A B S T R A C T

This systematic review investigated the relationship between early childhood caries (ECC) and breastfeeding. The systematic review methodology used by the Cochrane Collaboration was modified and adopted for this review. 28 of 151 articles (18.5%) were relevant for the study and were rated as strong (0), moderate (3), weak (9) or very weak (16). Validity scores indicated whether a study met the reviewer's criteria for research rigour. The percentage of studies that received a passing score for each criterion examined were: study design (3.6%), confounders (21%), data collection method (54%), definition of ECC (57%), dental health practices (28%) and infant feeding practices (4%). A lack of methodological consistency related to the study of the association of breastfeeding and ECC, and inconsistent definitions of ECC and breastfeeding, make it difficult to draw conclusions. Moderate articles indicate that breastfeeding for over one year and at night beyond eruption of teeth may be associated with ECC. Due to conflicting findings in less rigorous research studies, no definitive time at which an infant should be weaned was determined, and parents should begin an early and consistent mouth care regime.

A B R É G É

L'étude porte sur la relation entre les caries du jeune enfant (CJE) et l'allaitement. Elle se fonde sur une version modifiée de la méthode d'étude méthodique du Centre de collaboration Cochrane. Nous avons sélectionné en fonction de leur pertinence 28 articles sur 151 (18,5 %) et nous leur avons attribué un indice de validité – élevé (0), moyen (3), faible (9) ou très faible (16) – en fonction de critères de rigueur analytique établis au préalable. Les critères examinés (et le pourcentage d'articles ayant obtenu la note de passage à leur égard) étaient les suivants : conception de l'étude (3,6 %), facteurs confusionnels (21 %), méthode de collecte des données (54 %), définition des CJE (57 %), pratiques de santé dentaire (28 %) et pratiques d'alimentation du nourrisson (4 %). En raison du manque d'uniformité méthodologique dans l'étude de la relation entre l'allaitement et les CJE, ainsi que des variantes dans les définitions de ces deux concepts, il a été difficile de tirer des conclusions. Les articles pondérés semblent établir un lien entre les CJE et l'allaitement nocturne pendant plus d'un an, après la poussée des dents. Les constatations des études moins rigoureuses sont contradictoires. Vu cette ambiguïté, nous ne recommandons aucun moment précis où sevrer les nourrissons, mais nous encourageons les parents à entreprendre un régime précoce et régulier de soins de la bouche.

A Systematic Review of the Relationship Between Breastfeeding and Early Childhood Caries

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The purpose of this systematic review was to investigate the relationship between breastfeeding and early childhood caries (ECC). The review was initiated when dental, nutrition and nursing professionals at the Hamilton-Wentworth Regional Social and Public Health Services Division were giving contradictory recommendations to the public on the practice of "night-time" and prolonged breastfeeding. The dental and nutrition staff prepared a brief article for the local newspaper related to the prevention of ECC, recommending "to try to wean your child off night time feedings and offer plain tap water as an evening drink if a beverage is required." This message was consistent with the position statement of the American Academy of Pediatric Dentistry (AAPD) which recommends that "ad libitum nocturnal breastfeeding should be avoided after the first primary tooth begins to erupt".¹ However, public health nurses (PHNs) were providing information which encouraged unrestricted breastfeeding up to and beyond two years of age, based on guidelines from the WHO and Health Canada's Breastfeeding Committee of Canada.^{2,3} It was clear that there was a need to address this inconsistency.

The AAPD states that:

The risk of potentially devastating nursing-pattern dental decay exists for the breast-fed child as it does for the bottle-fed child, and is related to extended and repetitive feeding times with prolonged exposure of erupted teeth to fermentable carbohydrates without appropriate oral hygiene measures...Parents should be encouraged to have infants drink from a cup as they approach their first birthday. Infants should be weaned from the bottle at 12-14 months of age.¹

"Prolonged exposure" is not defined and the terminology around "weaning" is also open to interpretation. Dental professionals have the perception that "weaning" from the breast or the bottle should have commenced by the first birthday;⁴ frequent and prolonged breastfeeding should be discouraged; and that on-demand breastfeeding is implicated in the development of caries and should be discouraged.^{1,5-9}

Breastfeeding position papers aim to support, promote, and protect breastfeeding. The Forty-seventh World Health Assembly (WHA)² encourages exclusive breastfeeding for the first six months. Health Canada's Breastfeeding Committee of Canada and the WHA^{2,3} recommend continuing breastfeeding with complementary foods from six months to two years or more, while the Canadian Pediatric Society (CPS) recommends that breastfeeding may continue for up to two years and beyond with complementary foods introduced at four to six months.¹⁰ Breastfeeding position papers tend not to address dental health issues.^{2,3,11-13} The CPS position paper¹⁰ on nutrition for healthy term

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infants contains a dental caries prevention section that emphasizes fluoride and the avoidance of excessive use of bottles and any use of sweetened pacifiers. However, it contains no information related to breastfeeding and caries.

Consistent recommendations, based on strong research evidence, must be developed surrounding this issue. Historically, dental, nutrition and nursing health professionals have worked in isolation from one another on this topic. The multidisciplinary approach used in this review demonstrates a collaborative model of research that can well address this cross-disciplinary public health issue.

PURPOSE

This study was undertaken to investigate the following questions:

1. What is the current quality of the literature regarding the relationship between ECC and breastfeeding?
2. What is the association between breastfeeding beyond eruption of primary dentition and ECC?
3. Does breastfeeding duration of any length have an effect on the development of ECC?

LITERATURE REVIEW

Although dental caries rates in children have fallen dramatically over the past twenty years in North America and Northern Europe, the importance of a healthy primary dentition cannot be overstated.¹⁴ Apart from the job of initiating the digestion of food, primary teeth serve multiple roles such as preserving adequate spacing for secondary teeth, assistance in the development of early speech, and contributing to the development of healthy social skills and confidence. Of particular concern is the group of very young children who suffer from the condition known as "Early Childhood Caries" (ECC), also referred to in past literature as "Baby Bottle Syndrome" or "Infant Feeding Caries". It is of interest to note that the earlier labels implied causation. ECC can affect the child's ability to sleep, concentrate and eat. Chronic infection around the tooth-buds of the developing

TABLE I Steps in this Systematic Review	
1.	Defined research questions.
2.	Search Strategy Key words used in the search included: dental caries, infant or child, preschooler or child, breast feeding or breastfeeding. Potentially relevant journal articles, chapters, abstracts, and press releases were identified, retrieved and reviewed. Four strategies were used. <ol style="list-style-type: none"> a. A search of electronic bibliographic databases including MEDLINE, CINAHL, Biological Abstracts, and Social Science Index was conducted for the years 1980 to 1996. b. Documents that related to ECC and any aspect of infant feeding based on its title or abstract were pulled. c. Key informants working in the field of both dentistry and breastfeeding promotion were contacted to ensure completeness of the literature for the study. d. Reference lists from articles rated as relevant (see criteria below) were identified, retrieved and reviewed.
3.	Relevance Criteria for relevance were established. An article was determined relevant if it included the following: <ol style="list-style-type: none"> a. it consisted of primary research (i.e., not case studies or review articles) b. it included "early childhood caries" and "breastfeeding" as variables investigated in the article c. the study population included children who were 0 to ≤ 4 years; or a subset of children within this age group (i.e., a population 2-6 years) d. the study design was a cohort, cross-sectional, case-control or case series.
4.	Articles were reviewed for relevance.
5.	Inter-rater reliability of relevancy ratings was determined since more than one reviewer was used.
6.	Validity Tool A dictionary was created to include all items in each category of the validity tool (see below) in order to promote consistency in ratings.
7.	Validity Rating All articles were rated for each category in the validity tool. Categories and examples of items in each include: <ol style="list-style-type: none"> a. Study design (included: cohort, cross-sectional, case-control, case series) b. Confounders (included 9 variables, plus other category, e.g., age, gender, ethnicity, health status, socioeconomic status) c. Data collection method (included 6 variables, e.g., description of tools, pretesting of tools, use of self report, assessment/ screening tools pretested for validity, reliability) d. Definition of ECC (included: age of child, number of teeth, involvement of anterior teeth, sites of lesions) Investigation of relevant variables associated with caries including: <ol style="list-style-type: none"> e. Dental health practices (included 6 variables, e.g., frequency and method of cleaning, use of chemotherapeutic agents, fluoridation) f. Infant feeding practices (included 15 variables, e.g., breastfeeding duration, demand breastfeeding, breastfeeding during the night, solid foods, sweetened pacifier, formula use).
8.	Determined inter-rater reliability of validity ratings between reviewers.
9.	A score was assigned for each category (pass, fail) according to determined criteria (e.g., Early Childhood Caries received a pass if at least 3 of the 4 factors were described).
10.	Determined overall rating of the paper based on the results from category ratings (Strong articles passed on 5-6 categories and could not have obtained any fail ratings in the criteria for study design; moderate articles passed on at least 4 categories; weak articles passed on 2-3 categories; very weak passed on 1 or less categories).

permanent dentition can cause hypoplasia (a particular type of malformation of tooth enamel) of the developing teeth. In Ontario, it is estimated that over \$13 million is spent on the treatment of ECC annually.⁶

The health and economic benefits of breastfeeding in both developing and developed countries have been extensively documented.¹⁵⁻¹⁸ Research has also shown that protection against certain diseases appears to be related to duration of breastfeeding, including: otitis media, diarrhea, insulin dependent diabetes, and lymphoma. Increased intelligence in breastfed children has also been associated with longer duration of breastfeeding.^{18,19}

Despite the evidence of the benefits of continued breastfeeding, Health Canada reports that while 80% of Canadian women choose to breastfeed, only 30% continue breastfeeding for up to six months.²⁰

Many case study findings have been cited in the literature to support a causal relationship between breastfeeding and ECC^{6,7,21} or that prolonged breastfeeding (past 12 months) is related to ECC development.²²⁻²⁴ Case studies were not included here, since findings from individual cases cannot be generalized to the larger population. Many report on a sample size of one and are methodologically very weak.

METHODS

The internationally recognized systematic review methodology used by the Cochrane Collaboration is outlined in detail in the Reviewers' Handbook for systematic reviews.²⁵ The Cochrane systematic reviews provide direction for reviews of controlled trials. As this clinical research topic cannot be measured using randomized controlled trials (where randomly allocating children in breastfed versus non-breastfed groups is inappropriate), modifications were made to the review process.

The methodology of the steps of this systematic overview are detailed in Table I. Research literature related to the topic was located using methods outlined under "Search Strategy". Measures of infant feeding likely address breastfeeding, therefore articles that mentioned infant feeding were retrieved. The above strategy yielded 151 documents deemed "*potentially relevant*".

To be rated as relevant, the article had to measure both ECC and breastfeeding as well as meet other criteria outlined in Table I. Two readers independently rated 20 randomly selected articles for relevance and obtained a high level of agreement (Kappa of 0.9). Remaining articles were then divided equally among two readers and were rated independently. Of the 151 articles that were retrieved, 28 were judged to be relevant.

The articles (n=28) were then rated for their quality or validity (Table I). Validity (quality) considers the extent to which the design and conduct of the study are likely to bias the results.²⁶ In this review, validity criteria were modified to exclude criteria related to controlled trials including blinding of researchers. The tool included appraisals of study design, confounders, and data collection methods as per the Cochrane systematic review protocol. Three other categories of confounding

variables included: infant feeding variables, ECC definition, and dental health practices.

Rationale for inclusion of these variables are illustrated in the authors' model of the interrelationship of factors in the development of ECC, including the factors: breastfeeding, individual and community risk factors (Figure 1). The unknown effect of breastfeeding on the development of ECC is noted under breastfeeding factors. Under the individual risk factors, bacteria, host resistance (teeth which have the potential to develop caries), substrate (factors that support oral bacteria to form acids causing caries, such as fermentable carbohydrates) and time reflect individual variables that must be present for the development of caries. Community risk factors such as education level, socioeconomic status and gender have also been shown to be related to caries development and were considered confounders in this review.

The validity tool underwent three formal pretests, with modifications following each application of the tool. Once finalized, each of the 28 articles was independently reviewed and rated by two readers according to pass-fail criteria for each category. A detailed dictionary was used to ensure consistency in understanding of terms and ratings. The readers achieved a high level of agreement for validity ratings (Kappa = 0.9). Four overall ratings for each article, including strong, moderate, weak and very weak, were assigned based on the pass-fail criteria for each of the categories (Table I). Very weak was included as an overall rating, due to the high number of weak papers. The authors felt that it would be important to distinguish between them as they made up the bulk of the papers.

RESULTS

Studies came from a variety of different countries and represented many cultural groups. None of the 28 articles were considered to be strong. Three (11%) were rated as moderate,²⁷⁻²⁹ 9 (32%) were weak,³⁰⁻³⁸ and 16 (57%) were very weak.³⁹⁻⁵⁴ Of the total articles reviewed, 24 (86%) articles used a case-control design, 3 (11%) used a case-series and 1 (4%) utilized a cross-sectional approach. Six (21%) of the articles passed controlling for at least four relevant confounders (Figure 2). Fifteen (54%) articles met the criteria for data collection. Twenty-seven articles (96%) used a self-report for data collection which was well described in 13 cases (48%). However, only 2 (7%) studies pretested their self-report collection tools. Twenty-seven (96%) articles used a clinical examination in their assessment. Twenty-one (78%) of these described their screening tool well and 6 (21%) pretested it.

The definition of infant caries was most consistently addressed, with 16 articles (57%) meeting 75% of the criteria required to pass in this category (Figure 3). One study passed the infant feeding category.²⁸ Bottle-feeding duration (68%) and breastfeeding duration (64%) were most often measured. Research papers often failed to include other key variables such as: breastmilk in a bottle, definition of “exclusive breastfeeding”, and “demand”

Figure 2. Confounders described in studies (n=28)

Figure 3. ECC definition: Variables described in studies (n=28)

breastfeeding (Figure 4). The dental health practice category was similarly poorly addressed with 6 (28%) articles achieving a pass by addressing at least four out of the six factors. Variables often absent included: frequency of teeth cleaning, who is cleaning the child's teeth, use of chemotherapeutic agents, and length of time cleaning teeth (Figure 5).

As there were no articles of strong quality, only findings from articles rated as moderate and weak are presented here. All three

moderate articles failed to be rated ‘strong’ as a result of lack of rigor in their study design. All three were case-control (retrospective) studies. With a varied degree of confidence, all indicated that there appears to be a positive association between prolonged breastfeeding and the development of caries, nursing caries syndrome, or ECC.^{*27-29} Prolonged breastfeeding was

* Detailed tables can be obtained from the corresponding author.

Figure 4. Infant feeding practices: Variables described in studies (n=28)

Figure 5. Dental practices described in studies (n=28)

defined either as greater than six months²⁸ or greater than one year.^{27,29} The practice of “at night, at will” or “night time and nap time” breastfeeding was also associated to ECC.^{27,28} Two studies were conducted in Canada, one of which involved only children of Asian descent;²⁹ the third study originated in Kuwait.²⁷ All three relied on parent interviews to collect dental health and feeding practices information.

Many of the weak articles found that children who were breastfed for longer

than one year had increased caries.^{29,31,38} Wendt and Birkhed³⁸ found that when comparing three-year-old children with and without caries, those with caries were more likely to have been breastfed for less than 2 months or greater than 12 months. While some studies found associations with ECC and the length of time a child was breastfed, many studies found no associations between the two variables.^{30,33,35,37} Some papers stated that children who were breastfed had an advantage, with more of

them being caries free as compared to children who were bottle-fed.^{32,33,36}

Of the 12 moderate and weak studies combined, 2 recommended that breastfeeding should be discouraged after 12 months of age and children should be encouraged to use a cup at this time, or even earlier.^{29,31} Many research studies cited a need to educate mothers or health professionals concerning the need to stop breastfeeding after 12 months and the possible risk factors associated with breastfeeding and ECC.^{27,28,30} Some authors suggest that it is not the practice of breastfeeding in itself that causes ECC, but rather factors such as the child’s dietary habits and the parents’ infant rearing practices.³⁸ However, Silver³⁶ supports and encourages breastfeeding as a preventive measure against ECC.

DISCUSSION

The results of this systematic overview indicate that the overall state of the research quality related to ECC and breastfeeding is relatively weak. The inconsistent methodological approach in the research makes it difficult to compare findings and draw definitive conclusions. The results from these studies often contradict one another and findings are not always reproducible from one study to another. It is difficult to compare variables between studies as they are often poorly and inconsistently defined. In addition, key breastfeeding variables (e.g., demand breastfeeding, breastfed only, night-time feeding) are often ambiguous or not defined at all. Other important variables such as the use of sweetened pacifiers are similarly equivocal.

The three moderate studies suggest that breastfeeding for longer than one year and night-time breastfeeding beyond primary dentition are associated with some form of ECC.* However, all three studies evaluated their data based on different ECC definitions.²⁷⁻²⁹ In contrast, some of the more poorly rated studies show no association between ECC and breastfeeding, while others suggest that breastfeeding may have a protective effect.^{35,36,39}

* Detailed tables can be obtained from the corresponding author.

We know there are numerous community and individual factors associated with ECC as indicated in the model (Figure 1). We proposed at the start of the paper to elucidate the breastfeeding factors; however based on this review, we have made little progress. In light of the contradictory nature of the research findings, and the weak methodology found in this systematic review, we conclude that the evidence remains equivocal. The evidence does not suggest a consistent and strong association between breastfeeding and the development of ECC. Thus practice recommendations related to breastfeeding promotion are:

- The current research examining the relationship between IFC and breastfeeding is equivocal.
- There is no right time to stop breastfeeding. Women should be encouraged to continue breastfeeding as long as they wish.
- Consistent public messages regarding breastfeeding and IFC need to be developed based on rigorous research studies.

Only one study found in this review addressed the association between ECC and breastfeeding as its primary research purpose. Thus it is suggested that future research be conducted with this as the principal goal to ensure the use of rigorous research methods. As supported by Ismail and Sohn,⁵⁵ we recommend that future researchers use consistent definitions of ECC. Infant feeding practices also need clear measures. Studies should control for other relevant variables related to ECC (e.g., dental health practices). Research protocols need to be strengthened to include more rigorous study designs including: measurements of all validity criteria described in this review, as well as the use of a prospective study design to help reduce recall bias in parents' reports of their children's dental health and feeding practices. Finally, interdisciplinary research teams could help to enhance the understanding of the multi-factorial analysis of this complex relationship and could contribute to the development of relevant practice implications that are consistent for all disciplines involved in infant and child health.

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utilisé depuis peu, met en relief l'urgence du traitement des AVC. Cependant, tous les prestataires de services d'urgence ne considèrent pas ces accidents comme nécessitant une attention urgente.⁷ C'est pourquoi le délai entre les premiers symptômes et l'arrivée à l'hôpital peut être plus long que celui jugé acceptable pour d'autres états pathologiques comme les infarctus aigus du myocarde ou les traumatismes.⁸

Même sans la technologie et les agents nouveaux, les études permettent de croire que les vérifications de la température corporelle, de la non-obstruction des voies aériennes, de la respiration et de la présence de troubles épileptiques, la compensation pour l'affaiblissement de la circulation et la réadaptation précoce des patients d'AVC, si elles sont utilisées à temps et correctement, sont bénéfiques pour les patients.⁹ Nous devons donc revoir notre attitude actuelle face aux AVC et notre mode de gestion de ces accidents, qu'il faut traiter comme des urgences. Pour que les technologies et les traitements nouveaux soient efficaces, nous devons établir des unités spéciales pour les AVC, les doter d'une approche de soins globale et unifiée, puis implanter ces unités dans tout le pays.

La prévention et la gestion des AVC au Canada nécessitent un leadership vigoureux de la part des intervenants des sciences de la santé. Pour que les pratiques cliniques changent, il faut commencer par sensibiliser les professionnels à l'urgence du problème et modifier la structure et la prestation des services. Parallèlement, il faut renseigner le grand public. Tous ces changements peuvent être apportés avec la coopération et la collaboration des cliniciens, des décideurs, des régimes de soins de santé locaux, provinciaux et national, ainsi que du public.

De premiers pas ont déjà été faits en ce sens : au palier national, le Laboratoire de lutte contre la maladie de Santé Canada, la Fondation des maladies du cœur du Canada et la *Canadian Stroke Society* ont formé la coalition Systèmes pour accidents vasculaires cérébraux,¹⁰ qui se veut le fer de lance de la mise au point d'une approche nationale et coordonnée qui permette de gérer les AVC de façon globale et intégrée au Canada.³ On vient aussi de fonder le Réseau canadien contre les accidents cérébrovasculaires, dans le cadre du programme fédéral Réseaux de centres d'excellence. Ce programme de recherche de plusieurs millions de dollars doit renforcer les liens entre les scientifiques, les cliniciens, la Fondation des maladies du cœur du Canada, l'industrie et les ministères provinciaux de la Santé afin d'élaborer de nouvelles approches coordonnées de guérison et de réadaptation des survivants d'AVC au Canada.

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