development of evidence-based, culturally competent oral health promotion programs. Positive health outcomes are more likely for Aboriginal people when programs are co-designed with the community and tailored to local needs. This study aims to determine the impact of a community-led oral health promotion program for Aboriginal children in rural and remote communities. **Basic research design:** Consecutive surveys. Baseline data were collected on the oral health of Aboriginal children aged five–12 years in rural and remote communities in Central Northern New South Wales in 2014. Then, an evidence-based oral health promotion program was co-designed with local Aboriginal communities. It included daily toothbrushing, water bottle program, regular application of fluoride varnish, regular distribution of toothbrushes and fluoride toothpaste and dental health education and commenced in 2016 in three schools in the region. In 2018, oral health status and oral hygiene behaviours of participating children were compared against baseline data to evaluate the program. **Results:** There was a significant reduction in tooth decay, plaque scores and gingivitis. The mean number of teeth affected by tooth decay was 4.13, compared to 5.31 in 2014. An increase was also seen in positive oral hygiene behaviour. **Conclusions:** The co-design elements of the program are critical to its success. Engaging local Aboriginal communities to co-design and deliver oral health promotion can reduce the burden of tooth decay experienced by Aboriginal children.

Keywords: Child; Oral Health; Australia; Health Promotion

Introduction

Australian Aboriginal children experience higher levels of tooth decay than non-Aboriginal children (Australian Institute of Health and Welfare, 2007), which impacts on their nutrition, socialisation and education (Christian and Blinkhorn, 2012). In New South Wales, Aboriginal children experience an average of 2.64 primary and permanent teeth affected by tooth decay, compared to 1.54 teeth for non-Aboriginal children (NSW Centre for Oral Health Strategy, 2009). Aboriginal children in rural and remote communities in Central Northern NSW have a greater burden of disease, having an average of 5.31 teeth affected by tooth decay (Dimitropoulos *et al.*, 2018). Improving the oral health of Aboriginal children has been identified as a national and New South Wales state priority with public policies recommending the development of evidence-based, culturally competent oral health promotion programs and improving access to fluoride in Aboriginal communities (Oral Health Monitoring Group, 2015; NSW Centre for Oral Health Strategy, 2014).

Aboriginal people experience improved health outcomes when services and health programs are tailored to the local needs of communities (Gwynne *et al.*, 2018). Additionally, health programs are more likely to be

effective if they are developed in partnership with the local community, engage the local community in service delivery and are sustainable (Gwynne *et al.*, 2018; Rogers 2011). These principles should be used to guide the development and delivery of oral health promotion for Aboriginal people, including children in Australia.

Elders in rural and remote Aboriginal communities across Central Northern NSW expressed growing concern over the burden of tooth decay affecting children in their communities. In response, we collaborated with Aboriginal communities in the region to develop and co-design of a community-led oral health promotion program. The process of co-design presents evidence-based strategies to the community and works alongside them to design, implement and evaluate programs suitable to local Aboriginal customs, languages and tailored to local needs and requires shared power and resources and equally valuing cultural knowledge in the same weight as scientific knowledge (Dreise and Mazurski, 2018). Using co-design to develop and deliver a program is efficacious, culturally competent and more likely to result in improved health outcomes for Aboriginal people (Dreise and Mazurski, 2018).

This study aimed to determine the impact of the oral health promotion program on the oral health status and

oral hygiene behaviours of Aboriginal children aged five – 12 years; as well as the oral health knowledge and oral hygiene behaviours of parents and guardians of children aged five – 12 years living in Central Northern NSW.

Methods

The study took place in three schools in the three communities identified by local Elders in Central Northern NSW, Australia. Two communities are classed as ‘Moderately Accessible’, with an Accessibility/Remoteness Index of Australia (ARIA+) score of 2.4 - 5.92. The other is ‘Remote,’ with an ARIA+ score of 5.92 - 10.53 (Queensland Government, 2018). The three schools have low levels of socio-educational advantage. The Index of Community Socio-Educational Advantage (ICSEA) allows for comparisons among schools based on the socio-educational backgrounds of students, with an average set at 1000 (Australian Curriculum Assessment and Reporting Authority, 2016). The two ‘Moderately Accessible’ schools have very low ICSEA scores of 543 and 622. The school in the ‘remote’ community has a score of 771. Each school enrolls a majority of Aboriginal children who live in the three communities.

Baseline oral health status and oral hygiene behaviours of Aboriginal children aged 5 – 12 years, as well as oral health knowledge and oral hygiene behaviours of parents and guardians were collected in 2014 as part of the collaboration to ensure oral health promotion could be targeted and tailored to local needs (Dimitropoulos *et al.*, 2018). Most children had dental caries, with a mean number of teeth affected of 5.31. High levels of plaque and gingivitis and risk factors for dental caries including; low levels of toothbrush ownership, infrequent daily toothbrushing with a fluoride toothpaste, frequent sugar consumption and a high intake of sugar-sweetened beverages rather than drinking tap water were also present. Parents displayed limited oral health knowledge, particularly infant feeding practices.

Following the collaboration, a comprehensive oral health promotion program was co-designed with the local Aboriginal community (Dimitropoulos *et al.*, 2018b). It included simple, evidence-based strategies that are effective at enabling community engagement (Gwynne *et al.*, 2018), reducing tooth decay (Marinho *et al.*, 2003; Marinho *et al.*, 2013) and improving oral hygiene behaviours (Buckland and Kennedy, 2007; Oral Health Services Central District, 2008). The co-design process involved presenting the findings from the collaboration and a suite of oral health promotion strategies to local Elders, school principals and community members at a community ‘yarn-up’ in 2015. The development of a program was agreed upon that would be led and implemented by the local community. The community assisted the design of the program to suit the needs of each school and community, this ensured it was locally tailored. The comprehensive protocol of the oral health promotion program is published elsewhere.

The program commenced in the three schools in April 2016 and continued to be implemented during this study. It included:

- Daily in-school toothbrushing, led and supervised by existing classroom teachers and a local

Aboriginal oral health aide; who had completed training to supervise children brushing their teeth competently (Dimitropoulos *et al.*, 2019);

- The installation of refrigerated and filtered water fountains in schools and the wider community to facilitate a daily in school water bottle program, also led by existing classroom teachers;
- The distribution of fluoride toothpaste and toothbrushes for home use to school children and the wider community by a local Aboriginal dental assistant every three-months;
- In-school and community dental health education that covers the importance of daily toothbrushing, decreasing sugar consumption and increased water consumption delivered by the local Aboriginal dental assistant and an oral health therapist;
- The application of fluoride varnish by an oral health therapist for children in the schools every three months (Dimitropoulos *et al.*, 2019b) and;
- Building local skills and capacity so that the program was led by the local Aboriginal community. Local Aboriginal dental assistants were employed and credentials in health were provided for local Aboriginal people and existing school staff to facilitate and lead the program.

Data on the oral health status and oral hygiene behaviours of Aboriginal children aged five – 12 years in the three schools collected in October – December 2018 were compared with baseline data to determine the impact of the program on the children; as well as the oral health knowledge and oral hygiene behaviours of their parents and guardians.

Data collection

The standardised protocol of the Australian Research Centre for Population Oral Health was used to record baseline oral health status in 2014 and again in 2018. The protocol measured dental caries experience using the number of decayed (d/D), missing (m/M) and filled (f/F) teeth (t/T) as well as plaque and gingivitis scores. Screenings were completed in each school by two oral health therapists (one in 2014 and another in 2018) who were both trained in the diagnostic criteria via face-face and online training. Children as well as parents and guardians completed the same interviewer-assisted questionnaires used in 2014, however the questionnaires used in 2018 included additional questions specifically pertaining to the oral health promotion program. The questionnaires can be found in Appendix 1 (Available at https://www.dropbox.com/sh/0126konhp7pa7xs/AAC2y_SU4YRONw8MDWvzVjZ7a?dl=0). Throughout the program, children also received dental treatment as required through the local community oral health service, which is operated by new-graduate oral health clinicians and a local Aboriginal dental assistant.

Data analysis

Questionnaire responses were analysed using descriptive statistics in Statistical Package for the Social Sciences v24. dmft and DMFT data, the percentage caries free, plaque scores and gingivitis scores were analysed using Statistical Analysis Software Enterprise Guide version 9.3 (SAS Institute; <http://www.sas.com>). Multivariate

logistic regression (caries free, oral mucosa), ordinal logistic regression (plaque and gingivitis indices) and negative binomial regression (dmft/DMFT) analyses were conducted controlling for age, sex and school.

Ethics approval

This study was approved by the NSW Aboriginal Health and Medical Research Council (1281/17). A participant information sheet was provided to parents and guardians and written consent was sought for their child's inclusion in the study. Verbal assent was sought from each child before completing the dental screening and questionnaire. Parents and guardians also provided written consent to complete the questionnaire, after being issued with a participant information sheet.

Results

Oral health status and oral hygiene behaviours of children

Eighty-eight children were eligible to participate in the study. A consent response rate of 85% was achieved. Of these children, 64 (85%) received a dental screening and 61 (81%) completed the questionnaire. This is double the consent response rate achieved by another health survey conducted in NSW Government schools (Hardy *et al.*, 2015) and is attributed to the collaborative community-led approach and engaging Aboriginal Education Officers to assist in seeking consent from families.

There was a significant reduction in tooth decay in 2018 (Table 1). The greatest reduction was seen in the mean number of teeth with untreated tooth decay (d/D); 4.72 in 2014 vs 2.27 in 2018. Overall caries and treatment experience (dmft/DMFT) also reduced significantly. The mean dmft/DMFT score was 5.31 in 2014, compared to 4.13 in the 2018. A consistent decrease in caries experience was seen among 10 – 12-year-olds (Figure 1).

Proportionately more children presented caries-free (dmft/DMFT = 0) in 2018; 20.3% vs 12.5% in 2014. For some age groups, the proportion of caries-free children decreased, however overall a clear increase can be seen (Figure 2). The severity of dental caries decreased significantly; with only 3% of children having a dental abscess (infection) associated with a decayed tooth in 2018; compared to 21% in 2014. Children also received restorative dental care throughout the study; in 2014 the mean number of filled teeth (f/F) was 0.23 compared to 1.61 in 2014.

There was a decrease in plaque scores and improvement in gingival health (Table 1). Most (95%) of children in 2018 presented with level 1 and 2 plaque scores, whereas most children in 2014 had level 2 and 3 plaque scores. Only 3% of children in 2018 had severe inflammation of the gingiva, compared to 43% in 2014.

There was an increase in the proportion of children who brushed their teeth on the morning of the questionnaire (13% in 2014 vs 36% in 2018). Whilst the proportion of children who owned a toothbrush at home remained similar and fewer children reported having toothpaste at home in 2018, this is likely to be underreported because toothpaste and brushes were provided to every child every 3 months during the program.

Most children (84%) filled their water bottle from the newly installed filtered and refrigerated water fountains daily. When asked what they liked about the new fountains, 57% reported because the water is cold. In 2014, 64% of children reported they consumed sugar-sweetened beverages on a regular basis. Whereas only 33% of children did so on a daily basis in 2018.

Oral hygiene behaviours and health knowledge of parents and guardians

Thirty-one parents and/or guardians of Aboriginal children completed the questionnaire. There were no significant changes in oral health knowledge. All parents and guardians (100%) stated they were happy with the school toothbrushing program 97% were happy with the new water fountains at the school.

Discussion

This study demonstrates that it is possible to achieve significant, measurable and sustained improvements in the oral health of vulnerable children using co-design to develop a simple, evidence-based and community-led program. This study was able to deliver a measurable decrease in tooth decay, plaque scores and gingivitis and increased positive oral hygiene behaviours in just over two years utilising existing school staff and new local Aboriginal staff. The co-design elements of the program likely contributed to its success and sustainability (Gwynne *et al.*, 2018; Dreise and Mazurski; 2018).

Over the past decade the oral health of Aboriginal children in rural and remote Australia has progressively worsened, despite significant public oral health policy and programs aimed at prevention (Australian Institute of Health and Welfare, 2007; Roberts-Thomson *et al.*, 2016). This study adds to the existing body of evidence that co-designing the implementation of evidence-based strategies with Aboriginal communities so that they are appropriate to context and culture enhances efficacy and the likelihood of achieving health improvement (Gwynne *et al.*, 2018; Dreise and Mazurski; 2018). The additional time and respect required to implement co-design, was rewarded with significant health outcomes in a relatively short period of time.

Many programs to improve the oral health of Australian Aboriginal children have relied on external organisations to deliver the intervention, so providing minimal opportunities for community input into their design. This approach is not culturally competent and may explain why dental caries rates in Aboriginal children remain stubbornly high, especially in rural and remote communities. This program was co-designed with the local Aboriginal community and is led, implemented and supported by the local community including Aboriginal Land Council, Elders, existing classroom teachers, local Aboriginal oral health aides and local Aboriginal dental assistants. It created a culturally safe environment for children increasing the likelihood of their participation and exposure to evidence-based strategies to prevent caries, including the daily application of fluoride through daily in-school toothbrushing and the regular application of fluoride varnish. It has been able to sustain implementation since 2016 and achieved a measurable impact on

Table 1. Characteristics of children attending three remote schools: 2014 vs 2018

| | | 2014 N= 88 | 2018 N = 64 | |
|-----------------------------------|---|---------------|----------------|-----------------------|
| <i>Demographic characteristic</i> | | % | % | |
| Sex | Male | 44.3 | 48.4 | |
| | Female | 55.7 | 51.6 | |
| Age (years) | 5-9 | 70.5 | 62.5 | |
| | 10-12 | 29.5 | 37.5 | |
| Aboriginal | Yes | 100.0 | 100.0 | |
| <i>Oral health status</i> | | % | % | <i>p</i> ⁵ |
| Plaque score ¹ | 1 (Film of plaque) | 19.3 | 37.5 | <0.01 |
| | 2 (Moderate plaque) | 36.4 | 57.8 | |
| | 3 (Abundant plaque) | 44.3 | 3.1 | |
| Gingival index ¹ | 0 (No gingivitis) | 25.0 | 26.6 | <0.01 |
| | 1 (Mild gingivitis) | 31.8 | 68.7 | |
| | 2 (Severe gingivitis) | 43.2 | 3.1 | |
| Oral mucosa | Odontogenic abscess (infection) associated with decayed tooth | 23.9 | 3.1 | <0.01 |
| Caries free | dmft/DMFT = 0 | 12.5 | 13 (20.3) | 0.15 |
| | | <i>Mean</i> | <i>Mean</i> | <i>p</i> ⁵ |
| dmft Index | Decayed primary teeth (d) | 4.06 | 1.51 | <0.01 |
| | Missing primary teeth due to decay (m) | 0.36 | 0.25 | 0.83 |
| | Filled primary teeth due to decay (f) | 0.17 | 1.28 | <0.01 |
| | Overall dmft ² | 4.59 | 3.05 | 0.02 |
| DMFT Index | Decayed permanent teeth (D) | 0.66 | 0.75 | 0.58 |
| | Missing permanent teeth due to decay (M) | 0 | 0 | - |
| | Filled permanent teeth due to decay (F) | 0.06 | 0.33 | 0.02 |
| | Overall DMFT ³ | 0.72 | 1.08 | 0.56 |
| dmft/DMFT Index | Decayed teeth (d/D) | 4.72 | 2.27 | <0.01 |
| | Missing teeth due to decay (m/M) | 0.36 | 0.25 | 0.83 |
| | Filled teeth due to decay (f/F) | 0.23 | 1.61 | <0.01 |
| | Overall dmft/DMFT ⁴ | 5.31 | 4.13 | 0.02 |

¹Silness & Loe Index used to measure plaque scores and gingival index

²dmft: decayed, missing or filled due to decay primary teeth

³DMFT: decayed, missing or filled due to decay permanent teeth

⁴dmft/DMFT: Overall caries experience in both primary and permanent teeth

⁵Multivariate regression analysis controlling for age, sex and location

oral health. The greatest impact was seen among children aged 10 – 12 years, as this age group had been exposed to the program since 2016.

While the program engaged community members in its design and employed and provided credentialing for local Aboriginal people to deliver it (which inherently raises health literacy), the oral health knowledge of parents and guardians remained stable. Other Australian studies have also shown the limitation of community dental health education to change oral hygiene behaviours (Roberts-Thompson *et al.*, 2010).

The frequent consumption of sugar-sweetened beverages is a risk factor for dental caries (Skinner *et al.*, 2014). Their consumption among Aboriginal children is associated with remoteness (Thurber *et al.*, 2014),

perhaps because rural and remote communities in Australia experience temperatures exceeding 45°C in the summer. With old plumbing infrastructure, tap water can often be warm and unpalatable, increasing the reliance on sugar-sweetened beverages over tap water. In 2014, 64% of children consumed sugar sweetened beverages on a regular basis and the local Aboriginal community expressed concerns on the palatability and overall quality of existing water supplies (Dimitropoulos *et al.*, 2018). The community supported the installation of refrigerated and filtered water fountains in each school and in the wider community to encourage water consumption. In 2018, most children reported that they used the new water fountain daily reported they liked it because it was cold. Additionally, only 33% of children consumed

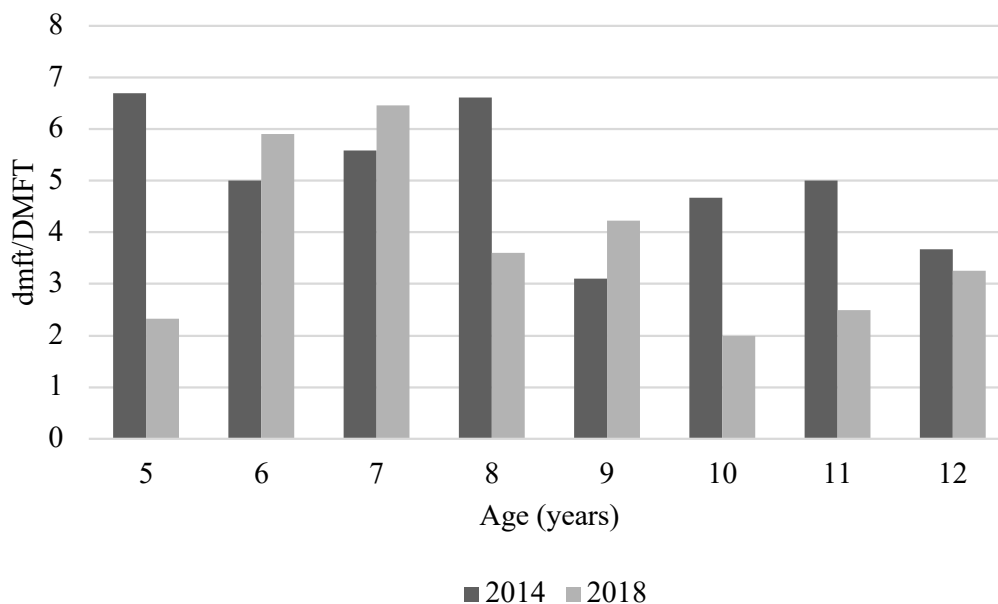


Figure 1: Caries experience in the primary and permanent dentition (dmft/DMFT) by age in 2014 and 2018

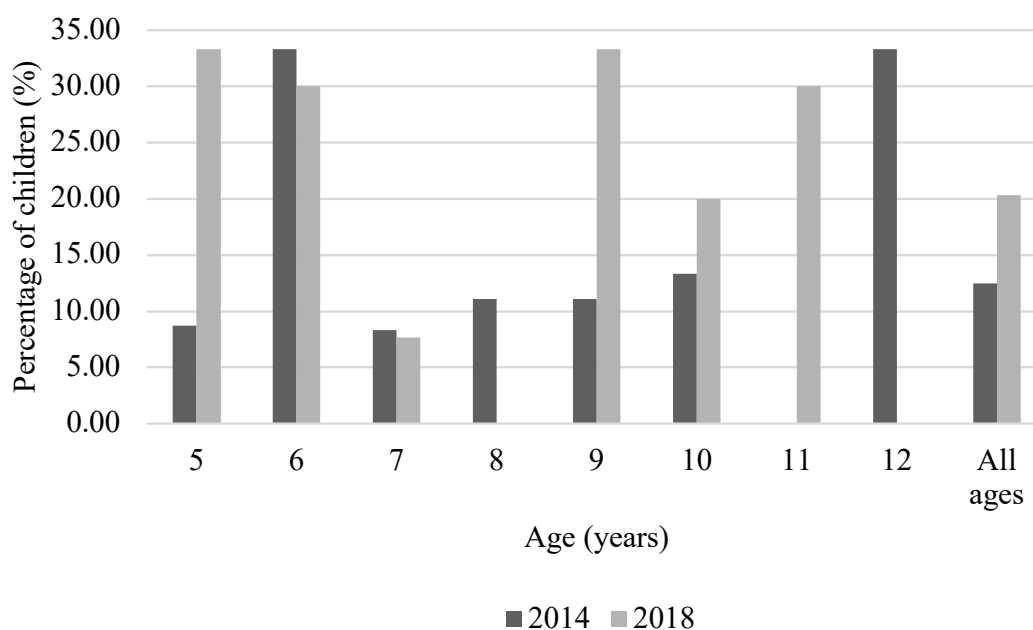


Figure 2: Proportion of children caries-free (dmft/DMFT = 0) by age in 2014 and 2018

sugar sweetened beverages daily basis. Installing filtered and refrigerated water fountains in schools in rural and remote communities may decrease the reliance on sugar-sweetened beverages and further study about the provision of refrigerated and filtered water within Aboriginal communities is warranted.

Fluoride varnish was applied by an oral health therapist. NSW State legislation currently restricts the application of fluoride varnish to a registered medical or dental professional. In 2019, we were able to enable the local Aboriginal dental assistants to apply the fluoride varnish as part of the program after successfully seeking approval from the NSW Chief Health Officer. This approach will increase the sustainability of this aspect of the program in these communities and has enabled the scalability of the routine application of fluoride varnish in schools across NSW.

Limitations

This study evaluated the oral health promotion program by comparing survey data. While there are limitations on this type of evaluation, the translational nature of this research indicated that this was the most suitable method. Given the oral health disparities experienced by Aboriginal children, rapid evaluation was important so that ineffective strategies could be ceased and effective ones scaled. Additionally, while the sample size is small, we achieved a consent response rate of 85% of children enrolled in the three participating schools for evaluation. The wording regarding the consumption of foods was changed in the interviewer assisted questionnaire for children used in this study. In 2014 the questionnaire asked which foods or drinks children consumed on a *regular* basis, and in 2018, use the term *daily* basis. While this affected the

comparability of the data, the 2018 terminology should more accurately reflect consumption. We have explored why more some age groups in the 2018 had more tooth decay, but no plausible explanation could be reached. Nevertheless, it does not detract from the very strong effect in the study. The intervention was not able to increase oral health knowledge among parents and guardians. More specific research is warranted to explore and overcome the barriers to increasing oral health knowledge and improving oral hygiene behaviours among Aboriginal families including health literacy, cost and priority.

Conclusion

This program improved the oral health of Aboriginal children in three rural and remote communities in Central Northern NSW. Engaging local Aboriginal communities to co-design and deliver locally tailored, evidence-based and simple oral health promotion strategies reduced the burden of tooth decay experienced by children in this region and would likely be a highly effective approach in other Aboriginal communities.

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