



Breastfeeding and early childhood caries: are they associated?

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Abstract

Introduction and objectives: there is debate whether prolonged breastfeeding is a risk factor for caries. Breastfeeding, recommended for at least two years, has been associated with several benefits, including in oral health. We reviewed the literature on the subject, and present the results observed in the cohort under study.

Methods: study conducted in a prospective, open-enrolment and multipurpose cohort of children aged 4-5 years, whose parents completed a self-administered questionnaire regarding diet and lifestyle habits. We performed a retrospective analysis of the prevalence of caries based on the duration of breastfeeding. We adjusted the analysis by age, sex, race, parental knowledge and attitudes, total energy and sugar intake and adherence to the Mediterranean diet.

Results: the sample included 370 children, of who 50 had developed caries. Breastfeeding up to 12 months was associated with a lower risk of caries, but breastfeeding longer than 12 months was associated with an increased risk (OR 2.75; 95 IC: 1.397 - 5.44; $p = 0.003$). The total energy and sugar intakes were not significant confounders in the association under study. Adherence to the Mediterranean diet may have a protective effect, but more research is needed to confirm it.

Conclusions: we found a significant direct association between breastfeeding for more than 12 months and the prevalence of caries. However, breastfeeding for less than 12 months had a protective effect. Our findings were consistent with the previous literature.

Key words:

- Breastfeeding
 - Caries
 - Child
 - Cohorts
- Early childhood

Lactancia materna y caries dental infantil: ¿tienen alguna relación?

Resumen

Introducción: existe controversia sobre si la lactancia materna (LM) prolongada puede ser un factor de riesgo de caries. La LM se recomienda hasta al menos los dos años y tiene demostrados beneficios sobre la salud, incluida la bucodental. Repasamos la evidencia científica y presentamos los resultados de nuestra cohorte.

Métodos: cohorte prospectiva, abierta y multipropósito de niños de 4-5 años, cuyos padres responden a cuestionarios autorreferidos acerca de hábitos nutricionales y estilo de vida. Análisis retrospectivo de prevalencia de caries según duración de LM. Ajustamos por edad, sexo, raza, conocimientos nutricionales y actitudes dietéticas de los padres, adhesión a la dieta mediterránea, ingesta energética total y de azúcar.

Resultados: se alcanzó un tamaño muestral de 370 participantes, 50 de los cuales había tenido, al menos una caries. La LM hasta los 12 meses se asociaba con un menor riesgo de caries, pero la LM de más de 12 meses se asociaba con un riesgo mayor (*odds ratio* [OR]: 2,75; intervalo de confianza del 95% [IC 95]: 1,397 a 5,44; $p = 0,003$). La ingesta energética total o la de azúcar no resultaron ser confusores importantes para la asociación estudiada. La adhesión a dieta mediterránea puede tener un efecto protector, hace falta más investigación al respecto.

Conclusiones: existe una asociación directa estadísticamente significativa entre de más de 12 meses y el riesgo de caries. Sin embargo, la LM hasta los 12 meses es un factor protector. Los resultados obtenidos son consistentes con la literatura médica existente.

Palabras clave:

- Caries dental
 - Cohortes
- Lactancia materna
 - Niño
 - Preescolar

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INTRODUCTION

Dental caries is currently the most frequent chronic disease in the paediatric age group, with a high prevalence in early childhood. In Spain, 31% of children aged less than 6 years have caries, which corresponds to decay in 7 million deciduous teeth.¹ Dental caries is considered a sugar-dependent infectious disease. In fact, most dental associations continue to include on-demand or nocturnal bottle feeding or breastfeeding (BF) among the risk factors for dental caries.²

The association between BF and caries is a highly controversial subject. The World Health Organization (WHO) and the Asociación Española de Pediatría (Spanish Association of Pediatrics, AEP) recommend exclusive BF in the first 6 months of life, with continued BF combined with other foods through age 2 years or longer.^{3,4} However, some professionals recommend earlier BF cessation with the rationale that it increases the risk of tooth decay. For this reason, the Committee on Breastfeeding of the AEP issued a statement in 2015 that underscored the lack of scientific evidence supporting an association between BF and caries.⁵ Furthermore, there is robust evidence of the health benefits of BF, including in oral and dental health.⁷⁻¹⁰ Other associations have stated the same position. According to the Sociedad Española de Ortodoncia (Spanish Society of Orthodontics), it is poor oral hygiene when the child already has teeth, and not BF, that may result in the development of caries. In addition, BF contributes to the development of the masticatory system, prevents oral habits that deform the mouth (such as thumb and finger sucking) and prevents dentomaxillofacial abnormalities and malocclusion.¹¹⁻¹³ The La Leche League has also published a statement declaring that while BF is the best option for oral health, breastfed children may also develop caries, even if BF is not the cause, and therefore it is important to implement the available strategies to prevent or reduce tooth decay.¹⁴

The most recent scientific evidence demonstrates that BF has a clear protective effect against early

childhood caries (ECC) when it is maintained through age 12 months. However, after age 1 year, BF does seem to be associated with an increased risk of caries.¹⁵ Specifically, we found evidence from 5 systematic reviews with meta-analyses. Ávila *et al.* (2015) concluded that BF may protect against caries in early childhood, but BF past age 12 months could be associated with an increased risk of ECC.¹⁶ Tham *et al.* (2017) found an increased risk of ECC when BF was maintained past age 12 months (odds ratio [OR], 1.99; 95% confidence interval [95 CI]: 1.35 to 2.95) compared to BF discontinued by age 12 months, and, in children BF past age 12 months, an increased risk in children BF at night or more frequently (OR: 7.14; 95 CI: 3.14 to 16.23).¹⁶ Angelika Kobyli *et al.* (2017) considered that the time when BF starts to be associated with an increased risk of ECC cannot be established with precision, but that once the maxillary incisors start to erupt, it would be prudent to recommend avoiding BF at night and before daytime naps and toothbrushing after feedings.¹⁸ Cui *et al.* (2017) found a decreased risk of caries in infants that had been breastfed at all compared to infants that were never breastfed (OR: 0.77; 95 CI: 0.61 to 0.97; $p = 0.026$), although in the analysis by subgroups, children that had been breastfed for 12 months or longer the risk of caries increased significantly compared to children that have been breastfed less than 12 months (OR: 1.86; 95 CI: 1.37 to 2.52; $p < 0.001$)¹⁹.

All these reviews highlight the substantial variability in the available evidence and conclude that further research is required to understand the increased risk of caries observed in children breastfed past age 12 months.¹⁶ Factors that need to be considered as potential confounders include socioeconomic status, exposure to fluoride and specific dietary and oral hygiene habits that may play a role in the observed association.²⁰⁻²²

Previous cohort studies have yielded similar results: Peres *et al.* (2017) concluded that children breastfed for 24 months or longer had a 2.4-fold risk of ECC compared to children breastfed for less than 12 months (relative risk [RR]: 2.4; 95 CI: 1.7 to

3.3) and that BF between ages 13 and 23 months did not have an effect on dental caries.²³ The only randomised controlled trial identified in the literature search (Kramer *et al.*, 2007) concluded that the intervention (promotion of BF) did not have an effect on the incidence of caries.²⁴

The aim of our study was to analyse the current prevalence of dental caries in children aged 4 to 5 years and its association with the feeding modality during infancy: BF versus formula feeding (FF) and duration of BF. The most important confounders considered in the analysis were sugar intake and adherence to the Mediterranean diet, which we assessed with the KIDMED questionnaire.

MATERIAL AND METHODS

Sample

The SENDO project (Seguimiento de Escolares Navarros para un Desarrollo Óptimo [Longitudinal Study of Schoolchildren in Navarre for Optimal Development], www.proyectosendo.es) is a prospective, dynamic and multi-purpose paediatric cohort study initiated in Navarre in 2015 that uses self-reported data obtained through online questionnaires filled out by parents and children themselves. Recruitment was conducted through primary care paediatricians in health care centres or schools. The inclusion criteria were: 1) age greater than 4 and less than 6 years; 2) residence in Spain and 3) access to the Internet. There were no exclusion criteria.

The data used in this study were obtained from the baseline questionnaires completed by participants recruited from 2015 to June 2019 ($n = 370$).

Variables

The baseline questionnaire (Q0) collects information regarding breastfeeding (including duration), diagnosis of dental caries by a dental professional (including the number), sociodemographic variables (sex, date of birth and race), family and personal habits (parental tobacco use and age of enrolment in childcare centre/school), age at

introduction of specific foods (cow's milk, cereal and sugary drinks), food consumption frequency, and lifestyle habits (physical activity and screen time).

Statistical analysis

We conducted a retrospective analysis of the association of ECC and the duration of BF. We performed a logistic regression analysis to compare the presence or absence of caries based on the duration of BF: less than 3 months, 3 to 6 months, 6 to 9 months, 9 to 12 months, more than 12 months. We also considered the following categories: BF lasting less than 1 month, BF lasting 1 to 12 months, BF lasting more than 12 months.

The analysis was adjusted for age, sex, race, maternal age (continuous variable), adherence to the Mediterranean diet (low, moderate, high), body mass index (BMI, continuous variable), nutritional knowledge and dietary habits (low, moderate, high), total energy intake (tertiles) and sugar intake (tertiles).

We performed the statistical analysis with the software STATA 15.0. We considered p -values of less than 0.05 statistically significant.

Ethical considerations

Participation in the SENDO project is voluntary; most families are informed about the project by primary care paediatricians, and they sign an informed consent form.

The SENDO project has been approved by the Ethics Committee of Navarre under file no. 279 of 27/10/2015.

RESULTS

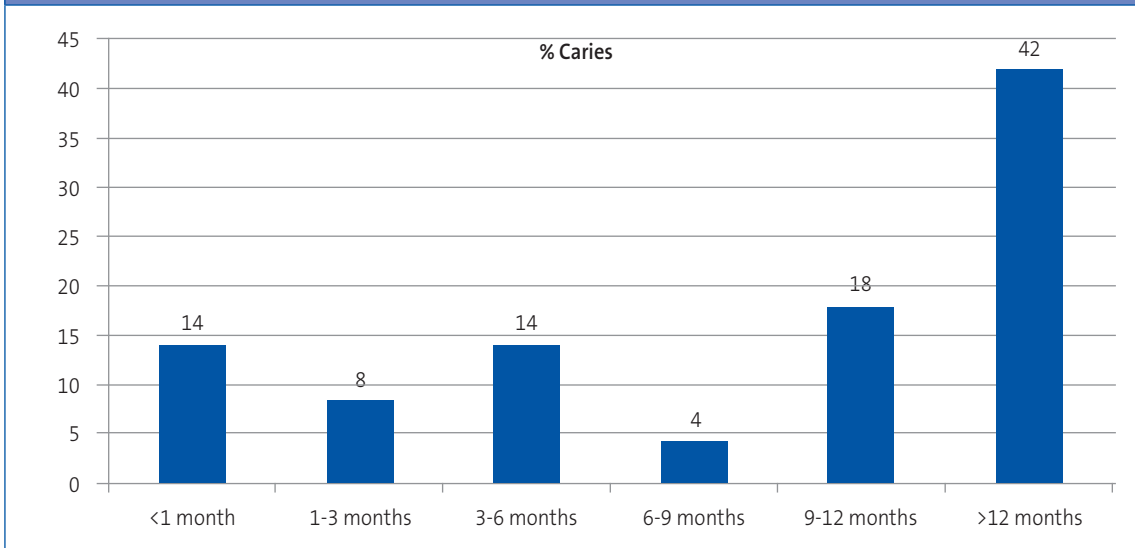
Of the 370 recruited participants, we excluded 35 that did not complete the questionnaire (9.46% loss to followup), resulting in a final sample size of 335. In this sample, 51 participants (15.22%) were fed artificial formula from birth and 284 (84.78%) were breastfed. **Tables 1** and **2** summarise the base-

Table 1. Baseline characteristics of participants. Qualitative variables					
Caries		No (%)		Yes (%)	
Sex	Female	118	41.4	28	56
	Male	167	58.6	22	44
Race	Black	2	0.7	0	0
	Asian	1	0.35	0	0
	White	279	97.89	48	96
	Hispanic/Latino	1	0.35	1	2
	Other	2	0.7	1	2
Paternal educational attainment	No formal education	0	0	0	0
	Compulsory primary and secondary education	21	7.39	7	14
	Vocational training or non-compulsory secondary education	73	25.70	17	34
	Undergraduate degree	133	46.83	17	34
	Graduate degree	57	20.07	9	18
Maternal educational attainment	No formal education	2	0.70	0	0
	Compulsory primary and secondary education	5	1.75	3	6
	Vocational training or non-compulsory secondary education	40	14.04	12	24
	Undergraduate degree	158	55.44	22	44
	Graduate degree	80	28.07	13	26
Candies/sweets	Never or seldom	46	16.67	7	14,58
	2-3 times/month	59	21.38	4	8,33
	Once a week	117	42.39	25	52,08
	2-4 times/week	46	16.67	8	16,67
	(nearly) every day	8	2.90	4	8,34
Adherence to Mediterranean diet	Low (1)	40	14.04	9	18
	Moderate (2)	132	46.32	21	42
	High (3)	113	39.65	20	40
Introduction of sugary drinks <12 months	No	23	8.07	3	6
	Yes	262	91.93	47	94
Dietary knowledge of parents	<40%	51	17.89	12	24
	40-70%	190	66.67	28	56
	>70%	44	15.44	10	20
Attitude of parents regarding food	<40%	30	10.53	5	10
	40-70%	89	31.23	17	34
	>70%	166	58.25	28	56
Breastfeeding	No	44	15.44	7	14
	Yes	241	84.56	43	86

Table 2. Baseline characteristics of participants. Quantitative Variables				
Caries	No		Yes	
	Mean	SD	Mean	SD
Age	4.79	0.74	5.23	0.71
Maternal age	39.41	3.72	38.74	3.90
Age at enrolment in childcare (months)	13.26	8.47	14.6	7.02
BMI (z-score)	0.017	1.09	0.276	1.27
Total energy intake (kcal)	1924.38	489.73	1913.12	466.28
Age at introduction of cow's milk (months)	15.12	6.18	16.64	7.45
Age at introduction of cereal (months)	5.97	3.76	7.24	5.10
Age at introduction of sugary drinks (months)	4.65	6.70	4.08	5.27
Total sugar intake (mg/day)	109.03	22.57	112.14	30.30

BMI: Body mass index.

Figure 1. Prevalence of caries in children aged 4 to 6 years in the cohort based on the duration of breastfeeding (% of total sample)



line characteristics of participants based on whether or not they reported development of caries.

Figure 1 represents the detected prevalence of caries based on the duration of BF. Of all participants, 50 (14.93%) reported having had at least 1 caries diagnosed. The maximum number of caries in a single participant was 13, and the mean number of caries per participant was 2.74 (standard deviation [SD]: 2.46). In the crude model we found a lower prevalence of caries in children breastfed through age 9 months (lowest risk of caries associated with BF duration of 6-9 months) and a higher prevalence associated with longer durations of BF, although the difference was only significant in children breastfed for more than 12 months (OR: 2.6; 95 CI: 1.02 to 6.60; p :0.045) (**Table 3**).

After adjusting for age, sex, race, maternal age, total energy intake and adherence to the Mediterra-

nean diet, we did not find statistically significant differences in the prevalence of caries based on whether participants had been breastfed or not (FF versus BF of any duration), with an OR for the total sample of 1.17 (95 CI: 0.45 to 3.03).

In the analysis by subgroups, we divided the sample into 3 groups: FF or BF lasting less than 1 month ($n = 59$), BF lasting 1 to 12 months ($n = 195$) or BF lasting more than 12 months ($n = 81$). Using the first group as reference, we found a lower risk of caries in the group with BF lasting less than 12 months and greater in the group with BF lasting more than 12 months, although the differences were not statistically significant.

When we compared only BF duration of more versus less than 12 months, we obtained an OR of 2.88 (95 CI: 1.41 to 5.89; $p = 0.004$) for BF longer than 12 months (**Table 3**). When we included chil-

Table 3. Caries based on breastfeeding duration (crude odds ratio)

Duration of breastfeeding	Odds ratio	p	95 CI
1-3 months	0.93	0.911	0.25 to 3.4
3-6 months	0.76	0.635	0.25 to 2.32
6-9 months	0.38	0.245	0.07 to 1.93
9-12 months	1.97	0.219	0.67 to 5.78
>12 months	2.6	0.045	1.02 to 6.61

95 CI: 95% confidence interval

Table 4. Caries in “breastfeeding up to 12 months” group compared to “breastfeeding past 12 months” (adjusted odds ratio)

Breastfeeding	Odds ratio	p	95 CI
Breastfeeding <12 months	1.25	0.658	0.46 to 3.41
Breastfeeding >12 months	2.89	0.004	1.41 to 5.89

IC 95: intervalo de confianza al 95%.

dren that were not breastfed (FF) in the reference group, the association was stronger, with an OR of 2.75 (95 CI: 1.39 to 5.44; $p = 0.003$) (Table 4).

The adjusted analysis identified confounders that could contribute to an increased risk of caries, such as age (OR: 2.13; 95 CI: 1.38 to 3.30; $p = 0.001$) and female sex (OR: 2.23; 95 CI: 1.14 to 4.39; $p = 0.019$), which is probably not relevant, as this association has not been described in the previous literature. We did not find an association between the risk of caries and parental dietary knowledge and attitudes, total energy intake or total sugar intake (Table 5). Adherence to the Mediterranean diet showed a beneficial effect of marginal significance.

DISCUSSION

In this study, we found BF lasting less than 12 months was associated with a decreased prevalence of caries, while BF longer than 12 months was associated with an increased prevalence.

A pathophysiological mechanism that could explain this association is the large number of feedings commonly observed in breastfed children, especially at night, when cleaning the teeth is more difficult and the production of saliva decreases. In fact, Tham found a greater increase in the risk of caries in children that continued to breastfeed frequently or to breastfeed at night from age 1 year.¹⁷ Other authors believe that the risk of tooth decay is associated with genetic or environmental factors unrelated to BF.²⁶ Recent studies support the hypothesis that colonization by *Streptococcus mutans* is responsible for the development of dental caries.^{27,28} Another possible explanation is the potential cariogenicity of hu-

Table 5. Caries in “breastfeeding up to 12 months” group compared to rest of the sample (including formula feeding) and adjustments (adjusted odds ratio)

	Odds ratio	p > z	95 CI
Caries			
Breastfeeding >12 m	2.76	0.003	1.40-5.45
Age	2.13	0.001	1.38-3.30
Sex	2.24	0.019	1.14-4.39
Race	2.38	0.138	0.76-7.48
Dietary knowledge of parents			
Low	0.52	0.122	0.23-1.19
Moderate - high	0.94	0.907	0.34-2.62
Attitude of parents			
Inadequate	2.01	0.279	0.57-7.10
Adequate	1.92	0.305	0.55-6.65
Adherence (KIDMED)			
Low	0.55	0.243	0.20-1.50
Moderate-high	0.45	0.161	0.15-1.37
Total energy intake (kcal)			
Low	0.54	0.151	0.24-1.25
Moderate-high	0.95	0.896	0.42-2.15
Total sugar intake			
Alta	1.17	0.705	0.52-2.66
Moderate-low	1.67	0.243	0.71-3.96

95 CI: 95% confidence interval

man milk (greater compared to cow's milk but lower compared to artificial formula), as the high concentrations of lactose in contact with tooth surfaces may cause a pH reduction in dental plaque.²⁹ While in vitro studies have demonstrated that human milk in contact with teeth does not produce a reduction in the pH, sucrose does have this effect.³⁰

It is evident that caries is a multifactorial disease and that it is important to control the associated risk factors, or at least those that are most important. A recent systematic review and meta-analysis published in 2019 (Kirthiga *et al.*) analysed 123 factors associated with caries and concluded that enamel defects, the presence of other caries and colonization by *Streptococcus mutans* were the factors associated most strongly with tooth decay.³¹ There is also no evidence of an association between overweight/obesity and caries.^{32,33} Based on a recent systematic review,³⁴ the recom-

mendation of restricting consumption of foods and beverages with free sugars before bed, while founded on a solid physiological premise, is only supported by evidence of very low quality. Our results supported this view, as we did not find an association between the total sugar intake and the risk of caries.

Traditionally, it was recommended that deciduous teeth be cleaned exclusively with water or fluoride-free toothpaste due to the risk of fluorosis in young children. On the other hand, there is evidence that application of fluoride to the enamel may inhibit the demineralization of teeth produced by milk-based drinks³⁵ and that only toothpastes with fluoride concentrations of 1000 ppm or greater have proven effective in reducing caries.³⁶ The risk of fluorosis resulting from ingestion of toothpaste with fluoride at these concentrations and in the recommended amount is minimal.³⁷ Our results could be explained by residual confounding, as we were not able to include the oral hygiene of participants in our analysis.

The population must be educated on correct oral hygiene habits from an early age and be made aware of their importance. Current guidelines³⁸⁻⁴⁴ recommend that parents assist children in toothbrushing until age 6 years, and to use toothpaste with a fluoride concentration of 1000 ppm from age 0 to 3 years (using an amount the size of a rice grain). From age 3 years, the toothpaste must contain from 1000 to 1450 ppm (using a pea-sized amount) and 1450 ppm from age 6 years.

Encouraging discontinuation of BF for any reason detracts from the potential benefits of prolonged BF, blames mothers that wish to continue BF beyond 12 months and discourages other mothers from continuing to breastfeed, who then lose all the benefits of prolonged BF.⁵

Limitations and potential biases

Participants in cohort studies tend to be more aware of their health and take better care of it, which can give rise to nonrepresentative samples that limit the generalizability of results. However,

the analysis of an association between two variables does not require a representative sample. In fact, some authors have suggested that nonrepresentative samples may be a strength in this type of studies, as the data provided by participants tend to be more valid.⁴⁵

A possible explanation of the lack of significance in the association with certain variables, such as adherence to the Mediterranean diet, could be that the sample was too small.

Since the information was self-reported, there is a risk of information bias. However, in case information bias was at play, it would probably be nondifferential and move the distribution towards the null. Also, since the data were collected retrospectively, we must also consider the risk of recall bias. If participants that had breastfed longer happened to have a more accurate recall of the development of tooth decay, our analysis may have overestimated the association between BF and the prevalence of ECC.

Since the study had an observational design, there is a risk of confounding by variables that we may not have taken into account or adjusted for correctly.

CONCLUSIONS

We found a statistically significant positive correlation between BF duration greater than 12 months and the prevalence of ECC. However, BF up to 12 months was a protective factor against early childhood caries. Further research is required to investigate this association thoroughly and to account for the use of fluoride toothpaste in oral hygiene.

We did not find an association between total energy intake or total sugar intake and the prevalence of ECC. Our findings suggest an inverse association between adherence to the Mediterranean diet and the development of caries, although further research is required on this subject.

While we await the results of additional studies assessing the association of tooth decay with the combination of feeding modality in infancy, dietary

habits, oral hygiene habits and other factors to establish specific risks with greater precision, we must insist on the importance of oral hygiene with fluoride toothpaste starting with the eruption of the first tooth. Given the above considerations and the multiple health benefits of BF on maternal and child health, we encourage families to prolong BF for as long as the mother and child wish.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare in relation to the preparation and publication of this article. The

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ABBREVIATIONS

AEP: Asociación Española de Pediatría • **BF** breastfeeding • **BMI:** body mass index • **ECC:** early childhood caries • **FF:** formula feeding • **OR:** odds ratio • **ppm:** parts per million • **RR:** relative risk • **SD:** standard deviation • **WHO:** World Health Organization.

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