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Early Childhood Feeding Practices and the Development of Severe Early Childhood Caries (S-ECC): A Prospective Cohort Study in Medan, Indonesia

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A B S T R A C T

Introduction: Severe early childhood caries (S-ECC) is a significant public health problem, particularly in developing countries like Indonesia. Early childhood feeding practices are recognized as major risk factors, but prospective data from specific regions like Medan, Indonesia, are limited. This study aimed to investigate the association between various feeding practices and the development of S-ECC in a cohort of children in Medan. **Methods:** A prospective cohort study was conducted involving 450 mother-child dyads recruited from Posyandu (integrated health posts) in Medan, Indonesia. Baseline data on maternal demographics, socioeconomic status, oral health knowledge, and infant feeding practices were collected via questionnaires and interviews. Children were followed up at 6-month intervals for 36 months. Dental examinations were performed by calibrated dentists using the dmft index (decayed, missing, filled teeth) to diagnose S-ECC. Cox proportional hazards regression was used to analyze the association between feeding practices and S-ECC development, adjusting for potential confounders. **Results:** The incidence of S-ECC at 36 months was 38.2% (n=172). Prolonged bottle feeding (beyond 12 months) (Hazard Ratio [HR] = 2.15; 95% Confidence Interval [CI]: 1.55-2.98; p<0.001), nocturnal bottle feeding with sweetened liquids (HR = 2.85; 95% CI: 2.01-4.03; p<0.001), and frequent consumption of sugary snacks/drinks (≥3 times/day) (HR = 1.92; 95% CI: 1.38-2.67; p<0.001) were significantly associated with an increased risk of S-ECC. Exclusive breastfeeding for the first 6 months showed a protective effect (HR = 0.62; 95% CI: 0.45-0.86; p=0.004), even after adjusting for socioeconomic status and maternal oral health knowledge. **Conclusion:** This study confirms the significant impact of early childhood feeding practices on S-ECC development in Medan, Indonesia. Prolonged and nocturnal bottle feeding, particularly with sweetened liquids, and frequent consumption of sugary snacks/drinks were key risk factors. Promoting exclusive breastfeeding for the first six months and educating mothers about appropriate feeding practices are crucial for S-ECC prevention in this population.

1. Introduction

Dental caries, a chronic disease characterized by the demineralization of tooth enamel and subsequent destruction of tooth structure, continues to be a significant public health concern worldwide. Among the various forms of dental caries, severe early childhood caries (S-ECC) stands out as a particularly aggressive and devastating condition, affecting children under the age of six. S-ECC is not merely a cosmetic issue; it has profound and far-reaching

consequences for children's overall health and well-being. The impact of S-ECC extends beyond the oral cavity, affecting various aspects of a child's life. The pain and discomfort associated with S-ECC can disrupt sleep patterns, leading to irritability, fatigue, and difficulty concentrating. The presence of carious lesions can also impair a child's ability to chew food properly, potentially leading to nutritional deficiencies and growth retardation. Moreover, S-ECC can negatively impact a child's self-esteem and social development, as the appearance of decayed teeth may lead to teasing and social isolation. The etiology of S-ECC is complex and multifactorial, involving a dynamic interplay of biological, behavioral, and socioeconomic factors. While genetic predisposition and oral hygiene practices undoubtedly play a role, early childhood feeding practices have emerged as one of the most critical modifiable risk factors for S-ECC. The foods and liquids consumed by infants and young children, as well as the frequency and timing of their consumption, can profoundly influence the oral environment and the risk of developing caries.[1-3]

Indonesia, a rapidly developing nation with a large and diverse population, faces a substantial burden of S-ECC. National surveys have consistently revealed high caries prevalence rates among Indonesian preschool children, highlighting the urgent need for effective preventive strategies. Medan, the capital of North Sumatra province, is a bustling metropolis with a complex socioeconomic and cultural landscape. While some studies have investigated caries prevalence in Indonesian children, there remains a paucity of prospective cohort studies specifically examining the longitudinal relationship between early feeding practices and S-ECC development in this region. Breastfeeding, universally recognized as the optimal feeding method for infants, provides a myriad of health benefits, including protection against infections, promotion of cognitive development, and fostering a strong mother-infant bond. The World Health Organization (WHO) recommends exclusive breastfeeding for the first six months of life, followed by continued breastfeeding alongside complementary foods for up to two years or beyond. However, the relationship between breastfeeding and caries is complex and not fully elucidated. While some studies suggest a protective effect of exclusive breastfeeding against early caries, prolonged or on-demand breastfeeding, especially at night, has been associated with an increased risk in some populations, particularly when combined with other cariogenic dietary factors. Bottle feeding, especially when prolonged beyond 12 months and containing sweetened liquids such as formula with added sugar, juice, or sweetened condensed milk, is a well-established risk factor for S-ECC. The prolonged exposure of teeth to fermentable carbohydrates in sweetened liquids, coupled with the decreased salivary flow and more acidic oral environment that occur during sleep, creates a perfect storm for demineralization and caries development.[4-7]

The early introduction of sugary snacks and drinks is another significant contributor to S-ECC, providing a frequent and readily available source of substrate for cariogenic bacteria. The consumption of sugary treats between meals, especially those that are sticky or adhere to the teeth, can lead to prolonged acid attacks and accelerate the caries process. Understanding the specific feeding practices prevalent in Medan and their association with S-ECC is crucial for developing targeted and effective preventive interventions.[8-10] This study aimed to address this knowledge gap by conducting a prospective cohort study to investigate the relationship between early childhood feeding practices (including breastfeeding duration, bottle feeding practices, and the introduction of sugary foods/drinks) and the development of S-ECC in a cohort of children in Medan, Indonesia.

2. Methods

This study utilized a prospective cohort design, a robust epidemiological approach that follows a group of individuals over time to observe the incidence of a particular outcome, in this case, S-ECC. This design is particularly well-suited for investigating the temporal relationship between potential risk factors (early feeding practices) and the development of disease. The study was conducted in Medan, the capital city of North Sumatra province in Indonesia. Medan, being one of the largest metropolitan areas in

Indonesia, presents a diverse socioeconomic and cultural landscape, making it an ideal setting to explore the interplay of various factors influencing early childhood feeding practices and oral health outcomes. The study population consisted of mother-child dyads recruited from Posyandu (Pos Pelayanan Terpadu), which are integrated community-based health posts that provide a comprehensive range of maternal and child health services. These services include immunizations, growth monitoring, health education, and nutritional counseling, making Posyandu a central hub for healthcare access and community engagement, particularly for mothers and young children.

The inclusion criteria for participants were carefully defined to ensure the recruitment of a representative sample of mother-child dyads from the target population. Mothers were eligible to participate if their infants were aged between 0 and 6 months at the time of recruitment, residing within the designated Posyandu catchment areas in Medan, and if the mothers expressed their intention to remain in the study area for the entire 36-month follow-up period. The 0-6 month age range for infants was chosen to capture the critical period of early feeding practices, as this period encompasses the introduction of complementary foods and the transition from exclusive breastfeeding to mixed feeding. Residency within the selected Posyandu catchment areas was essential to ensure the feasibility of follow-up and minimize attrition due to relocation. The willingness of mothers to participate and provide informed consent was also a prerequisite for enrollment. Exclusion criteria were applied to minimize potential confounding factors that could influence the relationship between feeding practices and S-ECC development. Children with known systemic diseases or developmental disabilities that could affect oral health were excluded to isolate the impact of feeding practices on caries development. Mothers with severe medical or psychiatric conditions that would preclude participation were also excluded to safeguard their well-being and ensure the reliability of data collection.

The sample size was meticulously calculated to ensure adequate statistical power for detecting meaningful associations between feeding practices and S-ECC development. The calculation was based on an estimated S-ECC prevalence of 30% in the target population, a figure derived from preliminary data and previous studies conducted in similar settings. A desired precision of 5% and a 95% confidence level were chosen to achieve a balance between accuracy and feasibility. Additionally, an estimated attrition rate of 20% was factored into the calculation to account for potential loss to follow-up due to various reasons such as relocation or withdrawal of consent. The calculated sample size was 384 mother-child dyads. However, to further mitigate the impact of potential attrition and maintain statistical power, the study aimed to recruit 450 dyads, providing a buffer against unforeseen losses to follow-up.

The recruitment phase spanned from January 2019 to June 2019, coinciding with routine infant check-ups at Posyandu to maximize the reach and efficiency of recruitment efforts. Mothers attending these check-ups were approached by trained research assistants who provided detailed information about the study objectives, procedures, and potential benefits and risks of participation. Mothers who expressed interest in participating were then screened for eligibility based on the inclusion and exclusion criteria. Upon confirmation of eligibility, written informed consent was obtained from each participating mother before enrollment. Baseline data were then collected using a structured questionnaire administered through face-to-face interviews conducted by the trained research assistants. The baseline questionnaire was meticulously designed to capture a comprehensive range of variables that could potentially influence feeding practices and S-ECC development. These variables were categorized into maternal demographics, socioeconomic status, maternal oral health knowledge, and infant feeding practices; Maternal Demographics: This category encompassed maternal age, education level (categorized as ≤ primary school, secondary school, ≥ high school), occupation, and marital status. These variables were chosen to assess the potential influence of maternal socioeconomic and cultural background on feeding practices; Socioeconomic Status (SES): SES

was assessed using a combination of household income (categorized into quartiles based on local income distribution), household assets (using a standardized asset index), and housing conditions. This multi-faceted approach aimed to capture the complex interplay of economic resources and living conditions that could affect access to nutritious foods and oral healthcare; Maternal Oral Health Knowledge: This crucial aspect was assessed using a validated questionnaire adapted from previous studies, covering topics such as the causes of caries, the role of sugar, and the importance of oral hygiene. Scores were categorized as low, moderate, or high to provide a quantifiable measure of maternal understanding of oral health, which could influence feeding choices and oral hygiene practices for their children; Infant Feeding Practices: This core component of the questionnaire focused on capturing detailed information about breastfeeding, bottle feeding, and the introduction of sugary snacks and drinks. Data collected included the initiation of breastfeeding, exclusive breastfeeding duration (defined as receiving only breast milk and no other liquids or solids), and continued breastfeeding duration. Information gathered encompassed the age of introduction of bottle feeding, frequency of bottle feeding per day, content of the bottle (formula, sweetened condensed milk, juice, other), and nocturnal bottle feeding (yes/no); Introduction of Sugary Snacks/Drinks: This section explored the age of introduction of sugary snacks and drinks, frequency of consumption (times per day/week), and types of sugary snacks/drinks consumed. Follow-up visits were meticulously scheduled at 6-month intervals (6, 12, 18, 24, 30, and 36 months) to monitor changes in feeding practices and assess the development of S-ECC over time. These visits were primarily conducted at the Posyandu, leveraging the established infrastructure and accessibility of these health posts. However, to minimize attrition and ensure data completeness, visits were also conducted at the participant's home if necessary, demonstrating flexibility and participant-centricity in data collection. At each follow-up visit, the questionnaire was re-administered to update information on feeding practices, capturing any shifts or transitions in breastfeeding, bottle feeding, and consumption of sugary snacks and drinks. This longitudinal approach allowed for the identification of patterns and trends in feeding practices and their potential association with S-ECC development. Dietary habits were assessed using a combination of 24-hour dietary recall and a food frequency questionnaire, both of which focused on sugary items. The 24-hour dietary recall provided a snapshot of the child's dietary intake over the past 24 hours, while the food frequency questionnaire captured the habitual consumption patterns of sugary foods and drinks over a longer period. Dental examinations were a cornerstone of this study, providing the primary outcome measure for assessing S-ECC development. These examinations were conducted at baseline (when the child reached approximately 12 months of age, to allow for sufficient tooth eruption) and at each subsequent follow-up visit, ensuring a longitudinal assessment of oral health status. The examinations were performed by two calibrated dentists who underwent rigorous training and calibration using standardized criteria for diagnosing dental caries according to the World Health Organization (WHO) criteria. This standardization aimed to minimize inter-examiner variability and ensure consistency in caries assessment. Inter-examiner reliability was assessed using Cohen's Kappa statistic, a robust measure of agreement between raters, with a target Kappa value of ≥0.8, indicating a high level of agreement. The dmft index (decayed, missing due to caries, filled teeth) was used to record caries experience in primary teeth. This index is widely used in epidemiological studies of dental caries in children and provides a quantifiable measure of caries prevalence and severity. S-ECC was defined as a dmft score of ≥4 at 36 months, consistent with established definitions.

Ethical considerations were paramount throughout the study, ensuring the protection of participants' rights and well-being. The study protocol was reviewed and approved by the Ethical Review Committee of CMHC Indonesia, an independent body responsible for overseeing the ethical conduct of research involving human subjects. Written informed consent was obtained from all participating mothers

before enrollment, ensuring their voluntary participation and understanding of the study procedures, potential benefits, and risks. Confidentiality of participant data was maintained throughout the study, with all data stored securely and accessed only by authorized personnel.

Data analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY), a comprehensive statistical software package widely used in health research. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize baseline characteristics and feeding practices, providing a clear overview of the study population and their feeding patterns. Cox proportional hazards regression, a powerful statistical technique for analyzing time-to-event data, was employed to investigate the association between feeding practices (independent variables) and the time to development of S-ECC (dependent variable). This method allowed for the assessment of the risk of developing S-ECC associated with different feeding practices, while controlling for potential confounding factors. Hazard ratios (HRs) and 95% confidence intervals (CIs) were calculated to quantify the strength of association between feeding practices and S-ECC development. Time-varying covariates, such as changes in feeding practices over time, were incorporated into the models to capture the dynamic nature of feeding behaviors and their potential impact on caries risk. Potential confounders, including maternal age, education, SES, and oral health knowledge, were adjusted for in the multivariable models to isolate the independent effect of feeding practices on S-ECC development. A p-value of <0.05 was considered statistically significant, indicating that the observed association was unlikely to be due to chance.

3. Results and Discussion

Table 1 provides a comprehensive overview of the baseline characteristics of the 398 mother-child dyads who participated in the study. The data is categorized into maternal characteristics, socioeconomic status, maternal oral health knowledge, and infant characteristics. The average age of the mothers was 28.5 years, with a standard deviation of 4.2 years. This suggests that the study population included mothers from a relatively young age range. The majority of mothers (49%) had completed secondary school, followed by those with a high school education or higher (29.6%). A smaller proportion (21.4%) had completed primary school or less. This distribution indicates a relatively diverse educational background among the mothers. A large majority of the mothers (70.4%) were housewives, while the remaining 29.6% were employed in either formal or informal sectors. This highlights the significant role of mothers as primary caregivers in this population. Most mothers (95%) were married, while a small percentage (5%) reported other marital statuses. This suggests that the majority of children in the study were raised in two-parent households. The distribution of household income was relatively even across the four quartiles, with each quartile representing roughly 25% of the participants. This indicates that the study population included families from a range of socioeconomic backgrounds. A substantial proportion of mothers (30.2%) had low oral health knowledge, while 46.5% had moderate knowledge and 23.3% had high knowledge. This suggests a need for improved oral health education among mothers in this population. The sex distribution of infants was almost equal, with 51.5% being male and 48.5% being female. The average age of infants at baseline was 4.8 months, with a standard deviation of 1.1 months. This indicates that most infants were enrolled in the study around the time when complementary foods were typically introduced.

Table 2 presents a longitudinal overview of feeding practices among the 398 mother-child dyads participating in the study, tracking changes in breastfeeding, bottle feeding, and the introduction of sugary snacks/drinks over time, from baseline to 36 months; Breastfeeding: The vast majority of mothers (98%) had ever breastfed their child, indicating breastfeeding initiation is prevalent in this population. At 6 months, 64.1% of infants were exclusively breastfed, aligning with WHO recommendations. However, this number steadily declines at subsequent follow-ups. While 70.4% of infants were still being

breastfed at 12 months, this number dropped significantly to 37.7% at 18 months and further down to 20.1% at 24 months. This suggests a rapid decline in breastfeeding continuance beyond the first year; Bottle Feeding: 45.2% of infants were ever bottle-fed, indicating that bottle feeding is a common practice in this population. 38.9% of infants were still being bottle-fed at 12 months, decreasing to 22.6% at 24 months. Although declining, prolonged bottle feeding beyond 12 months is still observed in a considerable proportion. 21.4% of infants were reported to have nocturnal bottle feeding at 12 months, dropping to 12.6% at 24 months and 6.3% at 30 months. This suggests that while nocturnal bottle feeding is practiced, it tends to decrease with age. Notably, 17.6% of infants had sweetened liquids in their bottles at 12 months, decreasing to 10.1% at 24 months and 3.8% at 30 months. This indicates that while the use of sweetened bottles decreases over time, a significant proportion of infants are exposed to these cariogenic liquids, especially in the first year; Sugary Snacks/Drinks: 30.2% of infants were introduced to sugary snacks/drinks by 12 months, with this number rising sharply to 62.8% by 24 months. This reflects a common trend of increasing exposure to sugary foods as infants grow. At 24 months, 20.1% of infants consumed sugary snacks/drinks 3 or more times a day, increasing to 27.6% by 36 months. This indicates a concerningly high and increasing frequency of consumption of sugary foods, potentially posing a significant risk for dental caries.

Table 1. Baseline characteristics of participants (n=398).

Characteristic	n (%) or Mean (SD)
Maternal Characteristics	
Age (years)	28.5 (4.2)
Education level	
≤ Primary School	85 (21.4)
Secondary School	195 (49.0)
≥ High School	118 (29.6)
Occupation	
Housewife	280 (70.4)
Employed (formal/informal)	118 (29.6)
Marital status	
Married	378 (95.0)
Other	20 (5.0)
Socioeconomic status	
Household income (Quartiles)	
Q1 (Lowest)	105 (26.4)
Q2	98 (24.6)
Q3	95 (23.9)
Q4 (Highest)	100 (25.1)
Maternal oral health knowledge	
Low	120 (30.2)
Moderate	185 (46.5)
High	93 (23.3)
Infant characteristics	
Gender (Male)	205 (51.5)
Age at baseline (months)	4.8 (1.1)

*A total of 450 mother-child dyads were enrolled in the study. The follow-up rate at 36 months was 88.4% (n=398). The main reasons for loss to follow-up were relocation outside the study area (n=32) and withdrawal of consent (n=20).

Table 2. Feeding practices over time (n=398).

Feeding practice	Baseline (n, %)	6 Months (n, %)	12 Months (n, %)	18 Months (n, %)	24 Months (n, %)	30 Months (n, %)	36 Months (n, %)
Breastfeeding							
Ever breastfed	390 (98.0)	-	-	-	-	-	-
Exclusive breastfeeding (at 6 months)	255 (64.1)	255 (64.1)	-	-	-	-	-
Continued breastfeeding (at 12 months)	-	-	280 (70.4)	-	-	-	-
Continued breastfeeding (at 24 months)	-	-	-	150 (37.7)	80 (20.1)	-	-
Bottle feeding							
Ever bottle fed	180 (45.2)	-	-	-	-	-	-
Bottle feeding at 12 months	-	-	155 (38.9)	-	-	-	-
Bottle feeding at 24 months	-	-	-	90 (22.6)	45 (11.3)	-	-
Nocturnal bottle feeding (at 12 months)	-	-	85 (21.4)	-	-	-	-
Nocturnal bottle feeding (at 24 months)	-	-	-	50 (12.6)	25 (6.3)	-	-
Sweetened bottle content (at 12 months)	-	-	70 (17.6)	-	-	-	-
Sweetened bottle content (at 24 months)	-	-	-	40 (10.1)	15 (3.8)	-	-
Sugary snacks/drinks							
Introduced by 12 months	-	-	120 (30.2)				
Introduced by 24 months	-	-		250 (62.8)			
≥3 times/day (at 24 months)	-	-	-	80 (20.1)	-	-	-
≥3 times/day (at 36 months)	-	-	-	-	-	-	110 (27.6)

Table 3 illustrates the incidence and severity of S-ECC among the 398 children over different time points, from 12 months to 36 months. It also provides a breakdown of the 'd' (decayed), 'm' (missing), and 'f' (filled) components of the dmft index. The prevalence of S-ECC (defined as dmft ≥ 4 at 36 months) shows a clear upward trend over time. Starting at 5.8% at 12 months (representing any caries experience, not S-ECC by definition), it rises to 14.3% at 18 months, 25.1% at 24 months, 34.9% at 30 months, and finally reaches 43.2% at 36 months. This highlights the increasing risk and severity of caries as children grow. The mean dmft score also exhibits a steady increase over time, starting at 0.7 at 12 months and reaching 4.5 at 36 months. This reflects the cumulative nature of dental caries, with more teeth being affected over time. The 'd' component (decayed teeth) is the major contributor to the dmft score at all time points, indicating that most of the caries observed were untreated. This underscores the need for early intervention and access to dental care. The 'm' component (missing teeth) remains relatively low throughout the study period, suggesting that tooth loss due to caries was not a major issue in this cohort.

The 'f' component (filled teeth) is consistently low, indicating limited access to restorative dental care. This further emphasizes the need for preventive measures to reduce the incidence of caries in the first place.

Table 3. Incidence and severity of S-ECC at different time points (n=398).

Time point (Months)	S-ECC Prevalence (%)*	Mean dmft (SD)	Mean 'd' component (SD)	Mean 'm' component (SD)	Mean 'f' component (SD)	95% CI for Prevalence
12	5.8 (23/398)	0.7 (1.1)	0.6 (1.0)	0.05 (0.2)	0.05 (0.2)	3.7% - 8.5%
18	14.3 (57/398)	1.8 (1.6)	1.6 (1.4)	0.1 (0.3)	0.1 (0.3)	10.9% - 18.3%
24	25.1 (100/398)	2.9 (2.1)	2.6 (1.9)	0.2 (0.5)	0.1 (0.4)	20.8% - 29.8%
30	34.9 (139/398)	3.7 (2.4)	3.3 (2.2)	0.3 (0.6)	0.1 (0.4)	30.2% - 39.8%
36	43.2 (172/398)	4.5 (2.7)	4.0 (2.5)	0.3 (0.7)	0.2 (0.5)	38.3% - 48.2%

*S-ECC defined as dmft ≥ 4 at 36 months. For time points before 36 months, this represents the prevalence of any caries (dmft > 0), *not* S-ECC by the formal definition.

Table 4 presents the results of the Cox proportional hazards regression analysis, which was used to examine the associations between various feeding practices and the time to development of S-ECC in the cohort of 398 children. The table displays both unadjusted and adjusted hazard ratios (HR) with their corresponding 95% confidence intervals (CI) and p-values. Exclusive breastfeeding for 6 months or less was associated with a significantly reduced risk of S-ECC, with an adjusted HR of 0.62 (95% CI: 0.45-0.86, p=0.004). This suggests a protective effect of exclusive breastfeeding against S-ECC development. Continued breastfeeding at 12 months and 24 months did not show a statistically significant association with S-ECC development after adjusting for confounders. Bottle feeding at 12 months was significantly associated with an increased risk of S-ECC (adjusted HR = 2.15, 95% CI: 1.55-2.98, p<0.001). Nocturnal bottle feeding at 12 months showed an even stronger association with S-ECC (adjusted HR = 2.85, 95% CI: 2.01-4.03, p<0.001). Having sweetened bottle content at 12 months was also significantly associated with increased S-ECC risk (adjusted HR = 2.70, 95% CI: 1.88-3.87, p<0.001). Introducing sugary snacks/drinks by 12 months was associated with a higher risk of S-ECC (adjusted HR = 1.88, 95% CI: 1.34-2.64, p<0.001). Consuming sugary snacks/drinks 3 or more times per day at 24 months was also linked to an increased risk of S-ECC (adjusted HR = 1.92, 95% CI: 1.38-2.67, p<0.001).

Table 4. Cox proportional hazards regression analysis of feeding practices and S-ECC development (n=398).

Feeding practice	Unadjusted HR (95% CI)	p-value	Adjusted HR (95% CI)*	p-value
Breastfeeding				
Exclusive Breastfeeding (≤ 6 months vs. > 6 months)	0.58 (0.42-0.80)	0.001	0.62 (0.45-0.86)	0.004
Continued Breastfeeding (at 12 months)	0.85 (0.65-1.11)	0.23	0.92 (0.70-1.21)	0.55
Continued Breastfeeding (at 24 months)	1.10 (0.78-1.55)	0.58	1.05 (0.74-1.49)	0.78
Bottle Feeding				
Bottle Feeding (at 12 months)	1.95 (1.40-2.71)	<0.001	2.15 (1.55-2.98)	<0.001
Nocturnal Bottle Feeding (at 12 months)	2.60 (1.85-3.66)	<0.001	2.85 (2.01-4.03)	<0.001
Sweetened Bottle Content (at 12 months)	2.45 (1.72-3.49)	<0.001	2.70 (1.88-3.87)	<0.001
Sugary Snacks/Drinks				
Introduced by 12 months	1.75 (1.25-2.45)	0.001	1.88 (1.34-2.64)	<0.001
≥3 times/day (at 24 months)	1.80 (1.29-2.51)	0.001	1.92 (1.38-2.67)	<0.001

*Adjusted for maternal age, education level, household income quartile, and maternal oral health knowledge.

The high incidence of S-ECC (43.2%) observed in this study is a cause for concern and underscores the urgent need for effective preventive interventions in this population. This prevalence is higher than some reported rates in other parts of Indonesia and globally, but it is consistent with findings from other studies in similar low-resource settings. The observed prevalence of S-ECC in this study is likely influenced by a confluence of factors, including socioeconomic disparities, limited access to oral healthcare, and cultural feeding practices that may favor prolonged bottle feeding and early introduction of sugary foods and drinks. The high prevalence of S-ECC in this population has far-reaching implications, not only for individual children's oral health but also for the overall health and well-being of the community. S-ECC can lead to a cascade of adverse consequences, affecting a child's physical, psychological, and social development. S-ECC can cause significant pain and discomfort, disrupting a child's ability to eat, sleep, and concentrate. The presence of carious lesions can also lead to infections, which can spread to other parts of the body and cause serious health complications. In severe cases, S-ECC can result in tooth loss, which can affect a child's speech development and self-esteem. The pain and discomfort associated with S-ECC can make it difficult for children to chew food properly, leading to reduced food intake and potential nutritional deficiencies. These deficiencies can have a negative impact on a child's growth and development, affecting their physical and cognitive development. S-ECC can also have a significant impact on a child's psychological and social well-being. The appearance of decayed teeth can lead to teasing and social isolation, affecting a child's self-esteem and confidence. The pain and discomfort associated with S-ECC can also make it difficult for children to participate in social activities and interact with their peers. The adverse effects of S-ECC can extend far beyond childhood, affecting an individual's health and well-being throughout their life. Untreated S-ECC can lead to chronic oral health problems, such as periodontal disease and tooth loss, which can affect an individual's ability to eat, speak, and maintain overall health. The psychological and social consequences of S-ECC can also persist into adulthood, affecting an individual's self-esteem, social relationships, and overall quality of life. The economic burden of treating S-ECC can be substantial, both for individuals and for healthcare systems. The cost of dental treatment, including fillings, extractions, and restorative procedures, can be prohibitive for many families, particularly those from low-income backgrounds. The burden on healthcare systems is also significant, as S-ECC requires specialized dental care, which may not be readily available in all communities. The high prevalence of S-ECC in a community can have broader implications, affecting the overall health and well-being of the population. S-ECC can contribute to health disparities, as children from low-income families and marginalized communities are disproportionately affected by this condition. The adverse consequences of S-ECC can also have a ripple effect, affecting a child's family, school, and community. The high incidence of S-ECC and its far-reaching consequences underscore the urgent need for effective preventive interventions. These interventions should be multi-faceted, addressing both individual and community-level factors that contribute to S-ECC. Parents and caregivers should be educated about the importance of oral health, the risk factors associated with S-ECC, and the preventive measures that can be taken to protect their children's teeth. Dietary counseling can help families make informed choices about their children's diets, promoting healthy eating habits that reduce the risk of S-ECC. Parents and caregivers should be encouraged to establish good oral hygiene practices for their children, including brushing twice a day with fluoride toothpaste and flossing daily. Establishing a dental home for children early in life can ensure that they receive regular dental check-ups and preventive care, reducing the risk of S-ECC and other oral health problems. Community water fluoridation is a safe and effective way to reduce the incidence of dental caries, including S-ECC. School-based programs can provide oral health education, preventive services, and access to dental care for children. Public health campaigns can raise awareness about the importance of oral health and the risk factors associated with S-ECC, promoting healthy

behaviors and encouraging families to seek preventive care.[11-15]

The strong association between prolonged bottle feeding and S-ECC is consistent with a large body of evidence. Prolonged bottle use, especially at night, exposes the teeth to fermentable carbohydrates for extended periods, leading to prolonged acid production and demineralization of enamel. The addition of sweeteners to bottle contents exacerbates this effect, creating a highly cariogenic environment in the oral cavity. The findings of this study highlight the importance of educating parents about the risks of prolonged bottle feeding and encouraging the transition to a cup by 12 months of age. This transition can be challenging for some families, as bottle feeding may be deeply ingrained in cultural practices and beliefs. However, healthcare providers can play a crucial role in providing guidance and support to parents, emphasizing the benefits of early cup use for oral health and overall development. To fully understand the detrimental effects of prolonged bottle feeding, it is essential to delve into the mechanisms of caries development. Dental caries is a complex, multifactorial disease process that involves the interaction of bacteria, fermentable carbohydrates, and host factors, such as saliva and tooth enamel. The human oral cavity harbors a diverse community of bacteria, many of which are capable of metabolizing fermentable carbohydrates, such as sugars and starches, to produce acids. These acids, primarily lactic acid, lower the pH of the oral environment, creating an acidic milieu that promotes the demineralization of tooth enamel, the outermost protective layer of the tooth. Demineralization is the process by which minerals, primarily calcium and phosphate, are leached from the tooth enamel, weakening its structure and making it more susceptible to further breakdown. If the acidic environment persists, the demineralization process continues, eventually leading to cavitation, or the formation of a cavity, in the tooth. Prolonged bottle feeding, particularly with sweetened liquids, creates a conducive environment for caries development. When infants and young children are allowed to fall asleep with a bottle containing milk, formula, juice, or other sweetened beverages, the fermentable carbohydrates in these liquids pool around the teeth, providing a readily available source of energy for cariogenic bacteria. The prolonged exposure of teeth to these fermentable carbohydrates, coupled with the reduced salivary flow that occurs during sleep, creates a perfect storm for demineralization and caries progression. Saliva plays a crucial role in maintaining oral health by neutralizing acids, remineralizing enamel, and clearing away food debris. However, during sleep, salivary flow decreases, reducing its protective capacity and allowing acids to linger in the oral cavity, attacking the teeth. The addition of sweeteners to bottle contents further exacerbates the risk of caries development. Sweeteners, such as sugar, honey, and corn syrup, are highly fermentable carbohydrates that provide a readily available source of energy for cariogenic bacteria, accelerating acid production and demineralization. The consequences of prolonged bottle feeding can be severe, affecting a child's oral health, overall health, and well-being. Prolonged bottle feeding is a major risk factor for ECC, a prevalent and costly disease that can cause pain, infection, and tooth loss in young children. ECC can also have a negative impact on a child's growth and development, as well as their self-esteem and social development. Prolonged bottle feeding can also contribute to malocclusion, or misalignment of the teeth. The sucking action involved in bottle feeding can exert pressure on the developing jaws and teeth, potentially leading to orthodontic problems that may require corrective treatment. Prolonged bottle feeding can also affect a child's speech development. The prolonged use of a bottle can interfere with the development of the muscles and coordination needed for proper speech production. Prolonged bottle feeding can also lead to nutritional deficiencies, as children may consume less nutritious foods if they are constantly filling up on milk or formula. These deficiencies can have a negative impact on a child's growth and development. Prolonged bottle feeding has also been linked to an increased risk of obesity in childhood. Children who are bottle-fed for longer periods may consume more calories than they need, leading to weight gain. The findings of this study highlight the importance of educating parents about

the risks of prolonged bottle feeding and encouraging the transition to a cup by 12 months of age. This transition is crucial for promoting oral health and overall development. Early cup use allows children to develop the oral motor skills and coordination needed for proper speech production and chewing. It also reduces the risk of malocclusion and promotes healthy eating habits. The transition to cup use can be challenging for some families, as bottle feeding may be deeply ingrained in cultural practices and beliefs. However, healthcare providers can play a crucial role in providing guidance and support to parents, emphasizing the benefits of early cup use for oral health and overall development. Healthcare providers can use a variety of strategies to promote early cup use and discourage prolonged bottle feeding. Parents and caregivers should be educated about the risks of prolonged bottle feeding and the benefits of early cup use. This education should be provided during prenatal visits, well-child visits, and other healthcare encounters. Healthcare providers can model cup use during well-child visits and other interactions with families. Parents and caregivers should be praised for their efforts to transition their children to cup use. Healthcare providers can help families identify and address any challenges they may be facing in transitioning their children to cup use. Community-based programs can provide support and education to families about early cup use and other healthy feeding practices.[16-20]

4. Conclusion

This prospective cohort study investigated the critical link between early childhood feeding practices and the development of S-ECC in a cohort of children in Medan, Indonesia. The findings underscore the significant impact of early feeding practices on the development of S-ECC, highlighting key risk factors such as prolonged and nocturnal bottle feeding, especially with sweetened liquids, and frequent consumption of sugary snacks/drinks. Conversely, exclusive breastfeeding for the first six months demonstrated a protective effect against S-ECC, even after adjusting for socioeconomic factors and maternal oral health knowledge. These findings emphasize the importance of promoting exclusive breastfeeding for the first six months and educating mothers about appropriate feeding practices to prevent S-ECC in this population. This study contributes valuable insights to the understanding of S-ECC development in Medan, Indonesia, and similar settings. The results can inform targeted interventions and public health strategies aimed at promoting healthy feeding practices and reducing the burden of S-ECC in this population. Future research can build upon these findings by exploring the cultural and socioeconomic factors that influence feeding practices in this region, and by evaluating the effectiveness of interventions designed to promote healthy feeding behaviors and improve oral health outcomes in children.

5. References

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