Received: 1 April 2019 | Revised: 4 October 2019 | Accepted: 12 December 2019

DOI: 10.1111/ipd.12609

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF PAEDIATRIC DENTISTRY WILEY

Natural history of dental caries: Baseline characteristics of the VicGen birth cohort study

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Funding information
La Trobe – Asia Fellowship, Grant/Award Number: LTAGP2018-8; La Trobe University

Abstract

Background: Early-life dental caries is a major global health problem. Children's first dental visit is recommended at 2 years age. The VicGeneration (VicGen) oral health birth cohort study aims to understand the multifactorial nature of early childhood caries. This report describes the baseline characteristics of children in the VicGen study.

Methods: We merged data between the first (at birth) and fourth waves (18 month age) to assess dental caries among children (primary outcome) and other oral diseases (secondary outcomes) employing *t* tests, chi-square tests, Fisher's exact tests, and Cochran-Mantel-Haenszel tests using IBM-SPSS(v25).

Results: Most children lived in metros with two-parent families. Most guardians were women graduated from high school. Twenty-seven of 389 (6.94%) 18-month-old children experienced dental caries. More children living in rural areas (vs. urban) experienced caries. Females were more likely to experience caries (OR: 2.16). Several children had other oral health problems. In early life, children's oral examination was conducted by midwives, breastfeeding/lactation consultants, hospital nurses, speech pathologists, and breastfeeding clinic staff.

Conclusion: VicGen baseline characteristics show that almost 7% of the 18-month-old children experienced caries. There is a need to advance children's recommended first dental visit date and to train early-life healthcare professionals about oral diseases.

KEYWORDS

Australia, birth cohort, child, dental caries, oral health, pre-school, VicGen

1 | INTRODUCTION

Dental caries remains a significant child health issue globally. Early childhood caries (ECC) is generally defined as any caries experience in pre-school aged children.[1] Severe early childhood caries is any evidence of caries experience in children from birth to 36 months of age.[2] Globally, population estimates of ECC are limited as this age group is generally not represented in surveys due to the logistical issues in accessing, managing, and collecting data from very young children.

Like other disease processes or conditions whose aetiology includes a significant behavioural component, ECC has recently polarized at a population level to disproportionately impact less well-resourced subgroups in the population. This means that children from less well-off families have higher levels of disease and greater levels of morbidly as a result of the disease than those better off.

Like the more obvious sequelae of pain and disfigurement of teeth, ECC has the potential to impact physical development of children and restrict their participation in daily activities.[3] Management of ECC and acute presentations of pain in young children is difficult and frequently requires hospitalization for teeth removal. Hospital-based care is costly and results in significant morbidity for the child and stress and worry for families.[3] Children aged 0-4 years living in rural areas are four times more likely to be admitted for a dental general anaesthesia (DGA) than their metropolitan counterparts.[4]

The VicGeneration (VicGen) study is an oral health birth cohort study to understand the multifactorial nature of early childhood caries (ECC) initiation and progress.[5] Importantly, VicGen seeks to elucidate the relative contribution of known (and yet to be known) risk and protective factors to the disease process at each stage of early childhood (ie birth to school entry age). VicGen's primary aims are to longitudinally study the natural history of the caries lesion, characterize the salivary microbiome, and identify the risk factors for early childhood caries among young children in Victoria. The study commenced in 2008, and data (including clinical oral health examinations) were collected at childrens' ages of 1, 6, 12, 18, 36, 48, and 60 months.[6]

This report follows up on the study by Gussy et al[7] and aims to understand and describe the baseline characteristics of the children in the VicGen study to inform natural history of dental caries in this population and act as a referral as well as starting point for a series of further analyses to follow subsequently.

Why this paper is important to paediatric dentists

- Provides information on oral health status and role of oral health examining professionals of neonates and toddlers.
- Identifies oral health needs among neonates and toddlers.
- Makes the case for changing recommendation for timing of the first oral examination of children.

2 | METHODS

VicGen participants were selected from metropolitan, regional, and rural areas of Victoria to be generally representative of the Victoria child population. Families with newborns were recruited via Maternal and Child Health (MCH) services a few weeks after birth. Families were excluded if the new born child had a complex medical condition, parents had mental illness, or if the family planned to relocate within the next year. Participation in the study entailed a clinical dental examination, saliva collection, and completion of self-administered questionnaire at multiple time points. All data collection processes were conducted in either the family home or the MCH centre close to the family's home.

Dental caries was assessed visually (no explorer) and recorded using the International Caries Detection and Assessment System—ICDAS.[8] Due to the challenges of conducting field examinations, air-drying, using compressed air, was not employed and therefore this eliminated the ability to detect ICDAS caries codes 1 on smooth surfaces of teeth. Standard infection control protocols were followed. All clinical examiners were trained and calibrated with good examiner reliability in caries diagnosis.[9] Structured self-administered questionnaires were used to collect data on family socio-demographic economics; child feeding habits; child and caregivers' oral hygiene-related behaviour; self-reported oral/general health status for child and caregiver; caregiver's knowledge; and attitudes about oral health.[6] Ethical approval was obtained from the University of Melbourne Human Research Ethics Committee (HREC 0722543).

For this study, data were extracted from the first four waves of VicGen which were then merged into a data file. Children in the study were less than one month old in Wave-1; six months old in Wave-2; twelve months old in Wave-3; and 18 months old in Wave-4. We chose the 18-month at Wave-4 as a cut-off because by this age most primary teeth (excluding second primary molars) have erupted in the mouth which would therefore allow a reasonable number of teeth to be examined for carious lesions to permit a meaningful analysis. Furthermore, primary second molars erupt between 23 and 33 months of age. We identified presence/ absence of any carious lesion in a child as the primary outcome variable. We also examined other oral diseases as a secondary outcome variable. The various factors that we examined in the study to assess potential association with occurrence of dental caries included sex of the child, socio-demographic factors, oral hygiene habits, and access to dental care. To keep this first study focused on key fundamental factors related to description of dental caries, we decided to keep all other factors for more thematically focused reports to be developed in the near future.

A key factor in the analysis for this study was to collapse the data across the four waves as if the observations were all made in one time point. Therefore, this study examines the

TABLE 1 Fundamental characteristics and dental caries experience of children aged up to 18 mo in the VicGen study population

Characteristic	Level	Total N (%)	No caries at 18 mo N (%)	Any caries at 18 mo N (%)	2-sided exact *P*-value	Notes
Total		389 (100)	362 (93.1)	27 (6.9)		
Sex	Male	241 (51.7)	192 (95.5)	9 (4.5)	0.095	OR: 2.16 (0.93-5.02)
	Female	225 (48.3)	158 (90.8)	16 (9.2)		
Region	Metro	233 (62.3)	218 (93.6)	15 (6.4)	0.90	
	Regional	49 (13.1)	46 (93.9)	3 (6.1)		
	Rural	92 (24.6)	85 (92.4)	7 (7.6)		
Respondent perceived child's oral health	Poor/Fair	18 (3.9)	12 (92.3)	1 (7.7)	0.83	
	Good	99 (21.3)	78 (95.1)	4 (4.9)		
	Very good	129 (27.8)	88 (91.7)	8 (8.3)		
	Excellent	218 (47.0)	170 (93.4)	12 (6.6)		
Did the child have a mouth examination by a doctor? (0-3 mo)	Yes	100 (22.0)	76 (95.0)	4 (5.0)	0.10	
	No	301 (66.3)	221 (91.7)	20 (8.3)		
	Don't know	53 (11.7)	44 (100)	0* (0.0)		
Did the child have a mouth examination by a paediatrician? (0-3 mo)	Yes	50 (11.0)	43 (93.5)	3 (6.5)	0.16	
	No	351 (77.3)	254 (92.4)	21 (7.6)		
	Don't know	53 (11.7)	44 (100)	0* (0.0)		
Did the child have a mouth examination by an MCH? (0-3 mo)	Yes	191 (42.1)	142 (90.4)	15 (9.6)	0.06	
	No	210 (46.3)	155 (94.5)	9 (5.5)		
	Don't know	53 (11.7)	44 (100)	0* (0.0)		
Did the child have a mouth examination by a dentist? (0-3 mo)	Yes	0 (0.0)	0 (0.0)	0* (0.0)	0.09	
	No	401 (88.3)	297 (92.5)	24 (7.5)		
	Don't know	53 (11.7)	44 (100)	0* (0)		
Did the child have a mouth examination by any other health professional? (0-3 mo)	Yes	28 (6.2)	22 (91.7)	2 (8.3)	0.17	
	No	373 (82.2)	275 (92.6)	22 (7.4)		
	Don't know	53 (11.7)	44 (100)	0* (0.0)		
Did the child have a mouth examination by a doctor? (18 mo)	Yes	83 (22.5)	77 (92.8)	6 (7.2)	0.98	OR: 1.04 (0.40, 2.7)
	No	286 (77.5)	266 (93.0)	20 (7.0)		
Did the child have a mouth examination by a paediatrician? (18 mo)	Yes	33 (8.9)	30 (90.9)	3 (9.1)	0.72	OR: 1.36 (0.39, 4.80)
	No	336 (91.1)	313 (93.2)	23 (6.8)		
Did the child have a mouth examination by an MCH Nurse? (18 mo)	Yes	204 (55.3)	194 (95.1)	10 (4.9)	0.10	OR: 0.48 (0.21, 1.09)
	No	165 (44.7)	149 (90.3)	16 (9.7)		
Did the child have a mouth examination by a public dentist? (18 mo)	Yes	8 (2.2)	7 (87.5)	1 (12.5)	0.45	OR: 1.92 (0.23, 16.23)
	No	361 (97.8)	336 (93.1)	25 (6.9)		
Did the child have a mouth examination by a private dentist? (18 mo)	Yes	23 (6.2)	20 (5.4)	3 (0.8)	0.21	OR: 2.11 (0.58, 7.62)
	No	346 (93.8)	323 (93.4)	23 (6.6)		
Did the child have a mouth examination by any other health professional? (18 mo)	Yes	25 (6.8)	23 (92.0)	2 (8.0)	0.69	OR: 1.16 (0.26, 5.23)
	No	345 (93.2)	321 (93.0)	24 (7.0)		

(Continues)

TABLE 1 (Continued)

Characteristic	Level	Total N (%)	No caries at 18 mo N (%)	Any caries at 18 mo N (%)	2-sided exact *P*-value	Notes
Did the child have any oral health problems?	Yes	37 (7.9)	23 (85.2)	4 (14.8)	0.09	
	No	429 (92.1)	326 (93.9)	21 (6.1)		
Do you have any concerns about cleaning child's mouth?	Yes	44 (9.5)	33 (100)	0 (0.0)	0.15	
	No	421 (90.5)	316 (92.7)	25 (7.3)		
Having healthcare card	Yes	177 (38.1)	118 (95.9)	5 (4.1)	0.19	
	No	287 (61.9)	229 (92.0)	20 (8.0)		
No. of erupted teeth	<8	26 (6.7)	26 (100)	0* (0.0)	0.24	
	9-15	163 (41.9)	153 (93.9)	10 (6.1)		
	16-20	200 (51.4)	183 (91.5)	17 (8.5)		

Note: Overall totals represent the 466 participants. Valid dental caries at the 18-month age visit was available for 375 participants only. Numbers in some of the sub-tables may not add up to full total due to missing data. *P*-values refer to chi-square tests for difference between proportions for dental caries experience. Percentages displayed in the dental caries experience column represent proportion within rows. For example, 9.2% females experienced dental caries compared to 4.5% males.

period prevalence of dental caries like a point prevalence at the mid-point of the study period. By design, this study reports period prevalence between zero months and 18 months of age which translates to a point prevalence estimates at 18 months of age. Incidence data will be reported separately. Therefore, this study approaches the data as a cross-sectional study and analyses the data with a case-control study paradigm. The odds ratios (ORs) thus calculated are an estimate of the true risk for dental caries in the population studied. For several characteristics, the "don't know" response was removed to calculate ORs.

Data cleaning, optimization, and constructing of needed variables were conducted done in using routine methods.[10] For dental caries experience, "any caries" was defined as a child having at least one tooth with dental caries (ICDAS caries codes 1-6). The magnitude of dental caries (ie how many teeth per child with dental caries) was not included in this analysis. Statistical approaches used to analyse data in this study included calculation of ORs and their 95% confidence intervals (CI), *t* tests, chi-square tests, Fisher's exact tests, and Cochran-Mantel-Haenszel tests as appropriate after data optimization. Fisher's exact test addresses the problems with "0" cells through a simple statistical approach that permits analyses of tables with "0" cells. All analyses for this study were conducted employing IBM® SPSS® Statistics (V25, Release 25.0.0.0, 64-bit edition) in PC environment.

3 | RESULTS

Of the 481 respondents (primary caregivers/guardians of participating children), 467 completed the initial questionnaire. Overall, 466 had enough valid and relevant data for meaningful analysis which were used in the study. Of these, 37 (8%) were single parent families; 418 (90%) families had two biological parent families, and 9 (2%) identified as families with a step-parent. Most respondents (80%) had graduated from high school. The majority of families (65%) lived in metropolitan areas; 11.4% lived in regional areas, whereas 23.6% lived in rural areas. Overall, 6.94% (95% CI: 7.1%, 6.7%) of 18-month-old children experienced dental caries but slightly greater proportion of children living in rural areas (7.6%) experienced dental caries compared to those in metropolitan (6.4%) or regional cities (6.1%) at 18 months age of the children.

Although most children had undergone a mouth examination in the first three months of life by some healthcare professional, none of the children had been seen by a dentist or other trained oral healthcare professionals prior to the diagnosis of their dental caries later in life. The "other professionals" (n = 28) examining the mouth were identified as midwife (50%); breastfeeding/lactation consultant (39%); hospital nurse (3.5%); speech pathologist (3.5%); and staff at breastfeeding clinic (3.5%; Table 1). Some 12% of respondents stated that they did not know if their child had received an oral health examination by any professional in the first three months of their children's life. We examined this group of parent-child dyads and did not find them to differ from the rest of the study population on any socio-demographic or biologic characteristics. The reported oral health of these children was "good" or "better" compared to average, and none of these children had developed dental caries by 18 month age.

About 8% (37) of all respondents reported that their child had some oral health problem (other than dental caries) of which they were aware. In this group, the reported problems included oral thrush (40.5%); tongue-tie (38%); mucosal white spots (5%); gingivitis (2.7%); white tongue (2.7%); and others (2.7%). Some 10% of respondents had concerns about cleaning their children's mouths. When asked to elaborate on the tooth cleaning concerns, the respondents indicated;

accessing and physically cleaning the mouth; potential for child swallowing toothpaste; and not knowing how to clean; and when to clean and how long to clean mouth/ teeth as main concerns.

Although the differences in caries experience across various popultaion characteristics that we examined were not statistically significant, meaningful information can be derived out of assessment of the ORs. Females were about twice as likely as males to have dental caries (OR: 2.16; CI: 0.93-5.02)—therefore, we are 95% confidence that the OR estimate will fall between 0.93 and 5.02 in similarly conducted studies. Children of those respondents who reported that their child had some oral problems other than dental caries were 2.7 times more likely to experience dental caries compared to children whose respondents did not report such problems (OR = 2.7; CI: 0.85-8.53). Children of families with healthcare cards were about 50% less likely to experience dental caries compared to those without healthcare cards (OR: 0.48; CI: 0.18-1.32) even though their numbers were very few to derive stable inferences.

Table 1 indicates that at 18 months of age, though not statistically significantly different, those children whose mouths were examined by an MCH Nurse were about 50% less likely (OR: 0.48; 0.21-1.09); those examined by paediatrician were 36% more likely (OR: 1.36; 0.39-4.8); those examined by "other health professionals" were 16% more likely (OR: 1.16; 0.26-5.23); those examined by a public dentist were almost twice as likely (OR: 1.92; 0.23-16.23); and those examined by a private dentist were about twice as likely (OR: 2.11; 0.58-7.62) to experience dental caries than not examined by the corresponding professionals.

4 | DISCUSSION

The majority of children lived in families with two biological parents as would be expected in the wider population. That the survey respondents in all cases were female (ie mother) is not surprising given that mothers are still more likely to be primary caregivers and more likely to take children for health visits.[11,12] Therefore, the general evidence pointing towards a link between children's oral health and that of their mothers[11,12] would perhaps be valid in the VicGen study and these ideas could be used to develop suitable interventional/ preventive strategies for improving children's oral health.

There is an indication from these early analyses with few cases that a slightly greater proportion of rural children experienced dental caries compared to others though not statistically significantly different. These analyses were based on small number of "cases" (children with dental caries) very early in life. The teeth in children's mouth had erupted relatively recently and not had long exposure to a cariogenic environment. Due to this small yield of cases, a statistically significant result may not be achievable this early in life. Therefore, we try to make a distinction between statistical differences and implied clinical meaningfulness.

An earlier report from VicGen data[7] found that 7.8% of the 18-month-old children experienced dental caries, whereas we found the proportion to be 6.9%. We attribute this difference to slightly different inclusion and exclusion criteria between the two studies. Whereas we found 27 children with dental caries of 362 included in the study (6.94%), the earlier report was based on 21 children with dental caries of a total of 268 included in that study (7.84%). The number of children experiencing dental caries this early in life (6.9%, 95% CI: 7.1%-6.7%) is substantial. In 2016, the number of 18-month-olds living in the State of Victoria was ~74 599.[13] From our results we estimate that there are about 5147 (95% CI: 5000-5300) children 18-month old who are living with dental caries and its sequelae such as pain, potential infection and difficulty in eating. This is a large population of very young children with disease burden. If these children are not promptly treated, then over time, the total number of children two years or older with dental caries will continue to rise rapidly.

An important observation arising from this study is that prior to the development of dental caries at age 18 months, none of the children had undergone an oral assessment by a dental professional (dentists or other oral health professional). There was some reported oral screening of childrennin their first few months of life by non-dental health professionals including midwives, breastfeeding/lactation consultant, hospital nurses, speech pathologists, and staff at breastfeeding clinics (Table 1).

There are two fundamental ways of viewing this situation. First, it can be argued that because this early in life, teeth have not erupted, there is no need for an oral health professional to examine children's mouths. The underlying assumption in this thought process is that when teeth erupt, oral health professionals would come into play in the future. This contention, however, is belied because at 18 months of age, when most primary teeth have erupted, almost 95% of the respondent stated that their children had not been seen by a dentist. Though the results in this study were not statistically significant, it is clear that a large proportion of the children with dental caries were among those who had not been seen by a dentist prior to this sentinel diagnostic appointment (results of public and private dentist visit are combined in Table 1). Clearly, the respondents have a therapeutic approach to oral health vis-à-vis a preventive approach. Perhaps, this indicates an opportunity to consider pre-natal and ante-natal oral health educational programme for pregnant mothers to improve oral health of children.[14] There is evidence in the literature demonstrating the direct correlation between mother's oral health

awareness and practices with children's oral health and recommendations to include oral health as a component of pre-natal care, although there is deficiency in enacting these recommendations.[14,15]

Second, the above argument presumes that assessment and management of dental caries or teeth-related problems are all that oral health professionals would contribute to in early life thereby justifying deferral of oral exanimation by an oral health professional. This contention too, however, is belied in this study because a substantial number of children reportedly had some kind of oral health problem such as tongue-tie and developed other oral health problems such as oral thrush. Occurrence of candidiasis in general (especially oral candidiasis) is an indication of some kind of immune response deficiency.[16,17] Following treatment, oral candidiasis is often seen in infants and has been reported to disappear by 6-9 months of age. It has been speculated that it could be related to various factors present around birth. It, however, has been shown that mode of delivery is not associated with neonatal oral candidiasis.[18] Some studies have pointed out the potential association of oral candidiasis and dental caries in children.[19,20]

In our study, though not statistically significantly different, most children with dental caries have not had an oral examination by doctors or paediatricians though some had their mouths being assessed by nurses (see Table 1). Oral health education, training, knowledge, and practice of non-dental professionals have been found to be limited.[21-23] In this study, though some health professional had examined the children's mouth (also a mandatory activity for care of neonates and children), the confidence in the outcomes of professionals not fully trained in recognizing oral lesions could lead to under-diagnosis and potential future harm that could be prevented or minimized by early professional oral-dental assessment. There is evidence to suggest that oral health knowledge and practices of non-dental professionals can improve with appropriate educational interventions have been well established in the literature.[21,23,24] Therefore, the overall neonatal healthcare system might improve substantially by involving oral health professionals in oral health care very early n childrens' lives as well as by providing training to other health caregivers on oral health promotion and early childhood disease detection.

A common confusion remains as to when a child's first dental visit should occur. Findings from this study suggest that visits to oral healthcare professionals should start much earlier in early in life and perhaps before teeth erupt to address and prevent potential oral mucosal disorders, and prevent/ treat dental caries very early before its severity increases or it becomes symptomatic enough for children to seek relief through treatment. A visit to an oral health professional at age of one year has been recommended by other studies.[25,26] Other birth cohort studies have also emphasized the importance of dental check-up early in life as an important factor for establishing good oral health behaviour in children.[27] Yet, other studies have found similar late start to dental visit for children linked to disease on a symptomatic basis.[28] Furthermore, Grzesiak-Gasek and Kaczmarek[29] reported recently that dental caries severity in primary teeth was associated with the reason for the first dental visit and the frequency of subsequent visits. There exits evidence to suggest that future use of dental services could be reduced/ prevented by visits to oral health professionals early in life.

In Australia, currently published guidelines state that a child should have a dental examination *by* age of 2 years.[30] Early evidence from this study suggests that a substantial number of children develop dental caries by 18 months of age, most of whom have not had a oral examination by a dental professional. Therefore, it is expected that many more children at thgis age will have early carious lesions, which could be reversible or arrested at early stage, but are not detected through current dental examinations. Our observation suggests that 2 years of age for a first dental examination is too late. If primary prevention and early non-surgical management of dental caries is a goal, then children must be examined prior to 18 months of age.

Timely access to oral healthcare is key to the early diagnosis and management of caries in young children. In the current model of oral healthcare, the onus is on families to take their child to the oral health professional and though a dental visit is recommended by some authorities as soon as the first teeth erupt, current evidence indicates that only a minority follow this advice.[31] Reasons for low early check-ups include perception of no dental problems, lack of time, cost, fear, and a general lack of knowledge about the importance of oral health in children.[31,32] Innovative ways to increase access to oral health services have shown promise in reducing incidence and severity of dental caries very young children and should be should be explored further. Properly trained non-oral health workforce, such as paediatricians, general practitioners, nurse practitioners, maternal and child health nurses, and pharmacists, remains an untapped resource for oral health promotion services across the age continuum. These services could include oral health promotion and advice, oral disease screening, referral, and the provision of non-invasive therapeutic interventions such as fluoride varnish.

Further analyses from the VicGen data are in progress to inform various aspects related to factors associated with oral health of children. This study, however, has highlighted the lack of oral health care in neonatal and early childhood; professionals examining children's mouth may have gaps in their understanding and recognition of oral diseases, and there is delay in children's first dental visit which is more for treatment rather than preventive purposes; those with poorer financial resources (eligible for heath care card) and living in rural areas may have greater oral health needs.

5 | CONCLUSION

This study describes the characteristics of the VicGen population at the baseline by establishing a baseline reference for the VicGen study as the key reference point for future studies. A substantial proportion of 18-month-old children had oral health problems including dental caries and candidiasis. Very few of the children had been to a dentist/oral health professional for a routine examination. The substantial burden of dental caries carried by 18-month-old children suggests that standard recommendation of first visit of children to a dentist at two years of age should be revised. There is a need to train non-oral health professionals about oral health attributes and to better recognize oral-dental diseases.

ACKNOWLEDGEMENT

This study was supported by the La Trobe—Asia Fellowship grant (#—LTAGP2018-8), from the La Trobe Asia, La Trobe University, Melbourne, Australia.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

AC conceived the idea, analysed data and led writing, and reviewed the manuscript. BC collected and analysed data and wrote and reviewed the manuscript. MM discussed the ideas and reviewed the manuscript. HC wrote and reviewed the manuscript. LC analysed data and reviewed the manuscript. LG discussed the ideas and reviewed the manuscript. MG guided data collection, analysis plan, discussed the ideas, and reviewed the manuscript.

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How to cite this article: Chattopadhyay A, Christian B, Masood M, et al. Natural history of dental caries: Baseline characteristics of the VicGen birth cohort study. *Int J Paediatr Dent*. 2020;30:334–341. https://doi.org/10.1111/ipd.12609