Oral health and nutritional status of children in developing countries: A scoping review

Yuni Putriyani,[1]* Zahroh Shaluhiyah,[1] Sri Winarni[1]

[1]Health Promotion Department, Diponegoro University, Semarang, Central Java, Indonesia

ABSTRACT

Oral diseases, especially caries and malnutrition, are two major problems the world faces in developing countries. World Health Organization (WHO) report 2019 states that caries is the first non-communicable disease (NCD) suffered by children worldwide. In addition, malnutrition rates are still very high and most of them are in low-income countries. Many studies have suggested a relationship between oral health and children's nutritional status. However, the relationship between the two has not been consistent. Therefore, we conducted a scoping review to learn more about the relationship in developing countries. We obtained a total of 1,707 articles published in the last 10 years from two databases, Scopus and Science Direct. Ten relevant articles, written in English and published from 2015 to 2024, were reviewed and satisfied the inclusion criteria: a study about the relationship between oral health problems and nutritional status of 6 years old children and below who live in developing countries. The 10reviewed articles were taken from eight developing countries in which nine articles used a cross-sectional design and only one article used a longitudinal cohort design. The result of the review shows that caries status studies related to nutritional status are five studies. Meanwhile, the remaining 5 articles show no substantial relationship. In this scope, we used BMI (Body Mass Index) as an indicator for nutritional status. Further research is still needed, particularly in a longitudinal cohort design to get a clearer understanding of the causal relationship between both.

INTRODUCTION

Until now oral health problem is still one of the major health problems globally. Based on World Health Organization WHO report in 2022, oral diseases have been the most common non-communicable disease suffered by approximately 3.5 billion people worldwide with almost all of them living in developing countries.[1] This number has a big gap with the second NCD, mental health, which is suffered by 967 million people.[2] This condition must be addressed and become a priority in most health systems.[3] Moreover, developing countries still have many barriers to solve this problem.

Malnutrition has also become a big issue in developing countries. Adequate nutrition during a child's early years is crucial as it protects against malnourishment, improves the immune system, averts obesity, and reduces the susceptibility of chronic illnesses., There are 187.9 million children around the world under the age of five who are undernourished. There are 45 million believed to be wasted and 149 million are considered stunted. Additionally, an estimated 38.9 million children are overweight. Most of them live in developing countries.[1,2]

Dental caries is one of the most prevalent oral health issues. Based on the data from WHO, dental caries affects 514 million children globally until 2019, making it the most prevalent chronic

illness in children. Consequently, children have the highest frequency, especially in cases of untreated decidui dental caries among low-income individuals.[3] The correlation between children's oral health issues and their nutritional status—particularly when it comes to inadequate nutrition—has been the subject of numerous prior research. Body mass index (BMI) is employed as a nutritional status and caries as an oral health status in almost all of them. However, there are also many epidemiological studies powerfully revealed that health problems involve bi-directional causation and comorbidity.[4] In addition, it is even more complicated because there were also studies say that there is no relationship between the two.

Early childhood caries in children can cause oral pain, both acute and chronic, which can negatively affect eating patterns, nutritional status, school attendance, and economic potential.[5] Research conducted by Shim et al. on children aged 4-6 years in Korea shows that children with higher caries have lower nutritional intake and are thinner than those who have lower caries.[6] A scoping review by Bramantoro et al. concluded that caries affects childrens' chewing ability.[7]

Research conducted by Alghofaili et al. on preschool children in Saudi shows no relationship between caries levels and BMI.[8] However, Salvatore et al. stated that children aged 2-5 years in the United States with white race increases their DFS (decayed, filled surface) score accompanied by an increase in BMI score, while the Afro-American race revealed the lower the DFT (decayed, filled teeth), the higher the BMI score.[9] Besides, Suresh et al. concluded that preschool children with dental caries has a significant relationship with BMI status of overweight or at risk of overweight.[10]

The diversity of research results regarding these two relationships is basically because oral health, especially caries, has a multifactorial disease etiology and does not stand alone. As with nutritional status, many factors can influence weight, height, diet, socioeconomics, education, and other things. In addition, factors from the research methodology can also give different perspective, including the characteristics of the samples taken, measurement tools, research design, and statistical test tools used.[11]

The varied and unclear results of the above studies on the relationship between oral health and nutritional status in preschool children prompted us to conduct a more in-depth research of previous studies.[11] In this review, we summarize the results of related studies conducted in developing countries to see the relationship between oral health and the nutritional status of preschool children in those countries, where previously, there have been no studies that specifically discuss the relationship between these variables in developing countries. This review makes a significant contribution to reduce the stunting prevalence of Indonesia as one of the Sustainable Development Goals.

METHODS

This study used a scoping review method developed by Arksey and O'Malley. It was based on the six-step methodological approach that included: identifying the research question, identifying the relevant studies, selecting several studies, charting the data, collating, summarizing, and reporting the data and consulting the result of the review. The method was chosen because it supports "to summarize and disseminate the research findings".[12]

Search strategy

We checked our proposed title in the COCHRANE database to ensure that it is not the same title published before. This study conducted a systematic search on two database journals, Scopus and Science Direct. The keywords used are "oral health", "caries", "nutritional status", and "BMI" combined by applying logical operators OR/AND to increase the sensitivity. In each database, we used automation tools to limit the article which are published in the last 10 years, from 2015 to 2024, and written in English.

Study selection

Three authors had decided on the selected papers through the first author performing as an initial screening after the second author checked the keywords. Both authors searched articles

in each database independently. Each study was screened first by exploring the title and abstract, and it was performed by two authors independently. The third author then checked all eligible articles before being reviewed.

Data extraction

The inclusion criteria of articles are based on participants, concept, and context domains (PCC). Participants (P) are children aged 6 years and below, regardless of gender/race, and non-disabled children. Concept (C) are the children assessed for caries and nutritional status. Context (C) are the studies conducted minimum of dental assessment and nutritional assessment. The articles were excluded when they were in review and systematic review articles, the chapter of the book and proceeding, and the full texts could not be accessed. Before the final review stage, we have selected studies conducted in developing countries. The list of developing countries is taken from the World Data for 2023 [https://www.worlddata.info/developing-countries.php].

The total number of articles identified in the search in the two databases was 1,707 articles, including 1,095 articles from Scopus and 622 from Science Direct. After that, the duplicated articles were checked by using Mendeley. The articles were then screened according to the topic and inclusion criteria of this study, and 149 articles were obtained to be screened based on the abstract by using Microsoft Excel. Thus, some articles had to be excluded due to unrelated titles, the sample age of children was not 6 years old or younger, the articles were in the form of review and systematic review articles, chapters of the book, and proceedings, they were not written in English, the full text could not be accessed, and the studies were not conducted in a developing country. In the end, there were 10 articles included to review in this study. We performed a selection process with a flowchart based on PRISMA, shown in Figure 1.

RESULTS

Ten articles have been selected for final review in total. Eight countries were included in the developing countries in which the studies were conducted. Two countries have two studies in this review that they were Indonesia and Nigeria. The description of the study's characteristics is shown in Table 1.

Description of the study characteristics

As shown in Table 1, most studies, specifically 9 articles, used a cross-sectional design study,[4,5,13–19] and one used a longitudinal study.[20] The articles from Badruddin et al. with cross-sectional design used secondary data for their studies.[15] The number of participants in the studies varied from 120 up to 1,549 children aged under 6 years old, but there is one also included the aged group 12 and 15 years old.[17] The studies were conducted in the development countries, to India, Vietnam, Ecuador, Indonesia, China, Czech Republic, Yemen, Nigeria, and Nepal.

Oral health assessment

The majority of the studies in this review obtained oral health assessment by using the DMFT (decay, missing, filling teeth) index for permanent and dmf (decay, missing, filling) index for deciduous teeth.[4,5,14,16,18,19] However, some studies added the depth of caries cavity, and dental caries severity and then classified them into treated and untreated teeth.[4,5] In addition, a study by Khan et al. used three survey questions—frequency of mouth pain, difficulties eating due to mouth pain, and difficulties sleeping due to mouth pain—that were asked of the mother or parent. These questions were used to assess the child's composite mouth pain, or pain originating from orofacial structures, such as dental soft and hard tissues. Children were then assigned to the highest pain value reported for any of the three questions.[5] Sahu et al. conducted an oral assessment by classified ECC (early childhood caries) or free caries, while Badruddin et al. classified based on ECC, S-ECC (severed-early childhood caries), and free caries.[13,15] Another study assessed oral health by oral hygiene index-simplified (OHI-S) and pufa/PUFA (the presence of pulpal involvement, ulceration, fistula, and abscess).[16,20] Karki et al. used another index, a new index, the grade of severity of untreated dental caries (GUDC) that combined the pufa/PUFA with

dt/DT (decay teeth) dental caries in primary and permanent teeth.[17]

Seven out of ten studies conducted oral health assessments by calibrated examiners or dentists. However, the other three studies stated: only that the oral health assessment was done by a licensed dentist, not conduct calibration, and done by the same examiner.
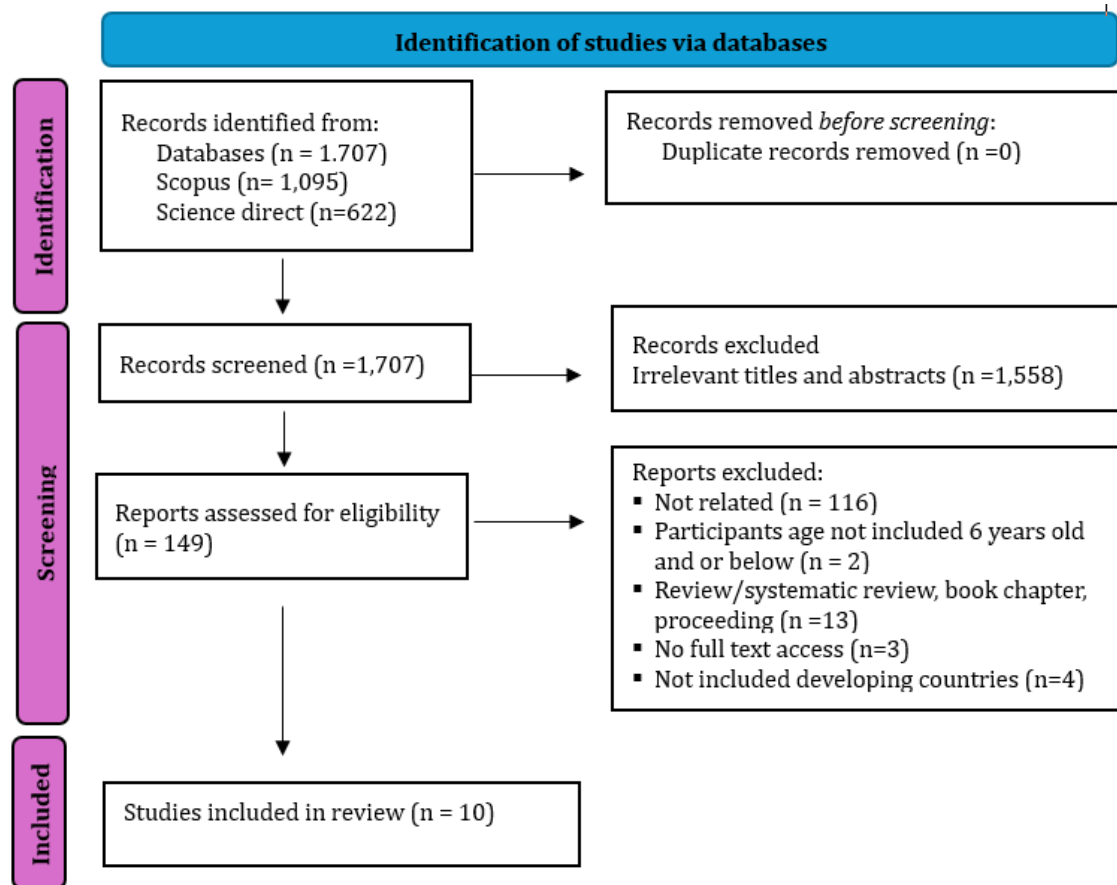

Figure 1. Article selection process

Nutritional assessment

All the studies measured the weight and height of each child to assess their nutritional status. The study from Folayan et al. combined three indices (height, weight, and BMI for age z-scores into one variable with three categories (normal, undernourished, and over-nourished).[16] So et al. also combined three indices as Folayan study, but they were different in classifying the result. So et al. classified them as stunted, underweight, wasted, and overweight or obese.[4] While Olatasi et al., Khan et al., Salah et al., and Wening et al. used the same measurement but did not describe their method to classify the results.[5,14,18,19] Sahu et al. used BMI and classified nutritional status into four categories: underweight, normal weight, overweight, and at risk of overweight.[13] Another classifying was done by Shen et al., which was: thinness or stunting.[20] Karki et al. added measurements of waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) to identify central obesity, but based on BMI, they were categorized into thin, normal, overweight, and obese.[17] The study by Badruddin just classified stunted or not stunted based on secondary data that they used (National Health Survey).[15]

Other assessments

Socioeconomic and demographic factors were measured in six studies.[4,5,13,15–17,20] Six studies conducted in Vietnam, Ecuador, China, Nigeria, and Nepal also measured dietary habits.[4,5,14,16,17,20] Some studies obtained parental or mother knowledge.[5,13–15] However, two studies obtained only oral health and nutritional assessment.[18,19]

Table 1. Description of the study characteristics

No	Author, Year, and Title of article	Research method	Country and sample (n)	Dental assessment	Nutritional assessment	Other assessment	Outcome/Findings
1	Sahu P, et al. 2023. Association of Early Childhood Caries and Multiple Variable Factors in 3–6-year-old Children	Cross-sectional	India; with 200 samples from children aged 3-6 years old, divided into ECC and without ECC	ECC diagnosed by the Department of Pedodontics and Preventive Dentistry, Government College of Dentistry, Indore, Madhya Pradesh, India	BMI	number of siblings, birth order, SES status, and mothers' education taken from the questionnaire	BMI had no significant association with the presence of ECC.
2	Olatosi OO, et al. 2022. Dental caries and oral health: an ignored health barrier to learning in Nigerian slums (a cross-sectional survey)	Cross-sectional	Nigeria; with 684 sample children with age 5 to 16 years old residing in the urban slum areas of Makoko	DMFT index	BMI	NA	The presence of caries had a significant association with low BMI.
3	Badruddin I, et al. 2021. Relationship between Oral Health Status and Stunting in 5-Year-Old Children in Indonesia	Cross-sectional study based on National Health Survey/*RISK ESDAS* 2018	Indonesia; 410 children aged 5 years old	Dental caries status, divided into: ECC, S-ECC, and free caries; and a self-reported questionnaire on oral health	stunted and not stunted	assessment of socioeconomic status and parental level of education by interview	The is no relationship between dental caries and stunting
4	Folayan MO, et al. 2020. Association between nutritional status and early childhood caries risk profile in a suburban Nigeria community	cross-sectional study	Nigeria; with 1549 under 6-year-old children.	Oral hygiene status assessment was conducted by the oral hygiene index simplified index (OHIS) and ECC were determined with DMFT index.	Nutritional status was determined by the World Health Organization (WHO) AnthroPlus Software measured the weight and height of each child, and BMI.	socioeconomic status and the frequency of daily between-meal sugar consumption.	Undernourished and over-nourished were not associated with ECC.

5	Shen A, et al. 2020. Undernutrition is associated with changes in severe dental caries	In a longitudinal study, follow-up time was 10-12 months.	China; Sample from children enrolled at 15 kindergartens in Shenyang, Liaoyang, and Fushun, Liaoning Province, China. A total of 772 children (n) participated at baseline and follow-up data were collected from October 2016 to November 2017	Dental caries was assessed according to the fifth WHO Basic Methods for Oral Health Surveys. The presence of pulpal involvement, ulceration, fistula, and abscess (pufa) were used to indicate severe dental caries in deciduous teeth/ pufa index	z-score for BMI-for-age was calculated using WHO Child Growth Standards.	The questionnaire was mainly based on the fifth WHO Oral Health Survey and was amended following a Chinese questionnaire (The Third National Oral Health Survey in China) to assess sociodemographic factors, dietary habits, and oral health behaviors of the children.	There was an association between the prevalence of stunting and the incidence of severe caries.
6	Karki S, et al. 2019. Body mass index and dental caries experience in Nepalese schoolchildren	Clinical cross-sectional	Nepal; with 340 samples in each age group. The group was based on three WHO index age groups (5- to 6-, 12- and 15-year-olds) in 18 out of 75 districts of Nepal.	Untreated dental caries in primary and permanent teeth (dt/DT) along with its consequences (pufa/PUFA). Then, the grade of severity of untreated dental caries (GUDC) was determined using both dt/DT and pufa/PUFA.	The body mass index (BMI), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) are based on three growth reference systems (WHO, IOTF, and Nepalese reference system).	A validated structured questionnaire was used to assess the children's oral hygiene practices and dietary habits.	Both low and high BMIs are associated with an increased severity of untreated dental caries.
7	Wening GRS, et al. 2019. Overview of dental caries severity and body mass index (BMI) on elementary school children	Cross-sectional	Indonesia; with 120 students was conducted in an elementary school in the working area of	All subjects answered interview questions on the WHO children's questionnaire form related to caries risk factors and	BMI	NA	All children who had high DMFT had a BMI thin category.

			Keputih Health Center.	questionnaire forms related to BMI supporting factors. The DMFT/deft measuring instrument, which is an index of measurement of damaged dental caries (cavities)			
8	Salah N. 2018. Comparison of oral health in children aged 5-6 years in the Czech Republic and Yemen	Cross-sectional	Czech and Yemen; with a total of 190 children aged 5–6 years (100 from Czech and 90 from Yemen, 111 males, 79 females – 22.5% of the wider study on 5–15 years old children	dmft/DMFT indexes for individual children	BMI for age	NA	There was no significant association between oral health (dmft/DMFT) and BMI.
9	So M, et al. 2017. Early childhood dental caries, mouth pain, and malnutrition in the Ecuadorian Amazon region	Cross-sectional study	Ecuador; with 1407 children from birth through age 6 in the "Alli Kiru" program (2011–2013)	dmft index recorded by visual and clinical examination. By licensed dentist	Nutritional status was determined by the WHO AnthroPlus Software measured the weight and height of each child (BMI)	Questions included demographic characteristics, nutrition practices, oral health practices, presence and frequency of mouth/dental pain, and access to medical/dental care.	The increased frequency of mouth pain interfering with sleeping had increased the odds of being underweight significantly and decreased the odds of being overweight significantly.

| 10 | Khanh LN, et al. 2015. Early childhood caries, mouth pain, and nutritional threats in Vietnam | Cross-sectional analysis of baseline data from a longitudinal intervention study | Vietnam; with 593 children and their parents from 5 preschools or kindergartens in 2 regions: Ho Chi Minh City (3 schools) and Da Nang (2 schools) Vietnamese children aged 1 to 6 years who were recruited in 2011 for a school-based oral health and nutrition study. | dmft/DMFT index. Following classification to record dmfts to rank dental caries severity, and in the 2 sites (approximately 60% of the sample), the dentist also recorded the depth of dental caries by visual inspection. | Nutritional status was determined by the World Health. Organization (WHO) AnthroPlus Software measured the weight and height of each child (BMI) | open-ended inquiries in four areas: (1) demographics; (2) mother's health care expertise and habits; (3) kids' food and dental habits; and (4) child reports of dental pain, general health, and mouth discomfort. Global oral health and quality-of-life surveys served as the basis for the questions in this survey. | Decreased weight- and body mass index-for-age z-scores were linked to the severity of ECC. The presence of pulp-involved caries was linked to remarkably decreased BMI, weight, and height for age. Lower body mass index-for-age z-scores were linked to mouth pain. |

BMI: body mass index; dmft: decay, missing, filling teeth (deciduous teeth); DMFT: decay, missing, filling teeth (permanent teeth); dt: decay teeth (deciduous teeth); DT: decay teeth (permanent teeth); ECC: early childhood caries; GUDC: grade of severity of untreated dental caries; IOTF: international obesity task force; NA: not applicable; OHIS: oral hygiene index simplified; pufa: pulpal involvement, ulceration, fistula, abscess (deciduous teeth); PUFA: pulpal involvement, ulceration, fistula, abscess (permanent teeth); *RISKESDAS: Riset kesehatan dasar*; S-ECC: severe early childhood caries; WHO: World Health Organization; SES: socioeconomic status; WHR; waist to hip ratio; WHtR: waist to height ratio

Sahu et al. study's included socioeconomic variables through the use of the Kuppuswamy modified scale (2019), which gathered information on the number of siblings, birth order, parental education, employment, and monthly income of the household head.[13] Khan et al. obtained data by utilizing a questionnaire that was based on inquiries from global surveys of oral health and quality-of-life in four domains: demographics, mother's healthcare knowledge and practices, child's diet (including consumption of junk food), oral health practices, and reports of oral health, general health, and mouth pain in children.[5]

Outcome or findings

Of ten studies that have been reviewed, the findings varied. Four studies revealed that there was no association between caries and malnutrition in preschool children; they were from Nigeria, Indonesia, India, Yemen, and the Czech Republic.[13,15–17,19] While six studies from Nigeria, Nepal, Vietnam, Indonesia, China, and Ecuador concluded that there was a relationship between the two variables.[4,5,14,18,20] Sahu et al. found BMI and caries had no significant association from multivariate analysis, but they reported the growth of humans can be affected by oral problems that cause chewing disturbances. They also found that children from more welfare families had free caries more number significantly than the lower-class economy.[13] Olatosi et al. reported maternal education, age of children, and dental visit history had a significant relationship with the occurrence of caries. Besides that, they also found children with caries have assessment anthropometry lower than free caries. In their study, the occurrence of dental caries was higher in people with lower education.[14]

So et al. concluded that dental caries and malnutrition are both complex conditions with shared and distinct risk factors. They suggested that the risk factor for malnutrition in children is non-treated severe tooth decay in early childhood caries (ECC) as they resulted that children in 3-6 years old will have a higher risk of being underweight significantly when their sleep interfered with by mouth pain.[4]

Badruddin et al. found that 90.7% of children in Indonesia have caries and most of them have severe early childhood caries. Meanwhile, 25% of children aged 5 years old and below are stunted. But there is no relationship between both. This is probably because stunting is a chronic condition that incorporates other factors such as environmental factors and pregnant women's nutrition.[21]

Folayan et al. reported that there are two risk indicators for early childhood caries, they are age and consumption of sugar. The more sugar consumed by children or older, the more caries they have. They concluded that the prevalence of ECC was not substantially correlated with nutritional status.[16] A study by Shen et al. reported an inversed relationship between undernutrition and caries. They found undernutrition leads children to have more incidence of caries.[20] Meanwhile, a study by Karki et al. informed that both lower and higher BMI have a relationship with the severity of caries because BMI and caries have the same risk factor, which is nutrition.[17]

Wening et al. found that all the children who have high DMFT also have low BMI.[18] However, Salah et al. reported the relationship between DMFT and BMI was inconsistent and also not significant. So, they found various degrees of positive and negative associations between BMI and oral health markers (dmft/DMFT).[19]

Khanh et al. reported undernutrition has a relationship with the severity of caries, and oral pain is the primary causation. ECC may have a negative impact on children's nutritional condition, which may be mediated by mouth pain, chronic inflammation, and the degree of decay. They also found that older age of children has more severe caries.[5]

Mostly the studies had a relationship based on the severity of dental caries. Those studies reported that more DMFT/dmft or prevalence caries in children have a relationship with their lower BMI. As we know, caries is the most oral disease suffered by children globally.

DISCUSSION

This review found that the results of studies conducted in different countries varied widely.

We have endeavored to get a picture of the relationship between oral health and nutritional status by limiting the selected articles to those that took participants from the age group of 6 years and below. Based on the results of previous studies, it is stated that the relationship between the two is complex. It is not only due to the association, but also as mentioned earlier, these two variables have a reciprocal relationship.[4]

We found two countries with two different studies and different results. The study conducted in Nigeria by Folayan et al. suggested that there was no relationship between oral health in this case ECC and children's nutritional status. Meanwhile, Olatosi et al. found a significant relationship. This is possible because although it was conducted in the same country, the population they took was different. Folayan et al. took samples from suburban children while Olatosi from Nigerian slums. According to the different environments, we can assume that there are some differences between two populations in the same country. The major gap between both is education including health education and economic status. However, both studies used the same method of oral assessment, nutritional status, and measurement of socioeconomic status and food consumption patterns. Consequently, these results align with research that states there is a significant relationship between economic status, BMI, and caries.[13,22] Children who come from welfare families also have parents with a higher level of education. Therefore, health awareness, such as tooth brushing behavior and visits to the dentist, is also becomes their main concern. The prevalence of caries is lower in children with higher socioeconomic status.[13]

Indonesia also has two studies with different results. This may also be due to differences in the methodology used. Badruddin et al. only assessed the relationship between caries and stunting using secondary data, while Wening et al. used primary data.[15,18] However, their sample coverage areas were different. Badruddin described the population data of all parts of the region while Wenning only in one part of the region. It can be concluded that the difference in sample characteristics is also the cause of the difference in results.

Research conducted by Olatosi et al., Khan et al., So et al., Shen et al., and Wening et al. showed an association between caries and a low BMI index. This is in line with the scoping review conducted by Lui et al. in 2022 which concluded that almost all articles mentioned the relationship between ECC and low nutritional status.[11] In this review, most of the study results that obtained significant results between caries and undernutrition, or lower BMI were in severe caries which could cause oral pain. The presence of pain in the mouth impedes eating, so children refuse to eat, and this causes children's nutrient intake to decrease. In addition, in children with severe caries, oral pain will be higher, and the intensity of pain will also be higher at night, causing sleep disturbances. So et al. assessed that severe caries in children aged 3-6 years is a risk factor for undernutrition due to sleep disturbances. Sleep disturbances can increase the amount of energy that must be expended activate hormones that can reduce appetite and food consumption patterns and activate inflammatory processes that can lead to chronic diseases.[4]

However, a longitudinal study by Shen et al. in China found a significant, but opposite relationship. Another study by Karki et al., and Khankh et al. has a similar conclusion. The presence of undernutrition in children causes the child to have a higher caries index due to insufficient nutritional intake causing the child's tooth structure to lack minerals, making it more susceptible to caries. This is in line with research conducted by Kim et al. in Korea.[23] Besides that, children with undernutrition also commonly consume more sugar to increase their appetite to eat, because many of them have lower appetites.[20]

The idea that alterations in dental enamel act as a mediator in the link between dental caries and diet is backed by several research. The study found a favorable correlation between enamel developmental abnormalities and childhood dental caries. This supported the theory that kids with severe caries have less protein intake, which is probably related to their inability to chew food because their teeth's ability to cut and grind food is compromised. This lowers the ability of the tooth to form an occlusion. If tooth infections are not treated, caries will spread into the dental pulp and generate cytokines that may stunt growth.[18]

There are 20 teeth called primary dentitions in children under 6 years old's mouth. While the adult person has 32 teeth in their mouth normally. If only one tooth has a problem, people

will be annoyed. Eating disturbances always be the main complaint and interfere the brain. But the disorder can be felt when the damage to teeth is widespread to the deepest layer, or the teeth have been diagnosed as severed caries.[24]

The other four studies that were reviewed found that there was no relationship between caries and nutritional status. These studies found other factors that affect children's nutritional status. Diet, mother's knowledge level, and socioeconomic factors have a significant relationship with children's nutritional status. However, there is another fact, both in developed and developing countries, children began to suffer from obesity. This condition is related to unhealthy diets such as high sugar consumption. So, they did not just suffer from obesity and other systemic diseases but also increased the risk of caries as the researchers agreed with this. If caries is not treated, the severity of caries is higher and can affect negatively the quality of life.[13,15,16,19,25]

Many children lack knowledge about the importance of oral health and about unhealthy diets. They tended to follow what their friends or idols were doing. However, they did not understand how to brush, how long an ideal brush was, and what time it should brush their teeth. These findings demonstrated the critical role that students' knowledge had in underpinning the development of oral hygiene-promoting practices. One strategy to enhance health at the young age of 19 is to practice good dental and oral hygiene while a student.[26]

The last and very important thing, especially in developing countries, is the use of antibiotics for oral or odontogenic infection. As described above, infection in the oral region including caries can interfere with quality of life. The risk of the nonrational use of antibiotics will become antibiotic-resistant in the future. In some developing countries, people can buy antibiotics without any restriction because most drug stores do not obey the regulation that certain drugs, primarily antibiotics, should be sold only under medical prescription. To solve that problem, the government must be ensuring the facility of oral disease treatment is easy to access by all people everywhere they live.[25]

The relationship between oral health and nutritional status in children, especially those under 6 years old in this review is still unclear. The limitation of this review is most of the studies were conducted with a cross-sectional design. To further clarify the relationship between the two, more cohort studies need to be conducted to assess the causal relationship.

CONCLUSION

There is a relationship between children's nutritional status and oral health in developing countries, but it is still unclear. Six studies showed that there is a relationship, but it is untable, whereas three studies stated there is a positive relationship. Another three studies informed that the relationship is negative. A cohort study in the future is needed to explain the causal relationship between these two variables. We hope the results of this review can be a reference for policymakers, academics, and stakeholders to determine the proper steps to solve two major health problems in children: caries and malnutrition, primarily in the terms of carrying out more effective promotive and preventive efforts. Apart from that, dental and oral health problems that have been ignored can become one of the main priorities to be addressed.

CONFLICT OF INTEREST

There is no conflict of interest in this study.

AUTHOR CONTRIBUTION

YP was designing, writing, and analyzing this paper; ZS and SW were reading, reviewing, and approving the final manuscript.

LIST OF ABBREVIATIONS

BMI: body mass index; DFS: decayed, filled surface; DFT: decayed, filled teeth; DMFT: decay, missing, filling teeth (for permanent teeth); dmft: decay, missing, filling teeth (for deciduous teeth); DT: decay teeth (for permanent teeth); dt: decay teeth (for deciduous teeth); ECC: early childhood caries; GUDC; grade of severity of untreated dental caries; NA: not applicable; NCD; non-communicable disease; OHI-S; oral hygiene index-simplified; PUFA: pulpal involvement, ulceration, and abscess (for permanent teeth); pufa: pulpal involvement, ulceration, and abscess (for deciduous teeth); *RISKESDAS*: *Riset kesehatan dasar;* S-ECC: severed early childhood caries; SES: socioeconomic status; WHO: world health organization; WHR: waist to hip ratio; WHtR: waist to height ratio

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