

Pacifier Use and Early Childhood Caries: An Evidence-Based Study of the Literature

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A b s t r a c t

This evidence-based study of the literature investigated the relationship between pacifier use (with and without sweetening and prolonged or short-term) and early childhood caries (ECC). The review was based on evidence from 3 main sources: a search of several electronic bibliographic databases, a review of the references from relevant studies for additional potentially relevant articles and a review of several dental textbooks. A total of 74 articles were reviewed. Of these, 8 were deemed relevant and were critically appraised according to a "causation checklist" of 13 items. The 8 studies assessed were methodologically inconsistent in terms of definitions of ECC, diagnostic criteria for identifying carious lesions, dental examination procedures, interviewing methods, and descriptions of pacifier use. None of the studies achieved a score greater than 6 and hence none was considered to present strong evidence. Six studies did not control for confounding variables, and the conclusions they generated were inconsistent. The evidence from the other 2 studies, which did control for confounding factors, presented slightly stronger evidence, but they indicated no statistical difference in pacifier use between children with and those without ECC; furthermore, the reported odds ratios suggested that pacifier use might have had a mildly protective effect. Overall, the evidence does not suggest a strong or consistent association between pacifier use and ECC.

MeSH Key Words: child, preschool; infant care/methods; dental caries/epidemiology

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A 2000 survey of infant oral health programs across Canada found that, in many instances, the dental public health message given to parents is "Give the child a soother, but never dip it in honey, syrup or anything sweet."¹ Similarly, the Canadian Dental Association Web site states, "[N]ever put sugar, honey or corn syrup on a soother. They can cause cavities."² However, the American Academy of Pediatric Dentistry, in its oral health guidelines on early childhood caries (ECC), does not make recommendations about pacifier use.³ Studies investigating public health messages that describe the potentially harmful effects of pacifier use on children's health have not been limited to ECC, and some studies suggest that pacifier use is a risk factor for otitis media in young children.⁴⁻⁸

The association of numerous variables, most notably infants' use of a bottle, with ECC has been investigated. A number of studies have demonstrated a significant relationship between nocturnal bottle-feeding behaviours and ECC.⁹⁻¹⁵ For example, in a study of 150 children 18-36 months old, night feeding was significantly related to both the number of carious teeth and the "sum of surface sever-

ity."⁹ Similarly, both Marino and others¹⁰ and O'Sullivan and Tinanoff¹¹ found that children who "took a bottle to bed" experienced significantly more ECC than children who did not. Others found that children who slept overnight with a bottle had more anterior maxillary caries than those who did not.^{12,13} However, the relationship between pacifier use and ECC is less well established.

This literature review was undertaken to investigate the following question: Is use of a pacifier, whether prolonged or short term and whether sweetened or not, a risk factor for the development of ECC? The null hypothesis was that there was no difference in use of a pacifier between children with and those without ECC. This paper summarizes the strongest sources of evidence regarding this relationship.

Methods

A systematic method was used to identify, select and critically appraise relevant studies.

Search Strategy

Three types of searches were conducted to locate potentially relevant published articles. The following key words

were used in the searches: early childhood caries, early childhood tooth decay, baby bottle caries, nursing caries, baby bottle tooth decay, rampant caries, labial caries, maxillary anterior caries, nursing bottle caries, dental caries, incisor, pacifier, dummy, soother and comforter. First, several electronic bibliographic databases were searched: PubMed (1966 to the present), Pre-MEDLINE and MEDLINE (1966 to the present), the Social Sciences Citation Index, Full Search (1993 to the present), Healthstar (January 1975 to June 2001), and Science Citation Index Expanded (1993 to the present). These searches were limited to studies of human subjects published in English. They yielded 42, 15, 10, 15, and 4 potentially relevant articles, respectively. Second, the reference lists from articles deemed relevant to the review (see explanation below) were examined to identify additional potentially relevant articles (on the basis of the article titles). This process yielded 14 more potentially relevant articles. Third, several dental textbooks, including pediatric dentistry textbooks, were reviewed for additional relevant references published after 1950, and the reference lists of those articles were also reviewed. This process yielded 5 potentially relevant articles.

Determination of Relevance

After elimination of 30 duplicate articles (resulting from overlap among the electronic bibliographic databases) and 1 document that was unavailable, a total of 74 unique articles were retrieved and reviewed for relevance. An article was considered relevant if it met all of the following 5 criteria. 1) The article reported primary research. Articles pertaining to guidance about infant oral health care, as well as case studies, reviews and commentaries, were excluded. A list of the articles excluded and the reasons for exclusion appears in **Appendix 1** (see appendix at the end of the article). 2) The study examined ECC specifically and not dental caries of the whole primary dentition. For the purposes of this review, an article was included if the authors defined ECC as decay of the deciduous maxillary incisor teeth, rampant caries, nursing caries, early childhood caries or decay, or rampant early childhood dental decay. The problems associated with inconsistency in case definition among studies have been investigated previously.¹⁶ 3) The study examined pacifier use (prolonged or short-term and with or without sweetening) as a *separate* potential risk factor for ECC. 4) The study design was a randomized controlled trial, a cohort study, a case-control study or a cross-sectional study. 5) Odds ratios were reported or could be calculated from the findings presented.

Validity Instrument

The 8 articles that were deemed relevant¹⁷⁻²⁴ were then scored according to a "checklist for assessing causation"

Table 1 Checklist for assessing causation for each relevant article²⁵

General questions
1. Was the study ethical?
2. Was a strong design used to assess causation or risk?
3. Were the cases validly defined and reliably measured?
4. Were the risks validly defined and reliably measured?
5. For diseases with multifactorial risks, did the assessment of risks control for potential confounding factors, and did the model have strong power of prediction?
6. Do the findings meet the tests for causation? (use questions below)
Questions about causation related to noninfectious agents
1. Did the purported cause precede the effect?
2. Was the estimate of risk beyond chance, and was it large?
3. Was there a dose-response relationship?
4. Was reversibility demonstrated?
5. Was the purported cause consistently observed in different times and places?
6. Is the purported cause biologically plausible?
7. Is the purported cause specific to that disease?
8. Is the purported cause analogous to another established disease or exposure?

developed by Leake²⁵ (**Table 1**). The highest possible score was 13.

Results

The 8 relevant studies came from different countries (**Tables 2** and **3**). None of the studies achieved a score greater than 6 out of the maximum 13, and hence none was considered to present strong evidence. Two of the studies controlled for potential confounding factors (**Table 2**), and the evidence they presented was considered stronger than that presented in the other 6 articles (see **Table 3** at the end of the article).

Petti and others¹⁷ and Serwint and others¹⁸ presented slightly stronger evidence in their investigation of the relationship between pacifier use and ECC. Both studies used logistic regression to control for a variety of confounding variables, including babies' nocturnal use of a bottle, socio-economic status, maternal education and maternal number of caries, but failed to meet some other criteria in the "causation checklist." The findings (odds ratios < 1) suggested that use of a pacifier (even with sweetening in the study by Petti and others¹⁷) may have a mildly protective effect, but the differences were not statistically significant.

The remaining 6 studies (**Table 3**) presented inconsistent findings. The odds ratios for these studies (calculated by the author of this review, but not reported in the studies themselves) were generally large, which suggests that pacifier use was a moderate to strong risk factor for ECC. However, closer examination revealed that many of the findings were not beyond chance. Furthermore, the odds ratios were unadjusted, so this measure of association

Table 2 Studies presenting slightly stronger evidence of the relationship between pacifier use and early childhood caries (ECC)

Authors (and study design)	Population	Prevalence of ECC (%)	Variables investigated	Type of dental examination and calibration or reliability	Condition recorded, definition of condition and definition of caries	Characteristics of pacifier use recorded	Control of confounding variables	Odds ratio and general conclusions
Petti and others ¹⁷ (case-control)	Randomly selected children 3 to 5 years old attending kindergartens in Rome, Italy, in 1996 (n = 1,494)	7.6	Clinical, microbiological and demographic factors; nutritional status and infant and child feeding and rearing practices; oral hygiene; exposure to fluoride	Three clinical examiners calibrated to known standard (= 0.83–1.00)	Rampant early childhood tooth decay, defined as 2 or more affected primary maxillary incisors; caries defined according to WHO diagnostic criteria	<ul style="list-style-type: none"> • Past and present use • Duration of regular pacifier use • Daytime use • Nocturnal use • Sweetening • Nocturnal sweetening 	Ordinal logistic regression	0.4 (95% CI 0.06–2.6) No significant difference in sweetened pacifier use between caries-free children and those with rampant early childhood tooth decay
Serwint and others ¹⁸ (cross-sectional)	Healthy children 18–36 months old visiting a hospital-based pediatric clinic in California (n = 110)	20	Clinical and demographic factors, infant and child feeding and rearing practices, oral hygiene, fluoride exposure	Visual examination only; clinical examiner calibrated to an undefined standard (sensitivity 100%, specificity 87%)	Nursing caries, defined as affecting one or more teeth, including maxillary central or lateral incisors or primary molars but sparing the mandibular incisors; caries not defined	General use (no details provided)	Logistic regression	0.8 (95% CI 0.2–3.2) ^a No significant difference in pacifier use between caries-free children and those with nursing caries

WHO = World Health Organization, CI = confidence interval.

^a Odds ratio calculated by the author of this review on the basis of results presented in the original reports.

between the specific risk factor (prolonged or short-term use of a pacifier with or without sweetening) and the disease outcome (ECC) may be a result of confounding. Confounding variables represent a source of bias in epidemiological studies and can lead investigators to conclude that the variable in question is causally linked to the disease outcome when it is really the confounder that is having the effect.

Discussion

According to this literature review, the evidence for pacifier use as a risk factor for ECC is generally weak because of inconsistencies in study methods. In particular, the definition of ECC varied among the studies or was not stated; the criteria used to identify carious lesions varied among researchers or were not stated; other factors that might have been causally related to ECC were not consistently examined; the factor of interest in this review, pacifier use,

was inconsistently described among studies, in that the studies did not clearly report duration and frequency of use, past or present use, or use of sweetening; and the age of the children varied among studies. Accordingly, it is difficult to compare the often conflicting and ambiguous results of these studies.

Much of the confusion in the literature surrounds the definition of “sweetened comforter,” which may include a bottle containing sweetened liquid; a pacifier to which a sweet substance has been applied; and miniature, “dinky” or hollow feeders (devices that permit fluid to be sucked into a reservoir fitted to a rubber nipple). Therefore, the role of a sweetened pacifier in the development of ECC cannot be separated from the role of other “sweetened comforters.”

Finally, none of the investigators indicated whether their questionnaires had been pretested, whether there was a

dose–response relationship or whether there was reversibility of causation.

Future research investigating pacifier use as a potential risk factor in ECC should employ stronger study designs. Some of the pitfalls and weaknesses of previous studies could be avoided by implementing the following recommendations.

- Examine the effect of pacifier use separately from the effect of other forms of sweetened comforters, including sweetened bottles.
- Clearly measure and report pacifier use, including duration of use, daytime or nocturnal use and whether the pacifier was sweetened.
- Perform multivariate analyses to control for other relevant variables related to ECC (e.g., oral hygiene practices and bottle use).
- Ensure that the study is ethically reviewed.
- Calibrate examiners to a known standard.
- Use consistent definitions of ECC and state both the definition of ECC used and the diagnostic definition of caries.
- Pretest the questionnaire about pacifier use.
- Employ a strong study design such as case-control or cohort study.

In conclusion, the evidence does not suggest a strong or consistent association between pacifier use and ECC. More studies (with either a cohort or a case-control design) that control for other relevant variables and that clearly investigate the role of the pacifier alone must be conducted before a clear recommendation on this subject can be made. ♦

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Appendix 1 List of articles excluded and reasons for exclusion

Articles	Reason for exclusion
Eronat and Eden 1992; Lo 1985; Wyne and others 1995	Did not present results for both ECC and ECC-free children
Aaltonen 1991; Gizani and others 1999; Janson and Fakhouri 1993; Ollila and others 1998a; Syrrist and Selander 1953	Examination of dental caries in general and not ECC specifically
Aaltonen and others 2000; Beaver 1972; Callanan and Hiner 1987; Davies and others 2001; Dennison 1996; Dilley and others 1980; Douglass 2000; Douglass and others 2001; Farsi and Salama 1997; Febres and others 1997; Grindejford and others 1995; Isokangas and others 2000; Kroll and Stone 1967; Logan and others 1996; Lulic-Dukic and others 2001; Primosch and others 2001; Rosenstein 1966; Rozier 1995; von Gonten and others 1995; Warren and others 2000; Weinstein and others 1996; Weinstein and others 1999; Wendt and Birkhead 1995	Did not discuss pacifier use as a risk factor for ECC
Alty 1998; Cunha and others 2000; Goepferd 1986; Maturu and Cullen 1993; Miller and Truhe 1995; Oppenheim 1996; Schalka and Rodrigues 1996; Sgan-Cohen and others 2001; Wandera 1998	Not a study but a description of infant oral health care
Clerehugh 1993; Levine 1999	Not a study but a commentary on pacifier use
Reisine and Psoter 2001; Turgeon-O'Brien and others 1996; Valaitis and others 2000; Winter 1980	Not a study but a review
Holt and others 1988; Holt and others 1996; Johnsen 1982; Silver 1992; Winter and others 1966; Winter and others 1971; Weinstein and others 1992	Did not specifically isolate pacifier use; pacifiers were grouped with other types of comforters, such as sweet drinks from a feeding bottle, miniature feeders or sucking of digits
Bruerd and others 1989; Kanellis 2000; Tewari and others 1994	Focused on oral health promotion
Jarvinen 1981; Larsson 1972a, 1972b, 1983, 1994; Steckslen-Blicks and Holm 1995	Focused on malocclusion
Thies and Jeris 1981	Could not be located
Ollila and others 1997	Focused on microbes and pacifier use
Ollila and others 1998b	Abstract of an excluded study
Oulis and others 1999	Odds ratio could not be calculated

ECC = early childhood caries.

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Table 3 Studies of the relationship between pacifier use and early childhood caries (ECC) with weaker evidence

Authors ^a	Population	Prevalence of ECC (%)	Variables investigated	Type of dental examination and calibration or reliability	Condition recorded, definition of condition and definition of caries	Characteristics of pacifier use recorded	Odds ratio and general conclusions ^b
James and others ¹⁹	Children 8–47 months old attending Eastman Dental Hospital, University of London, London, UK (<i>n</i> = 245)	24	Clinical and demographic factors, infant and child feeding and rearing practices, oral hygiene, medical history of child and mother while pregnant	Single examiner; details of examination and calibration not stated	Labial caries (not defined); definition of caries not provided	Use of various sweetening substances	8.4 (95% CI 3.7–19.0) Significant difference in use of sweetened pacifier between caries-free children and those with “labial caries”
Robinson and Naylor ²⁰	Children 5 years old visiting a dental department, United Kingdom (<i>n</i> = 110)	54	Limited demographic information, infant and child feeding and rearing practices, oral hygiene, medical history	Use of mirror and sharp probe; calibration of examiner not stated	Carious upper incisors (not defined); caries defined as obvious caries or areas of discoloration in which the probe would stick	Dummy use	3.1 (95% CI 1.1–9.4) Significant difference in pacifier use between caries-free children and those with “carious upper incisors”
Goose ²¹	Children 1–2 years old from 3 local authorities in the UK (<i>n</i> = 309)	6.8	Limited demographic information, infant and child feeding and rearing practices	Visual examination only by multiple examiners, including nondental health visitors; calibrated with reference to 2 photographs (one showing mild decay and the other advanced decay)	Caries of incisors (not defined); definition of caries not provided	Use of various sweetening substances Daytime use of pacifier	<ul style="list-style-type: none"> • 4.0 (95% CI 0.7–94.1) for use of pacifier with vitamin syrup • 1.2 (95% CI 0.6–16.1) for use of pacifier with honey, syrup or sugar • 1.3 (95% CI 0.4–4.2) for use of plain pacifier No significant difference in use of plain or sweetened pacifier between caries-free children and those with “caries of the incisors”

Table 3 Continued

Authors ^a	Population	Prevalence of ECC (%)	Variables investigated	Type of dental examination and calibration or reliability	Condition recorded, definition of condition and definition of caries	Characteristics of pacifier use recorded	Odds ratio and general conclusions ^b
Goose and Gittus ²²	Children 1–2 years old in England and Wales (n = 5,550)	5.9	Demographic factors, infant and child feeding and rearing practices	Visual examination only by trained health visitors; calibrated with reference to photographs	Caries of labial surfaces of front teeth, defined as “defective” front teeth; definition of caries not provided	Use of various sweetening substances	<ul style="list-style-type: none"> • 4.1 (95% CI 1.9–9.0) for use of pacifier with vitamin syrup • 1.1 (95% CI 0.7–1.6) for use of plain pacifier or pacifier with “other things” <p>Significant difference between groups for pacifier dipped in vitamin syrup but not for plain pacifier or pacifier with other substances</p>
Silver ²³	Children 3 years old attending a welfare clinic in Bishop's Stortford, UK (n = 263)	8	Demographic factors, infant and child feeding and rearing practices, oral hygiene, exposure to fluoride, medical history of child and mother while pregnant, first dental visit	Use of a probe under standard illumination; calibration of examiner not stated	Rampant caries, defined as one or more affected incisors; caries recorded when a lesion was visually apparent, a cavity had a detectably softened floor or probe became stuck under gentle pressure	Sweetened and plain dummy use	<p>5.7 (95% CI 0.4–16.1)</p> <p>No significant difference in use of sweetened or plain pacifier between caries-free children and those with rampant caries</p>
Holt and others ²⁴	Children 12–59 months old attending maternal and child welfare clinics in Camden and Islington Area Health Authority, UK (n = 555)	2–4	Demographic factors, infant and child feeding and rearing practices, oral hygiene	Visual examination only; examiners calibrated to an unnamed standard (r = 0.83)	Rampant caries, defined as labial or palatal carious lesions involving 2 or more maxillary incisors; caries diagnosed on the basis of a visible cavity in which dentin appeared to be involved	Dipped dummy use	<p>13.4 (95% CI 3.1–57.6)</p> <p>Significant difference in use of sweetened pacifier between caries-free children and those with rampant caries</p>

CI = confidence interval.

^a All studies had a cross-sectional design.

^b Odds ratios calculated by the author of this review on the basis of results presented in the original reports.