Scientific Research Report

Early Childhood Caries in Victorian Preschoolers: A Cross-Sectional Study

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ARTICLE INFO

Article history:
Received 28 January 2021
Received in revised form
18 May 2021
Accepted 27 May 2021
Available online 8 July 2021

Key words:
Dental caries
Oral health epidemiology
Child oral health
Preschool children
Early childhood caries

ABSTRACT

Aim: The objective of this work was to determine the prevalence of early childhood caries (ECC) in children attending preschools that are enrolled in the *Smiles 4 Miles* health promotion program in Victoria and determine the sociodemographic variables associated with ECC.

Materials and methods: A cross-sectional sample of 1,845 3- to 5-year-old children attending 61 preschools was selected by stratified cluster sampling. Dental caries was classified as non-cavitated/early lesions (d^{1-2}), cavitated (d^{3-6}) lesions, and cavitated/non-cavitated (d^{1-6}) lesions using the International Caries Detection and Assessment System. A self-administered parental questionnaire captured sociodemographic and behavioural data. Multivariate logistic regression and Poisson mixed model analysis was used to examine associations amongst sociodemographic variables, child oral health behaviours, and decayed tooth surfaces.

Results: In all, 56.6% (n = 1,044) of the children had ECC; more than one-third (36.6%) presented exclusively non-cavitated/early lesions, 5.7% solely cavitated lesions, and 14.2% both. Children from socioeconomically disadvantaged backgrounds had higher levels of dental caries. Parental pensioner/health care card status (incidence rate ratio [IRR] = 1.76, 95% CI, 1.57-1.97), non-English-speaking background (IRR = 2.09, 95% CI, 1.80-2.43), and Indigenous status (IRR = 1.91, 95% CI, 1.50-2.43) were associated with higher rates of cavitated lesions. Children who consumed soft drinks once or more per week had 1.66 times more cavitated lesions (95% CI, 1.48-1.86) compared to children who never/rarely consumed soft drinks. Soft drink consumption of once or more per week was associated with parental health care/pensioner card status (odds ratio [OR] = 1.73, 95% CI, 1.36-2.18), non-English-speaking background (OR = 1.58, 95% CI, 1.11-2.27), and Indigenous status (OR = 1.92, 95% CI, 1.04-3.52).

Conclusions: Higher levels of more severe caries rates in children from socioeconomically disadvantaged background highlight an opportunity for early preventive interventions targeting these groups.

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Introduction

Early childhood caries (ECC) is the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child younger than 6 years.[1] ECC is preventable; however, it is the most common chronic disease affecting children.[2] Dental conditions in children aged 0 to 14 years are the third most common cause of preventable hospital admissions in Australia.[3] In Victoria, potentially preventable dental hospitalisations represent the most potentially preventable hospitalisations for children younger than 10 years.[4] Treating ECC in very young children is often considered difficult due to noncompliance, fear, and anxiety.[5] These issues may partially explain the concerning increasing national trend to

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https://doi.org/10.1016/j.identj.2021.05.013
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receive dental treatment under general anaesthesia for preschool-aged children in Australia.[6]

In primary teeth, once the dental caries has moved from enamel to the dentine, caries progression accelerates quickly.[7] Severe ECC can affect children's quality of life and lead to poor health outcomes by causing pain, infection, sleep disturbances, impact on growth and development, chewing difficulties, weight loss, and changes in behaviour.[8] Poor oral health can be very costly to the community, health care system, and economy.[9] The direct costs of dental expenditure in Australia (2016-2017) were estimated at 10.2 billion Australian dollars,[10] and indirect costs relating to productivity losses per capita are estimated to be some of the highest in the world.[11] Severe levels of ECC have been shown to be associated with lower preschool attendance rates for children,[12] absenteeism from work for their parents, and increased parental stress and guilt.[13]

Our study is underpinned by the social determinants conceptual framework which recognises the multidimensional and multilevel influences on child oral health.[14] Socioeconomic conditions, parental knowledge, attitudes and beliefs, children's dietary behaviour, and dental visiting patterns are strong predictors of child oral health.[15] Studies have shown that children from disadvantaged backgrounds face wider disparities in oral health,[2,16] and a small proportion of children exhibit a large proportion of dental caries.[17] The 2012-2014 Australian National Child Oral Health Study (NCOHS) showed that one-fifth of the children aged 5 to 10 years exhibited more than 80% of the population overall dental caries experience in their primary dentition.[17] Lower parental income, being of Aboriginal and/or Torres Strait Islander decent (ATSI), living in rural communities, being of migrant background (in particular refugees), frequent consumption of sugar-sweetened beverages, and low parental oral health literacy are known risk factors for poor oral health outcomes for children.[9,18,19] Additionally, evidence suggests that children from low-income families and Indigenous and non-English-speaking backgrounds are less likely to access dental services and more likely to exhibit higher rates of sugar-sweetened beverage consumption.[16,20,21]

Australia's National Oral Health Plan 2015-2024 supports child oral health epidemiologic studies to be conducted every 10 years.[6] The only national epidemiologic studies on children's oral health conducted in Australia were in 1987-1988 and 2012-1014; however, children younger than 5 years were excluded from these studies.[22] Although there are several international studies[19,23--27] and few Australian studies[4,28] focusing on ECC in preschool-aged children, most of these studies are conducted at different time periods, making access to timely and current data on ECC difficult. Timely access to oral health epidemiologic data for preschool-aged children provides opportunities to prevent oral diseases early, use early intervention strategies to manage disease, and assist the development of evidence-based public oral health policies. The aim of this study was to determine the prevalence of ECC in children attending preschools that are enrolled in the *Smiles 4 Miles* health promotion program in Victoria and examine the sociodemographic variables associated with ECC.

Methods

Approval to conduct the study was obtained from the Victorian Department of Health and Human Services, Human Research Ethics Committee (13/14-Victorian Pre-school Oral Health Survey), and the Victorian Department of Education and Training Research Coordinating Committee (2014_002490). To ensure standardised reporting, the STROBE statement was used to guide the content of this paper.[29]

Study participants and recruitment

Children aged 3 to 5 years were recruited using stratified cluster sampling from preschools/childcare centres enrolled in the statewide *Smiles 4 Miles* program. *Smiles 4 Miles* is a Victorian state government–funded program that aims to create an environment that supports and promotes the oral health of preschool-aged children. The Victorian Department of Education and Training provided a list of 478 participating preschool/childcare centres across Victoria metropolitan sites (n=155, children n = 10,582) and rural sites (n = 323, children n = 16,003). Preschool/childcare centres were randomly selected from 4 strata consisting of a combination of 2 regional zones (metropolitan and rural) and 2 centre types (stand-alone preschool or long day care centre). We assigned a number to each preschool/childcare centre listed in the sampling frame and used a random number generator to randomly select the centres. For every centre that declined, a replacement from each stratum was selected.

Preschools/childcare centres were either cluster or independently managed. Cluster managers were contacted to provide information about the study and to request approval to contact preschools/childcare centre directors. Subsequently, preschool/childcare centre directors were contacted to share information about the study and invite them to participate. Once the director provided written approval, a meeting was scheduled to discuss the study further, schedule clinical oral health examination dates for children, identify examination sites within the centres, and send out parent study invitation packs comprising a participant information sheet, a parent/guardian consent form, and a self-administered parental questionnaire. Directors sent the study invitation packs to parents approximately 4 to 6 weeks prior to the examination. Two weeks before the examination, a study reminder was sent out to the parents of the children. One week before the examination, the directors shared with the researchers the list of children whose parents consented to participate; this list was then shared with the dental teams. Both the participating centres and children were allocated a unique identification number. Dental teams examined children only if parent consent was provided; parents were also given opportunity to provide consent for their child's participation on the day of the examination.

Examiner training

Clinical examiners were either oral health or dental therapists registered with the Dental Board of Australia. All examiners and recorders were trained and calibrated before commencing fieldwork to ensure a high degree of reliability and consistency in clinical measurements.

Oral health assessments

Examiners used standardised protocols to perform oral health assessments in the following sequence: (i) oral mucosal lesions, (ii) oral cleanliness and plaque, (iii) dental caries, and (iv) traumatic dental injuries (this paper focuses on ECC and excludes data relating to oral mucosal lesions and traumatic dental injuries). Children were examined in the preschool/childcare centre in supine position on portable dental chairs with a portable light. Examinations were conducted using disposable examination packs which included a blunt ball-ended Community Periodontal Index of Treatment Needs (CPITN) probe with an end diameter of 0.5 mm, a mouth mirror, and cotton rolls. Standardised infection control protocols were used. In place of compressed air, cotton rolls were used to dry the tooth surfaces. No radiographs were taken. Oral health assessments took place between November 2014 and June 2015.

All parents/guardians received a written examination report. Parents of children requiring urgent dental treatment were contacted by the clinician, and referrals were made to the nearest public dental clinics. Alternatively, parents were advised to see their private dentist for treatment.

Assessment of dental caries

Clinicians used cotton gauze and a CPITN probe to remove plaque and debris before assessing the tooth surfaces in the following sequence: mesial, buccal, distal, lingual, and occlusal (where present) using the international FDI 2-digit nomenclature. Clinicians recorded dental caries at the point of examination using the International Caries Detection and Assessment System (ICDAS II).[30] Dental assistants recorded the clinical data on a paper-based odontogram; they were then entered onto the study Excel spreadsheet by the researchers.

Inter-rater reliability of caries assessment

To assess the inter-rater reliability, 21 children were examined by 4 clinicians. The same clinicians then reexamined and reviewed each others' examination. The assessment of caries was recorded as per the ICDAS II protocol. To account for multiple examiners and additional variability caused by different teeth and surfaces, a linear mixed model was used to calculate the intra-class correlation (ICC). Due to multiple examiners being involved in the study, and because not all examiners rated every child, the usual calculation of weighted kappa was not suitable. Weighted kappa is an agreement measure designed for ordinal scores and, when using squared weights, is equivalent to the ICC. All the 88 surfaces of 20 teeth for each child were rated, and subsequently the ICC was calculated. The ICC value was 0.74 (95% CI, 0.72-0.76), which is considered a moderate to good score for inter-rater reliability.

Assessment of plaque

To assess visible plaque, the examiner lifted the child's upper lip (child was asked to bite teeth together) and checked the buccal surfaces from upper right to left canine. The assessment of plaque was based on a simpler modified version of the Silness and Loe Index[31] and was scored as: 0 "teeth appear clean'" (no plaque present); 1 "little plaque visible"; and 2 "substantial amount of plaque visible."

Data collection

Parents/guardians completed a self-administered paper-based questionnaire (which was previously tested in a different study) on social, demographic, and behavioural factors. Nonclinical data such as preschool as well as child ID, date of birth, sex, examination date, and referrals were recorded at the point of examination. Socioeconomic status was measured by the parent/guardian holding a current pensioner or health care card (PHCC). Remoteness was coded based on the child's home postcode using the Australian Statistical Geographical Standard (ASGS) Remoteness Structure.[32] Indigenous status was measured based on the child's parents reporting being of ATSI origin. Non-English-speaking background was measured based on whether the child's parent/guardian reported not speaking English as their main language at home. The main language spoken by the parent/guardian at home was collected and reported as a broad measure of diversity.

Behavioural data captured included the following: sugar-sweetened beverage consumption ("never/rarely" and "once or more per week"); toothbrushing habits ("≥ twice per day" or "< twice per day"); dental visiting behaviour ("history of previous dental visit" or "no history of dental visit"); and parental perceptions of their child's oral health ("excellent," "very good," "good," and "fair/poor"). To measure barriers to dental visits, parents were provided with a list of reasons that prevented them from taking their child to the dentist. Parents could select one or more and/or could also provide their own response (coded and collapsed into categories).

Statistical analysis

Data analyses were carried out using STATA (Version 11.2). For each child, caries data were collapsed into the following groups: non-cavitated/early lesions and cavitated lesions (ICDAS II Codes d^{1-6}); non-cavitated/early lesions (ICDAS II Codes d^{1-2}), and cavitated lesions (ICDAS II Codes d^{3-6}). The collapsed tooth surface caries d^{1-6} (d^1) and d^{3-6} (d^3) data were used for the analysis. Descriptive statistics were calculated to show caries prevalence (percentage of children caries-free) based on age, gender, parental PHCC and Indigenous status, English as the main language spoken at home, and remoteness. We have reported the non-cavitated/early lesions (d^{1-2}) as part of the descriptive statistics to quantify potentially reversable decay. Data collected at examination on decayed, filled, and missing teeth (lost due to dental caries) for each child were transformed (a counting process was used) to calculate the decayed, missing, and filled tooth surfaces and tooth indices (dmfs and dmft), and a mean for the sample was reported.

The study used the significant caries index (SiC) and modified index SiC[10] to calculate the mean dmft of one-third and one-tenth of the sample with the highest caries scores, respectively.[33] These are considered useful indices to report alongside the dmft to identify variations in decay proportions, especially in countries where the overall decay experience can be low.[34]

Poisson and logistic mixed models were used with preschool/childcare centre type as the random effect and age group, Indigenous status, parent health care/pensioner card status, English not the main language spoken at home, and remoteness as the fixed effects. An offset was used to account for the different number of tooth surfaces that were able to be rated for each child. Age groups were based on a three-level category of 3, 4, and 5 years. Poisson mixed model analysis was conducted using the ICDAS II d^1 and d^3 at the tooth surface level. The analyses were conducted using decayed surface level data, as they represent both the dental caries experience and the absence of treatment.[35] If a fixed effect was found to be significant ($P < .05$), further testing was conducted to examine pairwise effects. For each analysis, one variable was tested against another (eg, 5-year-old compared to 4-year-old children), whilst variables such as Indigenous status, parent health care/pensioner card status, English not the main language spoken at home, and remoteness were adjusted for to establish the main effects. For the Poisson mixed model analysis, dental caries at tooth surface level was the outcome variable. For logistic mixed model analysis, sugar-sweetened beverage consumption rates, brushing twice per day, and a history of a dental visit were outcome variables. Independent variables were child's age, gender, remoteness of residence, parental PHCC, Indigenous status, and main language spoken at home.

Results

Consent rates

Of the 81 preschools invited to take part, 75.3% (n = 61) consented. Twelve of the declining preschools already had dental services in place, two had recently changed management, five did not provide any reason, and one preschool amalgamated with another that participated. Of the 3,460 children invited to participate, 60.2% (n = 2,084) parents/guardians consented. Of the children whose parents consented, 88.5% (n = 1,845) were examined, 6.6% (n = 137) were absent on the examination day, 4.2% (n = 87) refused examination, and 0.7% (n = 15) were excluded from the study due to not meeting the eligible age requirement. Sixty-three parents (3.4%) whose children received a dental examination did not complete the questionnaire.

Sociodemographics

Gender distribution of the children was evenly represented, with slightly higher proportion of boys (51.3%, n = 946) participating in the study compared to girls (48.7%, n = 899). The mean ages of the children were 4.46 and 4.38 for boys and girls, respectively, and 4.42 years overall. A small proportion of parents in the sample identified themselves as being from ATSI background (3.1%, n = 57), and more than one-third of the parents (35.0%, n = 646) held a PHCC. Slightly more than 10% (11.2%, n = 206) of the parents did not speak English as their main language at home. Forty-six languages were identified as being spoken by parents as their main language at home. Whilst 40.1% (n = 740) of the children lived in major cities, 53.0% (n = 977) lived in inner regional and 6.6% (n = 121) lived in outer regional areas.

Oral health outcomes

Caries

Overall, 56.6% (n = 1,044) and 19.9% (n = 368) of the children had caries d^1 and d^3, respectively (Table 1). Of the children with decay, 36.6% (n = 676) presented exclusively non-cavitated/early lesions (d^{1-2}), 5.7% (n = 106) presented solely cavitated lesions (d^3), and 14.2% (n = 262) presented both cavitated and non-cavitated/early lesions (d^3 present with d^{1-2}). The mean d^1mft and d^3mft for the sample was 1.88 and 0.71, respectively (Table 2). The highest d^1mft and d^3mft scores were 20 and 13, respectively. A small proportion of children had missing (0.9%, n = 16) and filled (7.0%, n = 130) teeth.

The SiC for the sample was 4.61 (95% CI, 4.32-4.90) and 2.14 (95% CI, 1.87-2.42) for d^1mft and d^3mft, respectively. The SiC[10] was 8.17 (95% CI, 7.77-8.57) and 5.26 (95% CI, 4.91-5.61) for d^1mft and d^3mft, respectively.

The results of the Poisson mixed model testing the associations between demographic variables and decayed surfaces rates are shown in Table 3. Children aged 5 years had more than 3 times the d^3 surfaces compared to 3-year olds (IRR = 3.09, 95% CI, 2.48-3.84, $P < .001$). Children from non-English-speaking backgrounds had more than double the d^3 surfaces on average, compared to children from English-speaking backgrounds (IRR = 2.09, 95% CI, 1.80-2.43, $P < .001$). Children with parental Indigenous status (IRR = 1.91, 95% CI, 1.50-2.43, $P < .001$) and PHCC (IRR = 1.76, 95% CI, 1.57-1.97, $P < .001$) exhibited almost double the d^3 surfaces. Boys (IRR = 1.14, 95% CI, 1.07-1.22, $P < .001$) exhibited significantly more d^1 surfaces than females; however, significant associations were not found for gender (IRR = 1.08, 95% CI, 0.97-1.21, $P = .147$) at a more severe level of d^3. Significant differences in decayed tooth surface rates based on remoteness were not detected.

Plaque

Slightly over one-half of children (53.9%, n = 995) showed some sign of visible plaque (either "little plaque visible" or "substantial amount of plaque visible"), and 9.2% (n = 169) showed a "substantial amount of plaque visible" in at least 1 of the 6 teeth examined.

Oral health behaviour outcomes

Sugar-sweetened beverage consumption

Generally, children whose parents reported that their child consumed sugar-sweetened beverages more often showed

Table 1 – Number (%) and unadjusted mean decayed surface rates (n = 1,845).

Variable category	Variable category	*n (%)	Caries experience ^d^1 n (%)	Mean d^1 surfaces	95% confidence intervals	Caries experience ^d^3n (%)	Mean d^3 surfaces	95% confidence intervals
Overall sample		1,845	1,044 (56.6)	2.13	1.91-2.35	368 (19.9)	0.77	0.64-0.90
Child's age	3 years	425 (23.0)	209 (49.2)	1.44	1.19-1.69	58 (13.6)	0.39	0.26-0.53
	4 years	1178 (63.8)	691 (58.7)	2.30	2.07-2.53	258 (21.9)	0.85	0.70-1.00
	5 years	242 (13.1)	144 (59.5)	2.43	1.77-3.09	52 (21.5)	1.01	0.57-1.46
Child's gender	Male	946 (51.3)	566 (59.8)	2.35	2.06-2.65	195 (20.6)	0.85	0.68-1.03
	Female	899 (48.7)	478 (53.2)	1.90	1.64-2.17	173 (19.2)	0.69	0.52-0.87
Parent-Pensioner Health Care Card (PHCC)	Parent-PHCC	646 (35.0)	415 (64.2)	2.81	2.49-3.14	177 (27.4)	1.18	0.94-1.42
	Parent-non PHCC	1125 (61.0)	582 (51.7)	1.68	1.48-1.89	170 (15.1)	0.52	0.41-0.64
English main language at home (EMLaH)	Parent-non-EMLaH	206 (11.2)	138 (67.0)	3.60	2.98-4.22	62 (30.1)	1.62	1.08-2.16
	Parent-EMLaH	1,569 (85.0)	862 (54.9)	1.89	1.68-2.10	287 (18.3)	0.65	0.52-0.78
Indigenous status	Parent ATSI	57 (3.1)	34 (59.7)	3.02	1.79-4.25	14 (24.6)	1.28	0.00-2.55
	Parent non-ATSI	1,714 (92.9)	964 (56.2)	2.06	1.84-2.27	335 (19.5)	0.75	0.63-0.87
Remoteness	Major cities	740 (40.1)	399 (53.9)	2.24	1.91-2.58	169 (22.8)	0.97	0.79-1.14
	Inner regional	977 (53.0)	584 (59.8)	2.10	1.80-2.40	173 (17.7)	0.66	0.48-0.83
	Outer regional	121 (6.6)	56 (46.3)	1.74	1.49-1.99	26 (21.5)	0.84	0.57-1.11

*Missing data not shown.

^ d^1 refers to ICDAS II decay levels: 1-6; d^3 refers to ICDAS II decay levels 3-6.

higher decay rates than those who did not. Specifically, children whose parents reported their child consumed soft drinks (IRR = 1.66, 95% CI, 1.48-1.86, $P < .001$), fruit juice/cordial (IRR = 1.54, 95% CI, 1.34-1.77, $P < .001$), and flavoured milk (IRR = 1.17, 95% CI, 1.05-1.32, $P = .006$) one or more times per week had higher rates of cavitated (d^3) surfaces compared to those who never/rarely consumed these drinks (Table 4). Soft drink consumption of once or more per week was associated with parental PHCC status (OR =1.73, 95% CI, 1.36-2.18, $P < .001$), non-English-speaking background (OR = 1.58, 95% CI, 1.11-2.27, $P = .012$), and Indigenous status (OR = 1.92, 95% CI, 1.04-3.52, $P = .036$). Whilst not reaching statistical significance, higher odds were present in older children for consuming soft drinks once or more per week: 5- vs 4-year-olds (OR = 1.46, 95% CI, 0.97-2.21, $P = .072$) and 4- vs 3-year-olds (OR = 1.33, 95% CI, 0.98-1.80, $P = .066$). Fruit juice/cordial consumption of once or more per week was associated with parental PHCC status (OR = 1.49, 95% CI, 1.19-1.88, $P = .001$) and non-English-speaking background (OR = 1.72, 95% CI, 1.18-2.50, $P = .005$). Although a statistically significant association was not found for Indigenous status (OR = 1.88, 95% CI, 0.94-3.77, $P = .076$), a higher odds ratio and wide confidence intervals were observed. Flavoured milk consumption was associated with parental PHCC (OR = 1.43, 95% CI, 1.16-1.77, $P = .001$) (Table 5).

Dental visiting patterns and treatment

Overall, almost half of the children (47.8%, n = 882) examined had a history of a dental visit, with 39.8% (n = 169) of 3-, 48.6% (n = 573) of 4-, and 57.9% (n = 140) of 5-year-olds having visited the dentist. Generally, older children were significantly more likely to have visited a dentist (5- compared to 3-year-olds: OR = 2.36, 95% CI, 1.63-3.42, $P < .001$; 5- compared to 4-year-olds: OR = 1.51, 95% CI, 1.10-2.06, $P = .010$; and 4- compared to 3-year-olds: OR = 1.57, 95% CI, 1.21-2.02, $P = .001$). Children whose parents held a PHCC were significantly less likely to have visited the dentist (OR = 0.71, 95% CI, 0.57-0.87, $P = .001$) than those who did not hold a PHCC. Children of parents with Indigenous status were less likely to have visited the dentist; however, this did not reach statistical significance at .05 (OR = 0.55, 95% CI, 0.30-1.02, $P = .060$). Children residing in outer regional areas were almost twice as likely to have visited the dentist than those who resided in major cities (OR = 1.99, 95% CI, 1.16-3.42, $P = .013$) and inner regional areas (OR = 1.71, 95% CI, 1.01-2.92, $P = .048$) (Table 5).

Higher d^1 (IRR = 1.22, 95% CI; 1.14-1.31, $P < .001$) and d^3 (IRR = 1.48, 95% CI: 1.32-1.66, $P < .001$) surface decay rates were shown for children with a history of a dental visit. Most children visited dental practitioners for a checkup (87.9%, n = 775), with smaller proportions visiting for both a checkup and treatment (2.7%, n = 24) and for treatment alone (8.8%, n = 78). Fifty children (2.7%) reported to have received dental treatment under a general anaesthetic in hospital. The most frequently reported barriers for dental visits were cost 15.4% (n = 284), time (10.1%, n = 186), long waiting times (5.4%, n = 100), and parent fear/anxiety about pain (4.1%, n = 75).

Toothbrushing (supervised)

Overall, 40.5% (n = 747) of the children brushed (supervised) twice per day, 45.5% (n = 840) of children brushed once per

Table 2 – Oral health outcomes: caries experience, dmft/s, missing/filled teeth (n = 1,845).

Caries experience	Code	n(%)	Decayed, missing, filled teeth/surfaces	Mean	lin SE	95% confidence intervals
Non-cavitated/early lesions only	d^{1-2} only	[a]676(36.6)	[^]d^1mft (decayed, missing, filled teeth)	1.88	0.09	1.71-2.05
Cavitated and non-cavitated/early lesions	d^3 (with d^{1-2} present)	[b]262(14.2)	d^1mfs (decayed, missing, filled surface)	2.42	0.12	2.19-2.65
Cavitated lesions only	d^3 only	[c]106(5.7)	d^1s (decayed surfaces)	2.13	0.11	1.91-2.35
Total: all caries	d^1 (All caries)	1,044(56.6)	d^1t (decayed teeth)	1.73	0.09	1.55-1.90
Non-cavitated early lesions present	d^{1-2} present	[*]938(50.8)	[^]d^3mft (decayed, missing, filled teeth)	0.71	0.05	0.61-0.80
Cavitated lesions present	d^3 present	[**]368(19.9)	d^3mfs (decayed, missing, filled surfaces)	1.07	0.08	0.91-1.22
			d^3s (decayed surfaces)	0.77	0.06	0.64-0.90
			d^3t (decayed teeth)	0.54	0.04	0.46-0.62
			Filled surfaces	0.25	0.03	0.20-0.30
			Filled teeth	0.17	0.02	0.14-0.21
			Missing teeth	0.01	0.00	0.01-0.02

Linearized standard error.

^ *d^1 refers to ICDAS II decay levels: 1-6; d^3 refers to ICDAS decay levels 3-6.*

* *Non-cavitated/early lesions present = a + b.*

** *cavitated lesions present = b + c.*

day, 8.8% (n = 162) brushed less than once per day, and 1.4% (n = 26) never brushed their teeth. Boys (OR = 0.81, 95% CI, 0.67-0.99, *P* = .036) and children whose parents held a PHCC (OR = 0.74, 95% CI, 0.60-0.91, *P* = .004) showed lower odds for brushing their teeth (supervised) at least twice per day. Whilst children of parents with Indigenous status showed lower odds for brushing their teeth at least twice per day, results were not statistically significant (OR = 0.66, 95% CI, 0.36-1.19, *P*=.164) (Table 5). No significant associations were found between supervised toothbrushing twice per day and the prevalence of decayed surfaces (Table 4).

Parent reporting of their child's oral health

About 89% (n = 1,639) of parents rated their child's oral health positively, with 18.2% (n = 336), 40.9% (n = 755), and 29.7% (n = 548) reporting it as excellent, very good, or good. A smaller proportion of parents (6.7%) reported their child's oral health as fair (5.7%, n = 105) or poor (1.0%, n = 18). Poisson mixed model results indicated that parents who reported that their children's oral health as fair or poor (combined) had 9.33 (95% CI, 7.22-12.06, *P* < .001) times the number of d^3 surfaces compared to children whose parents reported their child's oral health as excellent. Further results are shown in Table 4.

Discussion

This study provides important oral health data relating to a large sample of Victorian preschool-aged children and is one of a growing number of studies[19, 23–27] to focus on the 3-to-5-year age group. The study findings show that over half of

Table 3 – Incidence rate ratios (IRRs) for the Poisson mixed model (decayed surfaces).

Variable	Variable category	[^]d^1 surfaces (decayed surfaces)			d^3 surfaces (decayed surfaces)		
		[†]IRR	95% confidence intervals	*P* value	[†]IRR	95% confidence intervals	*P* value
Age	4 years: 3 years	1.51	1.37-1.66	<.001	2.26	1.89-2.71	<.001
	5 years: 3 years	1.81	1.59-2.05	<.001	3.09	2.48-3.84	<.001
	5 years: 4 years	1.20	1.09-1.32	<.001	1.36	1.17-1.59	<.001
Gender	Male: Female	1.14	1.07-1.22	<.001	1.08	0.97-1.21	.147
Parent-Indigenous status	Parent ATSI: non ATSI	1.56	1.32-1.85	<.001	1.91	1.50-2.43	<.001
Parent-PHCC	Parent PHCC: Parent non PHCC	1.45	1.35-1.56	<.001	1.76	1.57-1.97	<.001
EMLaH	Parent not EMLaH: Parent EMLaH	1.83	1.66-2.02	<.001	2.09	1.80-2.43	<.001
Remoteness	Inner regional: Major cities	1.05	0.87-1.28	.588	0.74	0.51-1.08	.115
	Outer regional: Major cities	0.90	0.65-1.24	.525	0.92	0.50-1.68	.789
	Outer regional: Inner regional	0.85	0.64-1.15	.298	1.24	0.71-2.17	.448

† Model adjusts for age, gender, parent/guardian with health care card/pensioner card, ATSI, remoteness and language spoken at home. (Overall model *P* value < .001) (n = 1,753).

^ d^1 refers to ICDAS II decay levels: 1-6; d^3 refers to ICDAS II decay levels 3-6.

Table 4 – Incidence rate ratios (IRRs), 95% confidence intervals, and P values for those characteristics which were associated with sugar-sweetened beverage consumption; toothbrushing at least twice per day (supervised); having visited a dentist; and parent's perception of their child's oral health.

Oral health behaviour	Comparison	n	^d1 surfaces (decayed surfaces)			d3 surfaces (decayed surfaces)		
			†IRR	95% confidenceinterval	P value	†IRR	95% confidence intervals	P value
Soft drink	*Once or more per week: Never/rarely	1,701	1.32	1.23-1.42	<.001	1.66	1.48-1.86	<.001
Fruit juice/cordial	*Once or more per week: Never/rarely	1,692	1.22	1.13-1.32	<.001	1.54	1.34-1.77	<.001
Flavoured milk	*Once or more per week: Never/rarely	1,671	1.16	1.09-1.25	.001	1.17	1.05-1.32	.006
Brushed teeth at least twice per day (supervised)	Yes: No	1,748	0.99	0.92-1.05	.676	0.95	0.85-1.06	.352
History of a dental visit	Yes: No	1,723	1.22	1.14-1.31	<.001	1.48	1.32-1.66	<.001
Parents report: child's oral health	Fair/poor: Excellent	1,736	3.39	2.98-3.85	<.001	9.33	7.22-12.06	<.001
	Fair/poor: Very good		2.73	2.47-3.01	<.001	4.56	3.91-5.32	<.001
	Fair/poor: Good		1.96	1.78-2.16	<.001	2.43	2.11-2.80	<.001
	Good: Very good		1.39	1.28-1.51	<.001	1.88	1.64-2.15	<.001
	Good: Excellent		1.73	1.55-1.93	<.001	3.84	3.01-4.90	<.001
	Very good: Excellent		1.24	1.11-1.39	<.001	2.05	1.59-2.63	<.001

* Parent reported beverage consumption.
† Model adjusts for age, gender, parent/guardian with health care card/pensioner card, ATSI, remoteness and language spoken at home.
^ d^1 refers to ICDAS II decay levels: 1-6; d^3 refers to ICDAS II decay levels 3-6.

the children had ECC, with a fifth showing cavitated lesions. Older children and those with parental PHCC status, non-English-speaking backgrounds, and Indigenous status showed higher rates of cavitated lesions. Children who consumed sugar-sweetened beverages more often showed higher decay rates, and children from more disadvantaged backgrounds generally consumed these beverages more frequently. Younger children and those with parental PHCC status were less likely to have visited the dentist and less likely to be brushing their teeth (supervised) twice per day.

Our findings show similar trends to other studies in decay patterns amongst preschool-aged children.[23-25,36,37] The findings showed that a fifth of the children had cavitated decay; this is similar to other studies of preschool-aged children in Victoria.[5,15] The d^3mft of 0.71 in this study was lower than the Victorian arm of the NCOHS, which used older children (5 to 6 years: dmft of 1.30)[18] and therefore is not comparable.

A third of the children in our study showed a mean d^3mft of 2.14 and 10% showed a mean of 5.26 (as shown by the SiC and SiC^{10}, respectively), revealing that a small proportion of the children exhibited a substantially higher proportion of decay. This skewed prevalence of decay in children is shown in other studies.[17,38,39] The extremely high dmft scores in our study are concerning given the very young age of the children and that ECC has been shown to predict caries in adulthood even with improvements in socioeconomic circumstances.[40] It has also been shown that children with high d^3mft scores are at greater risk of missing preschool and needing more attention.[12] Parents of such children often report feelings of guilt and stress and missing sleep, normal activities, and work.[13] The potential flow-on effects of ECC in relation to general health and cost to the community are significant even for preschool age.

Our study showed that half of the children presented with non-cavitated/early lesions ($d^{1\text{-}2}$), either with or without cavitated lesions. This finding is not frequently reported in the literature; however, it is an important inclusion as it reveals the proportion of children showing potentially reversable non-cavitated/early lesions and shows a significant opportunity for prevention and early intervention. [15]

Similar to other preschool-aged child surveys,[19,26,31] our study showed that older children had higher decay rates (both cavitated and non-cavitated/early lesions) compared to younger children. A possible reason for this could be that caries development is a cumulative process that worsens over time.[17,19,23] Whilst many studies found no significant gender differences,[18,23–26] we found that boys had higher rates of d^1 surfaces compared to girls. Further longitudinal research is warranted to investigate gender variations in caries experience.

Existing studies show considerable variations in methodologies employed, sampling techniques, caries assessment methods, age groups of children, and settings, making comparisons amongst statewide, national, and international studies complex. Our findings on the association between decayed tooth surface rates and sociodemographic variables showed similarities with findings from other studies.[18,25,35,38] Children whose parents held a PHCC showed higher decay rates compared to parents without PHCC. Other studies showed similar trends, with higher decay rates observed in primary teeth where parents reported a lower income.[19,23,37] Cultural influences in relation to ECC risk remains unclear.[28] Although our study included children from diverse cultural backgrounds (46 languages spoken at home), we did not explore the influence of culture on caries experience. However, our study found that children whose parents were from non-English-speaking backgrounds were more likely to experience caries.

Table 5 – Odds ratios, 95% confidence intervals, and *P* values for those characteristics associated with the consumption of sugar-sweetened beverages once or more per week compared to never/rarely; having visited a dentist; brushed teeth (supervised) at least twice per day.

Variable	Variable category	[†]Odds ratio	95% confidence intervals	*P* value
[*]Soft drink (n = 1,701)	5 years: 3 years	1.46	0.97-2.21	.072
	4 years: 3 years	1.33	0.98-1.80	.066
	5 years: 4 years	1.10	0.79-1.54	.579
	Males: Females	1.10	0.88-1.38	.385
	Parent PHCC: non-PHCC	1.73	1.36-2.18	<.001
	Parent- ATSI: non-ATSI	1.92	1.04-3.52	.036
	Non-EMLaH: EMLaH	1.58	1.11-2.27	.012
	Inner regional: Major city	0.98	0.70-1.36	.893
	Outer regional: Major city	0.89	0.48-1.65	.718
	Outer regional: Inner regional	0.91	0.50-1.67	.769
[*]Flavoured milk (n = 1,671)	5 years: 3 years	1.35	0.94-1.93	.103
	4 years: 3 years	1.20	0.93-1.56	.149
	5 years: 4 years	1.17	0.82-1.51	.477
	Males: Females	1.03	0.84-1.26	.777
	Parent PHCC: non-PHCC	1.43	1.16-1.77	.001
	Parent- ATSI: non-ATSI	1.25	0.71-2.21	.433
	Non-EMLaH: EMLaH	1.20	0.85-1.68	.295
	Inner regional: Major city	1.15	0.90-1.47	.254
	Outer regional: Major city	1.34	0.85-2.11	.200
	Outer regional: Inner regional	1.17	0.75-1.83	.498
[*]Fruit juice/cordial (n = 1,692)	5 years: 3 years	1.03	0.71-1.50	.881
	4 years: 3 years	0.97	0.75-1.27	.849
	5 years: 4 years	1.06	0.77-1.46	.741
	Males: Females	1.16	0.94-1.42	.167
	Parent PHCC: non-PHCC	1.49	1.19-1.88	.001
	Parent-ATSI: non-ATSI	1.88	0.94-3.77	.076
	Non-EMLaH: EMLaH	1.72	1.18-2.50	.005
	Inner regional: Major city	1.18	0.89-1.56	.244
	Outer regional: Major city	0.79	0.48-1.30	.354
	Outer regional: Inner regional	0.67	0.41-1.10	.113
Brushed at least twice per day (supervised) (n = 1,748)	5 years: 3 years	0.94	0.66-1.32	.707
	4 years: 3 years	1.06	0.84-1.35	.620
	5 years: 4 years	0.88	0.65-1.19	.400
	Males: Females	0.81	0.67-0.99	.036
	Parent PHCC: non-PHCC	0.74	0.60-0.91	.004
	Parent- ATSI: non-ATSI	0.66	0.36-1.19	.164
	Non-EMLaH: EMLaH	1.22	0.89-1.68	.214
	Inner regional: Major city	1.14	0.92-1.42	.241
	Outer regional: Major city	0.97	0.64-1.47	.887
	Outer regional: Inner regional	0.85	0.56-1.29	.441
History of a dental visit (n = 1,723)	5 years: 3 years	2.36	1.63-3.42	<.001
	4 years: 3 years	1.57	1.21-2.02	.001
	5 years: 4 years	1.51	1.10-2.06	.010
	Males: Females	1.07	0.88-1.30	.495
	Parent PHCC: non-PHCC	0.71	0.57-0.87	.001
	Parent- ATSI: non-ATSI	0.55	0.30-1.02	.060
	Non-EMLaH: EMLaH	0.79	0.57-1.11	.168
	Inner regional: Major city	1.16	0.87-1.56	.313
	Outer regional: Major city	1.99	1.16-3.42	.013
	Outer regional: Inner regional	1.71	1.01-2.92	.048

* Parents reported beverage consumed once or more per week compared to never/rarely.
† Model adjusts for age, gender, parent/guardian with health care card/pensioner card, ATSI, remoteness and language spoken at home.

Parental Indigenous status in our study was also associated with higher decay rates compared to children whose parents did not report Indigenous status. This finding is similar to a small rural/remote West Australian study of 253 children aged 2 to 4 years old which showed that 69% of the Indigenous children exhibited decay compared to 25% of non-Indigenous children.[36] Higher decay rates in primary teeth of Indigenous children aged 5 to 6 years were also found in the Queensland Child Oral Health Survey.[35]

In our study, significant associations were not found between decayed surfaces and children's remoteness of residence. In studies in which children from remote and very remote areas were included, higher decay rates were reported.[18,35] Remoteness can be associated with poorer housing, poorer water quality, less reliable health services, problems with fresh food availability, lack of water fluoridation,[41] and problems associated with transport and distance to services.[19] Ninety percent of Victoria's water supply is fluoridated,[42] and this could be a factor influencing our results. Future preschool-aged child oral health surveys should be more representative of the state and include children from remote areas to further investigate any significant differences between these regions.

Children who consumed sugar-sweetened beverages including soft drinks, fruit juice/cordial, and flavoured milk showed higher caries rates, similar to the findings from other studies on preschool-aged children.[23,37] Our study showed that children with parental PHCC, Indigenous status, or non-English-speaking backgrounds were more likely to consume soft drinks once or more per week, and these findings are consistent with the NCOHS.[21] Our findings showed that older children had higher odds of consuming soft drinks (although not significant at .05) once or more per week than younger children. This indicates that caries prevention strategies should support behaviour changes early, before such patterns are established.

Dental visiting guidelines vary across countries; however, generally it is recommended that children receive an oral health assessment or examination by either a health care provider or an oral health professional after the first tooth erupts before the age of 12 to 24 months.[6,43] Generally it appears this recommendation is not being followed, with several studies showing that only 2% of children aged 1 year had visited a dentist.[44,45] In our study, fewer than half of the children visited the dentist, with 3-year-old children showing lower dental visiting rates; these findings are consistent with other preschool-aged child studies.[39,46] Here, children whose parents held PHCC and reported an Indigenous status (not statistically significant) showed lower odds for having a history of a dental visit with a similar pattern shown in the NCOHS.[20] An interesting finding in our study was that children from outer regional areas showed higher odds of having a history of dental visit compared to children from major cities and inner regional areas. Reasons for this could include outreach programs established through the local dental clinics to address oral health concerns in regional areas and oral health care programs offered within the childcare centres.

Australia's fluoride guidelines recommend supervised toothbrushing twice a day for children from 18 months to 5 years of age with a fluoride toothpaste (fluoride 500-550 ppm).[47] Whilst 46% of the children in our study were brushing their teeth (supervised) once per day, only 41% of children were brushing twice per day. In our study, children whose parents held a PHCC were less likely to be brushing their teeth at least twice per day, which was consistent with the NCOHS findings for children from lower-income families.[48] These findings are important, as they show toothbrushing trends in very young children. One of the major omissions of this study is that we did not explore whether the toothbrushing was undertaken with a fluoridated toothpaste.

Similar to other studies of preschool-aged children,[23,49] our results showed that parental perception of poor child oral health was associated with higher decay rates. Parent perceptions of poorer child oral health has also been found to be associated with poorer general health[50] and higher odds of dental visiting.[46] Higher oral health literacy has been found to be associated with better parental reporting of child oral health,[51] independent of factors such as racial background, education, and age.[52] Specifically, our findings indicated that the odds of children having cavitated lesions is 9 times higher when parents reported "fair/poor" child oral health compared to "excellent." These results support the notion that parental perceptions can be one of the useful nonclinical indicators of oral health status of preschool-aged children. Other studies suggest that parental perceptions of their child's oral health may also reveal important information about their oral health literacy,[52] dental service utilisation,[46] and their child's general health.[46,50]

Limitations

This study has a few limitations. Oral health examinations undertaken in an outreach setting are not as accurate as the examinations undertaken in clinical settings where the whole suite of examination instruments and equipment is available. For example, in our study, compressed air was not used to dry teeth during oral health examination, and therefore the ability to accurately detect early lesions may have been compromised.

We utilised the statewide *Smiles 4 Miles* program to recruit preschool children and their families. This means that the study is not representative of the general population of Victoria and, as such, cannot be generalisable. *Smiles 4 Miles* is a state government–funded program that provides resources and professional development training on oral health promotion and disease prevention for early childhood professionals. The program could have potentially influenced oral health behaviours and practices of parents and children participating in this program. In addition, the program is targeted to disadvantaged communities where the burden of dental caries is higher, and this could have resulted in selection bias. The study was opportunistic in nature, utilising experience, resources, equipment, and dental teams from a previous child oral health survey; future research should draw on the operational learnings from this study to improve recruitment and sampling methods to ensure generalisability.

Conclusion and practice implications

The higher levels of more severe caries rates observed in older children and those from disadvantaged backgrounds highlight the potential opportunity for health promotion and early preventive interventions. The World Health Organisation recommends that caries prevention strategies should start early, utilising general health services such as maternal child health nurses, midwives, and health workers who can assist families with early prevention and control of ECC.[53] Reducing sugar-sweetened beverage consumption amongst children and improving oral health behaviours such as dental visiting and toothbrushing with a fluoride toothpaste from an early age can reduce the incidence of ECC.[53] Public health interventions such as water fluoridation have been shown to reduce the incidence of ECC in the community.[42] Preschools and child care centres are well placed to provide families with oral health information and resources, model good oral health behaviours, and arrange dental visits for children.[53] Such prevention-focused interventions offered in the right settings could yield significant improvements in children's oral health. It can potentially save future public oral health spending and reduce the need for costly dental treatment for children under general anaesthetic. [6]

Conflict of interest

None disclosed.

Acknowledgement

We acknowledge the funding contribution from the Victorian Department of Health and Human Services. We also acknowledge the Department of Education and Training for their support including all parents and their children, DHSV staff, volunteers, *Smiles 4 Miles* managers, preschool and childcare centre directors, teachers, and members of the Victorian Preschoolers Oral Health Survey advisory group for their participation and support.

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