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Pattern and severity of early childhood caries

Kerrod B. Hallett[1] and Peter K. O'Rourke[2]

[1]Children's Oral Health Service, Royal Children's Hospital, Brisbane, [2]School of Population Health, University of Queensland, Brisbane, Australia

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Abstract – *Objectives:* The aim of this study was to investigate the association between selected social and behavioural variables and the pattern and severity of early childhood caries (ECC) within a community child population. *Methods:* A cross-sectional sample of 2515 children aged 4–5 years were examined in a preschool setting using decayed, missing, filled teeth/surface (dmft/dmfs) indices and a self-administered questionnaire was used to obtain information regarding social, demographic, birth, infant feeding, oral and general health attitudes. Children with caries (847) were divided into anterior or posterior caries pattern groups and severe (dmfs score ≥6) or non-severe (dmfs score <6) caries groups. The data were analysed using a chi-square test and modelled using a logistic regression procedure. *Results:* Significant variables associated with anterior ECC pattern were ethnicity other than Caucasian (OR = 2.1, 95% CI = 1.4–3.1), sipping from the bottle during the day (OR = 1.9, 95% CI = 1.3–2.7), male gender (OR = 1.6, 95% CI = 1.2–2.2) and sleeping with a bottle at night (OR = 1.5, 95% CI = 1.1–2.2). Significant variables associated with severe ECC form were sipping from the bottle during the day (OR = 2, 95% CI = 1.4–2.8), maternal age at birth ≤24 years (OR = 1.8, 95% CI = 1.3–2.7), ethnicity other than Caucasian (OR = 1.6, 95% CI = 1.1–2.5) and sleeping with a bottle at night (OR = 1.5, 95% CI = 1.1–2.2). *Conclusions:* Infant bottle-feeding habits (either allowing a child to sip from a bottle during the day or put to sleep at night) and ethnicity other than Caucasian were significant determinants for both anterior caries pattern and severity of ECC in 4–5-year-old Australian children.

Key words: bottle caries; caries pattern; caries severity; dental caries; early childhood caries; nursing caries

Kerrod B. Hallett, Children's Oral Health Service, Royal Children's Hospital, Herston QLD 4029, Brisbane, Australia
e-mail: kerrod_hallett@health.qld.gov.au

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Previously, clinical terms such as 'nursing caries' and 'bottle caries' were used to describe a form of rampant caries affecting primary incisor and molar teeth of infants and preschool children (1, 2). However, most epidemiological studies of preschool children have been limited to specific indigenous, ethnic and lower socioeconomic groups (3–15). This unique pattern of dental caries affecting the primary maxillary incisor and first molar teeth and sparing the mandibular incisor teeth in most cases is thought to be related to the chronology of primary tooth eruption and subsequent acquisition of cariogenic bacteria, namely mutans streptococci (1, 16–18). In certain ethnic groups, children with caries before 2.5 years of age usually have decayed smooth surfaces of maxillary incisor and occlusal fissures of the first molar teeth (19–22). By 3.5 years of age, caries progresses to the smooth surfaces of the maxillary canine and occlusal fissures of the second primary molar teeth (23) and by 5 years the approximal surfaces of all primary molar teeth are usually involved (24, 25).

However, standardized diagnostic criteria for reporting 'nursing caries' and 'bottle caries' have been lacking in the dental literature (26). These methodological differences make study comparison and risk assessment difficult to apply in public health settings (27). A workshop, convened by the National Institutes of Health (NIH) in 1999, proposed that the term early childhood caries (ECC) be used to describe the presence of one or more decayed (noncavitated or cavitated lesions), missing (because of caries), or filled tooth surfaces on any primary tooth in children up to 71 months of age (28). Furthermore, the participants recommended that 'severe early childhood caries (S-ECC)' refer to 'atypical', 'progressive', 'acute' or 'rampant' patterns of dental caries and be defined according to the child's age and the number of decayed, missing or filled smooth tooth surfaces (dmfs). By definition, caries in children under 3 years of age affecting one or more smooth surfaces and in children under 6 years of age affecting one or more smooth surfaces in anterior teeth or a total dmfs score ≥6 would be classified as S-ECC. These proposed terms seem to be gaining international acceptance in the current dental literature (29–33).

More recent epidemiological surveys of preschool children with caries have used the proposed ECC terminology to report caries experience and associated risk factors (34–43). However, research on specific patterns and severity of ECC in preschool child populations has been limited to date (22, 44, 45). The purpose of this study was to investigate the association between selected social and behavioural variables with ECC pattern and severity and to explore a statistical model to explain specific forms of ECC presence in an Australian preschool child population.

Table 1. Variables obtained from questionnaire

Infant feeding practice
History and duration of breast feeding
History and duration of bottle feeding
History of bottle feeding to sleep at night
History of bottle sipping during day
Contents of bottle feeding
Age of commencement of solids
Age of commencement of cup drinking
Social demographics
Age
Gender
Ethnicity
Language spoken at home
Family status at birth
Maternal age at birth
Child order in family
Annual family income
Mother's education level
Dental health behaviours
Age of commencement of tooth brushing
Current adult supervision of tooth brushing
Amount of toothpaste used on brush
Person that applies toothpaste
Previous dummy use with sweetener
Selection of food labels with no added sugar
Infancy and childhood illness and treatment
Medical illness longer than 1 month
Taken prescription medication longer than 1 month
Request an alternative sugar-free medication
General
Previous residence outside region
Oral health and general health beliefs
Exposure to previous oral health promotion activities

Methods

The research protocol was approved by the Research Ethics Committee of the Royal Children's Hospital and the Performance Measurement Office, Education Queensland. Study design, sampling methodology and examiner training and calibration has been reported previously (39). In summary, a cross-sectional study design using a preschool-based sampling technique was used.

All children enrolled in state preschools within the north Brisbane health region in 2000 were invited to participate in the study. This region has social and economic demographics commensurate with the Australian population and the natural fluoride level of the drinking water is <0.3 ppm (46, 47). Those children who had reached their fourth birthday but not their sixth birthday from each participating preschool were given a consent form and a self-administered questionnaire to be completed by a parent or caregiver. The survey instrument requested information on the child's social, ethnic and demographic status by a series of 36 closed questions. Relevant variables obtained from the questionnaire are shown in Table 1. The questions were carefully worded in lay terms to avoid interviewer confusion and misunderstanding after validation from a pilot study of 125 mothers attending a hospital dental clinic (48). Notwithstanding the potential limitations of a 3-year time lapse, the survey's purpose was to identify those past infant feeding practices, medical events and dental health interventions in early childhood that may have influenced the pattern and severity of current ECC experience.

All returned questionnaires were collated and consenting children were randomly selected for oral examination by a senior dental therapist until a predetermined sample size for each preschool was reached. Substitution for children not present or uncooperative on the day was discouraged. Each child was examined in the preschool director's office using a disposable, illuminated mouth mirror (Denlite, Welch Allyn, Navan, Co. Meath, Ireland) and a blunt ball-ended probe (CPITN explorer; Hu-Friedy, Chicago, IL, USA). Caries experience of each child was recorded using internationally recognized diagnostic criteria; decayed (d), missing (m), filled (f) teeth (t) and surfaces (s) (49). Caries affecting one or more anterior (incisor and canine) tooth surfaces (labial, palatal or proximal) was coded as an anterior caries pattern (A-ECC) and caries affecting one or more primary molar teeth surfaces (occlusal, buccal, lingual/palatal or proximal) was recorded as a posterior caries pattern (P-ECC). Anterior caries pattern was given a classification priority in that those children with caries affecting both anterior and posterior teeth were coded as A-ECC. Caries experience was subsequently classified as ECC when the dmfs score was 1–5 and S-ECC for six or more surfaces according to the proposed NIH case definition (28).

Associations between ECC pattern and severity and other variables were evaluated using the SPSS (ver. 12; Raleigh, NC, USA) program. Descriptive statistics and a generalized linear model for ECC presence have been published previously (39, 41). The strength of association between caries pattern and severity and each variable was measured by chi-square analysis. The caries data were further analysed using a binomial modelling procedure for the dichotomous outcomes of anterior/posterior caries pattern and non-severe/severe caries experience. This procedure allows for the identification of those factors that significantly influence the outcome without the underlying assumption of normal distribution of the data set (50). The covariates of infant feeding practice, social and behavioural factors were explored for each model outcome (Table 1). Model significance was measured using the Wald statistic, which has a chi-squared distribution (51). The statistical power of the final model is most efficient when the Wald statistic is maximal and the degrees of freedom are minimal.

Model estimates were reported as an odds ratio (OR) with 95% confidence interval (CI). In large cross-sectional samples with a dichotomous outcome, the OR can be considered a measure of the relative risk of the outcome within the population (52). Confounding was determined if the univariate OR was significantly altered in the multivariate model by the introduction of other covariates. The conventional P-value of <0.05 was chosen as the level of significance for all statistical calculations.

Results

All questionnaires were completed and children were examined between June and August 2000. Three preschools within the region declined to participate and the child consent rate ranged from 25% to 89% for each preschool. The final sample size, allowing for non-participation on the day, was 2515 (41.6% of the estimated population). Selection bias was reduced by sampling the first 42% of available children from each participating preschool on the nominated examination day. The sociodemographic profile of the sample has been reported previously (41). Children from higher socioeconomic backgrounds (>$35 000 annual income) were slightly over-represented (54% of sample) compared with the national mean annual gross income in 1999–2000 (53). The ethnic mix of the sample was 82.4% Caucasian, 11.8% non-Caucasian and 5.8% not stated, which we believe is comparable with the Australian population ethnic profile.

Overall, 847 (33.7%) of the children had caries experience, 308 (12.3%) had an anterior caries pattern and 539 (21.4%) had a posterior pattern, 611 (24.3%) children had non-severe caries and 236 (9.4%) had severe caries experience. The sample mean dmft was 1.4 ± 2.77 and the mean dmfs was 2.28 ± 6. Within the caries group, 168 (19.8%) had both an anterior caries pattern and severe caries experience whilst 68 (8%) had a posterior caries pattern and severe caries experience ($P < 0.001$).

Several infant feeding practices were significantly associated with caries pattern and severity (Table 2). Depending on duration of feeding, 37–42% of bottle-fed children had an A-ECC pattern compared with 27% not bottle-fed ($P = 0.04$). Anterior caries pattern was significantly higher in children put to sleep with a bottle (44%) or allowed to sip from a bottle during the day (50%) compared with those who did not feed in this manner ($P < 0.00$). The percentage of S-ECC was also significantly higher in these two groups (33% and 40% compared with 21% and 22% respectively). Reported daily use of sweetened liquids such as cordial (an artificially fruit-flavoured sugar concentrate added to water), fruit juice and soft drink in the feeding bottle significantly increased prevalence of A-ECC (45–80%) compared with water (38%), cow's milk (38%) and infant formula (36%). Prevalence of S-ECC was also significantly increased using daily fruit juice (35%) and cordial (43%) compared with water (29%), cow's milk (28%) and infant formula (27%) in a feeding bottle. Age of commencement of solid foods did not significantly affect ECC pattern or severity. Earlier commencement of cup drinking significantly

Table 2. ECC pattern and severity and infant feeding practice[a]

Practice	n	A-ECC (%)	P-ECC (%)	P-value	ECC (%)	S-ECC (%)	P-value
Breast feeding							
No	173	70 (41)	103 (59)		117 (68)	56 (32)	
≤12 months	537	192 (36)	345 (64)		398 (74)	139 (26)	
>13 months	136	45 (33)	91 (67)		96 (71)	40 (29)	
Bottle feeding							
No	133	36 (27)	97 (73)	0.04	101 (76)	32 (24)	
≤18 months	623	232 (37)	391 (63)		450 (72)	173 (28)	
>19 months	85	36 (42)	49 (58)		57 (67)	28 (33)	
Sleep with bottle							
No	279	80 (29)	199 (71)	<0.00	221 (79)	58 (21)	<0.00
Yes	435	190 (44)	245 (56)		290 (67)	145 (33)	
Sip from bottle							
No	449	140 (31)	309 (69)	<0.00	349 (78)	100 (22)	<0.00
Yes	248	123 (50)	125 (50)		148 (60)	100 (40)	
Daily bottle contents							
Water	512	194 (38)	318 (62)		365 (71)	147 (29)	0.03
Milk	583	219 (38)	364 (62)		422 (72)	161 (28)	
Formula	529	192 (36)	337 (64)		386 (73)	143 (27)	
Juice	196	89 (45)	107 (55)	0.02	128 (65)	68 (35)	0.04
Soft drink	5	4 (80)	1 (20)	0.04	2 (40)	3 (60)	
Cordial	35	22 (63)	13 (37)	0.002	20 (57)	15 (43)	0.04
Start solids							
<4 months	242	98 (40)	144 (60)		165 (68)	77 (32)	
4–6 months	480	163 (34)	317 (66)		355 (74)	125 (26)	
>7 months	117	46 (39)	71 (61)		83 (71)	34 (29)	
Start cup							
≤ 12 months	428	144 (34)	284 (66)		323 (76)	105 (24)	0.04
13–18 months	332	127 (38)	205 (62)		232 (70)	100 (30)	
>19 months	73	32 (44)	41 (56)		46 (63)	27 (37)	

[a]A-ECC anterior caries incisor/canine/molar teeth, P-ECC posterior caries molar teeth only, ECC early childhood caries dmfs > 1 ≤ 5, S-ECC severe early childhood caries dmfs ≥ 6.

decreased prevalence of S-ECC (24% vs 37%) but did not affect ECC pattern.

Table 3 shows the association of selected social demographic variables and ECC pattern and severity. Ethnicity, language spoken at home, family status at birth, maternal age at birth, annual family income and mother's educational level were all strong markers for socioeconomic status (SES) status both individually and collectively. However, for the purposes of this survey, each variable was analysed separately to determine an individual measure of association with ECC pattern and severity. Gender was significantly associated with caries pattern only. Forty-one per cent of males had an anterior pattern compared with 31% of females ($P = 0.002$). Significantly more preschool children from non-Caucasian and non-English speaking backgrounds had A-ECC pattern (54% and 61%, $P < 0.00$ and $P = 0.006$ respectively). Thirty-nine per cent of children from a non-Caucasian family had S-ECC compared with 25% from a Caucasian ethnic background ($P = 0.001$). Single-parent children had significantly more S-ECC compared with their counterparts from two-parent families ($P = 0.002$). Forty-five percent of children born to mothers younger than 24 years had an A-ECC pattern and 37% had S-ECC compared with children born to mothers ≥25 years (33%, $P = 0.001$ and 24%, $P < 0.00$ respectively). An annual family income of <AUD$20,000 was significantly associated with higher prevalence of A-ECC (45%, $P = 0.02$) and S-ECC (40%, $P < 0.00$). Other income groups were not significantly different. A lower level of maternal education was significantly associated with increased prevalence of S-ECC only ($P = 0.03$).

Two dental health behaviours were significantly associated with ECC pattern and severity (Table 4). Forty-six per cent of children who were not currently supervised by an adult when tooth brushing had an A-ECC pattern compared with 35% who were supervised by an adult ($P = 0.04$). Those children who brushed with a smear of toothpaste on their brush had significantly less S-ECC prevalence (21%) than those who used more toothpaste during routine tooth brushing (28–35%) ($P = 0.02$).

Table 3. ECC pattern and severity and social demographics[a]

Variable	n	A-ECC (%)	P-ECC (%)	P-value	ECC (%)	S-ECC (%)	P-value
Age							
4 years	259	98 (38)	161 (62)		184 (71)	75 (29)	
5 years	570	203 (36)	367 (64)		416 (73)	154 (27)	
Gender							
Male	460	189 (41)	271 (59)	0.002	321 (70)	139 (30)	
Female	386	119 (31)	267 (69)		289 (75)	97 (25)	
Ethnicity							
Caucasian	622	203 (33)	419 (67)	<0.00	466 (75)	156 (25)	0.001
Other	149	80 (54)	69 (46)		91 (61)	58 (39)	
Language							
English	819	291 (36)	528 (64)	0.006	594 (72)	225 (28)	
Other	28	17 (61)	11 (39)		17 (61)	11 (39)	
Family status							
Single parent	74	33 (45)	41 (55)		42 (57)	32 (43)	0.002
Two parent	769	275 (36)	494 (64)		566 (74)	203 (26)	
Maternal age							
≤ 24 years	246	110 (45)	136 (55)	0.001	155 (63)	91 (37)	<0.00
≥25 years	596	197 (33)	399 (67)		452 (76)	144 (24)	
Child order							
First	287	110 (38)	177 (62)		207 (72)	80 (28)	
Second	299	102 (34)	197 (66)		207 (69)	92 (31)	
Third or more	261	96 (37)	165 (63)		197 (75)	64 (25)	
Family income							
<$20 000	189	85 (45)	104 (55)	0.02	114 (60)	75 (40)	<0.00
$20–35 000	241	87 (36)	154 (64)		175 (73)	66 (27)	
$35–50 000	180	57 (32)	123 (68)		135 (75)	45 (25)	
>$50 000	173	55 (32)	118 (68)		139 (80)	34 (20)	
Mother's education level							
Year 10	332	118 (36)	214 (64)		228 (69)	104 (31)	0.03
Year 12	227	76 (34)	151 (66)		170 (75)	57 (25)	
Technical	84	36 (43)	48 (57)		55 (66)	29 (34)	
University	141	51 (36)	90 (64)		113 (80)	28 (20)	

[a]A-ECC anterior caries incisor/canine teeth, P-ECC posterior caries molar teeth only, ECC early childhood caries dmfs > 1 ≤ 5, S-ECC severe early childhood caries dmfs ≥ 6.

Similarly, two childhood illness and medication variables were significantly associated with ECC pattern and severity (Table 5). Thirty-five per cent of children who had taken a prescription medicine >1 month had S-ECC compared with 26% who had not ($P = 0.02$). Request for a sugar-free alternative medication was significantly associated with a lower percentage of A-ECC pattern (35% vs 50%) and less S-ECC prevalence (25% vs 41%).

None of the general variables such as previous place of residence outside the region, a belief that tooth decay affects general health or exposure to regional oral health promotional activities was significantly associated with ECC pattern or severity (Table 6).

Tables 7 and 8 show the key determinants for anterior caries pattern and severe ECC experience respectively. None of the social and behavioural variables confounded the infant-feeding variables. The most efficient explanatory model for A-ECC pattern was male gender, ethnicity other than Caucasian, child sleeping with the bottle and sipping from the bottle during the day (Wald statistic = 44.3, d.f. = 4, $P < 0.000$). Similarly, the model statistics for S-ECC presence were maternal age ≤24 years at birth, ethnicity other than Caucasian, child sleeping with the bottle and sipping from the bottle during the day (Wald statistic = 50.4, d.f. = 4, $P < 0.000$).

Discussion

This survey was conducted within a community preschool child population and presents epidemiological data to confirm known risk factors and identify new social and behavioural determinants for ECC pattern and severity. The two key behavioural determinants for A-ECC pattern and S-ECC experience were allowing a child to sip from a bottle during the day and putting a child to sleep with a bottle. Significant social

Table 4. ECC pattern and severity and dental health behaviours[a]

Variable	n	A-ECC (%)	P-ECC (%)	P-value	ECC (%)	S-ECC (%)	P-value
Start toothbrush							
6–12 months	540	191 (35)	349 (65)		400 (74)	140 (26)	
≥13 months	282	108 (38)	174 (62)		194 (69)	88 (31)	
Adult supervision							
Yes	734	257 (35)	477 (65)	0.04	534 (73)	200 (27)	
No	94	43 (46)	51 (54)		64 (68)	30 (32)	
Amount toothpaste							
Smear	184	59 (32)	125 (68)		145 (79)	39 (21)	0.02
Pea size	485	182 (37)	303 (63)		349 (72)	136 (28)	
Full brush	164	62 (38)	102 (62)		107 (65)	57 (35)	
Application toothpaste							
Child	289	97 (34)	192 (66)		212 (73)	77 (27)	
Parent	517	197 (38)	320 (62)		373 (72)	144 (28)	
Other	39	14 (36)	25 (64)		25 (64)	14 (36)	
Dummy use with sugar							
Yes	42	19 (45)	23 (55)		28 (67)	14 (33)	
No	450	169 (38)	281 (62)		335 (74)	115 (26)	
Selection no added sugar labels							
Yes	361	115 (32)	246 (68)		268 (74)	93 (26)	
No	395	151 (38)	244 (62)		290 (73)	105 (27)	

[a]A-ECC anterior caries incisor/canine teeth, P-ECC posterior caries molar teeth only, ECC early childhood caries dmfs > 1 ≤ 5, S-ECC severe early childhood caries dmfs ≥ 6.

Table 5. ECC pattern and severity and childhood illness and medication[a]

Variable	n	A-ECC (%)	P-ECC (%)	P-value	ECC (%)	S-ECC (%)	P-value
Medical illness							
Yes	159	63 (40)	96 (60)		107 (67)	52 (33)	
No	676	239 (35)	437 (65)		502 (74)	174 (26)	
Prescription medication							
Yes	159	61 (38)	98 (62)		104 (65)	55 (35)	0.02
No	680	242 (36)	438 (64)		506 (74)	174 (26)	
Sugar-free medication							
Yes	52	18 (35)	34 (65)	0.05	39 (75)	13 (25)	0.04
No	155	77 (50)	78 (50)		92 (59)	63 (41)	

[a]A-ECC anterior caries incisor/canine teeth, P-ECC posterior caries molar teeth only, ECC early childhood caries dmfs > 1 ≤ 5, S-ECC severe early childhood caries dmfs ≥ 6.

Table 6. ECC pattern and severity and general variables[a]

Variable	n	A-ECC (%)	P-ECC (%)	ECC (%)	S-ECC (%)
Previous residence					
Yes	240	95 (40)	1456 (60)	168 (70)	72 (30)
No	105	37 (35)	68 (65)	77 (73)	28 (27)
General health beliefs					
Yes	223	85 (38)	138 (62)	161 (72)	62 (28)
No	22	13 (59)	9 (41)	19 (86)	3 (14)
Oral health promotion					
Yes	247	140 (57)	107 (43)	174 (70)	73 (30)
No	48	26 (54)	22 (46)	37 (77)	11 (23)

[a]A-ECC anterior caries incisor/canine teeth, P-ECC posterior caries molar teeth only, ECC early childhood caries dmfs > 1 ≤ 5, S-ECC severe early childhood caries dmfs ≥ 6. No significant association between variables determined.

determinants were non-Caucasian background, male gender and a younger maternal age at birth of the child.

Our study has shown a strong inverse association between A-ECC, S-ECC and SES status, whether measured by ethnic background, family

Table 7. Multivariate modelling of anterior pattern of early childhood caries

Variable	Multivariate OR	95% CI	*P*-value
Gender		1.2–2.2	0.006
Female	1		
Male	1.6		
Ethnicity		1.4–3.1	0.001
Caucasian	1.00		
Non-Caucasian	2.1		
Sleep with bottle		1.1–2.2	0.02
No	1		
Yes	1.5		
Sip from bottle		1.3–2.7	<0.00
No	1		
Yes	1.9		

Table 8. Multivariate modelling of severe form of early childhood caries

Variable	Multivariate OR	95% CI	*P*-value
Maternal age		1.3–2.7	0.002
≥25 years	1		
≤24 years	1.8		
Ethnicity		1.1–2.5	0.02
Caucasian	1		
Non-Caucasian	1.6		
Sleep with bottle		1.1–2.2	0.03
No	1		
Yes	1.5		
Sip from bottle		1.4–2.8	<0.00
No	1		
Yes	2		

status, maternal age, annual family income or maternal education level. Previous cross-sectional studies conducted in large communities have also reported the strong potential for SES status to confound measures of caries experience in preschool age groups (22, 41, 54, 55). However, the modelling procedure in this survey has enabled the individual effect of each SES variable to be measured for A-ECC and S-ECC presence.

In our study, 34% of preschool children had ECC with a mean dmft of 1.4 (39). These data were comparable with epidemiological findings from similar cross-sectional surveys of preschool children living in England (56) and Ireland (57) but lower than those from Ohio, USA (58), Seoul, Korea (43) and Taiwan (59). In addition, within the group of children with ECC, 9.4% had the rampant or severe form of ECC, which was less than the prevalence rate reported by other epidemiological surveys using similar diagnostic criteria (9, 43, 56, 57, 59).

Anterior caries pattern and severe caries in preschool children has long been considered a distinct clinical entity described previously as 'nursing caries' or 'bottle caries' and attributed to prolonged frequent bottle feeding with sweetened liquids (1). Previous studies have reported a prevalence of caries affecting maxillary incisor teeth ranging from 6% to 16% in 3–4-year-old disadvantaged North American child populations (22, 58, 60). Our study reports a similar finding with 12.3% of 4–5-year-old children affected with an A-ECC pattern. As the incisor teeth are the first to erupt, they would be more susceptible to adverse bottle feeding habits and become decayed at an earlier age (19, 23). More recent evidence suggests that taking a bottle to bed may be a stronger predictor of A-ECC pattern than previously thought (2, 22, 61, 62). Our study supports this viewpoint by demonstrating that bedtime use of a bottle increases the risk of A-ECC pattern and S-ECC form 1.5 times compared with a P-ECC and ECC experience. In addition, previous logistic regression analysis of the non-ECC vs ECC groups using the same database concluded that these infant-feeding practices were key behavioural determinants for ECC presence within this population (41). Conversely, several studies have reported no significant difference between A-ECC cases who did not put their child to sleep with a bottle compared with those who did (15, 63, 64). However, these studies were undertaken in small convenience samples in a community health clinic, a medical setting and a dental office, respectively, leading to the potential for a recruitment and reporting bias. Our study findings should also be tempered by the possibility of a reporting bias at the time of questionnaire completion. Parents may have since learned of the harmful effects of night-time bottle feeding after seeing their child's teeth decay at an early age or have been advised so by a dentist during the intervening period leading to a biased reporting of previous infant-feeding practice.

Our study reports an increased risk of A-ECC (1.9×) and S-ECC (2×) compared with P-ECC and ECC by allowing a child to sip from a bottle during the day. This adverse feeding habit has not been highlighted as a potential risk factor in the recent dental literature. In Australian communities, infants are often observed sipping from a bottle whilst on family outings in recreational parks and shopping centres. Harrison et al. (65), investigated a similar habit amongst a Canadian population of refugee Vietnamese preschool children attending a child healthcare clinic. They reported that the current and past use of a 'comfort' bottle was common in this population and was significantly related to the presence of nursing caries (≥2 maxillary anterior teeth with decay). However, our study did not show that ethnic background confounded the strength of association between the sipping habit and A-ECC or S-ECC and that the potential risk of this feeding behaviour was independently significant within this population.

Aboriginal, Asian and Pacific Islander children have consistently exhibited statistically higher ECC experience compared with their Caucasian counterparts in the Australian population (41, 66, 67). Similar findings of severe caries among minority ethnic groups within industrialized countries have been reported in preschool children by many other researchers when ethnicity was used as a variable in their statistical analyses (4, 7, 15, 42, 56, 68–71). The increased risk of ECC within ethnic minorities could be due to different cultural, social and family values that encourage inappropriate infant feeding practice. However, none of the significant infant feeding practices were confounded by ethnic background in our study. Although the number of affected children from ethnic minorities is small in comparison with the general child population, their disease experience is extremely high, leading to concerns of increased disease susceptibility to oral pathogens such as mutans streptococci within particular ethnic groups (72, 73).

Our study has identified maternal age <25 years as a key social determinant of S-ECC. This finding was reported in our previous survey (41) and Mattila et al. (2000) (74). The increased risk (1.8–5×) of S-ECC in preschool children of younger mothers is interesting in the context of societal trends towards single-parent families and increasing maternal age for the firstborn child. It is possible that younger mothers are less likely to commence preventive health behaviours such as regular tooth brushing, supervise child tooth brushing and regulate sugar intake compared with older, more experienced mothers. However, none of these dental health behavioural factors were identified as significant determinants of S-ECC or confounded the effect of maternal age at childbirth in our population.

Finally, the increased risk (1.6×) of A-ECC in boys in our population group is a perplexing finding. Overall, boys had the same caries experience but a higher prevalence of A-ECC within the caries cohort compared with girls of similar age. Male gender has been reported as a risk factor for caries in other studies from The Netherlands and Brazil (75, 76). These findings raise questions as to whether boys are parented differently to girls. Marciel et al. (76) suggested that mothers play an important role in the establishment of sweetness preference in their children and that boys may be favoured with more sweets in their low SES culture. The reason for the increased prevalence of A-ECC in boys in our study is unclear, although it has been reported that male children who have the same genotype of mutans streptococci as their mother have up to 13 times greater risk of caries development than female children who acquire the same strain of bacteria from their mother (17). However, further research for gender-specific biological mechanisms of dental caries initiation and progression is required to explain gender differences in this area.

Overall, this survey has highlighted the significant association between certain SES markers (ethnicity, maternal age and annual family income), infant feeding practice and A-ECC and S-ECC, previously termed 'nursing caries' or 'bottle caries' and 'rampant caries' respectively. However, as with all cross-sectional survey designs, a potential selection bias towards more health conscious responders, the ability of mothers to report adverse behaviours accurately and to analyse previous infant feeding practices and present caries profiles are accepted limitations of this survey methodology. These scientific shortcomings have been comprehensively discussed and evaluated in a recent review of the current ECC literature (32). However, we believe that the sampling size and statistical analysis of the data are sufficiently robust to support valid epidemiological conclusions and add to the current body of scientific information in this area.

Conclusions

We conclude that the determinants for anterior caries pattern and severe caries form in the primary teeth of preschool children within an Australian community are comparable. Key social risk factors are ethnicity other than Caucasian, male gender and young maternal age at childbirth. Key behavioural risk factors are bottle sipping during the day and putting a child to bed with a bottle at night. Early childhood caries is a more appropriate diagnostic term rather than 'nursing or bottle' caries to describe this clinical entity based on the complex social and behavioural interactions that underlay its development.

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