The Impact of Sugar Intake, Household Income, and Maternal Education on the Occurrence of Dental Caries in Children: A Meta-Analysis

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ABSTRACT

Background: In Indonesia, the prevalence of dental caries in early childhood is still very high, around 93%. This study aims to analyze and estimate the magnitude of the relationship between sugar consumption, family income, and maternal education and the incidence of dental caries in children, through a meta-analysis of primary studies conducted by previous authors.

Subjects and Method: This study is a systematic review and meta-analysis using PICO as follows, Population: children aged 1 to 5 years 11 months, Intervention: high sugar consumption, high family income, high maternal education, Comparison: low sugar consumption, low family income, low maternal education, and Outcome: dental caries. The articles used in this study were obtained from three databases, namely PubMed, Google Scholar, and Science Direct, using the keywords "Sugar" OR "Sweet food" AND "Household income" OR "Parental income" AND "Parental education" OR "Education status" AND "Dental caries" AND "Child" OR "Children" AND "Cross-sectional" AND "aOR". The included articles were full-text in English, with a cross-sectional study design from 2013 to 2023, and reported adjusted Odds Ratio (aOR) in multivariate analysis. Article selection was carried out using the PRISMA diagram and analyzed using the ReMan 5.3 application.

Results: A total of 11 cross-sectional were selected for meta-analysis. Children who frequently consume sugar have an increased risk of dental caries 1.50 times compared to children who rarely consume sugar, and this is statistically significant (aOR=1.50; 95% CI=1.32 to 1.70; p<0.001). Children from families with high incomes had a reduced risk of dental caries 0.65 times compared to children from families with low incomes, and this was statistically significant (aOR=0.65; 95% CI=0.59 to 0.71; p<0.001). Children who have highly educated mothers have a reduced risk of dental caries 0.71 times compared to children who have mothers with low education, and this is statistically significant (aOR=0.71; 95% CI=0.64 to 0.78; p<0.001).

Conclusion: Sugar consumption statistically significantly increases the incidence of dental caries in children. High family income and high maternal education statistically significantly reduce the incidence of dental caries in children.

Keywords: sugar consumption, family income, mother's education, child, dental caries.

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BACKGROUND

Dental caries is still a major dental and oral health problem because it is the most common disease throughout the world. According to WHO, it is estimated that 2 billion people worldwide experience permanent tooth caries and more than 514 million children experience primary tooth caries (WHO, 2022). Caries that are often experienced by children under 6 years of age is usually called Early Childhood Caries (ECC) or early childhood caries (Utomo et al., 2023). Early childhood caries is characterized by one or more tooth decay (non-cavitating or pitted lesions), missing or filled (due to caries) tooth surfaces in primary teeth. This disease develops faster than caries in permanent teeth (Phantumvanit et al., 2018).

The impact of early childhood caries can affect children's health in general and contribute to their quality of life (Nursani et al., 2017). Children who suffer from dental caries will experience pain, teeth alignment problems, difficulty chewing, speech problems, and can also increase the risk of caries developing in permanent teeth (Meyer and Enax, 2018). The results of Basic Health Research in 2018 show that the prevalence of cavities in early childhood is still very high, namely around 93%, meaning that only 7% of Indonesian children are free from dental caries (Indonesian Ministry of Health, 2018).

Dental caries is a complex, multifactorial chronic disease. Four basic components cause dental caries, namely host (teeth), substrate (carbohydrates), microorganisms (bacteria), and time (Laksmiastuti et al., 2019). Dental caries is caused by plaque bacteria which can produce acid through carbohydrate fermentation. The acid produced causes demineralization of the hard tissue structure of the teeth which begins with the formation of white spots on the surface of the teeth which will turn brown and over time a cavity will form (Almujadi and Taadi, 2017).

Children's habits of eating solid and sticky foods and sweet drinks at inappropriate times can cause dental caries (Sudarsini et al., 2020). Cariogenic microorganisms metabolize sugar to produce acids, which contribute to the demineralization of tooth hard tissue (Anil and Anand, 2017). Based on research by Olczak-Kowalczyka et al., (2021) in Poland, Li et al., (2020) in Southern China, and Chouchene et al., (2022) in Tunisia, consumption of cariogenic foods is significantly related to the incidence of caries teeth in preschool children.

Another factor that plays a role in the occurrence of dental caries is socio-economic level (Aprilia et al., 2022). Dental caries is more often found in children from families with low income, or parents with a low level of education. Income has a direct influence on medical care, if income increases, the budget for dental health care also increases (Li et al., 2017). Someone with a high level of education will find it easier to absorb information and apply it in everyday life; for example, they can practice maintaining healthy teeth, thereby reducing the risk of dental caries (Tanaka et al., 2013). Ghasemianpour et al., (2019) study in Iran reported that parents' socio-economic status has a large role in children's dental caries experience. Ellakany et al., (2021) study in Saudi Arabia reported that parents with low education and low monthly income influenced the higher prevalence of dental caries in their children.

Based on the background above and several similar previous study findings regarding sugar consumption, family income, and maternal education which can influ-

ence the incidence of dental caries, researchers are interested in conducting a research study using a systematic review and meta-analysis that can summarize several study results. previous primers to combine the results and obtain more precise estimates from which to draw new conclusions. This study aims to analyze and estimate the magnitude of the relationship between sugar consumption, family income, and maternal education with the incidence of dental caries in children.

SUBJECTS AND METHOD

1. Study Design
This study used systematic review and meta-analysis methods, with PRISMA guidelines and the PICO model. Population: children aged 1 to 5 years 11 months. Intervention: high sugar consumption, high family income, high maternal education. Comparison: low sugar consumption, low family income, low maternal education. Outcome: dental caries. Articles are collected from databases such as PubMed, Google Scholar, and Science Direct. Literature search using the keywords "Sugar" OR "Sweet food" AND "Household income" OR "Parental income" AND "Parental education" OR "Education status" AND "Dental caries" AND "Child" AND "Cross-sectional" AND " aOR".

2. Steps of Meta-Analysis
1) Create research questions using the PICO model, which involves defining the Population, Intervention, Comparison, and Outcome.
2) Search for primary study articles from electronic databases such as Google Scholar, PubMed, and Science Direct
3) Screening articles with Critical Appraisal assessment of primary research.
4) Extract data and enter impact estimates from each primary study into RevMan 5.3.

5) Conducting interpretation and conclusion of study results.

3. Inclusion Criteria
Full text primary study article in English with cross-sectional study design, analysis using multivariate with adjusted Odds Ratio (aOR), outcome is dental caries.

4. Exclusion Criteria
Articles published before 2013, anonymous studies and studies that do not have clearly verifiable data.

5. Operational Definition of Variables
Dental caries: damage to hard tooth tissue caused by acids resulting from the interaction of cariogenic microorganisms, hosts, and substrates over a certain period of time.

Sugar consumption: frequency of consumption of sweet foods or drinks that can cause dental caries.

Family income: total fixed and side income of the head of the family, mother and other family members in 1 month.

Maternal education: the last level of formal education completed by the mother.

6. Study Instruments
The instrument used in this research is the Critical Appraisal Check-list for Cross-Sectional study published by Murti in 2023.

7. Data Analysis
The studies that have been collected are selected using predetermined criteria, then the results of the studies will be analyzed based on variations between studies with fixed effect models and random effect models using RevMan 5.3 software. issued by the Cochrane Collaboration. RevMan software functions to calculate the overall aOR value by describing the 95% Confidence Interval using an effect model and also data heterogeneity.

RESULTS

Articles in this study were searched through databases such as PubMed, Google Scholar, and Science Direct. The article review process can be seen in the PRISMA flow diagram in Figure 1. The initial search process obtained 4,108 articles, then article selection was carried out so that the final results for articles that met the requirements were 11 articles and could be included in the meta-analysis study. Figure 2 showed map of the study area included in study.
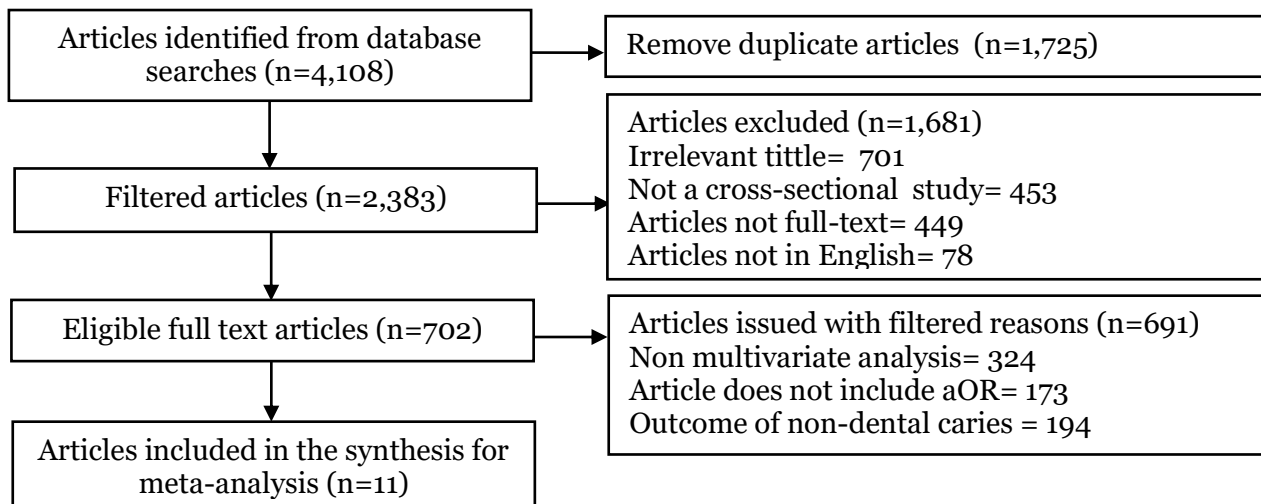
Articles identified from database searches (n=4,108) → Remove duplicate articles (n=1,725)

Filtered articles (n=2,383) →
Articles excluded (n=1,681)
Irrelevant tittle= 701
Not a cross-sectional study= 453
Articles not full-text= 449
Articles not in English= 78

Eligible full text articles (n=702) →
Articles issued with filtered reasons (n=691)
Non multivariate analysis= 324
Article does not include aOR= 173
Outcome of non-dental caries = 194

Articles included in the synthesis for meta-analysis (n=11)

Figure 1. PRISMA flowchart

Figure 2. Map of the distribution of articles included in the meta-analysis

Table 1. The Critical Appraisal of Articles with a Cross-Sectional Study

Authors (Year)	Criteria													Total
	1a	1b	1c	1d	2a	2b	3a	3b	4	5	6a	6b	7	
AlMarshad et al. (2021)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Fernandes et al. (2022)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Gibbs et al. (2016)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Kato et al. (2017)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Laksmiastuti et al. (2019)	2	2	2	2	2	1	2	2	1	2	2	2	2	24

Authors (Year)	Criteria													Total
	1a	1b	1c	1d	2a	2b	3a	3b	4	5	6a	6b	7	
Li et al. (2017)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Li et al. (2020)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Luz et al. (2020)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Nakayama and Mori (2015)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Olczak-Kowalczyk et al. (2021)	2	2	2	2	2	1	2	2	1	2	2	2	2	24
Pinto-Sarmento et al. (2016)	2	2	2	2	2	1	2	2	1	2	2	2	2	24

Description of question criteria:

1a. Is the population in the primary study the same as the population in the PICO meta-analysis?

1b. Is the operational definition of the intervention, i.e. exposed status in the primary study the same as the definition intended in the meta-analysis?

1c. Is the comparison, i.e. unexposed status used by the primary study the same as the definition intended in the meta-analysis?

1d. Are the outcome variables studied in the primary study the same as the definitions intended in the meta-analysis?

2a. In analytical cross-sectional studies, did researchers randomly select samples from the population (random sampling)?

2b. Alternatively, if in an analytically cross-sectional study, the sample was not randomly selected, did researchers select the sample based on outcome status or based on intervention status?

3a. Were both exposure and outcome variables measured with the same instruments in all primary studies?

3b. If variables were measured on a categorical scale, were the cutoffs or categories used the same across primary studies?

4. If the sample was not randomly selected, had the researcher made efforts to prevent bias in choosing the study subject? For example, selecting subjects based on outcome status was not affected by exposure status (intervention), or in selecting subjects based on exposure status (intervention) was not affected by outcome status.

5. Whether the primary study researcher has made efforts to control for the influence of confusion (e.g., performing a multivariate analysis to control for the influence of several confounding factors)

6a. Did the researchers analyze the data in this primary study with multivariate analysis models (e.g., multiple linear regression analysis, multiple logistic regression analysis)

6b. Whether the primary study reports effect size or the association of the results of the multivariate analysis (e.g., adjusted OR, adjusted regression coefficient)

7. Is there no possibility of a conflict of interest with the research sponsor, which causes bias in concluding research results?

Description of Scoring:
Yes=2; Hesitate=1; No=0

Table 2. Description of primary study articles included in the meta-analysis study (N= 17,484)

Author (year)	Country	Sample	P	I	C	O
AlMarshad et al. (2021)	Saudi Arabia	383	Age child 36 to 71 months	Sweets > 1 time/ day	Candy 1 time/ day	Dental caries
Fernandes et al. (2022)	Brazil	759	Age child 1 to 5 years	>2 BMWW	≤ 2 BMWW	Dental caries
Gibbs et al. (2016)	Australia	630	Age child 1 to 4 years	Sweet drinks several times/ day, trade education	Several times/ week, primary education	Dental caries
Kato et al. (2017)	Japan	6,315	Age child 3 years	≥ ¥ 500,000, edu cation≥14 years	<¥333,333, education <13 years	Dental caries
Li et al. (2017)	China	1,727	Age child 3 to 5 years	Candy >1 time/day, ≥ 8,000 (RMB), >Primary school	Candy ≤1 time /day, < 8000 (RMB), None/ Primary	Dental caries
Laksmiastuti et al. (2019)	Indonesia	248	Age child 3 to 5 years	Frequent sugary drinks, high income, high education	Sugary drinks are rare, low-income, low education	Dental caries
Li et al. (2020)	China	2,592	Age child 3 to 5 years	Frequent sweet foods 7,690 to 25,000 yuan, edu-cation >9 years ≤12 years	Sweets are rare, < 7690 yuan, education ≤9 years	Dental caries
Luz et al. (2020)	Brazil	674	Age child 3 to 4 years	>5 BMWs	≤ 2 BMWs	Dental caries
Nakayama and Mori (2015)	Japan	1,675	Age child 18 to 23 months	Sweets ≥4 times/ week	Sweets ≤4 times/week	Dental caries
Olczak-Kowalczyk et al. (2021)	Poland	1,638	Age child 3 years	Sweet drinks ≥1 time/day, education >secondary	Drink sweet rare, education ≤secondary	Dental caries
Pinto-Sarment et al. (2016)	Brazil	843	Age child 3 to 5 years	>U$ 312.50, edu-cation >8 years	≤ U$ 312.50, education ≤8 years	Dental caries

Table 3. Adjusted odds ratio data of the relationship between sugar consumption and the incidence of dental caries in children

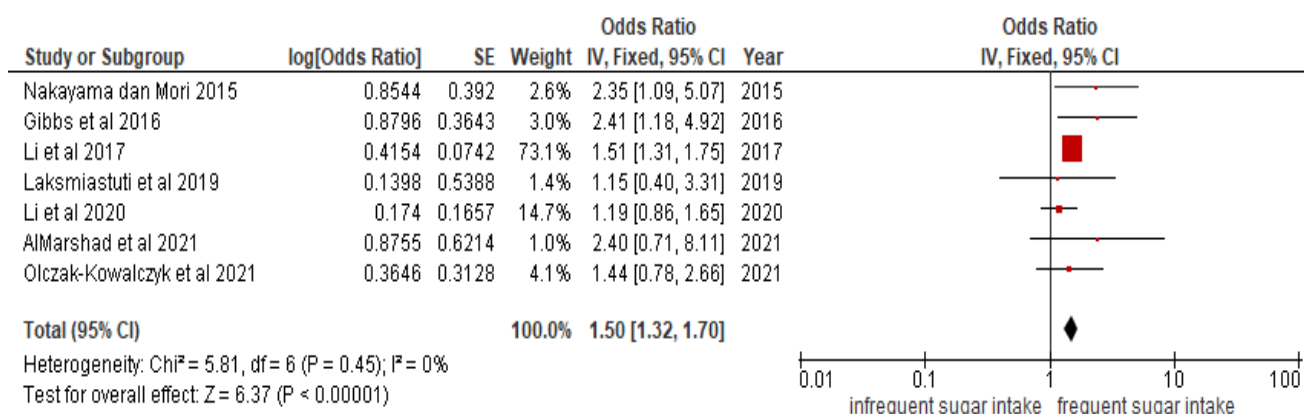| Author (Year)	aOR	CI 95%	
		Lower Limit	Upper Limit
Nakayama and Mori. (2015)	2.35	1.09	5.07
Gibbs et al. (2016)	2.41	1.18	4.95
Li et al. (2017)	1.51	1.31	1.75
Laksmiastuti et al. (2019)	1.15	0.40	3.31
Li et al. (2020)	1.19	0.86	1.65
AlMarshad et al. (2021)	2.40	0.71	8.11
Olczak-Kowalczyk et al. (2021)	1.44	0.78	2.66

Figure 3. Forest Plot of the relationship between sugar consumption and incidence of dental caries in children

Table 3 displays the statistical summary results of effect estimates with the highest aOR value, namely 2.41, and the lowest aOR value, namely 1.15. The 95% CI with the largest range is 0.71 to 8.11, while the smallest range is 1.31 to 1.75.

Figure 3 shows a forest plot of the relationship between sugar consumption and the incidence of dental caries in children, and it statistically significant. Children who frequently consume sugar have a risk of experiencing dental caries 1.50 times compared to children who rarely consume sugar (aOR=1.50; 95% CI= 1.32 to 1.70; p<0.001). The forest plot also shows low heterogeneity of effect estimates between primary studies (I^2=0%). Thus, the calculation of effect estimates was carried out using a fixed effect model approach.
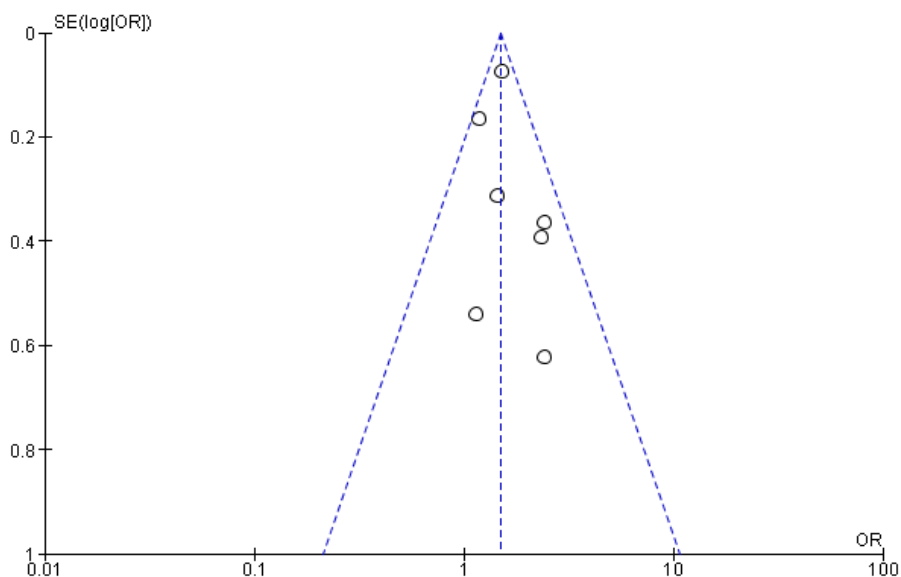

Figure 4. Funnel plot of the relationship between sugar consumption and incidence of dental caries in children

Figure 4 shows a slightly greater distribution of effect estimates located on the left than to the right of the average vertical line of effect estimates, thus indicating a slight

publication bias. Because the distribution of the effect estimate is more to the left of the average vertical line which is also the same as the location of the diamond in the forest plot which is also located on the left, the publication bias somewhat overestimates.

Table 4. Adjusted odds ratio data of the relationship between family income and the incidence of dental caries in children

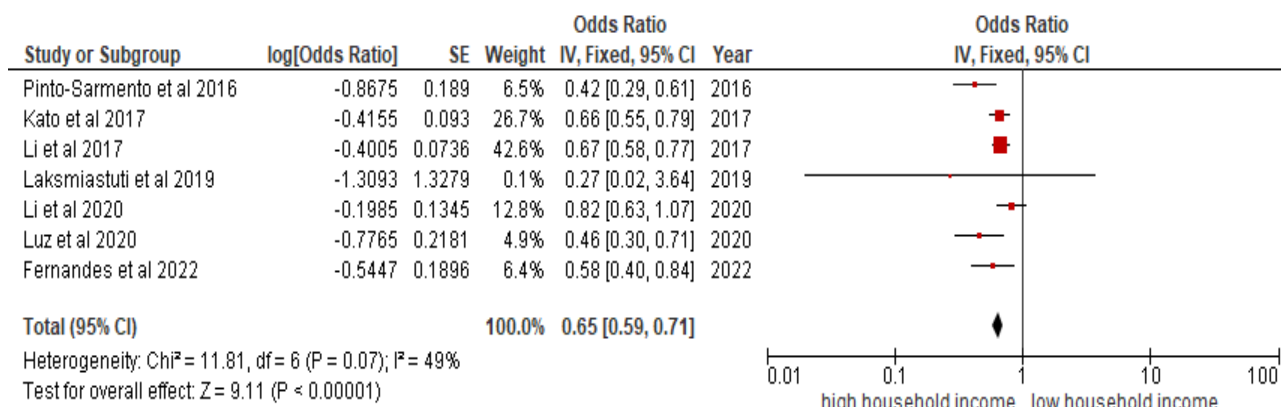| Author (Years)	aOR	95% CI	
		Lower Limit	Upper Limit
Pinto-Sarmento et al. (2016)	0.42	0.29	0.61
Kato et al. (2017)	0.66	0.55	0.79
Li et al. (2017)	0.67	0.58	0.77
Laksmiastuti et al. (2019)	0.27	0.02	3.64
Li et al. (2020)	0.82	0.63	1.07
Luz et al. (2020)	0.46	0.30	0.71
Fernandes et al. (2022)	0.58	0.40	0.84

Figure 5. Forest Plot of the relationship between family income and incidence of dental caries in children

Table 4 displays the statistical summary results of effect estimates with the highest aOR value, namely 0.82 and the lowest aOR value, namely 0.27. The 95% CI with the largest range is 0.02 to 3.64, while the smallest range is 0.58 to 0.77.

Figure 5 shows a forest plot of the relationship between family income and the incidence of dental caries in children, and this relationship is statistically significant.

Children from families with high incomes have a risk of experiencing dental caries 0.65 times compared to children from families with low incomes (aOR=0.65; 95% CI= 0.59 to 0.71; p<0.001).

The forest plot also shows low heterogeneity of effect estimates between primary studies (I^2=49%). Thus, the calculation of effect estimates was carried out using a fixed effect model approach.
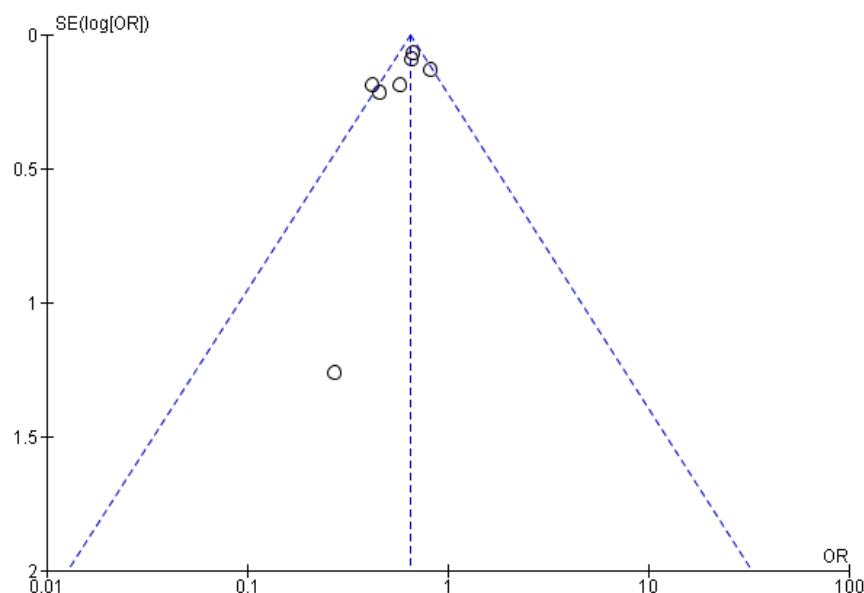
**Figure 6. Funnel plot of the relationship between family income
and incidence of dental caries in children**

In Figure 6 the funnel plot shows a more or less symmetrical distribution of effect estimates to the right and left of the vertical line of average effect estimates. Thus, the funnel plot does not indicate publication bias.

**Table 5. Adjusted odds ratio data of the relationship between maternal education
and the incidence of dental caries in children**

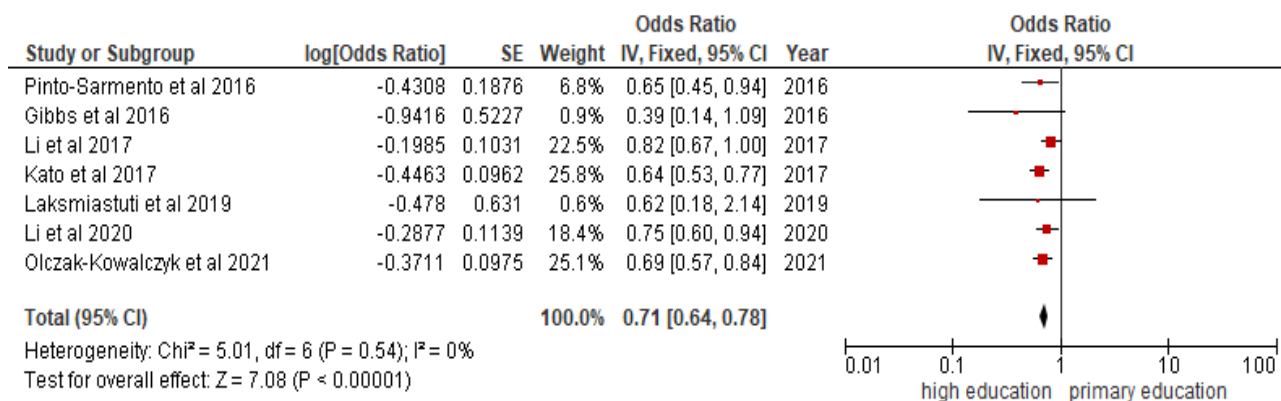| Author (Years)	aOR	95% CI	
		Lower Limit	Upper Limit
Pinto-Sarmento et al. (2016)	0.65	0.45	0.94
Gibbs et al. (2016)	0.39	0.14	1.09
Li et al. (2017)	0.82	0.67	1.00
Kato et al. (2017)	0.64	0.53	0.77
Laksmiastuti et al. (2019)	0.62	0.18	2.14
Li et al. (2020)	0.75	0.60	0.94
Olczak-Kowalczyk et al. (2021)	0.69	0.57	0.84

**Figure 7. Forest Plot of the relationship between maternal
education and incidence of dental caries in children**

Figure 7 shows children who have highly educated mothers have a risk of experiencing dental caries 0.71 times compared to children who have mothers with low education (aOR=0.71; 95% CI= 0.64 to 0.78; p<0.001).

The forest plot also shows low heterogeneity of effect estimates between primary studies (I²=0%). Thus, the calculation of effect estimates was carried out using a fixed effect model approach.
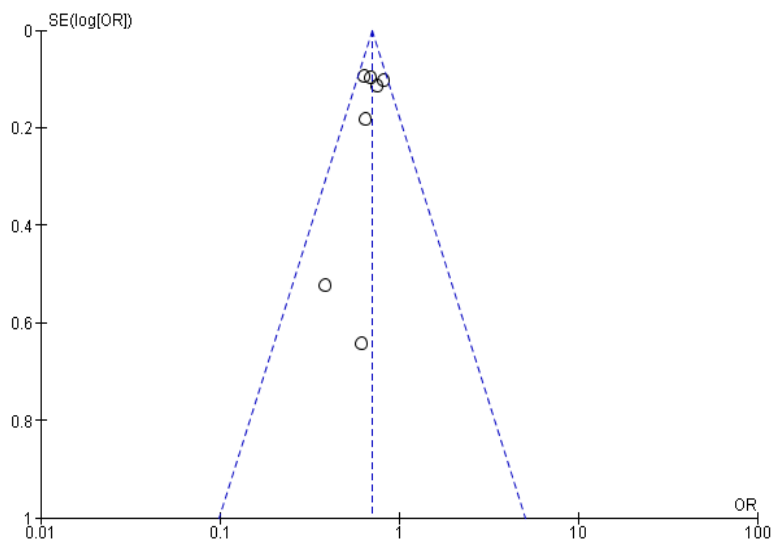

Figure 8. Funnel plot of the relationship between mother's education and incidence of dental caries in children

In Figure 8 the funnel plot shows a more or less symmetrical distribution of effect estimates to the right and left of the vertical line of average effect estimates. Thus, the funnel plot does not indicate publication bias.

<div style="text-align:center">DISCUSSION</div>

1. The relationship between sugar consumption and the incidence of dental caries in children

This study shows the results of the analysis that children who frequently consume sugar have an increased risk of dental caries 1.50 times compared to children who rarely consume sugar, and this relationship is statistically significant (aOR= 1.50; 95% CI= 1.32 to 1.70; p<0.001). The heterogeneity of the study data shows I²= 0% so that the data distribution is declared homogeneous (fixed effect model).

Sugar consumption greatly influences the incidence of dental caries in children. The habit of frequently consuming sugar can increase the incidence of dental caries in children, this result is in accordance with the hypothesis. Every time you consume fermented carbohydrate food, it causes a decrease in salivary pH which starts 5-15 minutes after consuming the food. (Ramayanti and Purnakarya, 2013).

This is supported by the study of Chouchene et al. (2022) who reported that children who often consume sweet drinks can increase the incidence of dental caries by 1.10 times compared to children who rarely consume sweet drinks (aOR= 1.10; 95% CI=1.67 to 2.83; p=0.009). Foods and drinks containing sugar will reduce the pH of plaque quickly, therefore frequent and repeated consumption of sugar will continue to keep the pH of plaque below normal and cause demineralization of tooth enamel.

The results of this study are also in line with Olczak-Kowalczyk et al. (2020) which states that children who during the first 2 years of life were given sweet foods had an increased incidence of dental caries by 2.96 times compared to children who were not given sweet foods (AOR= 2.96; 95% CI= 1.48 to 5.93; p=0.001).

This study is also in accordance with the meta-analysis study conducted by Sandy et al. (2023) which showed that children who consumed sweet foods more than 5 times a day had an increased risk of dental caries by 3.24 times compared to children who consumed sweet foods more than 2 times a day (AOR= 3.24; 95% CI=2.59 to 4.03).

Based on several theories from several supporting studies, this proves that there is a relationship between consuming sweet foods and the incidence of caries. The higher the frequency of children consuming sweet foods, the higher the incidence of caries. Pre-school children really like sweet foods but don't yet have the ability to brush their teeth clean, so the role of parents is really needed in directing children to choose healthy foods and accompanying children in caring for their teeth (Almutairi et al., 2022).

2. The relationship between family income and the incidence of dental caries in children

This study shows the results of the analysis that children from high-income families have a reduced risk of developing dental caries by 0.65 times compared to children from low-income families, and this relationship is statistically significant (aOR=0.65; 95% CI=0.59 to 0.71; p<0.001). The heterogeneity of the study data shows I^2=49% so that the data distribution is declared homogeneous (fixed effect model).

Family income can influence the incidence of dental caries in children. Children whose families have high incomes reduce the incidence of dental caries in children, this result is in accordance with the hypothesis. Income has a direct influence on medical care, if income increases, the budget for dental health care also increases. People who are at a low economic level or poor will find it difficult to get health services because they cannot afford to pay for these health services (Li et al., 2017).

This is supported by the study of Sun et al. (2017) who reported that a high annual family income has a risk of their children developing dental caries of 0.2 times compared to a low annual family income. High family income affects the family's ability to provide enough nutritious, low-sugar food as well as access to dental and oral health services.

This study is in accordance with the study of Liu et al. (2022) who reported that children from families with low incomes had a risk of dental caries of 1.45 times compared to children from families with high incomes.

This study is also in line with the study of Wulaerhan et al. (2014) which states that families with low incomes are 2.9 times more likely to experience dental caries in children than families with high incomes. This is in contrast to the study of Nunjung et al (2015), which states that there is no influence of family income on the incidence of dental caries. Children have a habit of consuming snacks and sweet foods that are packaged attractively and parents can buy them easily. This happens because parents do not have sufficient knowledge about the dangers of consuming sweet foods on children's dental health.

Children from low-income families often have diets characterized by poor nutrition and rich in sugar and fat, which makes children vulnerable to the development of caries and obesity. A diet rich in beverages and foods containing sugar, with a total of

more than 10% of total daily energy intake, is in fact strongly associated with an increase in the prevalence and index of caries universally (WHO, 2015).

A high income level indicates the family's ability to obtain access to dental health services and efforts to prevent the development of dental caries. Efforts to prevent dental caries can be made by regulating diet, fluoride, plaque control, maintaining oral hygiene, pit and fissure sealants, as well as periodic visits to the dentist in order to reduce the incidence of dental caries (Ramayanti and Purnakarya, 2013). According to Ellakany et al. (2021) middle class family income and not having insurance are significantly associated with a high prevalence of dental caries. Low economic levels have an impact on reducing the frequency of visits to the dentist, resulting in a lack of prevention and treatment of dental caries.

3. The relationship between maternal education and the incidence of dental caries in children

This study shows the results of the analysis that mothers with higher education reduce the risk of dental caries in children by 0.71 times compared to mothers with low education, and this relationship is statistically significant (aOR= 0.71; 95% CI= 0.64 to 0.78; p<0.001). The heterogeneity of the study data shows I^2= 0% so that the data distribution is declared homogeneous (fixed effect model).

Maternal education greatly influences the incidence of dental caries in children. Mothers with higher education reduce the incidence of dental caries in children, this result is in accordance with the hypothesis. According to Tanaka et al. (2013), someone with a high level of education will be more open to new things and more easily apply them in everyday life. Through education it will encourage someone to know something,

and influence someone to respond rationally to something that comes from outside. The simple application is that a mother with higher education will be more likely to know the importance of maintaining her child's dental health from an early age.

This is supported by the study of Ellakany et al. (2021) who reported that mothers with higher education had a risk of their children developing dental caries of 0.48 times compared to mothers with low education (aOR= 0.48; 95% CI=0.23 to 1.00; p=0.050).

This study is also in line with the study of Boonyawong et al. (2022) who reported that mothers with low education increased the risk of dental caries in children by 2 times compared to mothers with high education. Maternal education level was proven to be a significant predictor of the experience of dental caries, because mothers have a large influence on their children's oral health behavior, which includes feeding practices, food menu selection and tooth brushing. Therefore, a lack of education and oral health information has the potential to influence the dental health status of children (Sharma et al., 2019).

The study of Chouchene et al. (2022) also reported that mothers with higher education have a risk of dental caries in children of 0.8 times compared to mothers with low education (aOR=0.80; 95% CI=0.17 to 0.65). This study is also in accordance with the meta-analysis study conducted by Yousaf et al. (2022) who reported that mothers who only received primary education had a 25% higher chance of their children experiencing dental caries (aOR= 1.25; 95% CI= 1.02 to 1.54).

The higher a person's level of formal education, the better their knowledge and behavior regarding healthy living. Healthy behavior allows educated individuals to recognize symptoms of poor health at the

right time and seek appropriate medical help (Pradono and Sulistyowati, 2014). The mother's level of education has an influence on the way the mother educates, guides and supervises their children regarding maintaining good and correct dental and oral health (Ellakany et al., 2021).

This is in contrast to the study by Thwin et al. (2016) and Sun et al. (2017) which states that the mother's education level does not affect the dental health of their children. Mothers' knowledge and oral health attitudes about how to care for their children's teeth have a greater influence on reducing the risk of dental caries in their children. Good knowledge can motivate a person to behave and behave well regarding maintaining dental and oral health so that it will then influence the individual's dental and oral health status.

AUTHOR CONTRIBUTION
Arddha Maha Pawitra Dwi Puspita Dewi was the main researcher for this study who determined the topic, searched for articles and collected data, and wrote the article. Eti Poncorini Pamungkasari and Bhisma Murti analyzed and reviewed the study documents.

CONFLICT OF INTEREST
There is no conflict of interest in this study.

REFERENCES
AlMarshad LK, Wyne AH, AlJobair AM (2021). Early childhood caries prevalence and associated risk factors among Saudi preschool children in Riyadh. Saudi Dent J. 33(8):1084–1090.doi:10.1016/j.sdentj.2021.04.003

Almujadi T (2017). Hubungan pengetahuan kesehatan gigi dan mulut terhadap jumlah karies anak kelas III - V di SD Muhammadiyah Sangonan II Godean Yogyakarta. JKG. 4(1). doi: 10.31983/j-kg.v4i1.2710.

Almutairi S, Scambler S, Bernabé E (2022). Family functioning and dental caries among preschool children. J Public Health Dent. 82(4):406-414. doi:10.11-11/jphd.12475.

Anil S, Anand PS (2017). Early childhood caries: Prevalence, risk factors, and prevention. Front Pediatr. 5:157. doi: 10.3389/fped.2017.00157

Aprilia SD, Kumalasari VA, Utsani WS, Anasulfalah H (2022). Meta Analysis: Relationship between Obesity and Dental Caries in Children. J Epidemiol Public Healt, 7(2):196–203. doi: 10.2-6911/jepublichealth.2022.07.02.05.

Boonyawong M, Auychai P, Duangthip D (2022). Risk Factors of Dental Caries in Preschool Children in Thailand: A Cross-Sectional Study. Healthcare. 10(5):794. doi: 10.3390/healthcare10-050794

Chouchene F, Masmoudi F, Baaziz A, Maatouk F, Ghedira H (2022). Early childhood caries prevalence and associated risk factors in Monastir, Tunisia: a cross-sectional study. Front Public Health. 10:821128. doi: 10.338-9/fpubh.2022.821128

Ellakany P, Madi M, Fouda S M, Ibrahim M, Alhumaid J (2021). The effect of parental education and socioeconomic status on dental caries among saudi children. Int J Environ Res Public Health. 18(22): 11862. doi: 10.3390/-ijerph182211862

Fernandes IB, Ramos-Jorge J, Coelho VS, Pinto ACS, Pordeus IA, Paiva SM,

Ramos-Jorge ML (2022). Association between different stages of dental caries in preschoolers and familial socioeconomic factors. Braz Oral Res, 36:e018. doi: 10.1590/1807-3107bor-2022.vol36.0018.

Ghasemianpour M, Bakhshandeh S, Shirvani A, Emadi N, Samadzadeh H, Moosavi FN, Ghasemian A (2019). Dental caries experience and socio-economic status among Iranian children: A multilevel analysis. BMC Public Health. 19(1):1569. doi: 10.1186/s12889-019-7693-1.

Gibbs L, de-Silva AM, Christian B, Gold L, Gussy M, Moore L, Calache H, et al. (2016). Child oral health in migrant families: A cross-sectional study of caries in 1-4 year old children from migrant backgrounds residing in Melbourne, Australia. Community Dent Health. 33(2):100-106.

Kato H, Tanaka K, Shimizu K, Nagata C, Furukawa S, Arakawa M, Miyake Y (2017). Parental occupations, educational levels, and income and prevalence of dental caries in 3-year-old Japanese children. Environ Health Prev Med. 22(1):80. doi:10.1186/s12199-017-0688-6

Kemenkes RI (2018). Laporan Nasional Riskesdas 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan

Laksmiastuti SR, Astoeti T, Sutadi H, Budiardjo S (2019). Caries risk factors among children aged 3-5 years old in Indonesia. Contemp Clin Dent. 10(3): 507–511.doi: 10.4103/ccd.ccd_ 877_18

Li J, Fan W, Zhou Y, Wu L, Liu W, Huang S (2020). The status and associated factors of early childhood caries among 3 to 5-year-old children in Guangdong, Southern China: A provincial cross-sectional survey. BMC Oral Health. 20(1):265. doi:10.1186/s12903-020-0-1253-w

Li Y, Wulaerhan J, Liu Y, Abudureyimu A, Zhao J (2017). Prevalence of severe early childhood caries and associated socioeconomic and behavioral factors in Xinjiang, China: A cross-sectional study. BMC Oral Health. 17(1):144. doi: 10.1186/s12903-017-0432-z.

Liu M, Song Q, Xu X, Lai G (2022). Early childhood caries prevalence and associated factors among preschoolers aged 3-5 years in Xiangyun, China: A cross-sectional study. Front Public Health. 10: 959125. doi: 10.3389/fpubh.2022.959125.

Luz PB, Pereira JT, Knorst JK, Bonfadini I, Piva F, Scapinello M, Hugo FN, et al. (2020). The role of mother's knowledge, attitudes, practices in dental caries on vulnerly preschool children. Pesqui Bras Odontopediatria Clín Integr. 20: e4687. doi: 10.1590/-pboci.2020. 007.

Meyer F, Enax J (2018). Early childhood caries: epidemiology, aetiology, and prevention. Int J Dent. 2018:1415873. doi: 10.1155/2018/1415873.

Murti B. (2023). Critical Appraisal Checklist for Cross-Sectional Study. Magister Ilmu Kesehatan Masyarakat, Sekolah Pascasarjana Universitas Sebelas Maret.

Nakayama Y, Mori M (2015). Association between nocturnal breastfeeding and snacking habits and the risk of early childhood caries in 18-to 23-month-old Japanese children. J Epidemiol. 25(2):142–147. doi:10.2188/jea. JE20-140097.

Ngantung RA, Pangemanan DHC, Gunawan PN (2015). Pengaruh tingkat sosial ekonomi orang tua terhadap karies anak di TK Hang Tuah Bitung. E-Gigi. 3(2). doi: 10.35790 /eg.3.2.2015.10319

Nursani A R, Murti B, Pamungkasari E P.

(2017). Social Learning Theory on Factors Associated with Dental Caries among Mentally Disabled School Children in Surakarta, Central Java. J Epidemiol Public Health. 2(3).

Olczak-Kowalczyka D, Kaczmarek U, Gozdowski D, Kaczmarekc U (2021). Association of parental-reported vitamin D supplementation with dental caries of 3-year-old children in Poland: a cross-sectional study. Clin Oral Investig. 25(11): 6147–6158. doi: 10.1007/s00784-021-03914-8.

Olczak-Kowalczyk D, Gozdowski D, Kaczmarekc U (2020). Factors Associated with Early Childhood Caries in Polish. Oral Health Prev Dent. 18:833–841.

Phantumvanit P, Makino Y, Ogawa H, Rugg-Gunn A, Moynihan P, Petersen PE, Evans W, et al. (2018). WHO global consultation on public health intervention against early childhood caries. Community Dent Oral Epidemiol. 46(3): 280–287. doi: 10.1111/cdoe.12-362.

Pinto-Sarmento TC, Abreu MH, Gomes MC, Costa EM, Martins CC, Granville-Garcia AF, Paiva SM (2016). Determinant Factors of Untreated Dental Caries and Lesion Activity in Preschool Children Using ICDAS. PLoS One. 11(2):e0150116. doi: 10.1371/journal.pone.0150116.

Pradono J, Sulistyowati N (2014). Correlation between education level, knowledge of environmental health, healthy behavior with health status (correlation study on people aged 10–24 in Jakarta Pusat). Buletin Penelitian Sistem Kesehatan. 17(1): 89–95.

Ramayanti S, Purnakarya I (2013). Peran makanan terhadap kejadian karies gigi. J Kesehat Masyarakat Andalas. 7(2):89-93.

Sandy LPA, Helmyati S, Amalia R (2023). Nutritional factors associated with early childhood caries: A systematic review and meta-analysis. Saudi Dent J. doi: 10.1016/j.sdentj.2023.12. 001.

Sharma K, Gupta K, Gaur A, Sharma A, Pathania V, Thakur V (2019). A cross-sectional study to assess the prevalence of early childhood caries and associated risk factors in preschool children in district Mandi, Himachal Pradesh. J Indian Soc Pedod Prev Dent. 37(4): 339–344. doi: 10.4103/-JISPPD.JISPPD.

Sudarsini E, Wardhani PK, Supartinah A (2020). Pengaruh tingkat kariogenitas dan frekuensi makan terhadap tingkat keparahan early childhood caries pada anak usia 3-5 tahun dengan status sosial ekonomi rendah (kajian di PAUD Kecamatan Pulo Gadung Jakarta Timur. Universitas Gajah Mada.

Sun HB, Zhang W, Zhou XB (2017). Risk factors associated with early childhood caries. Chin J Dent Res. 20(2):97–104. doi: 10.3290/j.cjdr. a38274.

Tanaka K, Miyake Y, Sasaki S, Hirota Y (2013). Socioeconomic status and risk of dental caries in Japanese preschool children: the Osaka Maternal and child health study. J Public Health Dent. 73(3):217-23. doi:10.1111/jphd.12016.

Thwin KM, Zaitsu T, Ueno M, Kawaguchi Y (2016). Early childhood caries and related risk factors among Myanmar preschool children. Int J Clin Prev Dent. 12(4): 229–236. doi: 10.15236/-ijcpd.2016.12.4.229.

Utomo A I, Murti B, Pamungkasari E P. (2023). Meta-Analysis the Effectiveness of Fluoride Varnish Use to Prevent Deciduous Dental Caries in Children. J Epidemiol Public Healt, 8(2): 205–212. doi:10.26911/jepublichealth-

.2023.08.02.05.

WHO (2022). Oral health. World Health Organization.

WHO (2015). WHO calls on countries to reduce sugars intake among adults and children. World Health Organization.

Wulaerhan J, Abudureyimu A, Bao X L, and Zhao J (2014). Risk determinants associated with early childhood caries in Uygur children: A preschool-based cross-sectional study. BMC Oral Health. 14(1). doi: 10.1186/1472-6831-14-136.

Yousaf M, Aslam T, Saeed S, Sarfraz A, Sarfraz Z, Cherrez-Ojeda I (2022). Individual, Family, and Socioeconomic Contributors to Dental Caries in Children from Low- and Middle-Income Countries. Int J Environ Res Public Health. 19(12). doi: 10.3390/ijerph191-27114.