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**THE RELATIONSHIP BETWEEN FORMULA MILK CONSUMPTION AND
 THE SEVERITY OF CARIES IN PRESCHOOL-AGED CHILDREN AT TK
 AISYIYAH BUSTANUL ATHFAL 42 SEMARANG**

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ABSTRACT

Background: The most common dental and oral disease in children is dental caries. The high prevalence rate of caries, which reaches 81.5% in children aged 3-4 years, is still a problem for Indonesia. One of the causes of the high incidence of caries in preschool children is improper breastfeeding or formula-feeding patterns. **Purpose:** This research aims to analyze the relationship between formula milk consumption and the severity of caries in preschool children at TK Aisyiyah Bustanul Athfal 42 Semarang. **Methods:** This study employs an observational-analytical design, specifically a cross-sectional approach. The population of this study were 71 children from Aisyiyah Bustanul Athfal 42 Kindergarten, Semarang. The sample in this study was 66 children. The research sample consisted of 66 respondents selected using a total sampling technique. Data were obtained from dental examinations using the deft index and questionnaires completed by parents/guardians. The data were analyzed using the chi-square test. **Results:** The study shows that the length, duration, and frequency of formula milk consumption, the use of bottles/pacifiers, the duration of teat/bottle use, the addition of sweeteners to formula milk, as well as the history of breastfeeding until the age of 2 years and the age at which formula milk was first consumed, all show a p-value <0.05, indicating a significant relationship with caries severity. **Conclusion:** there is a relationship between formula milk consumption patterns and the severity of caries in preschool children at TK Aisyiyah Bustanul Athfal 42 Semarang

Keywords: Dental caries, DMF-T/def-t, Formula milk, Preschool children

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INTRODUCTION

Formula milk is an industrially produced milk designed to meet nutritional needs and facilitate digestion (Angki & AR, 2020). However, formula milk can stimulate the growth of *Streptococcus mutans*, a bacterium associated with dental caries. This is due to its high sucrose content, which is considered the most cariogenic sugar as it is rapidly metabolized by bacteria. Oral bacteria convert glucose, fructose, and sucrose into lactic acid through glycolysis, a process known as fermentation. When this acid comes into contact with teeth, it can lead to demineralization. If demineralization persists, cavities may develop, making the teeth more vulnerable to caries (Afiat et al., 2023). Dental caries can significantly impact children's learning and daily activities, causing oral pain, difficulty chewing, eating problems, trouble sleeping, and reduced concentration (Apro et al., 2018).

The most common dental and oral disease is dental caries (Suratri et al., 2021). Dental caries affect the hard tissue of the teeth, leading to tissue damage that begins at the tooth surface and can extend to the pulp (Afrinis et al., 2020). Due to differences in morphology and structure, primary teeth are more susceptible to damage than permanent teeth (Kotsanos et al., 2022).

Dental caries can negatively impact children's development, reduce cognitive function, and, if left untreated, diminish their overall quality of life. Therefore, efforts to maintain oral health should begin as early as possible to prevent the occurrence of dental caries in children (Nugraheni et al., 2019).

According to the 2018 National Basic Health Survey (Riskesdas), dental caries was found in 88.8% of Indonesians, with a prevalence of 81.5% among children aged 3 to 4 years (Riskesdas, 2018). Data from the 2018 Riskesdas Central Java report indicate that 43.45% of children in Central Java had dental caries, with 38.4% of cases occurring in children aged 3 to 4 years. In Semarang, the prevalence of

dental caries was reported at 43.9% (Risksdas Central Java, 2018). In 2019, the average milk consumption in Indonesia was 16.23 liters per capita, reflecting an increase of 0.20 liters per capita compared to the previous year (Central Statistics Agency, 2019). In 2020, Johnny Angki and Sainuddin conducted a study on 50 children aged 4 to 6 years at Panca Marga Kindergarten, West Tanete Riattang, Bone Regency. Their findings revealed that 48% of the children consumed formula milk and experienced dental caries (Angki & AR, 2020).

Jingga's research (2019) found that 66 students at Prince Diponegoro Islamic Kindergarten were at risk of developing dental caries due to prolonged consumption of formula milk. The study also revealed that consuming formula milk for more than two years increased the risk of dental caries by 7.718 times (Jingga et al., 2019).

This study aimed to examine the relationship between formula milk consumption and the severity of dental caries in preschool-aged children at Aisyiyah Bustanul Athfal 42 Kindergarten, Semarang. The findings of this research will contribute up-to-date information and relevant data for academics and researchers in this field.

METHODS

This study employs an observational-analytical design, specifically a cross-sectional approach. A cross-sectional research design examines the correlation between exposure or risk factors (independent variables) and their consequences or effects (dependent variables), with data collection conducted simultaneously at a single point in time. This approach ensures that both independent and dependent variables are observed at the same time (point-time approach) (Maturoh et al., 2018). This research has been reviewed and approved by the Health Research Ethics Commission, Faculty of Nursing and Health Sciences, Muhammadiyah University, Semarang, under approval number 339/KE/12/2023.

The study population consisted of 71 children from Aisyiyah Bustanul Athfal 42 Kindergarten, Semarang, with a final sample of 66 children who met the inclusion criteria. The sample was selected using a total sampling technique, considering both the inclusion and exclusion criteria of the study.

The inclusion criteria for this study were preschool-aged children whose parents had provided informed consent. The exclusion criteria included students who were absent during the study and children who were uncooperative during data collection. This research was conducted at Aisyiyah Bustanul Athfal 42 Kindergarten, Semarang, from August 2023 to February 2024.

The data sources included primary data obtained from respondents' answers to questionnaires on formula milk consumption patterns and dental caries incidence, assessed using the DMF-T/def-t index. Secondary data consisted of student records from Aisyiyah Bustanul Athfal 42 Kindergarten, Semarang, obtained from the attendance book. Data analysis was conducted using univariate and bivariate methods to test the research hypothesis with a statistical software program (Notoatmodjo, 2014). The chi-square (X^2) test was used for analysis, with a significance level set at $\alpha = 0.05$.

RESULTS

1. Characteristics of Research Subjects

Table 1. Characteristics of respondents

Gender	Frequency	Percentage
Man	25	37.9
Woman	41	62.1
Total	66	100

Table 1 shows that among the 66 study respondents, the majority were female (41 respondents, 62.1%), while 25 respondents (37.9%) were male.

2. Univariate Test Results

a. Consumption of Formula Milk

Table 2. Consumption of formula milk

Characteristics / Categories	N	Frequency Distribution	
		Frequency	Presentation
Duration of Formula Milk Consumption			
<1 Year	66	8	12.1
1-3 Year		23	34.8
>3 Year		35	53.0
Duration of Formula Milk Consumption			
<10 Minute	66	31	47.0
10-15 Minute		22	33.3
>15 Minute		13	19.7
Frequency of Formula Milk Consumption			
<1 Time	66	5	7.6
2-3 Time		31	47.0
>3 Time		30	45.5
Use of bottles/pacifiers when consuming formula milk			
Never	66	16	24.2
Seldom		21	31.8
Often		29	43.9
Duration of Bottle/Dot Use When Consuming Formula Milk			
0-1 Year	66	16	24.2
1-3 Year		22	33.3
>3 Year		28	42.4
Adding Sweeteners to Formula Milk Consumption			
No	66	51	77.3
Yes		15	22.7
History of Breastfeeding up to Age 2 Years			
Just breast milk	66	15	22.7
Just formula milk		14	21.2
Breast milk + formula milk		37	56.1
Early History of Consuming Formula Milk			
<1 Year	66	30	45.5
1-3 Year		23	34.8
>3 Year		13	19.7

Based on Table 2, the majority of children in the study consumed formula milk for more than three years (35 children, 53.0%), which was higher than the <1 year and 1–3 year categories. In terms of the duration of formula milk consumption per feeding, the <10 minutes category had the highest number of children (31 children, 47.0%), compared to the 10–15 minutes and >15 minutes categories. Regarding the frequency of formula milk consumption, the 2–3 times per day category was the most common (31 children, 47.0%), exceeding the <1 time per day and >3 times per day categories. The use of bottles or pacifiers during formula milk consumption was most frequent in the "often" category (29 children, 43.9%), compared to the "never" and "rarely" categories. In terms of the duration of pacifier or bottle use, children in the >3 years category had the highest proportion (28 children, 42.4%), compared to the 0–1 year and 1–3 year categories. Additionally, the majority of children did not have sweeteners added to their formula milk (51 children, 77.3%). Regarding breastfeeding history, the combination of breast milk and formula milk was the most common feeding pattern (37 children, 56.1%), compared to exclusive

breastfeeding and exclusive formula feeding. Lastly, the majority of children began consuming formula milk before the age of one year (30 children, 45.5%), which was higher than the 1–3 years and >3 years categories.

b. The incidence of dental caries

Table 3. Incidence of dental caries

Caries Severity Level	Frequency	Percentage (%)
Very Low	7	10.6
Low	7	10.6
Moderate	15	22.7
High	12	18.2
Very High	25	37.9
Total	66	100.0

Table 3 indicates that the majority of respondents had a very high level of caries severity (37.9%), while a smaller proportion had low or very low severity levels (each 10.6%).

3. Bivariate Test Results

Table 4. Relationship Between the Duration of Formula Milk Consumption and the Severity of Dental Caries

Duration of Formula Milk Consumption	Caries Severity Level										Total	P- value	
	Very Low		Low		Moderate		High		Very High				
	n	%	n	%	n	%	n	%	n	%	n		%
<1 Year	1	12.5	2	25.0	1	12.5	3	37.5	1	12.5	8	100	0.002
1-3 Year	2	8.7	2	8.7	11	47.8	5	21.7	3	13.0	23	100	
>3 Year	4	11.4	3	8.6	3	8.6	4	11.4	25	37.9	35	100	

Based on table 4, it shows that respondents who consumed formula milk for >3 years had a higher percentage than the others, namely 35 respondents with a caries severity level of very low 11.4%, low 8.6%, medium 8.6%, high 11.4%, very high 37.9%. The chi-square analysis yielded a p-value of 0.002, which is <0.05, indicating a significant relationship between the duration of formula milk consumption and the severity of caries.

Table 5. Relationship Between the Duration of Formula Milk Consumption and Caries Severity

Duration of formula milk consumption	Caries Severity Level										Total	p- value	
	Very Low		Low		Moderate		High		Very High				
	n	%	n	%	n	%	n	%	n	%	n		%
<10 minute	5	16.1	4	12.9	10	32.3	6	19.4	6	19.4	31	100	0.020
10-15 minute	2	9.1	2	9.1	5	22.7	5	22.7	8	36.4	22	100	
>15 minute	0	0.0	1	7.7	0	0.0	1	7.7	11	84.6	13	100	

Based on table 5, it shows that research respondents who consumed formula milk for more than 15 minutes per session had a very high caries severity rate (84.6%). This shows that the level of oral health knowledge is in the medium category. The results obtained from the chi-square analysis test show a p-value of 0.020, this value is <0.05, so it can be concluded that there is a relationship between the duration of formula milk consumption and the severity of caries.

Table 6. Relationship Between Frequency of Formula Milk Consumption and Caries Severity

Frequency of formula milk consumption	Caries Severity Level										Total	p-value	
	Very Low		Low		Moderate		High		Very High				
	n	%	n	%	n	%	n	%	n	%	n	%	
1 time	2	40.0	2	40.0	0	0.0	1	20.0	0	20.0	5	100	0.002
2-3 time	4	12.9	3	9.7	12	38.7	5	16.1	7	22.6	31	100	
>3 time	1	3.3	2	6.7	3	10.0	6	20.0	18	60.0	30	100	

Based on table 6, it shows that the majority of respondents have a frequency of consuming formula milk >3 times a day, namely 18 respondents have a very high caries severity level of 60.0%. The results obtained from the chi-square analysis test show a p-value of 0.002, this value is <0.05, so it can be concluded that there is a relationship between the frequency of formula milk consumption and the severity of caries.

Table 7. Relationship between bottle/pacifier use and formula milk consumption with the severity of caries

Use of bottles/pacifiers when consuming formula milk	Caries Severity Level										Total	P- value	
	Very Low		Low		Moderate		High		Very High				
	n	%	n	%	n	%	n	%	n	%	n	%	
Never	5	31.3	1	6.3	5	31.3	1	6.3	4	25.0	16	100	0.000
Seldom	1	4.8	3	14.3	5	23.8	9	42.9	3	14.3	21	100	
Often	1	3.4	3	10.3	5	17.2	2	6.9	18	62.1	29	100	

Based on table 7, it shows that the majority of respondents who often use bottles/pacifiers when consuming formula milk, 18 respondents, have a very high caries severity level of 62.1%. The results obtained from the chi-square analysis test show a p-value of 0.000, this value is <0.05, so it can be concluded that there is a relationship between the use of bottles/pacifiers in formula milk consumption and the severity of caries.

Table 8. Relationship Between Duration of Bottle/Pacifier Use for Formula Milk Consumption and Caries Severity

Length of use of bottles/pacifiers when consuming formula milk	Caries Severity Level										Total	p-value	
	Very Low		Low		Moderate		High		Very High				
	n	%	n	%	n	%	n	%	n	%	n	%	
0-1 Year	4	25.0	2	12.5	5	31.3	1	6.3	4	25.0	16	100	0.006
1-3 Year	1	4.5	3	13.6	9	40.9	5	22.7	4	18.2	22	100	
>3 Year	2	7.1	2	7.1	1	3.6	6	21.4	17	60.7	28	100	

Based on Table 8, the majority of respondents who used bottles or pacifiers for formula milk consumption for more than three years (17 respondents) had a very high caries severity level of 60.7%. The chi-square analysis yielded a p-value of 0.006, which is <0.05, indicating a significant relationship between the duration of bottle/pacifier use for formula milk consumption and caries severity.

Table 9. Relationship Between Added Sweeteners in Formula Milk and Caries Severity

Adding sweeteners/sugar to formula milk consumption	Caries Severity Level										Total	p- value	
	Very Low		Low		Moderate		High		Very High				
	n	%	n	%	n	%	n	%	n	%	n	%	
No	6	11.8	7	13.7	15	29.4	7	13.7	16	31.4	51	100	0.020
Yes	1	6.7	0	0.0	0	0.0	5	33.3	9	60.0	15	100	

Based on Table 9, the majority of respondents who added sweeteners or sugar to formula milk (9 respondents) had a very high caries severity level of 60.0%. The chi-square analysis yielded a p-value of 0.020, which is <0.05, indicating a significant relationship between the addition of sweeteners in formula milk and caries severity.

Table 10. Relationship Between Breastfeeding History Up to Two Years of Age and Caries Severity

History of breast milk consumption up to 2 years of age	Caries Severity Level										Total	P-value	
	Very Low		Low		Moderate		High		Very High				
	n	%	n	%	n	%	n	%	n	%	n	%	
Just breast milk	3	20.0	3	20.0	4	26.7	3	20.0	2	13.3	15	100	0.026
Formula Milk Only	1	7.1	0	0.0	0	0.0	2	14.3	11	78.6	14	100	
Breast milk and formula milk	3	8.1	4	10.8	11	29.7	7	18.9	12	32.4	37	100	

Based on Table 10, the majority of respondents who exclusively consumed breast milk until the age of two years (4 respondents) had a moderate caries severity level of 26.7%. The chi-square analysis yielded a p-value of 0.026, which is <0.05, indicating a significant relationship between breastfeeding history up to the age of two years and caries severity.

Table 11. Relationship Between Age at the Start of Formula Milk Consumption and Caries Severity

History of the age at which formula milk was first consumed	Caries Severity Level										Total	p- value	
	Very Low		Low		Moderate		High		Very High				
	n	%	n	%	n	%	n	%	n	%	n	%	
<1 Year	2	6.7	2	6.7	5	16.7	3	10.0	18	60.0	30	100	0.007
1-3 Year	1	4.3	2	8.7	8	34.8	6	26.1	6	26.1	23	100	
>3 Year	4	30.8	3	23.1	2	15.4	3	23.1	1	7.7	13	100	

Table 11 shows that 18 respondents who started consuming formula milk before the age of one year had a very high caries severity rate of 60.0%. The chi-square analysis yielded a p-value of 0.007, which is <0.05, indicating a significant relationship between the age at which formula milk consumption began and caries severity.

DISCUSSION

1. Relationship Between Duration of Formula Milk Consumption and Caries Severity

The overall findings of this study indicate a significant relationship between formula milk consumption and caries severity in preschool-aged children at Aisyiyah Bustanul Athfal 42 Kindergarten, Semarang. The study found that the majority of respondents had been consuming formula milk for more than three years, with 37.9% experiencing a very high level of caries severity.

Chi-square analysis confirmed a significant association between the duration of formula milk consumption and caries severity. These findings align with a study by Jingga et al. (2019) on the relationship between formula milk consumption duration and caries severity. Their research found that children who consumed formula milk for less than two years had a very low incidence of dental caries, whereas those who consumed it for more than two years experienced moderate dental caries (Jingga et al., 2019). Carbohydrate-containing foods have physical properties that play a crucial role in caries formation. The longer these foods remain in contact with tooth enamel, the greater the risk of prolonged acid production in the oral cavity. Consequently, the degree of acid demineralization of the enamel is directly related to the duration of food attachment to the tooth surface (Jingga et al., 2019).

2. Relationship Between Duration of Formula Milk Consumption and Caries Severity

The study found that the majority of respondents who consumed formula milk for more than 15 minutes experienced a very high level of caries severity (84.6%). Chi-square analysis confirmed a significant relationship between the duration of formula milk consumption and caries severity. These findings align with a study by Lestari et al. (2022) on the relationship between consumption duration and caries severity. Prolonged exposure to sugar is a major trigger for caries development. After consuming sugary foods such as milk, bacteria produce acid that remains in the oral cavity for 20–40 minutes. This acid lowers the pH of the mouth, leading to the loss of mineral ions from tooth enamel (demineralization), which ultimately results in dental caries, as tooth enamel is highly sensitive to acid (Jingga et al., 2019).

3. Relationship Between Frequency of Formula Milk Consumption and Caries Severity

The study found that most respondents who consumed formula milk more than three times a day experienced a very high level of caries severity. Chi-square analysis confirmed a significant relationship between the frequency of formula milk consumption and caries severity. These findings align with a study by Afiat et al. (2023), which identified frequent formula milk consumption as a risk factor for dental caries. The study also found that children with a high frequency of formula milk intake had an increased risk of developing caries. The combination of formula milk—most brands of which contain sucrose—and poor oral hygiene contributes to dental caries. Sucrose is the most cariogenic sugar, as frequent consumption lowers plaque pH and promotes plaque formation. When carbohydrate-rich foods and sugary drinks are consumed excessively, the oral cavity remains in an acidic state, preventing proper remineralization of tooth enamel and ultimately leading to caries (Afiat et al., 2023).

4. Relationship Between Bottle/Pacifier Use and Caries Severity

The study found a significant association between bottle/pacifier use and caries severity. Among children who frequently used bottles or pacifiers for formula milk consumption, 62.1% exhibited a very high level of caries severity. These findings align with a study by Fauziah and Arin Proborini (2022) on the relationship between bottle/pacifier use and dental caries incidence. Drinking milk from a bottle without proper oral hygiene can lead to dental caries, as it creates an ideal environment for acid-producing bacteria that contribute to tooth decay, ultimately affecting the def-t index. When milk is consumed from a bottle just before bedtime, the residual milk acid accumulates under the tongue and around the mouth, lowering oral pH and increasing the risk of caries. Bottle-feeding-related caries are common in children who frequently consume sugary drinks, such as milk, fruit juice, and soft drinks, especially before bedtime. Prolonged contact between tooth surfaces and sugar-containing liquids leads to a distinctive pattern of cavities (Nugroho, 2020).

5. Relationship Between the Duration of Bottle/Pacifier Use for Formula Milk Consumption and Caries Severity

The study results indicated that the majority of respondents used bottles or pacifiers for formula milk consumption for more than three years, with 60.7% experiencing a very high level of caries severity. The chi-square analysis confirmed a significant relationship between the duration of bottle/pacifier use and the severity of caries. These findings are consistent with a study conducted by Lestari et al. (2022) on the timing of bottle milk consumption and its association with caries risk in children. The prolonged use of milk bottles or pacifiers for formula feeding is a common cause of caries in toddlers. The longer a child consumes formula milk from a bottle, the more frequently carbohydrate substrates (such as sugar, sucrose, and glucose) are fermented by bacteria, leading to acid production, a decrease in saliva pH, and plaque formation. This can be prevented by encouraging children to drink water and brush their teeth after consuming milk (Hilmiah et al., 2021).

6. Relationship Between Sweetener Addition to Formula Milk and Caries Severity

The study revealed that among the respondents who added sweeteners or sugar to formula milk, 60.0% experienced a very high level of caries severity. Chi-square analysis shows that there is a relationship between the addition of sweeteners to formula milk consumption and the severity of caries. Results of this research are in line with the research conducted by (Jingga et al., 2019) regarding the addition of sweeteners/sugar to formula milk consumption and the severity of caries. The concentration and amount of added sugar used in food and drinks also has a significant relationship in the process of dental caries in children. The higher the sugar concentration, the greater the possibility that the sugar can penetrate into dental plaque quickly and be metabolized by bacteria in dental plaque to produce lactic acid which is the main factor causing caries in teeth before it can be effectively neutralized by saliva through the buffer system. (Jingga et al., 2019).

7. Relationship Between Breastfeeding History Up to Two Years of Age and Caries Severity

There were 37 respondents with a history of breastfeeding up to the age of two years, of whom 32.4% experienced a very high level of caries severity. Chi-square test results confirmed a significant relationship between breastfeeding history up to the age of two years and caries severity. These findings align with a study by Hafizhah et al. (2022) on the association between prolonged breastfeeding and dental caries incidence. Sucrose introduced early in infancy influences food preferences and increases the risk of health problems, both in the long term—such as obesity—and in the short term, including dental caries. If sucrose and glucose remain on the teeth without proper cleaning, oral microorganisms ferment them into acid through glycolysis. *Lactobacillus* and *Streptococcus mutans* are the primary bacteria involved in this process. The acid produced by glycolysis dissolves tooth enamel, leading to demineralization. This process begins with white-spot lesions on the teeth, eventually progressing to dentin damage and the development of caries (Agustini & Parmasari, 2021).

8. Relationship Between Age at First Formula Milk Consumption and Caries Severity

The study found that the majority of respondents who started consuming formula milk before the age of one year exhibited a very high level of caries severity (60%). Chi-square analysis confirmed a significant relationship between the age at which formula milk consumption began and caries severity. Sucrose introduced early in infancy influences food preferences and increases the risk of health problems, including dental caries. If sucrose and glucose remain on the teeth without proper cleaning, oral microorganisms ferment them into acid through glycolysis. *Lactobacillus* and *Streptococcus mutans* are the primary bacteria involved in this process. The acid produced by glycolysis dissolves tooth enamel, leading to demineralization. This process begins with white-spot lesions on the teeth and progresses to dentin damage, eventually resulting in caries (Agustini & Parmasari, 2021). The morphology of the mandibular primary first molar has a larger mesiodistal width and deeper grooves compared to the maxillary primary first molar, facilitating plaque accumulation. The increased affinity of *S. mutans* for primary molars is due to the occlusal surface's concave fissures and close proximal contacts. Extensive bacterial colonization in these areas contributes to the development of dental caries (Baihaqi et al., 2021).

Based on the research findings and discussion, it can be concluded that formula milk consumption is significantly associated with the severity of caries in preschool-aged children at Aisyiyah Bustanul Athfal 42 Kindergarten, Semarang.

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