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Cohort Profile: South Australian Aboriginal Birth Cohort (SAABC); a prospective birth cohort

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ABSTRACT:

PURPOSE: The South Australian Aboriginal Birth Cohort (SAABC) is a prospective, longitudinal birth cohort established to: (1) provide estimates of Aboriginal child dental disease compared with general population estimates; (2) determine if an intervention aiming to reduce prevalence of early childhood caries was more effective in early versus late infancy; (3) examine if these differences were sustained over time and; (4) to document factors influencing social, behavioural, cognitive, anthropometric, dietary and educational attainment over time.

PARTICIPANTS: The original SAABC comprised 449 women pregnant with an Aboriginal child recruited Feb 2011 to May 2012. The sample represented two-thirds of those eligible, and was representative by age, socio-economic position and tobacco smoking status. At child age 2 years, 324 participants were followed up (74% retention), at child age 3 years, 324 participants were followed up (74% retention) and at child age 5 years, 299 participants were followed up (69% retention). Fieldwork for follow-up at child age 7 years is underway (interrupted due to COVID-19 restrictions), with funding available for follow-up at child age 9 years.

FINDINGS TO DATE: At baseline, 53% of mothers were aged 14 to 24 years and 72% had achieved high school or less as their highest educational attainment. At child age 3 years, rates of dental disease were less among among cohort children exposed to the intervention earlier rather than later in childhood. The effect appeared to be sustained at child age 5 years, rates were still higher than general child population estimates. Experiences of racism were high among mothers, with impacts on tooth brushing behaviours and experience of toothache. Compared with population estimates, levels of self-efficacy and self-rated oral health of mothers at baseline were low. The proportion of total energy from discretionary foods was far higher for study children at age 3 years than for non-Aboriginal Australian children. Breastfeeding >24 months was associated with higher dental caries prevalence at child age 3 years compared with children who were never breastfed.

FUTURE PLANS: The current follow-up, and child age 9 year follow-up, will hopefully be completed without future interruption from COVID-19. We will seek funding for continued follow-up of the cohort at ages 11, 13 and 15 years. The data yielded will contribute to a greater understanding of the environmental, behavioural, dietary, biological and psychosocial factors contributing to Aboriginal child/adolescent oral health, general health and social and emotional wellbeing. This will be beneficial in charting the trajectory of cohort participants' health and

wellbeing overtime, particularly in identifying the antecedents of chronic diseases which are highly prevalent among Aboriginal Australian adults.

REGISTRATION: Australian and New Zealand Clinical Trial Registry, ACTRN12611000111976.

INTRODUCTION: Untreated dental caries (tooth decay) in children may cause substantial pain and have severe consequences on eating, sleeping, playing, learning and general quality of life.[1] It is associated with other chronic childhood conditions such as malnutrition, and is the strongest predictor of poor oral health in adulthood.[2] Childhood caries is entirely preventable, yet Indigenous Australian children experience high levels of the disease, with Indigenous children in some areas having up to 5 times the prevalence of their non-Indigenous counterparts.[3] In the 2012-14 National Child Oral Health Survey, the mean number of decayed, missing or filled tooth surfaces in the primary dentition of Indigenous children aged 5 to 10 years was 6.3 compared with 2.9 among non-Indigenous children.[4]

Provision of dental care to young Indigenous children can pose many challenges because of child stage of emotional and physical development, and consequent capacity for co-operation in the dental chair. The issues are multiplied for Indigenous children in rural and remote locations, where access to dental care is severely limited. Hospital-based treatment under general anaesthetic is an increasingly utilised mode of dental treatment for such children, with Indigenous Australian children having twice the rate of hospital admissions for dental care than non-Indigenous children.[5] However, dental treatment under general anaesthetic does not prevent the occurrence of new dental decay, with children frequently re-admitted for hospital-based dental general anaesthetic after their initial treatment.[6] Oral rehabilitation under general anaesthetic also does little to alleviate dental fear or to change non-cooperative behaviour and may, in fact, heighten these characteristics. Moreover, comprehensive dental care under general anaesthetic is not without risk, including the potential for long-term adverse neuro-developmental effects.[7-9] Dental general anaesthetics are extremely expensive for the tax-payer and community more broadly, and require considerable time and financial investments from carers (to transport child to hospital, stay overnight, ensure fasting prior to operation etc). The estimated mean cost of dental general anaesthetics for Indigenous children is substantially higher than the cost of care for non-Indigenous children.[7] Preventive approaches that can be undertaken in the homes or Aboriginal Community Controlled Health Organisations of Indigenous children to reduce the number of children undergoing dental general anaesthetics is thus urgently required.

The South Australian Aboriginal Birth Cohort study was established in 2011 to provide direct estimates of Aboriginal child dental disease in South Australia compared with general population estimates, to determine if an intervention aiming to reduce prevalence of early childhood caries was more effective in early versus late infancy, to examine if these differences were sustained over time, and to document social, behavioural, cognitive, anthropometric, dietary and educational attainment

over time. Funding was originally received in 2011 to establish the cohort and to follow-up at child ages 2 and 3 years.[10] Further funding was received to follow-up the children at age 5 years, with current funding received to follow-up the children at age 7 years (currently suspended due to COVID-19 restrictions) and 9 years.

COHORT DESCRIPTION

Who is in the cohort? This prospective birth cohort study was developed in partnership with local Aboriginal communities and endorsed by the study's Aboriginal Reference Group. Participants were 449 women pregnant with an Aboriginal child who were residing in South Australia during the recruitment period of February 2011 to May 2012. Recruitment was through the antenatal clinics of South Australian Aboriginal Community Controlled Health Organisations and hospitals. The sample represented two-thirds of those who were eligible during the recruitment period, and was representative by age, socio-economic position and tobacco smoking status.[11] One child passed away in utero and a further 12 passed away before their 2nd birthday. At child age 2 years, 324 participants were followed up (74% retention; Figure 1). At child age 3 years, 324 participants were followed up (74% retention). At child age 5 years, 299 participants were followed up (69% retention). An early childhood caries intervention (that involved dental care to mothers, fluoride application to teeth of children and anticipatory guidance delivered via motivational interviewing) was implemented between pregnancy and child age 18 months (immediate intervention group) and between child age 2 years and 3 years (delayed intervention group).

How often have they been followed up? Participants were recruited during pregnancy (baseline) and have been followed up at child mean ages 2 years, 3 years, 5 years and 7 years (currently suspended due to covid-19). Baseline and loss to follow-up sample characteristics are shown for pregnancy and child ages 2, 3 and 5 years in Table 1. At baseline, over half (53%) of mothers were aged 14 to 24 years and 72% had achieved high school or less as their highest educational attainment. Around 86% received their income from Centrelink (Government agency who provide welfare based on means testing) and 82% owned a health-care card (means-tested, allows access to some health services, for example, dental public health services that otherwise incur out-of-pocket expenses). Around 61% resided in non-metropolitan locations and almost two-thirds (64%) usually visit a dentist because of a problem. Three-quarters (75%) of mothers reported brushing their teeth the previous day and while 55% rated their oral health as fair or poor, only 10% rated their general health as fair or poor. A higher proportion of participants who were not followed-up at child ages two, three and five years had (at baseline) lower educational attainment, received their income from Centrelink, owned a healthcare card, resided in metropolitan locations, usually visited a dentist

because of a problem, did not brush their teeth the previous day, rated their oral health as fair or poor and rated their general health as fair or poor. All missing data for dental caries outcomes used in subsequent analyses was imputed (except outcomes for deceased children) under the assumption that data was missing at random using the Fully Conditional Specification method with logistic regression for binary variables and linear regression for continuous variables. We created 50 imputed datasets using 50 iterations, with the results from the imputed datasets combined using Rubin's rules via the 'Proc mianalyse' function.

What has been measured? Broad categories of variables collected at baseline and each follow-up phase are provided in Table 2, with more detail of these variables provided in Table 3. Data linkage to government repositories has been approved and is currently underway, with participant consent. Details of the government linkage datasets is provided in Table 4. Self-report questionnaires were completed with the assistance of trained research officers if required. Dental examinations were standardised and conducted by three calibrated dental professionals. Procedures appropriate for young children were used when children were aged 2 years and 3 years, for example, in the 'knee-to-knee' position on their carer's lap. Before examinations, teeth were dried with cotton pads. Standard infection control procedures were followed and a fibre-optic light used as a light source. Diagnosis was based on visual criteria only. Any child diagnosed with carious lesions was referred for dental care through the South Australian Dental Service (provided free of charge). Weight was measured in duplicate to the nearest 0.1 kg using Seca model 803 scales and averaged. If measures differed by >0.2 kg, a third measure was taken and the average of the two closest values used in analyses. Height was measured in duplicate to the nearest 1 mm using a Seca model 213 portable stadiometer, using a standard anthropometric procedure. If measures differed by >5 mm a third measurement was taken and the average of the closest two used in analyses. Blood pressure was measured using a portable oscillometric device (Omron HEM-7211) and a cuff selected to suit the child's mid-upper arm circumference using a standard protocol.

FINDINGS TO DATE: Rates of dental disease among Aboriginal children in South Australia were less among those exposed to the intervention earlier rather than later in childhood.[12,13] The effect appeared to be sustained at child age 5 years, although the rates of dental disease were still far higher than estimates reported in Australia's National Child Oral Health Survey 2012-14.[14] Rates of psychosocial stress among mothers pregnant with Aboriginal children were high compared with general Australian population estimates.[15] Experiences of racism were high among mothers, with impacts on tooth brushing behaviours[16] and experience of toothache.[17] Compared with population estimates, levels of self-efficacy and self-rated oral health of study participants at baseline were

low,[18] with differences in the frame of reference regarding participants' self-rated oral health and self-rated general health described.[19] Smithers and colleagues reported that the proportion of total energy from discretionary foods (including sugars in discretionary foods) was far higher for study children at age 3 years than for non-Aboriginal Australian children.[20] Haag and others described how breastfeeding >24 months was associated with higher dental caries prevalence at child age 3 years compared with children who were never breastfed.[21] Santiago and colleagues demonstrated how social support was characterised among study participants,[22] and the impact of personal control on self-reported health outcomes.[23] The effectiveness of implementing a motivational interviewing approach to preventing poor oral health among Indigenous children and their families was discussed,[24] with comparisons made with other studies involving motivational interviewing and the oral health of vulnerable children.[25]

STRENGTHS AND LIMITATIONS: The main strength of the study is the Aboriginal community engagement, involvement and partnership, orchestrated through the study's Aboriginal Reference Group, through the Aboriginal Community Controlled Health Organisation stakeholder groups and by the Senior Aboriginal research officer (JH). This has, without doubt, contributed to the excellent follow-up rates, which need to be taken into context. For example, this cohort study has been undertaken over vast distances (e.g. travelling 700 km to the west of South Australia, 400 km east, 800 km north), involving highly disadvantaged participants who have not always enjoyed positive research interactions. The fact that participants represented two-thirds of those eligible to be recruited during the recruitment period demonstrates the widespread community support and generalisability of the results. The main limitation is the small sample size, which was essentially limited by the small population size of Aboriginal people in South Australia (around 2% of the total population). That we were able to recruit two thirds of those who were eligible at baseline (and have had strong retention of participants since) suggests that had the target population size been larger at baseline, the sample size of our study would consequently also be larger. Participants reported that the dietary recalls (collected at child age 2 years) were burdensome and this may have increased non-response or socially desirable responses. At the time of writing, follow-up at child age 7 years was suspended due to social distancing restrictions necessitated by the COVID-19 pandemic. This may impact our child age 9 years follow-up also.

COLLABORATION: Study data are not freely available because of ethical and data protection constraints. The de-identified data are stored at the University of Adelaide and cannot be sent outside the institution. Proposals for possible collaborations in further analyses of the data should be addressed to Lisa Jamieson (lisa.jamieson@adelaide.edu.au)

and will be reviewed by the SAABC research team and Aboriginal Reference Group.

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Table 1. Baseline and follow-up/loss to follow-up characteristics at child age 2 years, 3 years and 5 years

	Baseline (pregnancy) (n=448)	Child age 2 years follow-up (n=324)	Child age 2 years loss to follow-up (n=112)	Child age 3 years follow-up (n=324)	Child age 3 years loss to follow-up (n=112)	Child age 5 years follow-up (n=299)	Child age 5 years loss to follow-up (n=137)
Maternal age							
14-24	238 (53.1)	172 (53.1)	66 (53.2)	173 (53.2)	59 (52.7)	156 (52.2)	76 (55.5)
25+	210 (46.9)	152 (46.9)	58 (46.8)	152 (46.8)	53 (47.3)	143 (47.8)	61 (44.5)
Education							
High school or less	322 (72.4)	226 (70.0)	88 (79.3)	232 (72.1)	82 (73.2)	203 (68.4)	111 (81.0)
Trade or University	123 (27.6)	97 (30.0)	23 (20.7)	90 (28.0)	30 (26.8)	94 (31.7)	26 (19.0)
Income							
Job	62 (14.0)	56 (17.34)	4 (3.7)	55 (17.1)	5 (4.5)	47 (15.9)	13 (9.6)
Centrelink	381 (86.0)	267 (82.7)	105 (96.3)	267 (82.9)	106 (95.5)	249 (84.1)	123 (90.4)
HCC status							
Yes	358 (82.2)	254 (79.9)	95 (89.6)	252 (79.3)	97 (91.5)	236 (80.8)	113 (85.6)
No	77 (17.8)	64 (20.1)	11 (10.4)	66 (20.8)	9 (8.5)	56 (19.2)	19 (14.4)
Residential location							
Metropolitan	171 (38.7)	116 (36.3)	55 (45.1)	116 (36.1)	51 (46.0)	132 (44.8)	35 (25.7)
Non- metropolitan	271 (61.3)	204 (63.8)	67 (54.9)	205 (63.9)	60 (54.1)	163 (55.2)	101 (74.3)
Usual reason visit dentist							
Problem	275 (64.0)	195 (61.9)	72 (69.2)	194 (62.4)	74 (67.9)	184 (63.7)	83 (63.8)
Check-up	155 (36.1)	120 (38.1)	32 (30.8)	117 (37.6)	35 (32.1)	105 (36.3)	47 (36.2)
Brush yesterday							
Yes	321 (75.0)	239 (76.0)	74 (69.8)	240 (77.4)	74 (67.9)	217 (75.9)	96 (72.7)
No	107 (25.0)	73 (23.4)	32 (30.2)	70 (22.6)	35 (32.1)	69 (24.1)	36 (27.3)
Self-rated oral health							
Excellent, very good or good	203 (45.3)	153 (47.2)	43 (38.4)	151 (46.5)	46 (41.1)	130 (43.5)	66 (48.2)
Fair or poor	245 (54.7)	171 (52.8)	69 (61.6)	174 (53.5)	66 (58.9)	169 (56.5)	71 (51.8)
Self-rated general health							
Excellent, very good or good	402 (89.9)	294 (91.0)	97 (86.6)	298 (92.0)	94 (83.9)	272 (91.0)	119 (87.5)
Fair or poor	45 (10.1)	29 (9.0)	15 (13.4)	26 (8.0)	18 (16.1)	27 (9.0)	17 (12.5)

Table 2. Broad categories of variables collected at baseline and each follow-up phase

Phase	Measurements
Baseline	Mother self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral self-efficacy, self-rated oral health and oral health related quality of life. • General health conditions, health-related behaviours and self-rated general health. • Socioeconomic and psychosocial factors, including income, education, employment, experience of racism and cultural identity.
Child mean age 2 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health, 24-hour dietary recalls (child), breastfeeding habits. • Socioeconomic and psychosocial factors, including income, education, employment, experience of racism and cultural identity. • Family functioning and home environment Child height, weight, blood pressure, upper arm circumference Child dental examination
Child mean age 3 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits • Socioeconomic factors. Child height, weight, blood pressure, upper arm circumference Child dental examination
Child mean age 5 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits. • Socioeconomic factors. • Family functioning and home environment. • Child socioemotional well-being and cognitive outcomes. Child height, weight, blood pressure, upper arm circumference Child dental examination

Child mean age 7 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits. • Socioeconomic factors. • Family functioning and home environment. • Child socioemotional well-being and cognitive outcomes. Child height, weight, blood pressure, upper arm circumference Child dental examination

Table 3. Detail of variables collected at baseline and each follow-up phase

	Baseline (Pregnancy n=449)	2 years (n=324)	3 years (n=324)	5 years (n=299)	7 years (ongoing)
Oral health-related variables					
Dental examinations (child- dental caries, gingivitis, trauma)		✓	✓	✓	✓
Dental treatment needs (mother and child)	✓	✓	✓	✓	✓
Oral health-related behaviours (oral hygiene habits)	✓	✓	✓	✓	✓
Oral health self-efficacy (mother)	✓	✓	✓	✓	
Oral health literacy (mother)		✓	✓	✓	
Knowledge of children's oral health (mother)	✓	✓	✓	✓	
Oral health fatalism (mother and child)	✓	✓	✓	✓	
Dental perceptions			✓		
Oral health-related quality of life (mother and child)	✓	✓	✓	✓	✓
General health					
Anthropometric measurements (height weight, arm circumference, blood pressure) (child)		✓	✓	✓	✓
General health conditions and hospitalisations (child)	✓	✓	✓	✓	✓
Health-related behaviours (smoking, alcohol intake) (mother)	✓	✓	✓	✓	✓
Physical activity (child)			✓	✓	
Self-rated general and oral health (mother and child)	✓	✓	✓	✓	✓
24-hour dietary recalls (child)		✓			
Breastfeeding habits (child)		✓			
Other dietary-related habits (mother and child)	✓	✓	✓	✓	✓
Socioeconomic and psychosocial factors					
Income, education, socioeconomic hardship, employment (mother)	✓	✓	✓	✓	✓
Experience of Racism (mother)	✓	✓			✓

Cultural identity (mother)	✓	✓			
Self-stem (child)					✓
Social support and sense of self-control (mother)	✓				
Family functioning and home environment					
Parental functioning and home environment (mother and child)		✓		✓	✓
Time-use diaries (child)					✓
Child development					
Cognitive outcomes (child)				✓	✓
Social and emotional well-being (child)				✓	✓

Table 4. Datasets to be included in data linkage

Database domain	**Types of information**
Hospital admissions	Length of stay, ICD codes describing each hospitalisation event
Presentations at hospital emergency departments	Presenting problem, diagnosis
Well-child health checks	Child growth and development collected by nurses at routine health checks and ad hoc visits to local health clinics
Perinatal information	Medical information about pregnancy and child's birth
Public dental care	Dental treatments received by child in public dental clinics
School Enrolment	Information provided by carers at the time the child was enrolled at school including carer education, languages spoken at home and school absences
Literacy and Numeracy	Results on reading, writing and numeracy collected from a national assessment program when child is in year 3 (approximate age 8) at school
Housing	Information about families living in homes provided by the government

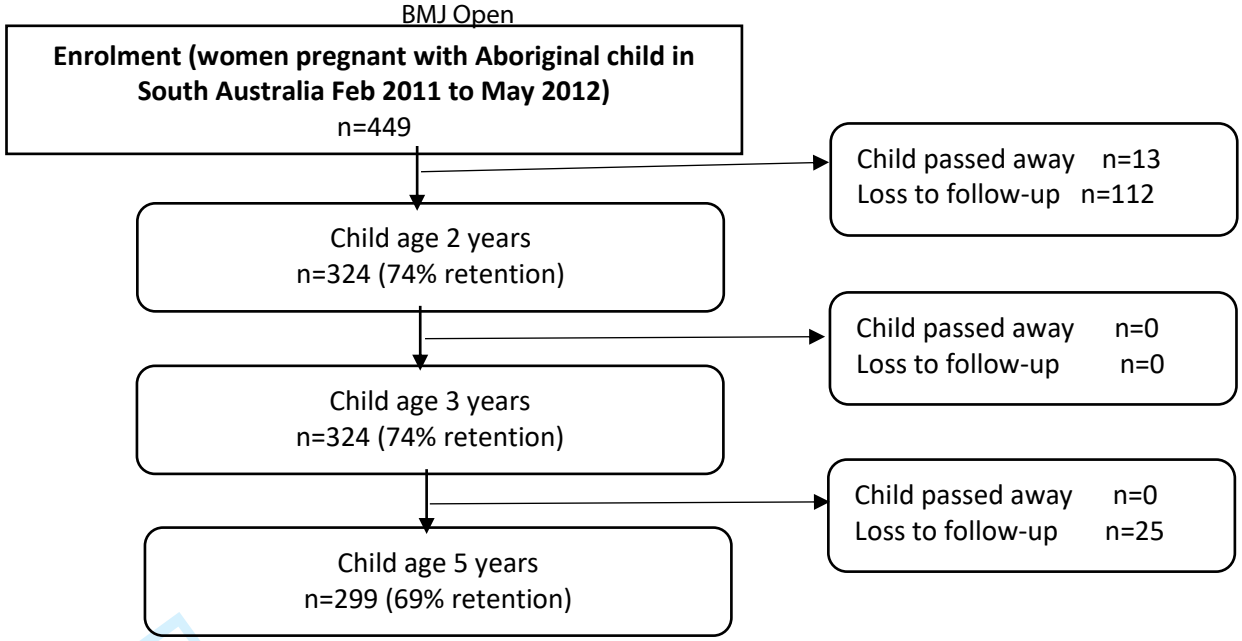

Fig 1: Flow diagram of participants through key stages of the cohort study

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Cohort Profile: South Australian Aboriginal Birth Cohort (SAABC); a prospective longitudinal birth cohort

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Cohort Profile: South Australian Aboriginal Birth Cohort (SAABC); a prospective longitudinal birth cohort

BMJ Open

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ABSTRACT:

PURPOSE: The South Australian Aboriginal Birth Cohort (SAABC) is a prospective, longitudinal birth cohort established to: (1) estimate Aboriginal child dental disease compared with population estimates; (2) determine the efficacy of an early childhood caries intervention in early versus late infancy; (3) examine if efficacy was sustained over time and; (4) document factors influencing social, behavioural, cognitive, anthropometric, dietary and educational attainment over time.

PARTICIPANTS: The original SAABC comprised 449 women pregnant with an Aboriginal child recruited Feb 2011 to May 2012. At child age 2 years, 324 participants were retained (74%), at child age 3 years, 324 participants were retained (74%) and at child age 5 years, 299 participants were retained (69%). Fieldwork for follow-up at child age 7 years is underway, with funding available for follow-up at child age 9 years.

FINDINGS TO DATE: At baseline, 53% of mothers were aged 14-24 years and 72% had high school or less educational attainment. At child age 3 years, dental disease experience was higher among those exposed to the intervention later rather than earlier in infancy. The effect was sustained at child age 5 years, but rates were still higher than general child population estimates. Experiences of racism were high among mothers, with impacts on both tooth brushing and toothache. Compared with population estimates, levels of self-efficacy and self-rated oral health of mothers at baseline were low.

FUTURE PLANS: Our data has contributed to better understanding of the environmental, behavioural, dietary, biological and psychosocial factors contributing to Aboriginal child oral and general health, and social and emotional wellbeing. This is beneficial in charting the trajectory of cohort participants' health and wellbeing overtime, particularly in identifying antecedents of chronic diseases which are highly prevalent among Aboriginal Australians. Funding for continued follow-up of the cohort will be sought.

REGISTRATION: ACTRN12611000111976.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- One of the largest, most contemporary Aboriginal Birth Cohorts in Australia (indeed, of an Indigenous population in the world), that recruited during pregnancy and that will have follow-ups at five key time-points (child age 2 years, 3 years, 5 years, 7 years (data currently being collected) and 9 years (funding available)).
- Established Aboriginal Reference Group who provide governance and oversight of all study processes, strong rapport with South Australian Aboriginal community and excellent participant retention.
- There are very few insights into Aboriginal child development stemming from prospective longitudinal birth cohorts; our richly characterised and representative information is able to answer questions that Aboriginal communities want answered with respect to Aboriginal child health and development.
- Small sample size (n=449) due to the small sampling pool who were eligible during recruitment.
- Follow-up at child age 7 years has been impacted due to social distancing restrictions necessitated by the COVID-19 pandemic. This may impact our child age 9 years follow-up also.

INTRODUCTION: Untreated dental caries (tooth decay) in children may cause substantial pain and have severe consequences on eating, sleeping, playing, learning and general quality of life.[1] It is associated with other chronic childhood conditions such as malnutrition, and is the strongest predictor of poor oral health in adulthood.[2] Childhood caries is entirely preventable, yet Indigenous Australian children experience high prevalence of the disease, with Indigenous children in some areas having up to 5 times the prevalence of their non-Indigenous counterparts.[3] In the 2012-14 National Child Oral Health Survey, the mean number of decayed, missing or filled tooth surfaces in the primary dentition of Indigenous children aged 5 to 10 years was 6.3 compared with 2.9 among non-Indigenous children.[4]

Provision of dental care to young Indigenous children can pose many challenges because of child stage of emotional and physical development, and consequent capacity for co-operation in the dental chair. The issues are multiplied for Indigenous children in rural and remote locations, where access to dental care is severely limited. Hospital-based treatment under general anaesthetic is an increasingly utilised mode of dental treatment for such children, with Indigenous Australian children having twice the rate of hospital admissions for dental care than non-Indigenous children.[5] However, dental treatment under general anaesthetic does not prevent the occurrence of new dental decay, with children frequently re-admitted for hospital-based dental general anaesthetic after their initial treatment.[6] Oral rehabilitation under general anaesthetic also does little to alleviate dental fear or to change non-cooperative behaviour and may, in fact, heighten these characteristics. Moreover, comprehensive dental care under general anaesthetic is not without risk, including the potential for long-term adverse neuro-developmental effects.[7-9] Dental general anaesthetics are extremely expensive for the tax-payer and community more broadly, and require considerable time and financial investments from carers (to transport child to hospital, stay overnight, ensure fasting prior to operation etc). The estimated mean cost of dental general anaesthetics for Indigenous children is substantially higher than the cost of care for non-Indigenous children.[7] Preventive approaches that can be undertaken in the homes or Aboriginal Community Controlled Health Organisations of Indigenous children to reduce the number of children undergoing dental general anaesthetics is thus urgently required.

Regrettably, Australian Aboriginal children score worse on almost every indicator of general health and well-being relative to their non-Aboriginal counterparts. There is a higher prevalence of nutrition-related stunting, non-optimal blood pressure growth outcomes[10] and poorer social and emotional wellbeing.[11] Around one-fifth of Aboriginal children are overweight or obese,[12] and around 30% may not be exercising at recommended levels.[11] Little is known about the dietary

patterns of Aboriginal children but there is some evidence of low rates of fruit, vegetables, water and milk consumption.[13] The literature suggests that many of the conditions experienced in Aboriginal childhood are antecedents to chronic disease in later life. Recent studies have shown that growth in childhood, especially rapid weight gain around 4-5 years, is associated with increased risk of being overweight,[14] elevated blood pressure, clustered metabolic risk,[15] coronary events[16] and stroke.[17] Data suggest that individuals who are small in the first 2 years of life and subsequently gain weight rapidly present the greatest levels of risk. Evidence from a recent national report on the Australian Early Development Census, which contained information on almost 290,000 5-year old Australian children, indicated that almost half the Aboriginal children were developmentally vulnerable on one or more of the 5 domains (physical, social, emotional, cognitive/language and communication). This was more than twice the proportion of non-Aboriginal children.[18]

The South Australian Aboriginal Birth Cohort study was established in 2011 to provide direct estimates of Aboriginal child dental disease in South Australia compared with general population estimates, to determine if an intervention aiming to reduce prevalence of early childhood caries was more effective in early versus late infancy, to examine if these differences were sustained over time, and to document social, behavioural, cognitive, anthropometric, dietary and educational attainment over time. Funding was originally received in 2011 to establish the cohort and to follow-up at child ages 2 and 3 years.[19] Further funding was received to follow-up the children at age 5 years, with current funding received to follow-up the children at age 7 years (currently suspended due to COVID-19 restrictions) and 9 years.

At baseline, 449 women pregnant with an Aboriginal child were recruited and randomly allocated to either an immediate intervention (n=223) or delayed intervention group (n=225) (Figure 1). The immediate intervention group received the following:

1. Dental care to pregnant mothers: Mothers who were allocated randomly to the immediate intervention arm and who were eligible for publically-funded dental care (through ownership of a means-tested Government health care card) received dental care through the South Australian Dental Service (SADS). Study staff organised transport and appointments, through assistance from SADS's Aboriginal Liaison Program. Six private dentists provided care to participants who were not eligible for publically-funded care. Dental care included x-rays, check-ups, scale and prophylaxis, fillings and extractions (including wisdom teeth). Not provided were cosmetic dentistry, endodontics and orthodontics.

2. Fluoride varnish applied at child ages 6, 12 and 18 months: The protocol for fluoride varnish was based on that used by Slade and colleagues.[20] Study staff were trained in its use and applied it. Children were supine, with their teeth cleaned and dried with gauze. Fluoride varnish was applied from the back teeth first, before moving forward to the front teeth. Children (through their carers) were advised to not eat food or drink for half an hour.

3. Anticipatory Guidance: Oral health educational packages that were tailored to contain dental-specific information relevant for pregnant mothers (focus on dental treatment, pregnancy gingivitis) and when children were aged 6 months (focus on first solids, caring for baby teeth upon initial eruption), 12 months (focus on tooth brushing and fluoride, avoiding sugar-containing beverages and foods) and 18 months (focus on child's first dental check-up, molar teeth eruption).

4. Motivational interviewing (MI): In combination with anticipatory guidance, motivational interviewing was implemented with pregnant mothers and at child ages 6, 12 and 18 months. Study staff completed an initial two-day MI training course, followed by an intensive one-day follow-up. One-day follow-up training was continued monthly for six months. This was followed by one-day coaching every two months, with occasional telephone coaching, for a further year. Each MI session was conducted on a one-to-one basis in venues where participants felt comfortable (for example, community halls, local Aboriginal health services, participants' homes). MI sessions ranged from 30 to 90 minutes. Pictorial prompts and plain English summaries were used.[21] A member of the Motivational Interviewing Network of Trainers conducted the fidelity testing of the MI sessions, which was found to be acceptable. [22]

When children were aged 24 months, delayed intervention group mothers received dental care. Fluoride varnish application, anticipatory guidance and motivational interviewing for delayed intervention participants were delivered when children were aged 24, 30 and 36 months, respectively.

Statistical Analysis:

Intention-to-treat principles have been used for all data analyses to estimate the effect of the intervention on dental caries experience. General linear regression models were used to compare the efficacy of the intervention on mean dmft between immediate and delayed intervention groups at child age five years. To account for any contributing factors, we adjusted for baseline maternal socio-demographic, health status and dental behaviour characteristics. The "Proc genmod' function was used in SAS, with link=identity and distribution=normal, so GLM could be fitted and the least

squares estimates obtained. Because, at child age 5 years, nearly one-third of mother-child pairs were lost to follow-up, a Fully Conditional Specification method was used to impute missing data, based on the assumption that data was missing at random (MAR). Immediate and delayed intervention groups were imputed separately. Fifty imputed datasets were created using 50 iterations, with the results from the imputed datasets combined using Rubin's rules via the 'Proc mianalyse' function. Sensitivity analyses were conducted using the 'MNAR adjust statement', with different scenarios for dental outcomes, which included different percentages of MAR assumptions and maximum and minimum value imputations. SAS statistical software (SAS 9.4, SAS Institute Inc., Cary, NC, USA) was used for all analysis and imputation.

COHORT DESCRIPTION

Who is in the cohort? This prospective birth cohort study was developed in partnership with local Aboriginal communities and endorsed by the study's Aboriginal Reference Group. Ethical approvals were received from the University of Adelaide Human Research Ethics Committee (H-057-2010), the Aboriginal Health Council of South Australia (04-09-362), the South Australian Department for Health, including the human research ethics committees of participating South Australian hospitals (Flinders Medical Centre: 435-10; Lyell McEwin Hospital: 2010-160; and the Women's and Children's Hospital: REC2322/11/13). Participants provided signed informed consent. Participants were 449 women pregnant with an Aboriginal child who were residing in South Australia during the recruitment period of February 2011 to May 2012. Recruitment was through the antenatal clinics of South Australian Aboriginal Community Controlled Health Organisations and hospitals. The sample represented two-thirds of those who were eligible during the recruitment period, and was representative by age, socio-economic position and tobacco smoking status.[23] One child passed away in utero and a further 12 passed away before their 2nd birthday. At child age 2 years, 324 participants were followed up (74% retention; Figure 1). At child age 3 years, 324 participants were followed up (74% retention). At child age 5 years, 299 participants were followed up (69% retention).

How often have they been followed up? Participants were recruited during pregnancy (baseline) and have been followed up at child mean ages 2, 3, 5 and 7 years (currently suspended due to COVID-19). Baseline and loss to follow-up sample characteristics are shown for pregnancy and child ages 2, 3 and 5 years in Table 1. At baseline, over half (53%) of mothers were aged 14 to 24 years and 72% had achieved high school or less as their highest educational attainment. Around 86% received their income from Centrelink (Government agency who provide welfare based on means testing) and 82% owned a health-care card (means-tested, allows access to some health services, for

example, dental public health services that otherwise incur out-of-pocket expenses). Around 61% resided in non-metropolitan locations and almost two-thirds (64%) usually visit a dentist because of a problem. Three-quarters (75%) of mothers reported brushing their teeth the previous day and while 55% rated their oral health as fair or poor, only 10% rated their general health as fair or poor. A higher proportion of participants who were not followed-up at child ages two, three and five years had (at baseline) lower educational attainment, received their income from Centrelink, owned a healthcare card, resided in metropolitan locations, usually visited a dentist because of a problem, did not brush their teeth the previous day, rated their oral health as fair or poor and rated their general health as fair or poor.

What has been measured? Broad categories of variables collected at baseline and each follow-up phase are provided in Table 2, with more detail of these variables provided in Table 3. Most items have been based on those used in other national surveys of child health in Australia, for example, the Longitudinal Study of Indigenous Children and the National Child Oral Health Survey. Data linkage to government repositories has been approved and is currently underway, with participant consent. Details of the government linkage datasets is provided in Table 4. Self-report questionnaires were completed with the assistance of trained research officers if required. Dental examinations were standardised and conducted by three calibrated dental professionals. Procedures appropriate for young children were used when children were aged 2 years and 3 years, for example, in the 'knee-to-knee' position on their carer's lap. Before examinations, teeth were dried with cotton pads. Standard infection control procedures were followed and a fibre-optic light used as a light source. Diagnosis was based on visual criteria only. Any child diagnosed with carious lesions was referred for dental care through the South Australian Dental Service (provided free of charge). Weight was measured in duplicate to the nearest 0.1 kg using Seca model 803 scales and averaged. If measures differed by >0.2 kg, a third measure was taken and the average of the two closest values used in analyses. Height was measured in duplicate to the nearest 1 mm using a Seca model 213 portable stadiometer, using a standard anthropometric procedure. If measures differed by >5 mm a third measurement was taken and the average of the closest two used in analyses. Blood pressure was measured using a portable oscillometric device (Omron HEM-7211) and a cuff selected to suit the child's mid-upper arm circumference using a standard protocol.

PATIENT AND PUBLIC INVOLVEMENT: The study's Aboriginal Reference Group has been involved in the design, governance and general oversight of all phrases of the research to date. Study participants have been encouraged to communicate to the research team through Facebook and other social media platforms. Newsletters and community presentations are frequently shared

with participants and relevant key stakeholder groups. Members of the study's Aboriginal Reference Group have presented the study findings at international conferences.

FINDINGS TO DATE: The prevalence of mothers who were pregnant with their first child at baseline was 38.5%. Rates of dental disease among Aboriginal children in South Australia were less among those exposed to the intervention earlier rather than later in childhood.[24, 25] The effect appeared to be sustained at child age 5 years, although the rates of dental disease were still far higher than estimates reported in Australia's National Child Oral Health Survey 2012-14.[26] Rates of psychosocial stress among mothers pregnant with Aboriginal children were high compared with general Australian population estimates.[27] Experiences of racism were high among mothers, with impacts on tooth brushing behaviours[28] and experience of toothache.[29] Compared with population estimates, levels of self-efficacy and self-rated oral health of study participants at baseline were low,[30] with differences in the frame of reference regarding participants' self-rated oral health and self-rated general health described.[31] Smithers and colleagues reported that the proportion of total energy from discretionary foods (including sugars in discretionary foods) was far higher for study children at age 3 years than for non-Aboriginal Australian children.[32] Haag and others described how breastfeeding >24 months was associated with higher dental caries prevalence at child age 3 years compared with children who were never breastfed.[33] This is contrary to the many findings that support prolonged breastfeeding among Indigenous Australians for better child health outcomes. Santiago and colleagues demonstrated how social support was characterised among study participants,[34] and the impact of personal control on self-reported health outcomes.[35] The effectiveness of implementing a motivational interviewing approach to preventing poor oral health among Indigenous children and their families was discussed,[22] with comparisons made with other studies involving motivational interviewing and the oral health of vulnerable children.[36]

STRENGTHS AND LIMITATIONS: The main strength of the study is the Aboriginal community engagement, involvement and partnership, orchestrated through the study's Aboriginal Reference Group, through the Aboriginal Community Controlled Health Organisation stakeholder groups and by the Senior Aboriginal research officer (JH). This has, without doubt, contributed to the excellent follow-up rates, which need to be taken into context. For example, this cohort study has been undertaken over vast distances (e.g. travelling 700 km to the west of South Australia, 400 km east, 800 km north), involving highly disadvantaged participants who have not always enjoyed positive research interactions. The fact that participants represented two-thirds of those eligible to be recruited during the recruitment period demonstrates the widespread community support and generalisability of the results. The main limitation is the small sample size, which was essentially

limited by the small population size of Aboriginal people in South Australia (around 2% of the total population). That we were able to recruit two thirds of those who were eligible at baseline (and have had strong retention of participants since) suggests that had the target population size been larger at baseline, the sample size of our study would consequently also be larger. Participants reported that the dietary recalls (collected at child age 2 years) were burdensome and this may have increased non-response or socially desirable responses. At the time of writing, follow-up at child age 7 years was suspended due to social distancing restrictions necessitated by the COVID-19 pandemic. This may impact our child age 9 years follow-up also.

CONTRIBUTORSHIP STATEMENT: Conceptualization, LMJ, JH, XJ, KK, CL, DH, PR, DM, RR, LS; methodology, XJ, DH, LS, LMJ; resources, LMJ; data curation, LMJ, JH, XJ, KK, CL, DH, PR, DM, RR, LS; writing—original draft preparation, LMJ; writing—review and editing, JH, XJ, KK, CL, DH, PR, DM, RR, LS; visualization, LMJ, JH, XJ, KK, CL, DH, PR, DM, RR, LS. All authors have read and agreed to the published version of the manuscript.

COMPETING INTERESTS: The authors declare no competing interests

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DATA SHARING STATEMENT: Study data are not freely available because of ethical and data protection constraints. The de-identified data are stored at the University of Adelaide and cannot be sent outside the institution. Proposals for possible collaborations in further analyses of the data should be addressed to Lisa Jamieson (lisa.jamieson@adelaide.edu.au)
and will be reviewed by the SAABC research team and Aboriginal Reference Group.

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FIGURE LEGEND:

Figure 1: Flow diagram of participants through key stages of the study

Intervention comprised: (1) dental care to mother; (2) Anticipatory guidance (mother); 3) Motivational interviewing (mother) and; (4) Fluoride varnish application (child).

Intervention delivered during pregnancy to child aged 18 months for immediate intervention group, at child aged 24 to 36 months for delayed intervention group.

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Table 1. Baseline and follow-up/loss to follow-up characteristics at child age 2 years, 3 years and 5 years

	Baseline (pregnancy) (n=448)	Child age 2 years follow-up (n=324)	Child age 2 years loss to follow-up (n=112)	Child age 3 years follow-up (n=324)	Child age 3 years loss to follow-up (n=112)	Child age 5 years follow-up (n=299)	Child age 5 years loss to follow-up (n=137)
Maternal age							
14-24	238 (53.1)	172 (53.1)	66 (53.2)	173 (53.2)	59 (52.7)	156 (52.2)	76 (55.5)
25+	210 (46.9)	152 (46.9)	58 (46.8)	152 (46.8)	53 (47.3)	143 (47.8)	61 (44.5)
Education							
High school or less	322 (72.4)	226 (70.0)	88 (79.3)	232 (72.1)	82 (73.2)	203 (68.4)	111 (81.0)
Trade or University	123 (27.6)	97 (30.0)	23 (20.7)	90 (28.0)	30 (26.8)	94 (31.7)	26 (19.0)
Income							
Job	62 (14.0)	56 (17.34)	4 (3.7)	55 (17.1)	5 (4.5)	47 (15.9)	13 (9.6)
Centrelink	381 (86.0)	267 (82.7)	105 (96.3)	267 (82.9)	106 (95.5)	249 (84.1)	123 (90.4)
HCC status							
Yes	358 (82.2)	254 (79.9)	95 (89.6)	252 (79.3)	97 (91.5)	236 (80.8)	113 (85.6)
No	77 (17.8)	64 (20.1)	11 (10.4)	66 (20.8)	9 (8.5)	56 (19.2)	19 (14.4)
Residential location							
Metropolitan	171 (38.7)	116 (36.3)	55 (45.1)	116 (36.1)	51 (46.0)	132 (44.8)	35 (25.7)
Non- metropolitan	271 (61.3)	204 (63.8)	67 (54.9)	205 (63.9)	60 (54.1)	163 (55.2)	101 (74.3)
Usual reason visit dentist							
Problem	275 (64.0)	195 (61.9)	72 (69.2)	194 (62.4)	74 (67.9)	184 (63.7)	83 (63.8)
Check-up	155 (36.1)	120 (38.1)	32 (30.8)	117 (37.6)	35 (32.1)	105 (36.3)	47 (36.2)
Brush yesterday							
Yes	321 (75.0)	239 (76.0)	74 (69.8)	240 (77.4)	74 (67.9)	217 (75.9)	96 (72.7)
No	107 (25.0)	73 (23.4)	32 (30.2)	70 (22.6)	35 (32.1)	69 (24.1)	36 (27.3)
Self-rated oral health							
Excellent, very good or good	203 (45.3)	153 (47.2)	43 (38.4)	151 (46.5)	46 (41.1)	130 (43.5)	66 (48.2)
Fair or poor	245 (54.7)	171 (52.8)	69 (61.6)	174 (53.5)	66 (58.9)	169 (56.5)	71 (51.8)
Self-rated general health							
Excellent, very good or good	402 (89.9)	294 (91.0)	97 (86.6)	298 (92.0)	94 (83.9)	272 (91.0)	119 (87.5)
Fair or poor	45 (10.1)	29 (9.0)	15 (13.4)	26 (8.0)	18 (16.1)	27 (9.0)	17 (12.5)

Table 2. Broad categories of variables collected at baseline and each follow-up phase

Phase	Measurements
Baseline	Mother self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral self-efficacy, self-rated oral health and oral health related quality of life. • General health conditions, health-related behaviours and self-rated general health. • Socioeconomic and psychosocial factors, including income, education, employment, experience of racism and cultural identity.
Child mean age 2 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health, 24-hour dietary recalls (child), breastfeeding habits. • Socioeconomic and psychosocial factors, including income, education, employment, experience of racism and cultural identity. • Family functioning and home environment Child height, weight, blood pressure, upper arm circumference Child dental examination
Child mean age 3 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits • Socioeconomic factors. Child height, weight, blood pressure, upper arm circumference Child dental examination
Child mean age 5 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits. • Socioeconomic factors. • Family functioning and home environment. • Child socioemotional well-being and cognitive outcomes. Child height, weight, blood pressure, upper arm circumference Child dental examination

Child mean age 7 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits. • Socioeconomic factors. • Family functioning and home environment. • Child socioemotional well-being and cognitive outcomes. Child height, weight, blood pressure, upper arm circumference Child dental examination

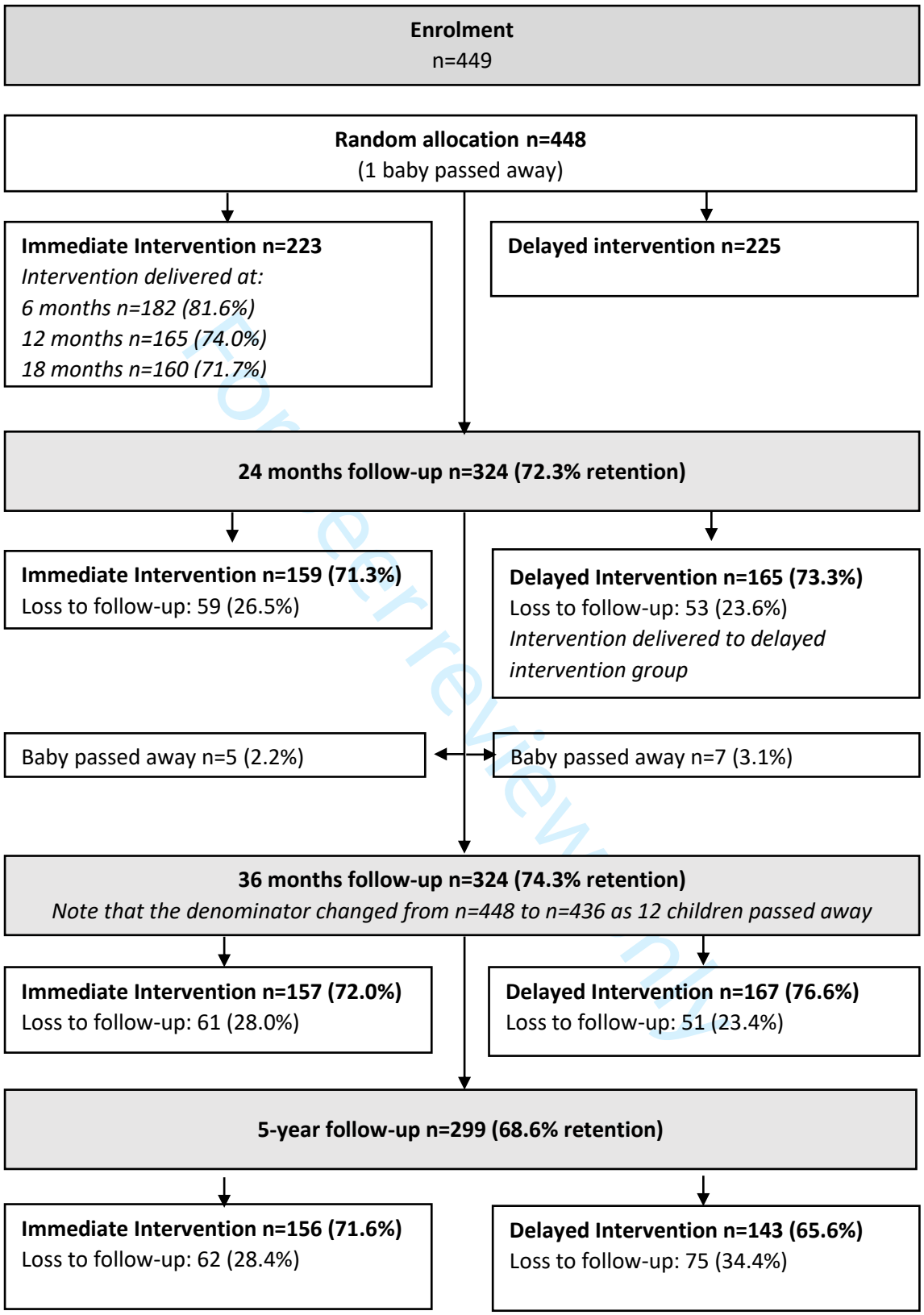
Table 3. Detail of variables collected at baseline and each follow-up phase

	Baseline (Pregnancy n=449)	2 years (n=324)	3 years (n=324)	5 years (n=299)	7 years (ongoing)
Oral health-related variables					
Dental examinations (child- dental caries, gingivitis, trauma)		✓	✓	✓	✓
Dental treatment needs (mother and child)	✓	✓	✓	✓	✓
Oral health-related behaviours (oral hygiene habits)	✓	✓	✓	✓	✓
Oral health self-efficacy (mother)	✓	✓	✓	✓	
Oral health literacy (mother)		✓	✓	✓	
Knowledge of children's oral health (mother)	✓	✓	✓	✓	
Oral health fatalism (mother and child)	✓	✓	✓	✓	
Dental perceptions			✓		
Oral health-related quality of life (mother and child)	✓	✓	✓	✓	✓
General health					
Anthropometric measurements (height weight, arm circumference, blood pressure) (child)		✓	✓	✓	✓
General health conditions and hospitalisations (child)	✓	✓	✓	✓	✓
Health-related behaviours (smoking, alcohol intake) (mother)	✓	✓	✓	✓	✓
Physical activity (child)			✓	✓	
Self-rated general and oral health (mother and child)	✓	✓	✓	✓	✓
24-hour dietary recalls (child)		✓			
Breastfeeding habits (child)		✓			
Other dietary-related habits (mother and child)	✓	✓	✓	✓	✓
Socioeconomic and psychosocial factors					
Income, education, socioeconomic hardship, employment (mother)	✓	✓	✓	✓	✓
Experience of Racism (mother)	✓	✓			✓

Cultural identity (mother)	✓	✓			
Self-stem (child)					✓
Social support and sense of self-control (mother)	✓				
Family functioning and home environment					
Parental functioning and home environment (mother and child)		✓		✓	✓
Time-use diaries (child)					✓
Child development					
Cognitive outcomes (child)				✓	✓
Social and emotional well-being (child)				✓	✓

Table 4. Datasets to be included in data linkage

Database domain	**Types of information**
Hospital admissions	Length of stay, ICD codes describing each hospitalisation event
Presentations at hospital emergency departments	Presenting problem, diagnosis
Well-child health checks	Child growth and development collected by nurses at routine health checks and ad hoc visits to local health clinics
Perinatal information	Medical information about pregnancy and child's birth
Public dental care	Dental treatments received by child in public dental clinics
School Enrolment	Information provided by carers at the time the child was enrolled at school including carer education, languages spoken at home and school absences
Literacy and Numeracy	Results on reading, writing and numeracy collected from a national assessment program when child is in year 3 (approximate age 8) at school
Housing	Information about families living in homes provided by the government



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Cohort Profile: South Australian Aboriginal Birth Cohort (SAABC); a prospective longitudinal birth cohort

BMJ Open

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ABSTRACT:

PURPOSE: The South Australian Aboriginal Birth Cohort (SAABC) is a prospective, longitudinal birth cohort established to: (1) estimate Aboriginal child dental disease compared with population estimates; (2) determine the efficacy of an early childhood caries intervention in early versus late infancy; (3) examine if efficacy was sustained over time and; (4) document factors influencing social, behavioural, cognitive, anthropometric, dietary and educational attainment over time.

PARTICIPANTS: The original SAABC comprised 449 women pregnant with an Aboriginal child recruited Feb 2011 to May 2012. At child age 2 years, 324 participants were retained (74%), at age 3 years, 324 participants were retained (74%) and at age 5 years, 299 participants were retained (69%). Fieldwork for follow-up at age 7 years is underway, with funding available for follow-up at age 9 years.

FINDINGS TO DATE: At baseline, 53% of mothers were aged 14-24 years and 72% had high school or less educational attainment. At age 3 years, dental disease experience was higher among children exposed to the intervention later rather than earlier in infancy. The effect was sustained at age 5 years, but rates were still higher than general child population estimates. Experiences of racism were high among mothers, with impacts on both tooth brushing and toothache. Compared with population estimates, levels of self-efficacy and self-rated oral health of mothers at baseline were low.

FUTURE PLANS: Our data has contributed to a better understanding of the environmental, behavioural, dietary, biological and psychosocial factors contributing to Aboriginal child oral and general health, and social and emotional wellbeing. This is beneficial in charting the trajectory of cohort participants' health and wellbeing overtime, particularly in identifying antecedents of chronic diseases which are highly prevalent among Aboriginal Australians. Funding for continued follow-up of the cohort will be sought.

REGISTRATION: ACTRN12611000111976.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

● One of the largest, most contemporary Aboriginal Birth Cohorts in Australia (indeed, of an Indigenous population in the world), that recruited during pregnancy and that will have follow-ups at five key time-points (child age 2 years, 3 years, 5 years, 7 years (data currently being collected) and 9 years (funding available)).

● Established Aboriginal Reference Group who provide governance and oversight of all study processes, strong rapport with South Australian Aboriginal community and excellent participant retention.

● There are very few insights into Aboriginal child development stemming from prospective longitudinal birth cohorts; our richly characterised and representative information is able to answer questions that Aboriginal communities want answered with respect to Aboriginal child health and development.

● Small sample size (n=449) due to the small sampling pool who were eligible during recruitment.

● Follow-up at age 7 years has been impacted due to social distancing restrictions necessitated by the COVID-19 pandemic. This may impact our age 9 years follow-up also.

INTRODUCTION

Untreated dental caries (tooth decay) in children may cause substantial pain and have severe consequences on eating, sleeping, playing, learning and general quality of life.[1] It is associated with other chronic childhood conditions such as malnutrition, and is the strongest predictor of poor oral health in adulthood.[2] Childhood caries is entirely preventable, yet Indigenous Australian children experience high prevalence of the disease, with Indigenous children in some areas having up to 5 times the prevalence of their non-Indigenous counterparts.[3] In the 2012-14 National Child Oral Health Survey, the mean number of decayed, missing or filled tooth surfaces in the primary dentition of Indigenous children aged 5 to 10 years was 6.3 compared with 2.9 among non-Indigenous children.[4]

Provision of dental care to young Indigenous children can pose many challenges because of child stage of emotional and physical development, and consequent capacity for co-operation in the dental chair. The issues are multiplied for Indigenous children in rural and remote locations, where access to dental care is severely limited. Hospital-based treatment under general anaesthetic is an increasingly utilised mode of dental treatment for such children, with Indigenous Australian children having twice the rate of hospital admissions for dental care than non-Indigenous children.[5] However, dental treatment under general anaesthetic does not prevent the occurrence of new dental decay, with children frequently re-admitted for hospital-based dental general anaesthetic after their initial treatment.[6] Oral rehabilitation under general anaesthetic also does little to alleviate dental fear or to change non-cooperative behaviour and may, in fact, heighten these characteristics. Moreover, comprehensive dental care under general anaesthetic is not without risk, including the potential for long-term adverse neuro-developmental effects.[7-9] Dental general anaesthetics are extremely expensive for the tax-payer and community more broadly, and require considerable time and financial investments from carers (to transport child to hospital, stay overnight, ensure fasting prior to operation etc). The estimated mean cost of dental general anaesthetics for Indigenous children is substantially higher than the cost of care for non-Indigenous children.[7] Preventive approaches that can be undertaken in the homes or Aboriginal Community Controlled Health Organisations of Indigenous children to reduce the number of children undergoing dental general anaesthetics is thus urgently required.

Regrettably, Australian Aboriginal children score worse on almost every indicator of general health and well-being relative to their non-Aboriginal counterparts. There is a higher prevalence of nutrition-related stunting, non-optimal blood pressure and growth outcomes[10] and poorer social and emotional wellbeing.[11] Around one-fifth of Aboriginal children are overweight or obese,[12] and

around 30% may not be exercising at recommended levels.[11] Little is known about the dietary patterns of Aboriginal children but there is some evidence of low rates of fruit, vegetables, water and milk consumption.[13] The literature suggests that many of the conditions experienced in Aboriginal childhood are antecedents to chronic disease in later life. Recent studies have shown that growth in childhood, especially rapid weight gain around 4-5 years, is associated with increased risk of being overweight,[14] elevated blood pressure, clustered metabolic risk,[15] coronary events[16] and stroke.[17] Data suggest that individuals who are small in the first 2 years of life and subsequently gain weight rapidly present the highest levels of risk. Evidence from a recent national report on the Australian Early Development Census, which contained information on almost 290,000 5-year old Australian children, indicated that almost half the Aboriginal children were developmentally vulnerable on one or more of the 5 domains (physical, social, emotional, cognitive/language and communication). This was more than twice the proportion of non-Aboriginal children.[18]

METHODS

STUDY DESIGN

The South Australian Aboriginal Birth Cohort study was established in 2011 to provide direct estimates of Aboriginal child dental disease in South Australia compared with general population estimates, to determine if an intervention aiming to reduce prevalence of early childhood caries was more effective in early versus late infancy, to examine if these differences were sustained over time, and to document social, behavioural, cognitive, anthropometric, dietary and educational attainment over time. Funding was originally received in 2011 to establish the cohort and to follow-up at child ages 2 and 3 years.[19] Further funding was received to follow-up the children at age 5 years, with current funding received to follow-up the children at age 7 years (currently suspended due to COVID-19 restrictions) and 9 years.

At baseline, 449 women pregnant with an Aboriginal child were recruited and randomly allocated to either an immediate intervention (n=223) or delayed intervention group (n=225) (Figure 1). The immediate intervention group received the following:

1. Dental care to pregnant mothers: Mothers who were allocated randomly to the immediate intervention arm and who were eligible for publically-funded dental care (through ownership of a means-tested Government health care card) received dental care through the South Australian Dental Service (SADS). Study staff organised transport and appointments, through assistance from SADS's Aboriginal Liaison Program. Six private dentists provided care to participants who were not eligible for publically-funded care. Dental care included x-rays, check-ups, scale and

prophylaxis, fillings and extractions (including wisdom teeth). Not provided were cosmetic dentistry, endodontics and orthodontics.

2. Fluoride varnish applied at child ages 6, 12 and 18 months: The protocol for fluoride varnish was based on that used by Slade and colleagues.[20] Study staff were trained in its use and applied it. Children were supine, with their teeth cleaned and dried with gauze. Fluoride varnish was applied from the back teeth first, before moving forward to the front teeth. Children (through their carers) were advised to not eat food or drink for half an hour.

3. Anticipatory Guidance: Oral health educational packages that were tailored to contain dental-specific information relevant for pregnant mothers (focus on dental treatment, pregnancy gingivitis) and when children were aged 6 months (focus on first solids, caring for baby teeth upon initial eruption), 12 months (focus on tooth brushing and fluoride, avoiding sugar-containing beverages and foods) and 18 months (focus on child's first dental check-up, molar teeth eruption).

4. Motivational interviewing (MI): In combination with anticipatory guidance, motivational interviewing was implemented with pregnant mothers and at child ages 6, 12 and 18 months. Study staff completed an initial two-day MI training course, followed by an intensive one-day follow-up. One-day follow-up training was continued monthly for six months. This was followed by one-day coaching every two months, with occasional telephone coaching, for a further year. Each MI session was conducted on a one-to-one basis in venues where participants felt comfortable (for example, community halls, local Aboriginal health services, participants' homes). MI sessions ranged from 30 to 90 minutes. Pictorial prompts and plain English summaries were used.[21] A member of the Motivational Interviewing Network of Trainers conducted the fidelity testing of the MI sessions, which was found to be acceptable. [22]

When children were aged 24 months, delayed intervention group mothers received dental care. Fluoride varnish application, anticipatory guidance and motivational interviewing for delayed intervention participants were delivered when children were aged 24, 30 and 36 months, respectively.

Statistical Analysis:

Intention-to-treat principles have been used for all data analyses to estimate the effect of the intervention on dental caries experience. General linear regression models were used to compare the efficacy of the intervention on mean number of decayed, missing and filled teeth (dmft) between

immediate and delayed intervention groups at child age five years. To account for any contributing factors, we adjusted for baseline maternal socio-demographic, health status and dental behaviour characteristics. The "Proc genmod' function was used in SAS, with link=identity and distribution=normal, so GLM could be fitted and the least squares estimates obtained. Because, at age 5 years, nearly one-third of mother-child pairs were lost to follow-up, a Fully Conditional Specification method was used to impute missing data, based on the assumption that data was missing at random (MAR). Immediate and delayed intervention groups were imputed separately. Fifty imputed datasets were created using 50 iterations, with the results from the imputed datasets combined using Rubin's rules via the 'Proc mianalyse' function. Sensitivity analyses were conducted using the 'MNAR adjust statement', with different scenarios for dental outcomes, which included different percentages of MAR assumptions and maximum and minimum value imputations. SAS statistical software (SAS 9.4, SAS Institute Inc., Cary, NC, USA) was used for all analysis and imputation.

COHORT DESCRIPTION

Who is in the cohort? This prospective birth cohort study was developed in partnership with local Aboriginal communities and endorsed by the study's Aboriginal Reference Group. Ethical approvals were received from the University of Adelaide Human Research Ethics Committee (H-057-2010), the Aboriginal Health Council of South Australia (04-09-362), the South Australian Department for Health, including the human research ethics committees of participating South Australian hospitals (Flinders Medical Centre: 435-10; Lyell McEwin Hospital: 2010-160; and the Women's and Children's Hospital: REC2322/11/13). Participants provided signed informed consent. Participants were 449 women pregnant with an Aboriginal child who were residing in South Australia during the recruitment period of February 2011 to May 2012. Recruitment was through the antenatal clinics of South Australian Aboriginal Community Controlled Health Organisations and hospitals. The sample represented two-thirds of those who were eligible during the recruitment period, and was representative by age, socio-economic position and tobacco smoking status.[23] One child passed away in utero and a further 12 passed away before their 2nd birthday. At child age 2 years, 324 participants were followed up (74% retention; Figure 1). At age 3 years, 324 participants were followed up (74% retention). At age 5 years, 299 participants were followed up (69% retention).

How often have they been followed up? Participants were recruited during pregnancy (baseline) and have been followed up at child mean ages 2, 3, 5 and 7 years (currently suspended due to COVID-19). Baseline and loss to follow-up sample characteristics are shown for pregnancy and child ages

2, 3 and 5 years in Table 1. At baseline, over half (53%) of mothers were aged 14 to 24 years and 72% had achieved high school or less as their highest educational attainment. Around 86% received their income from Centrelink (Government agency who provide welfare based on means testing) and 82% owned a health-care card (means-tested, allows access to some health services, for example, dental public health services that otherwise incur out-of-pocket expenses). Around 61% resided in non-metropolitan locations and almost two-thirds (64%) usually visit a dentist because of a problem. Three-quarters (75%) of mothers reported brushing their teeth the previous day and while 55% rated their oral health as fair or poor, only 10% rated their general health as fair or poor. A higher proportion of participants who were not followed-up at child ages two, three and five years had (at baseline) lower educational attainment, received their income from Centrelink, owned a healthcare card, resided in metropolitan locations, usually visited a dentist because of a problem, did not brush their teeth the previous day, rated their oral health as fair or poor and rated their general health as fair or poor.

What has been measured? Broad categories of variables collected at baseline and each follow-up phase are provided in Table 2, with more detail of these variables provided in Table 3. Most items have been based on those used in other national surveys of child health in Australia, for example, the Longitudinal Study of Indigenous Children and the National Child Oral Health Survey. Data linkage to government repositories has been approved and is currently underway, with participant consent. Details of the government linkage datasets is provided in Table 4. Self-report questionnaires were completed with the assistance of trained research officers if required. Dental examinations were standardised and conducted by three calibrated dental professionals. Procedures appropriate for young children were used when children were aged 2 years and 3 years, for example, in the 'knee-to-knee' position on their carer's lap. Before examinations, teeth were dried with cotton pads. Standard infection control procedures were followed and a fibre-optic light used as a light source. Diagnosis was based on visual criteria only. Any child diagnosed with carious lesions was referred for dental care through the South Australian Dental Service (provided free of charge). Weight was measured in duplicate to the nearest 0.1 kg using Seca model 803 scales and averaged. If measures differed by >0.2 kg, a third measure was taken and the average of the two closest values used in analyses. Height was measured in duplicate to the nearest 1 mm using a Seca model 213 portable stadiometer, using a standard anthropometric procedure. If measures differed by >5 mm a third measurement was taken and the average of the closest two used in analyses. Blood pressure was measured using a portable oscillometric device (Omron HEM-7211) and a cuff selected to suit the child's mid-upper arm circumference using a standard protocol.

PATIENT AND PUBLIC INVOLVEMENT: The study's Aboriginal Reference Group has been involved in the design, governance and general oversight of all phrases of the research to date. Study participants have been encouraged to communicate to the research team through Facebook and other social media platforms. Newsletters and community presentations are frequently shared with participants and relevant key stakeholder groups. Members of the study's Aboriginal Reference Group have presented the study findings at international conferences.

FINDINGS TO DATE: The prevalence of mothers who were pregnant with their first child at baseline was 38.5%. Rates of dental disease among Aboriginal children in South Australia were less among those exposed to the intervention earlier rather than later in childhood.[24, 25] The effect appeared to be sustained at age 5 years, although the rates of dental disease were still far higher than estimates reported in Australia's National Child Oral Health Survey 2012-14.[26] Rates of psychosocial stress among mothers pregnant with Aboriginal children were high compared with general Australian population estimates.[27] Experiences of racism were high among mothers, with impacts on tooth brushing behaviours[28] and experience of toothache.[29] Compared with population estimates, levels of self-efficacy and self-rated oral health of study participants at baseline were low,[30] with differences in the frame of reference regarding participants' self-rated oral health and self-rated general health described.[31] Smithers and colleagues reported that the proportion of total energy from discretionary foods (including sugars in discretionary foods) was far higher for study children at age 3 years than for non-Aboriginal Australian children.[32] Haag and others described how breastfeeding >24 months was associated with higher dental caries prevalence at child age 3 years compared with children who were never breastfed.[33] This is contrary to the many findings that support prolonged breastfeeding among Indigenous Australians for better child health outcomes. Santiago and colleagues demonstrated how social support was characterised among study participants,[34] and the impact of personal control on self-reported health outcomes.[35] The effectiveness of implementing a motivational interviewing approach to preventing poor oral health among Indigenous children and their families was discussed,[22] with comparisons made with other studies involving motivational interviewing and the oral health of vulnerable children.[36]

STRENGTHS AND LIMITATIONS: The main strength of the study is the Aboriginal community engagement, involvement and partnership, orchestrated through the study's Aboriginal Reference Group, through the Aboriginal Community Controlled Health Organisation stakeholder groups and by the Senior Aboriginal research officer (JH). This has, without doubt, contributed to the excellent follow-up rates, which need to be taken into context. For example, this cohort study has been undertaken over vast distances (e.g. travelling 700 km to the west of South Australia, 400 km east,

800 km north), involving highly disadvantaged participants who have not always enjoyed positive research interactions. The fact that participants represented two-thirds of those eligible to be recruited during the recruitment period demonstrates the widespread community support and generalisability of the results. The main limitation is the small sample size, which was essentially limited by the small population size of Aboriginal people in South Australia (around 2% of the total population). That we were able to recruit two thirds of those who were eligible at baseline (and have had strong retention of participants since) suggests that had the target population size been larger at baseline, the sample size of our study would consequently also be larger. Participants reported that the dietary recalls (collected at child age 2 years) were burdensome and this may have increased non-response or socially desirable responses. At the time of writing, follow-up at age 7 years was suspended due to social distancing restrictions necessitated by the COVID-19 pandemic. This may impact our age 9 years follow-up also.

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DATA SHARING STATEMENT: Study data are not freely available because of ethical and data protection constraints. The de-identified data are stored at the University of Adelaide and cannot be sent outside the institution.

COLLABORATIONS: Proposals for possible collaborations in further analyses of the data should be addressed to Lisa Jamieson (lisa.jamieson@adelaide.edu.au) and will be reviewed by the SAABC research team and Aboriginal Reference Group.

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FIGURE LEGEND:

Figure 1: Flow diagram of participants through key stages of the study

Intervention comprised: (1) dental care to mother; (2) Anticipatory guidance (mother); 3) Motivational interviewing (mother) and; (4) Fluoride varnish application (child).

Intervention delivered during pregnancy to child aged 18 months for immediate intervention group, at child aged 24 to 36 months for delayed intervention group.

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Table 1. Baseline and follow-up/loss to follow-up characteristics at child age 2 years, 3 years and 5 years

	Baseline (pregnancy) (n=448)	Child age 2 years follow-up (n=324)	Child age 2 years loss to follow-up (n=112)	Child age 3 years follow-up (n=324)	Child age 3 years loss to follow-up (n=112)	Child age 5 years follow-up (n=299)	Child age 5 years loss to follow-up (n=137)
Maternal age							
14-24	238 (53.1)	172 (53.1)	66 (53.2)	173 (53.2)	59 (52.7)	156 (52.2)	76 (55.5)
25+	210 (46.9)	152 (46.9)	58 (46.8)	152 (46.8)	53 (47.3)	143 (47.8)	61 (44.5)
Education							
High school or less	322 (72.4)	226 (70.0)	88 (79.3)	232 (72.1)	82 (73.2)	203 (68.4)	111 (81.0)
Trade or University	123 (27.6)	97 (30.0)	23 (20.7)	90 (28.0)	30 (26.8)	94 (31.7)	26 (19.0)
Income							
Job	62 (14.0)	56 (17.34)	4 (3.7)	55 (17.1)	5 (4.5)	47 (15.9)	13 (9.6)
Centrelink	381 (86.0)	267 (82.7)	105 (96.3)	267 (82.9)	106 (95.5)	249 (84.1)	123 (90.4)
HCC status							
Yes	358 (82.2)	254 (79.9)	95 (89.6)	252 (79.3)	97 (91.5)	236 (80.8)	113 (85.6)
No	77 (17.8)	64 (20.1)	11 (10.4)	66 (20.8)	9 (8.5)	56 (19.2)	19 (14.4)
Residential location							
Metropolitan	171 (38.7)	116 (36.3)	55 (45.1)	116 (36.1)	51 (46.0)	132 (44.8)	35 (25.7)
Non- metropolitan	271 (61.3)	204 (63.8)	67 (54.9)	205 (63.9)	60 (54.1)	163 (55.2)	101 (74.3)
Usual reason visit dentist							
Problem	275 (64.0)	195 (61.9)	72 (69.2)	194 (62.4)	74 (67.9)	184 (63.7)	83 (63.8)
Check-up	155 (36.1)	120 (38.1)	32 (30.8)	117 (37.6)	35 (32.1)	105 (36.3)	47 (36.2)
Brush yesterday							
Yes	321 (75.0)	239 (76.0)	74 (69.8)	240 (77.4)	74 (67.9)	217 (75.9)	96 (72.7)
No	107 (25.0)	73 (23.4)	32 (30.2)	70 (22.6)	35 (32.1)	69 (24.1)	36 (27.3)
Self-rated oral health							
Excellent, very good or good	203 (45.3)	153 (47.2)	43 (38.4)	151 (46.5)	46 (41.1)	130 (43.5)	66 (48.2)
Fair or poor	245 (54.7)	171 (52.8)	69 (61.6)	174 (53.5)	66 (58.9)	169 (56.5)	71 (51.8)
Self-rated general health							
Excellent, very good or good	402 (89.9)	294 (91.0)	97 (86.6)	298 (92.0)	94 (83.9)	272 (91.0)	119 (87.5)
Fair or poor	45 (10.1)	29 (9.0)	15 (13.4)	26 (8.0)	18 (16.1)	27 (9.0)	17 (12.5)

Table 2. Broad categories of variables collected at baseline and each follow-up phase

Phase	Measurements
Baseline	Mother self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral self-efficacy, self-rated oral health and oral health related quality of life. • General health conditions, health-related behaviours and self-rated general health. • Socioeconomic and psychosocial factors, including income, education, employment, experience of racism and cultural identity.
Child mean age 2 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health, 24-hour dietary recalls (child), breastfeeding habits. • Socioeconomic and psychosocial factors, including income, education, employment, experience of racism and cultural identity. • Family functioning and home environment Child height, weight, blood pressure, upper arm circumference Child dental examination
Child mean age 3 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits • Socioeconomic factors. Child height, weight, blood pressure, upper arm circumference Child dental examination
Child mean age 5 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits. • Socioeconomic factors. • Family functioning and home environment. • Child socioemotional well-being and cognitive outcomes. Child height, weight, blood pressure, upper arm circumference Child dental examination

Child mean age 7 years	Carer self-reported questionnaire • Dental treatment needs, oral health-related behaviours, maternal oral health literacy, self-efficacy, dental perceptions, self-rated oral health and oral health related quality of life. • General health conditions (mother and child), health-related behaviours, physical activity, self-rated general health and dietary habits. • Socioeconomic factors. • Family functioning and home environment. • Child socioemotional well-being and cognitive outcomes. Child height, weight, blood pressure, upper arm circumference Child dental examination

Table 3. Detail of variables collected at baseline and each follow-up phase

	Baseline (Pregnancy n=449)	2 years (n=324)	3 years (n=324)	5 years (n=299)	7 years (ongoing)
Oral health-related variables					
Dental examinations (child- dental caries, gingivitis, trauma)		✓	✓	✓	✓
Dental treatment needs (mother and child)	✓	✓	✓	✓	✓
Oral health-related behaviours (oral hygiene habits)	✓	✓	✓	✓	✓
Oral health self-efficacy (mother)	✓	✓	✓	✓	
Oral health literacy (mother)		✓	✓	✓	
Knowledge of children's oral health (mother)	✓	✓	✓	✓	
Oral health fatalism (mother and child)	✓	✓	✓	✓	
Dental perceptions			✓		
Oral health-related quality of life (mother and child)	✓	✓	✓	✓	✓
General health					
Anthropometric measurements (height weight, arm circumference, blood pressure) (child)		✓	✓	✓	✓
General health conditions and hospitalisations (child)	✓	✓	✓	✓	✓
Health-related behaviours (smoking, alcohol intake) (mother)	✓	✓	✓	✓	✓
Physical activity (child)			✓	✓	
Self-rated general and oral health (mother and child)	✓	✓	✓	✓	✓
24-hour dietary recalls (child)		✓			
Breastfeeding habits (child)		✓			
Other dietary-related habits (mother and child)	✓	✓	✓	✓	✓
Socioeconomic and psychosocial factors					
Income, education, socioeconomic hardship, employment (mother)	✓	✓	✓	✓	✓
Experience of Racism (mother)	✓	✓			✓

Cultural identity (mother)	✓	✓			
Self-stem (child)					✓
Social support and sense of self-control (mother)	✓				
Family functioning and home environment					
Parental functioning and home environment (mother and child)		✓		✓	✓
Time-use diaries (child)					✓
Child development					
Cognitive outcomes (child)				✓	✓
Social and emotional well-being (child)				✓	✓

Table 4. Datasets to be included in data linkage

Database domain	**Types of information**
Hospital admissions	Length of stay, ICD codes describing each hospitalisation event
Presentations at hospital emergency departments	Presenting problem, diagnosis
Well-child health checks	Child growth and development collected by nurses at routine health checks and ad hoc visits to local health clinics
Perinatal information	Medical information about pregnancy and child's birth
Public dental care	Dental treatments received by child in public dental clinics
School Enrolment	Information provided by carers at the time the child was enrolled at school including carer education, languages spoken at home and school absences
Literacy and Numeracy	Results on reading, writing and numeracy collected from a national assessment program when child is in year 3 (approximate age 8) at school
Housing	Information about families living in homes provided by the government