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Review Article

Nutritional factors associated with early childhood caries: A systematic review and *meta*-analysis

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ABSTRACT

Background: Many studies have examined the relationship between nutrition and dental caries. However further studies are needed regarding nutritional factors that can have a strong impact on the incidence of early childhood caries (ECC). Nutrition is one factor that determines caries occurrence. Exposure to carbohydrates in the oral cavity causes carbohydrate fermentation, which produces acids. This acidic substance erodes the enamel surface of teeth, leading to ECC. This systematic review and *meta*-analysis of cohort studies assessed the aspects of nutrition and diet that contribute to the incidence of ECC in children.
Materials and methods: We conducted a systematic review by extracting data according to Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines. A search was conducted of published articles in Scopus, MEDLINE via PubMed, and Science Direct using the keywords "nutrition," "sugar," "carbohydrate," "dietary habit," "dental caries," and "oral health." The protocol was registered at PROSPERO 2023 (Registration ID: CRD42023394583).
Results: The article screening yielded 6 articles that met the inclusion criteria. From the total of 443 studies found. Those that could not determine a correlation between the ECC variables and nutrition and with data analyses that only used a bivariate analysis were excluded. The results of the *meta*-analysis showed that nutritional factors had the strongest impact on caries including feeding practice (OR 3.64; 95% CI 2.03, 6.55), sugar intake (OR 3.24; 95% CI 2.59, 4.03), and low fruit and vegetable intake (OR 2.71; 95% CI 1.47, 5.01).
Conclusion: Two nutritional factors had the strongest relationship with the risk of ECC: feeding practice and sugar intake. The lowest risk factor for causing ECC was low fruit and vegetable intake.

1. Introduction

Dental caries in early childhood, known as early childhood caries (ECC) and commonly referred to as rampant caries or bottle-fed caries, occurs in many countries. The prevalence of ECC is quite high in various countries, and its severity increases with the increasing age of the child (Anderson et al., 2021). Early childhood caries affects preschool children and is a worldwide pandemic characterized by a high percentage of untreated carious lesions (Edelstein, 2009). This disease negatively affects general health and child development (Plutzer and Spencer, 2008). The physical symptoms of ECC include discomfort, pain, infection, abscess, gastrointestinal disturbances, malnutrition, stunted growth due to pain, and reluctance to eat (Seirawan et al., 2012). Children with ECC have lower oral health-related quality of life than those without (Alkarimi et al., 2012). In addition, it has an impact on the condition of the nutritional status of children.

Children with ECC tend to have a lower body weight and a 2 times greater risk of malnutrition (Renggli et al., 2021). This is due to severe tooth decay, which affects a child's ability to eat. A child feels uncomfortable chewing food because of teeth pain, causing insufficient calorie intake and affecting nutritional status (Monse et al., 2012). Early childhood caries can cause pain while chewing and drinking hot or cold liquids, difficulty biting, decreased appetite, weight loss, and trouble sleeping, among other problems that negatively affect a child's quality of life (Singh et al., 2020). Dental caries can have a significant impact on children's development during the key phases of growth; thus they need

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support from various parties for better developmental processes (Central Bureau of Statistics, 2021).

Diet and nutrition are 2 of the determining factors of ECC. Studies addressing the connection between eating habits and dental caries are considered classic and have been conducted since the 1950s (Gustafsson et al., 1954). Exposure of the oral cavity to carbohydrates causes carbohydrate fermentation, which produces acids. This acidic product damages the tooth enamel surface, which, causes ECC (Selwitz et al., 2007). A study on dietary habits published 10 years ago suggested that eating more free sugars increases the risk of dental caries (Peres et al., 2016; Sheiham and James, 2015; WHO, 2015). Feeding practices during early childhood play a role in ECC development in children. The findings of that study indicate that the practice of giving evening meals to children in the form of milk or foods containing milk, when given for more than 2 years, significantly increases the severity of dental caries in children (Perera et al., 2014).

Systematic studies have specifically assessed the effects of limiting sugar intake in children according to WHO guidelines. Children whose sugar intake was < 10 % of their total energy have a low caries incidence (Moynihan and Kelly, 2014). Several studies have discussed nutritional factors that affect ECC occurrence such as child-feeding practices, carbohydrate intake amount, carbohydrate intake frequency, type of food consumed, and fruit juice intake (Chankanka et al., 2011; Dye et al., 2004; Feldens et al., 2018; Pacey et al., 2010; Peltzer and Mongkolchati, 2015; Vargas et al., 2014). However, to date, no systematic review has addressed the nutritional or dietary factors contributing to ECC incidence in children. Thus, this study performed a systematic review and *meta*-analysis of cohort studies to assess the aspects of nutrition and diet that contribute to ECC incidence of in early childhood.

2. Materials and methods

This systematic review and *meta*-analysis was conducted using the Preferred Reporting Items for Systematic Review and Meta-Analyses Guidelines (PRISMA) and registered with PROSPERO (Registration ID: CRD42023394583). This study was published in English in full text (free full text) and is available for review.

2.1. Database search

Studies reporting the nutritional aspects that impact ECC risk in children were available in 3 databases: Scopus, MEDLINE via PubMed, and ScienceDirect. Once the aim of the systematic review was established, a research approach was developed based on the research question and search equation. Medical Subject Headings (MeSHs) and free text words were combined to create an equation. The search was performed in these 3 databases, using the following search equation: (((((“Diet, Food, and Nutrition” [MeSH]) AND (“Sugars” [MeSH] OR “Dietary Sugars” [MeSH])) AND “Carbohydrates” [MeSH]) AND “Dietary Habit” [MeSH] AND “Dental Caries” [MeSH]) AND “Oral Health” [MeSH]. After the search equation was established, the data bases were used by the first observer (LPAS), who verified the results with the second observer (SH). Additional relevant literature was found within the systematic reviews identified during the first search using snowball search strategies.

2.2. Screening strategy

Setting inclusion and exclusion criteria is essential in a systematic review because it improves sensitivity and specificity with regard to the study’s goal. The results of the screening based on the literature search keywords in the 3 databases comprised 443 studies.

2.3. Inclusion criteria

The inclusion criteria in this search were:

Articles published in English.
Studies conducted with human participants, particularly children younger than 6 years.
This study measured the relationship between nutritional aspects such as the amount of exposure and frequency of sugar intake, feeding habits, history of free sugar consumption, dietary habits, daily consumption of bottled milk, breastfeeding history, ECC incidence in children and several other aspects.
The research designs included in this review were cross-sectional, quasi-experimental, and randomized controlled trials.
Articles published from 2000 to April 2023.
Primary analysis should have controlled for confounding variables.
Data analysis used a multivariate test.

2.4. Exclusion criteria

Studies were excluded from this selection process if they included children older than 6 years, were unpublished articles from 2000 to April 2023, did not assess related nutritional aspects, did not assess the relationship between nutritional aspects and ECC, and data were analyzed only with a bivariate test.

2.5. Study selection for this systematic review

For this investigation, the entire text or abstracts of all publications, documents, and reports were searched using an advanced database search methodology. Sufficient procedures were implemented to eliminate republishing bias and repetitive content (Fig. 1). The publication dates of the full-text papers selected for the study were analyzed to determine the frequency of reports published in the context of investigation.

2.6. Quality assesment

The risk of bias for non-randomized studies was assessed using the Joanna Briggs Institute (JBI) approach, and all study quality assessments were conducted independently by 2 investigators (LPAS and SH); disagreements were discussed and resolved before the final stage of discussion. The study design, sample age, and factors related to nutrition and caries status were extracted. The JBI Critical Appraisal Tools including the 11-item Checklist for Cohort Studies was used; each item was rated as “yes,” “no,”, “unclear,” or “not applicable.” One point was awarded for a “yes” answer and 0 points awarded for a “no” answer. Of the 6 studies that met the quantitative analysis criteria for the *meta*-analysis, 2 still had deficiencies in their explanations. The research team categorized these deficiencies into “low to medium risk category (Pacey et al., 2010; Vargas, 2014; Chankanka, 2011). Data missing or not explained because 1) the address was unclear and 2) the follow-up was incomplete because there was no information regarding the intention to treat or analyze failure to follow up; and 3) explanation of the confounding factors was unclear because there were no characteristics or demographic tables Table 2.

2.7. Data extraction

Data screening was performed independently by 2 investigators (LPAS and SH). If there was a different title or abstract and there was a full text that has the potential to meet the inclusion criteria, it will be discussed and considered independently by the investigation team (LPAS and SH). Disagreements between the 2 investigators were resolved through discussions. Every reason for articles included in the selection list or not selected was documented in detail. The 2 investigators (LPAS and RA) extracted data from selected studies based on population, intervention, method, and study results according to PICO. The population, methods, results, and influencing factors were documented in detail for the comparison of research designs. In addition, the

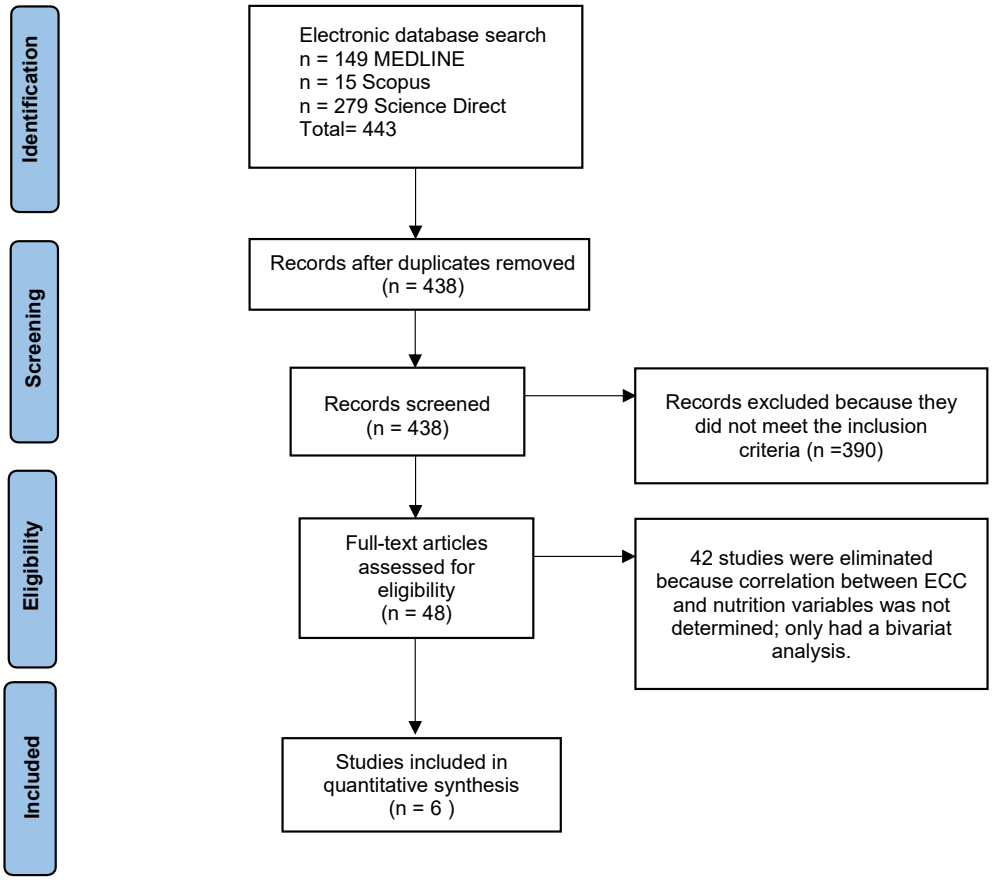


Fig. 1. Flow diagram of included and excluded studies according to the PRISMA statement.

results of the statistical data considerations were recorded, including the analyses, which were also documented.

2.8. Data synthesis and analysis

Data from selected the published research articles and *meta*-analyses were analyzed using the analysis software Review Manager Application 5.3 (RevMan 5.3). The RevMan analysis was performed using logistic regression. The standard heterogeneity of data (I^2) was 50 % for the fixed-effect models and > 50 % for the random-effects analysis.

3. Results

An initial search resulted in 443 potential articles; after removing duplicates, 438 articles were filtered by title. An additional 48 full-text publications were obtained, and 390 papers were excluded because they failed to meet the inclusion requirements. Another 42 articles were excluded because they did not discuss the relationship between nutritional aspects and ECC prevalence, and the analyses were only bivariate. Thus, 6 articles met the inclusion criteria and were suitable for further synthesis and *meta*-analysis for the 3 nutritional factors 1) feeding practice (Feldens et al., 2018; Pacey et al., 2010; Peltzer and Mongkolchati, 2015), 2) sugar intake (Dye et al., 2004; Feldens et al., 2018; Pacey et al., 2010), and 3) low fruit and vegetable intake (Chankanka et al., 2011; Dye et al., 2004; Vargas et al., 2014) and their relationships to ECC incidence (Fig. 1) Table 1 and 3.

3.1. Forest plot

3.1.1. Feeding practice factors

The RevMan analysis determined, feeding (bottle feeding and breast milk) more than 3 times in 1 day in children had increased ECC risk by up to 3.6 times and was significant **(OR 3.64, 95 % CI 2.03, 6.55)** Table 4**.**

The relationship between feeding practices and ECC was examined in 3 studies with a cohort design (Feldens et al., 2018; Pacey et al., 2010; Peltzer and Mongkolchati, 2015); the feeding practice factors (exclusive breastfeeding, breastfeeding duration, and nocturnal breastfeeding) in children could be used as predictors of children's dental caries. The results of the *meta*-analysis indicated that feeding practices (bottle feeding and breast milk) more than 3 times daily increased the risk of ECC events by up to 3.6 times and was significant **(OR 3.64, 95 % CI 2.03, 6.55).** The incidences of ECC and S-ECC are associated with a high frequency of breastfeeding. A positive relationship was found with ECC in children who breastfed 5 times a day (Feldens et al., 2018). A cross-sectional study reported that feeding method had a large effect on children aged 18 months who were at risk for dental caries (Nishimura et al., 2012). A longitudinal study found that the degree of dental caries in children may increase with prolonged breastfeeding (Ibrahim et al., 2009).

3.1.2. Sugar intake factors

The RevMan analysis indicated children who consumed sweet foods more than 5 times a day had increased ECC risk by up to 3.2 times and was significant **(OR 3.24, 95 % CI 2.59, 4.03)** Table 5**.**

The relationship between carbohydrate intake frequency and ECC was examined in 3 studies with a cohort design (Dye et al., 2004; Feldens et al., 2018; Pacey et al., 2010). According to the *meta*-analysis findings, children who ate sweets more than 5 times a day had a significant 3.2 times higher risk of developing ECC than children who ate sweets fewer than twice a day **(OR 3.24, 95 % CI 2.59, 4.03).** In a cohort study, the prevalence of ECC and S-ECC was strongly related with the frequency of

Table 1
Summary of studies included in the review.

Reference	Publication Year	Study Design	Age of Sample	Country	Nutrition Factors Assessed	Caries Index	Measured Significant Associations with Early Childhood Caries
Feldens *et al.*	2018	Cohort	1–3 years	Japan	- Moderate/high frequency mixed-feeding	dmft and dmfs	Children who were frequently breastfed and bottle-fed together (P = 0.04), children who were frequently breastfed and bottle-fed together (P = 0.07), children who were frequently breastfeed and bottle-fed together (P = 0.04), children who ate or drank different things more than 5 times a day (risk ratio (RR): 1.2; P = 0.10), and children who frequently breastfed and bottle-fed together (P = 0.001). Moderate/high frequency mixed- feeding OR: 1.45 (1.02–2.07) p = 0.04.
Pacey *et al.*	2010	Cohort	3–5 years	Canada	- Consumption of high-sugar foods and beverages High Sugar/ food intake	Reported caries experience	Frequency of milk intake (OR: 0.84, 95 % CI: 0.73 –0.97) A greater frequency of consuming foods high in sugar (OR: 1.11, 95 % CI: 1.02–1.12).
Peltzer & Mongkolchati	2015	Cohort	3 years	Thailand	Feeding practice	dmft and dmfs	Slept with bottle at 30 months: 1–6 times/week (OR: 1.79 95 % CI: 1.10–2.92).
Dye *et al.*	2004	Cohort	2–5 years	Brazil	- Ate fewer than 5 portions of fruits and vegetables each day, or every day missed breakfast Breakfast not everyday	dmfs	Ate fewer than 5 servings of fruit and vegetables per day or skipped breakfast every day (OR = 3.77; 95 % CI, 1.80 to 7.89 and OR = 3.21; 95 % CI, 1.74 to 5.95, respectively). Breakfast not every day OR: 2.76 (1.21–6.26). Skipped breakfast every day or had fewer than 5 servings of fruit and vegetables each day (OR: 3.77, 95 % CI: 1.80–7.89 and OR: 3.21, 95 % CI: 1.74–5.95, respectively). Not every day for breakfast OR: 2.76 (1.21–6.26).
Vargas *et al.*	2014	Cohort	2–5 years	USA	Intake fruit juice	dft index	Consumption of 100 % fruit juice was not linked to early childhood caries
Chankanka *et al.*	2011	Cohort	3–11 years	USA	100 % juice exposure level	dmft	High juice exposure levels (100 %) (aOR: 0.52, 95 % CI: 1.05–2.69; P = 0.03)

breastfeeding and bottle feeding in infants (Feldens et al., 2018). There was a relationship between total sugar intake and ECC in children. A cross-sectional study found a significant correlation between the frequency of daily sugar consumption, overall sugar consumption, and prevalence of dental caries in children (Nishimura et al., 2012).

3.1.3. *Low fruit and vegetable intake factors*

The RevMan analysis indicated, the children who consumed fruits and vegetables more than 5 times a day had reduced ECC incidence by up to 2.7 times and it was significant **(OR 2.71, 95 % CI 1.47, 5.01)** Table 6. This also showed that a low fruit and vegetable intake could increase ECC risk.

The prevalence of ECC in children was correlated with a lack of fruits and vegetables in their diets. This was examined in 3 studies with a cohort design (Chankanka et al., 2011; Dye et al., 2004; Vargas et al., 2014). The results of the *meta*-analysis showed that the children who consumed fruits and vegetables more than 5 times a day reduced the incidence of ECC by 2.7 times compared to children who consumed fewer fruits and vegetables, and this difference was significant **OR 2.71, 95 % CI 1.47, 5.01).** Children who ate fewer vegetables and fruit tended to be more susceptible to ECC (Dye et al., 2004).

4. Discussion

Our findings can be explained by the fact that only 6 papers deserved a review and *meta*-analysis. The 6 studies had cohort designs, and the results of the *meta*-analysis revealed that several factors related to nutritional aspects had a strong impact on the incidence of ECC, including feeding practices, sugar intake, and fruit and beverage intake. Of the 3 factors, feeding practice was associated with the highest ECC risk in children. A higher frequency of feeding (bottle feeding and breast milk) in children increased the ECC risk 3.6 times and was significant **(OR 3.64, 95 % CI 2.03, 6.55).** Our findings suggested that bottle-feeding and child-feeding increase ECC incidence. The duration of breastfeeding is 1–1.6 years in the general population, and the prevalence of caries increases as the duration of breastfeeding increases. Moreover, there is an additional provision for other foods, such as bottled milk. Breastfeeding together with bottle feeding can significantly increase ECC risk (Feldens et al., 2018). Bottle-feeding throughout the night causes the surface of the primary teeth to be wetted by milk fluid. Studies have shown that the mineral and lactose composition of cow milk contributes to its low cariogenicity (Bowen and Lawrence, 2005). Some parents add 2–3 teaspoons of sugar when giving bottle milk and the habit of sucking all night further triggers a child's vulnerability to ECC (Prakasha Shrutha et al., 2013). The sugar content of milk makes the consumption of bottled milk more cariogenic. Carbohydrates in bottled milk are converted into acids by Streptococcus mutans through the fermentation pathway, which can cause the demineralization of enamel and dentin (Loesche, 1986). Coupled with sleeping at night when the flow rate of saliva is lower, further increases ECC risk. Feeding practices in children are attractive targets for intervention, especially in children deficient in food intake. High sugar intake and lack of fiber intake are associated with the incidence of obesity and micronutrient deficiencies in addition to the incidence of dental caries (Fox et al., 2004; WHO, 2015).. Early feeding habits impact the risk of dental caries. During this period, good feeding arrangements for children are effective (Ccahuana-Vásquez et al., 2007; WHO, 2015). Sugar intake contributes to E C C incidence by 3.2 times more in children who consume sweet foods more than 5 times a day than in those who consume them fewer than twice a day.

Sugars and sucrose are simple carbohydrates in the form of disaccharides. Theoretically, exposure to carbohydrates in the oral cavity causes carbohydrate fermentation, which produces acids. This acidic product damages the tooth enamel surface, which, in turn, causes ECC (Ccahuana-Vásquez et al., 2007). The frequency of sugar intake has a major influence on the incidence of caries. Reducing sugar consumption

Table 2
Critical Summary Appraisal using the Joanna Briggs Institute approach.

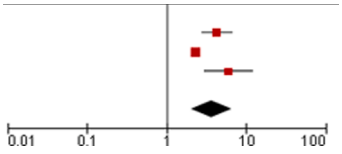
Criteria	Feldens et al.(2018)	Vargas et al. (2014)	Dye et al. (2004)	Peltzer & Mongkolchati (2015)	Chankankaet al. (2011)	Pacey et al.(2010)
Were the 2 groups similar and recruited from the same population?	Yes	Yes	Yes	Yes	Yes	Yes
Were the exposures measured similar to assign participants to both the exposed and unexposed groups?	Yes	Yes	Yes	Yes	Yes	Yes
Was the exposure measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes
Were strategies to handle confounding factors stated?	Yes	Yes	Yes	Yes	Yes	Yes
Were confounding factors identified?	Yes	Yes	Yes	Yes	Unclear	Unclear, there were no tables for characteristics or demographics for confounding factors
Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Yes	Yes	Yes	Yes	Yes	Yes
Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes
Was the follow up time reported and sufficiently long enough for outcomes to occur?	Yes	Yes	Yes	Yes	Yes	Yes
Was follow up complete, and if not, were the reasons for loss of follow up described and explored?	Yes	Yes	Yes	Yes	No, and not described	No, and described
Were strategies to address incomplete follow up utilized?	Yes	No, because no loss of follow up	Yes	Yes	Unclear	Unclear
Was an appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes	Yes

Table 3
Frequency of the potential risk factors identified in the included studies from 2000 to 2023.

Risk factors	Feldens et al., (2018)	Pacey et al. (2010)	Peltzer & Mongkolchati (2015)	Dye et al. (2004)	Vargas et al. (2014)	Chankanka et al. (2011)
Feeding practice	√	√	√			
Sugar intake	√	√		√		
Lowfruitand vegetable intake				√	√	√

Table 4
Forest plot of feeding practices.

Odds Ratio					
Study or Subgroup	Log (OR)	SE	Weight	IV, Random, 95 % CI	IV, Random, 95 % CI
Felden *et al.* (2018)	1.45	0.2194	33.5 %	4.26 [2.77, 6.55]	
Pacey et al. (2010)	0.84	0.0561	40.3 %	2.32 [2.08, 2.59]	
Peltzer *et al.* (2015)	1.79	0.352	26.1 %	5.99 [3.00, 11.94]	
Total 95 % CI			100.0 %	**3.64 [2.03, 6.55]**	

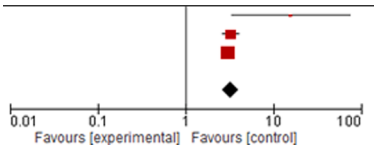


Heterogeneity: $Tau^2 = 0.22$; $Chi^2 = 13.82$, df = 2 (P = 0.0010); $I^2 = 86$ %.
Test for overall effect: Z = 4.32 (P < 0.0001).

without reducing its exposure on a regular basis is ineffective in preventing dental caries (Selwitz et al., 2007). The WHO guidelines recommend reducing the consumption of free sugars to below 10 % of the energy intake (10E%) or even below 5E% of the diet. Free sugars are defined as all monosaccharides and disaccharides added to packaged foods, foods served by cooks, and sugars found naturally in syrups, fruit juices, and honey (WHO, 2015). Meta-analytic studies have shown that the nutritional factor with the lowest risk of increasing ECC incidence in children is low fruit and vegetable intake. The lack of fruit and vegetable consumption in children can increase ECC risk. Thus, a higher consumption of fruits and vegetables can reduce the risk of caries. The results of the *meta*-analysis showed that the consumption of fruits and vegetables by children more than 5 times a day reduced ECC incidence by 2.7 times compared to children who consumed fewer fruits and vegetables (**OR 2.71, 95 % 1.47, 5.01).** Our findings indicated that the habit of consuming fruits and vegetables can be used as a solution in preventing ECC in children. Consumption of fresh fruits and vegetables can increase the flow rate of saliva, which has an impact on preventing caries in children due to an increase in the self-cleansing action (Touger-Decker and van Loveren, 2003).

Table 5
Forest plot of sugar intake.

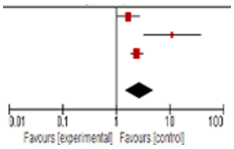
Odds Ratio					
Study or Subgroup	Log (OR)	SE	Weight	IV, Random, 95 % CI	IV, Random, 95 % CI
Dye et al. (2004)	2.76	0.7908	2.0 %	15.80 [3.35, 74.44]	
Felden *et al.* (2018)	1.19	0.1122	39.5	3.29 [2.64, 4.10]	
Pacey et al. (2010)	1.11	0.0459	58.6	3.03 [2.77, 3.23]	
Total 95 % CI			100.0 %	**3.24 [2.59, 4.03]**	



Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 4.72$, df = 2 (P = 0.09); $I^2 = 58$ %.
Test for overall effect: Z = 10.42 (P < 0.00001).

Table 6
Forest plot of fruit and vegetable intake.

Study or Subgroup	Odds Ratio				
	Log (OR)	SE	Weight	IV, Random, 95 % CI	IV, Random, 95 % CI
Chankaka *et al.* (2011)	0.52	0.2396	38.2 %	1.68 [1.05, 2.69]	
Dye et al. (2004)	2.4	0.6276	16.5	11.02 [3.22, 37.72]	
Vargas et al. (2014)	0.89	0.1327	45.3 %	2.44 [1.88, 3.16]	
Total 95 % CI			100.0 %	**2.71 [1.47, 5.01]**	



Heterogeneity: $Tau^2 = 0.20$; $Chi^2 = 8.08$, df = 2 (P = 0.02); $I^2 = 75$ %
Test for overall effect: Z = 3.19 (P = 0.001)

Early childhood is a time children are prone to developing cavities (dental caries). The development of dental caries in children is very rapid, which is due to the anatomy of the primary teeth (decidui), whose enamel thickness is half that of the permanent teeth, the pulp horns are higher and the pulp chamber is wide (van Loveren, 2019). This group requires serious attention from government policymakers, especially in efforts to prevent and control ECC prevalence in early childhood. Our findings indicated that the nutritional factors that increase ECC in early childhood include feeding practices, sugar intake, and low fruit and vegetable intake. These factors suggest that nutrition plays an important role in ECC incidence. Application of a healthy diet in children to prevent and control ECC is required. Parents use sweetness as a reward to control their children. Parents do not determine what kind of food their children should eat, but tend to comply with their child's wishes (Avery and Chiego, 2006). The JBI approach was used to evaluate the risk of bias assessment. Most studies met the quantitative analysis criteria for *meta*-analysis; only two articles could be said to have a " low-to-middle risk of bias because they still had deficiencies in explaining the methodology and results of the analysis.

4.1. Strengths and limitations

This study conducted a systematic review based on the PRISMA guidelines. All steps of this study were performed by 2 independent reviewers who reduced errors and increased the research power. This study has several limitations. First, the literature search conducted provided only complete literature available in English that discussed the relationship between nutritional aspects and the incidence of ECC in children. Second, articles published before the 2000s were excluded from analyses.

5. Conclusion

Based on the results of this study, the following conclusions can be drawn:

1. The two strongest nutritional factors associated with the risk of ECC are feeding practices and sugar intake.
2. The lowest risk factor for causing ECC was low fruit and vegetable intake.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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