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Do Income Inequalities Influence the Relationship between Dental Caries Experience and Nutritional Status in Children and Adolescents? A Scoping Review

Thaís de Oliveira Fernandes[a] Luiz Maurício Nogueira Nunes[b]
Leonardo Santos Antunes[a, b] Erika Calvano Küchler[c]
Lívia Azeredo Alves Antunes[a, b]

[a]Postgraduate Program in Dentistry, Health Institute of Nova Friburgo, Fluminense Federal University, Rio de Janeiro, Brazil; [b]Postgraduate Program in Dentistry, Niterói Faculty of Dentistry, Federal Fluminense University, Rio de Janeiro, Brazil; [c]Department of Orthodontics, Medical Faculty, University Hospital Bonn, Bonn, Germany

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Keywords
Dental caries · Upper-middle-income countries · High-income countries · Lower-middle-income countries · Socioeconomic factors · Nutritional status · Children · Adolescents

Abstract
Objective: The aim of this study was to demonstrate the state of the art in the effect of income inequalities on the relationship between dental caries and nutritional status in children and adolescents and provide an overview of the countries investigated. ***Methods:*** Seven databases, along with gray literature (Google Scholar), were searched to identify studies based on the acronym PCC (population: children and/or adolescents; concept: relationship of nutritional status with dental caries experience; context: income classifications (high, middle, and low) and the countries considered. Two independent reviewers performed study selection and data collection. The results were presented in table, graphic, and narrative formats. ***Results:*** After the eligibility assessment, 37 studies were included in 21 countries. Nineteen studies indicated that income inequalities may have repercussions on the relationship between nutritional status and dental caries, while 11 studies suggested a possible absence of effect on the relationship between these variables. Seven studies were considered inconclusive regarding children and adolescents. ***Conclusion:*** Although the evidence remains inconclusive in specific contexts, most of the included studies suggest a potential influence of income inequalities on the relationship between dental caries experience and nutritional status in children and adolescents.

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As desigualdades de rendimento influenciam a relação entre a experiência de cárie dentária e o estado nutricional em crianças e adolescentes? Scoping review

Palavras Chave
Cárie dentária · Países de renda média-alta · Países de renda elevada · Países de renda média-baixa · Fatores socioeconômicos · Estado nutricional · Crianças · Adolescentes

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Correspondence to:
Lívia Azeredo Alves Antunes, liviaazeredo@gmail.com

Resumo

Contexto: Demonstrar o estado da arte no efeito das desigualdades de rendimento sobre a relação entre cárie dentária e o estado nutricional em crianças e adolescentes, e fornecer uma visão geral dos países investigados. ***Métodos:*** Sete bases de dados, juntamente com literatura cinza (Google Scholar), foram pesquisadas para identificar estudos com base no acrônimo PCC (População: crianças e/ou adolescentes; Conceito: relação do estado nutricional com a experiência de cárie dentária; Contexto: classificações de rendimento (alta, média e baixa) e os países considerados. Dois revisores independentes realizaram a seleção dos estudos e a coleta de dados. Os resultados foram apresentados em formatos de tabela, gráfico e narrativa. ***Resultados:*** Após a avaliação de elegibilidade, 37 estudos foram incluídos, abrangendo 21 países. Dezenove estudos indicaram que as desigualdades de rendimento podem ter repercussões na relação entre o estado nutricional e a cárie dentária, enquanto 11 estudos sugeriram uma possível ausência de efeito na relação entre essas variáveis. Sete estudos foram considerados inconclusivos em relação a crianças e adolescentes. ***Conclusão:*** Embora as evidências permaneçam inconclusivas em contextos específicos, a maioria dos estudos incluídos sugere uma possível influência das desigualdades de rendimento na relação entre a experiência de cárie dentária e o estado nutricional em crianças e adolescentes.

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Introduction

Dental conditions are considered the most common of all chronic diseases in both lower-income countries and developed societies [1]. Over one-third of the world's population lives with untreated dental caries, which is a major public health problem worldwide [2]. Dental caries is known by its multifactorial character, and for this reason, its relationship with nutritional status has been discussed widely in the scientific literature due to shared etiological factors found, such as diet [3–5]. The number of investigations regarding nutritional status in a global scale has grown, and according to the report of the United Nations Children's Fund (UNICEF) on the state of food security and nutrition, the level of children with malnutrition is high, and in 2021, 148.1 million children experienced stunting, 37 million were classified as overweight, and 45 million faced wasting [6]. Additionally, due to the pandemic and ongoing global conflicts, over 122 million more people are facing hunger since 2019 [6].

The influence of socioeconomic disparities in diet-related health outcomes, such as dental caries, undernutrition, obesity, and overnutrition, is well recognized in the literature [7–9]. That can be illustrated by the fact that overweight levels are increasing in some low- or lower-middle-income countries, while obesity is more prevalent in lower-middle- or upper-middle-income countries, particularly among children residing in wealthier households [7]. Low- and lower-middle-income countries bear the greatest burden of wasting, stunting, and low birthweight, and there is a higher prevalence of children with overweight in these income groups [7]. Changes in income, combined with rising food prices, can directly worsen access to food, which is crucial for both dental caries and nutritional status. In the short term, these changes can significantly impact the poorest segments of the population, who may spend an even larger share of their income on food. In the long term, some households may adapt their consumption patterns due to changes in income and food prices, potentially leading to unhealthy food choices that can directly affect both children and adolescents under development [9].

In addition to purchasing more sugar-sweetened beverages and fewer healthful foods [10, 11], children from low-income households are also less likely to receive comprehensive dental care and are at higher risk of experiencing acute dental diseases when compared to children from middle- and upper-income families [12]. There are significant gaps in understanding the association between nutrition and dental caries due to the numerous variables related to the diverse settings of children and adolescents, including socioeconomic disparities.

This conceptual framework reflects the complex interactions between socioeconomic status (SES), nutritional status, and dental caries in children and adolescents. SES, as a key social determinant, shapes dietary patterns, access to oral healthcare, and health behaviors, all of which contribute to both nutritional and oral health outcomes [7–9]. Undernutrition and higher caries rates are more often reported in lower-income settings, while overweight and variable caries prevalence appear in higher-income groups, influenced by lifestyle and service access. Nutritional status may mediate the relationship between SES and dental caries, with contextual factors

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such as education and school type acting as moderators. For this reason, this Scoping review assessed the relationship between these variables.

The underlying socioeconomic factors affecting both conditions require thorough assessment to develop specific and well-designed treatment plans and public policies that cater to different groups of society. Therefore, this scoping review aimed to investigate the influence of income inequalities on the relationship between dental caries and nutritional status in children/adolescents, while providing a global overview of the topic.

Methods

This scoping review was conducted following the JBI methodology for scoping reviews [13], and it was reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) [14]. The protocol registration to this scoping review can be found in full at Open Science Framework (https://doi.org/10.17605/OSF.IO/XHQ25).

Eligibility Criteria

Population

The participants in eligible studies for this review were children and/or adolescents. There were no restrictions regarding gender, the presence of any kind of disabilities, or underlying chronic diseases.

Concept

In this review, we included sources of evidence that evaluated conceptual nutritional status (normal weight, underweight, overweight, obesity) and its relation to dental caries experience. Regarding caries assessment systems, all indices were accepted to represent dental caries experience. In terms of nutritional status, only indices related to anthropometric measurements were considered.

Context

Contextual focus was directed to observational studies that considered the income assessment of their population. In regard to index, those measuring socioeconomic positions were considered for inclusion.

Type of Sources

Sources of scientific literature considered for this review included peer-reviewed journal articles and grey literature, without restrictions on year and language. Only observational studies were considered for inclusion. Papers were excluded according to the following criteria: outside the proposed theme, other types of study design, only adult population, no direct comparison between nutritional status and dental caries experience, dental caries resulting in weight status, and papers without income or socioeconomic classification.

Search Strategy

A three-step search strategy was utilized in this review. The databases Medline via PubMed, Web of Science, Cochrane Library, Virtual Health Library (LILACS), Embase, Epistemonikos, and Scopus were searched on 30th November 2024. The gray literature was also searched through Google Scholar. The search was performed without any language restrictions. A manual search in the reference list of the included studies was also performed. The search strategy combined MeSH terms (Medical Subject Headings), descriptors DECS, Emtree terms (Embase Subject Headings), and free terms with the use of Boolean operators (OR, AND) related to the acronym PCC (Population, Concept and Context). The information regarding the specific databases and a complete and replicable search strategy is illustrated in a table form (online suppl. Table S1; for all online suppl. material, see https://doi.org/10.1159/000549569).

Studies Selection

All sources of information or studies were uploaded to the bibliography manager Mendeley®, and the duplicates were removed. Titles and abstracts were screened, and the eligibility criteria were applied by two independent reviewers (T.O.F and L.M.N.N.). In case of doubt, the full text was also assessed by the two independent reviewers. The conflicts were solved by a third reviewer (L.A.A.A.).

Data Extraction

Data extraction was conducted by 2 independent reviewers (T.O.F and L.M.N.N.), and discrepancies were mediated through discussion. The selected articles were grouped by year of publication. The data extraction files were made independently. Data regarding the sample age, sample size, objective, study design, dental caries index, income index, nutritional status index, country of origin, gap in the research, association status, hypotheses suggested by the authors, distribution of income, dental caries, and nutritional status in the samples were collected.

Data Analysis and Presentation

The search results and article selection were summarized in a flowchart. A narrative summary accompanies the tabulated and charted results, and it describes

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how the results relate to the review's objective and question. The results were presented in table, graphic, and narrative formats. This review provided a detailed narrative summary of the data assessed through the papers included, describing how the results relate to the review's questions. The presentation of the results mapped out the findings in a logical, descriptive format, therefore responding to the questions of the review. Tables and figures were arranged according to the information collected from those, therefore representing the distribution of sources as stated in the data collection process description.

Results

Search and Selection

A total of 3,769 records were identified through database searches. After duplicates removal, 2,275 records were screened. After eligibility assessment, 37 studies [15–51] were included (shown in online suppl. Fig. S1). No additional papers were included via other methods. The excluded studies and the reasons for exclusion are found in online supplementary Table S2.

Studies Characteristics and Countries Evaluated Considering Income

This scoping review included 30 cross-sectional, 2 longitudinal, 2 case-control, and 3 cohort studies. The year of publication ranged from 2006 to 2022 (Table 1). Regarding the publications' countries of origin, studies were distributed across income categories according to the World Bank classification (2022) (Fig. 1). Most studies were conducted in upper-middle-income countries, including Brazil (6), China (2), Turkey (2), Mexico (1), Thailand (1), Ecuador (1), and Indonesia (1). A smaller number originated from high-income countries, such as the USA (3), Germany (1), Finland (1), Sweden (1), Saudi Arabia (2), and South Korea (1). In addition, several studies came from lower-middle-income countries, including India (7), Bangladesh (1), and Pakistan (1). Two studies were from a low-income country, Nigeria (1) and North Korea (1), and one global analysis included data from multiple regions.

The age of participants ranged from 6 months to 15 years old. Sample sizes varied considerably, from 142 to 2,275 participants (online suppl. Table S3). Regarding objectives, most of the studies aimed to investigate the relationship between dental caries, nutritional status, and socioeconomic factors, where 20 studies assessed only children, 7 investigated adolescents, 9 both children and adolescents and 1 assessed only pre-adolescents. Also, within the 37 included studies, 13 studies [18, 19, 23, 25, 26, 32, 33, 37–39, 41, 47, 50] performed specific statistical analysis regarding the effect of income inequalities on existing associations found between dental caries and nutritional status (Table 1).

Dental Caries, BMI, and Socioeconomic Index

When assessing indexes, Decayed, Missing, and Filled teeth (DMFT) was the most used to measure dental caries in the permanent dentition. In the primary dentition, decayed, missing, and filled teeth (dmft) was the most used among the included studies. Other indexes, such as Decayed, Missing and Filled surfaces (DMFS), Decayed, missing and filled surfaces (dmfs), The International Caries Detection and Assessment System (ICDAS), pulpal involvement, ulceration, fistula, and abscess (PUFA) index were also used (online suppl. Table S3). The index most used to measure the nutritional status in the included studies was the body mass index (BMI). To measure SES, several indexes were used depending on the country and region where the study was undertaken, and part of the studies did not report which index was used to measure the data on income incorporated in their results.

Relationship between Dental Caries, Nutritional Status, and Income

The influence of income on the association between dental caries and nutritional status varied across the countries where the studies were conducted. In high-income countries, most studies indicated that income level plays a role in shaping the relationship between dental caries and nutritional status [17–19, 28, 33, 49]. In upper-middle-income countries, such as China, Brazil, Mexico, Indonesia, and Ecuador, most studies reported inconclusive results or no significant influence of income on the relationship between dental caries and nutritional status [20, 25, 27, 35, 38, 41, 50, 51]. In lower-middle-income countries, such as Nigeria, India, and North Korea, the studies reviewed showed important differences in how income influenced this association, with most reporting either inconclusive results or no significant influence [15, 23, 24, 31, 34].

After careful interpretation, within the 12 studies that performed specific statistical analyses, 7 studies [18, 19, 26, 32, 33, 37, 39] showed that income possibly influences the relationship between nutritional status and dental caries, while 5 studies [25, 30, 41, 47, 50] demonstrated the possibility of no influence. Among the 25 studies that did not perform regression analyses to

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Table 1. Included studies characteristics and outcome's assessment

Author (year)	Objective	Study type	Participants	Age	Location	Statistical analysis	Findings	Conclusion on income influence
Sahu et al. [15] (2023)	Assess association of ECC with BMI, SES, maternal education, birth order, and siblings	Case-control	*n* = 200 (100/group)	3–6 years old	India	No	ECC associated with SES, but SES not linked to nutritional status	Inconclusive
Ceylan et al. [16] (2022)	Examine effects of SES, oral health practices, diet, and anthropometry on dental health	Cross-sectional	*n* = 254 (112 boys, 142 girls)	12 years old	Turkey	No	Anthropometric measures and SES influenced caries	Inconclusive
Mohamed et al. [17] (2022)	Investigate ECC and obesity in preschoolers	Cross-sectional	*n* = 1,250 (552 boys, 698 girls)	Mean 4.3 years old	Saudi Arabia	No	ECC positively associated with obesity and high family income	Possibly yes
Piovesan et al. [18] (2022)	Assess obesity–caries relationship and role of SES and sugar intake	Cross-sectional	*n* = 2,275 (1,117 boys, 1,158 girls)	2–5 years old	USA	Yes	Association attenuated after adjusting for SES and sugar intake	Yes
Anzar et al. [19] (2021)	Assess caries and anthropometric z-scores (HAZ, WAZ, BAZ)	Cross-sectional	*n* = 376 (187 boys, 189 girls)	Mean 8.0±1.0 years old	Not reported (Saudi Arabia/Pakistan)	Yes	Caries linked to lower anthropometric outcomes in low-income children	Possibly yes
Badruddin et al. [20] (2021)	Assess stunting, caries, and SES using national survey data	Cross-sectional	*n* = 410 (190 boys, 220 girls)	5 years old	Indonesia	No	Caries and stunting not correlated; SES and parental education linked to stunting	Inconclusive
Haliti et al. [21] (2021)	Investigate sociodemographic factors linked to obesity and caries	Cross-sectional	*n* = 270 (142 boys, 128 girls)	12–14 years old	Kosovo	No	Obese children (12 years old) had higher DMFT; family income significant	Possibly yes
Bulut and Bulut [22] (2020)	Evaluate obesity-caries relationship by SES and lifestyle	Case-control	*n* = 176 (86 obese, 90 normal weight)	6–11 years old	Turkey	No	Higher caries in obese group; no clear SES/lifestyle effect	Possibly no

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Table 1 (continued)

Author (year)	Objective	Study type	Participants	Age	Location	Statistical analysis	Findings	Conclusion on income influence
Folayan et al. [23] (2020)	Explore ECC, overweight, breastfeeding, and sugar intake across income regions	Cross-sectional (Ecological)	Country-level data	0–5 years old (OW), 3–5 years old (ECC)	Global	Yes	No significant modification by income region	No
Reche et al. [24] (2020)	Assess nutritional status, SES, and caries	Cross-sectional	*n* = 150	4–14 years old	India	No	SES not associated with BMI or caries	Possibly no
Parra-Coronel et al. [25] (2020)	Evaluate ECC, diet, and nutrition in infants/preschoolers	Cross-sectional	*n* = 142 (80 boys, 62 girls)	10–48 months	Ecuador	Yes	No association between caries and nutrition in low-middle SES	Possibly no
Shen et al. [26] (2020)	Assess severe caries and thinness/stunting	Longitudinal	*n* = 772 (397 boys, 375 girls)	Preschoolers	China	Yes	Income attenuated caries-nutrition link but not fully	Yes
Garcia et al. [27] (2020)	Examine caries and obesity in schoolchildren	Cross-sectional	*n* = 522 (252 boys, 270 girls)	8–12 years old	Mexico	No	Negative caries-obesity association; no SES effect	Inconclusive
Al-Ansari and Nazir [28] (2020)	Assess BMI and GNI per capita vs. DMFT worldwide	Cross-sectional	Not reported	12 years old	Saudi Arabia	No	Higher GNI linked to lower DMFT; BMI correlated with GNI	Possibly yes
Aguiar et al. [29] (2019)	Assess obesity and caries in 5-year olds	Cross-sectional	*n* = 91 (51 girls, 40 boys)	5 years old	Brazil	No	Caries linked to lower income; overweight showed opposite trend	Possibly yes
Folayan et al. [30] (2019)	Assess ECC and malnutrition in <6 years old children	Cross-sectional	*n* = 370 (203 boys, 167 girls)	6–71 months	Nigeria	No	ECC associated with underweight, overweight, and stunting; SES not significant	Possibly no
Pinni et al. [31] (2019)	Assess caries, SES, and nutritional status	Cross-sectional	*n* = 1,022 (508 boys, 514 girls)	5–11 years old	India	No	SES influenced caries; no link between caries and nutrition	Possibly no
Elger et al. [32] (2018)	Investigate BMI, SES, and caries in young children	Cohort	*n* = 1,627 (877 boys, 750 girls)	6 months–9 years old	Germany	Yes	Higher BMI increased caries, especially in high SES	Yes

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Table 1 (continued)

Author (year)	Objective	Study type	Participants	Age	Location	Statistical analysis	Findings	Conclusion on income influence
Khadri et al. [33] (2018)	Assess obesity-caries link in adolescents	Cross-sectional	*n* = 802 (406 boys, 396 girls)	10–17 years old	UAE	Yes	Caries–obesity link lost significance after adjusting for SES/diet/oral hygiene	Yes
Kim et al. [34] (2018)	Assess obesity, SES, oral health, and caries by gender	Cross-sectional	*n* = 1,646 (879 boys, 767 girls)	13–18 years old	Korea	No	Caries higher in low-income adolescents; no link with obesity	Inconclusive
Li et al. [35] (2018)	Explore mediators between caries and obesity	Cross-sectional (nested cohort)	*n* = 381 (166 boys, 215 girls)	18 years old	China	No	No income effect; higher DMFT linked to overweight/obesity	Inconclusive
Mishu et al. [36] (2018)	Assess BMI, caries, and income in schoolchildren	Cross-sectional	*n* = 788 (388 boys, 400 girls)	5–9 years old	Bangladesh	No	BMI and anthropometry associated with income and caries	Possibly yes
Basha et al. [37] (2017)	Assess obesity and caries incidence longitudinally	Longitudinal	*n* = 764 (351 girls, 413 boys)	13 years old	India	Yes	Overweight/obese had 3.7× higher risk of caries, adjusted for SES	Yes
Fernandez et al. [38] (2017)	Assess caries, nutrition, and physical activity	Cross-sectional	*n* = 1,210 (574 boys, 636 girls)	8–12 years old	Brazil	Yes	Caries negatively linked to nutrition; income not significant after adjustment	No
Kumar et al. [39] (2017)	Assess BMI-caries link and SES influence	Cross-sectional	*n* = 1,092 (635 boys, 457 girls)	11–14 years old	India	No	BMI not linked to caries overall; overweight in high SES had fewer caries	Possibly yes
Lee and Jung-Ok [40] (2017)	Assess oral health behaviors and DMFT	Cross-sectional	*n* = 463 (253 boys, 210 girls)	12–19 years old	Korea	No	DMFT influenced by income, age, sex, and oral health behaviors	Possibly yes

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Table 1 (continued)

Author (year)	Objective	Study type	Participants	Age	Location	Statistical analysis	Findings	Conclusion on income influence
Ribeiro et al. [41] (2017)	Assess ECC, nutrition, and SES in preschoolers	Historical cohort	*n* = 388	24–79 months	Brazil	Yes	ECC linked to both under- and overweight, independent of SES	No
Nunes et al. [42] (2013)	Assess weight and caries in 12-year olds	Cross-sectional	*n* = 1,528 (758 boys, 770 girls)	12 years old	Brazil	No	SES linked to caries; no clear caries-obesity link	Inconclusive
Chiu et al. [43] (2013)	Assess obesity and caries in homeless children	Cross-sectional	*n* = 157 (70 boys, 87 girls)	Mean 7.5±3.9 years old	USA	No	Positive BMI-caries link, not significant after adjustments	Possibly yes
Lueangpiansamut et al. [44] (2012)	Assess caries, malnutrition, and SES	Cross-sectional	*n* = 111 (57 boys, 54 girls)	11–12 years old	Thailand	No	Income and malnutrition significantly associated with caries	Possibly yes
Sakeenabi et al. [45] (2012)	Assess caries, obesity, and SES	Cross-sectional	*n* = 1,550 (798 boys, 752 girls)	6 and 13 years old	India	No	Low SES children more likely to have caries; obesity also linked	Possibly yes
Subramaniam and Singh [46] (2011)	Assess BMI, caries, and SES	Cross-sectional	*n* = 2,033 (1,021 boys, 1,012 girls)	6–15 years old	India	No	Caries higher in low SES and in overweight children	Possibly yes
Cinar and Murtomaa [47] (2008)	Assess obesity, lifestyle, and dental health in two countries	Cross-sectional	*n* = 619 (448 Turkey, 171 Finland)	Mean 10.9±0.8 years old	Turkey and Finland	Yes	Turkish children had poorer oral health; no significant SES effect	No
Gerdin et al. [48] (2008)	Assess caries, BMI, and SES in Sweden	Cohort	*n* = 2,303 (53% boys, 47% girls)	10 and 12 years old	Sweden	No	Caries highest in lowest SES; BMI not linked	Possibly yes
Marshall et al. [49] (2007)	Assess caries-obesity link and role of SES	Cross-sectional	*n* = 413	0.5–10.9 years old	USA	No	Low SES increased both caries and obesity risk	Possibly yes

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Table 1 (continued)

Author (year)	Objective	Study type	Participants	Age	Location	Statistical analysis	Findings	Conclusion on income influence
Moreira et al. [50] (2006)	Assess caries, obesity and SES in adolescents	Cross-sectional	*n* = 1,715	12–15 years old	Brazil	Yes	Higher caries in state schools; no caries-obesity difference	No
Oliveira [51] (2006)	Assess caries, nutrition, and SES in young children	Cross-sectional	*n* = 1,267	5–59 months	Brazil	No	Income associated with caries; BMI-caries link not fully explored	Inconclusive

ECC, early childhood caries; SES, socioeconomic status; BMI, body mass index; DMFT, Decayed, Missing, and Filled Teeth; HAZ, height-for-age z-score; WAZ, weight-for-age z-score; BAZ, BMI-for-age z-score; OW, overweight; GNI, gross national income per capita; UAE, United Arab Emirates.

specifically investigate income's influence, 6 studies [22, 24, 27, 30, 31, 38] pointed to a possible absence of income's effect on the relationship between the variables. Additionally, results of 12 studies [17, 21, 28, 29, 34, 36, 43–46, 48, 49] displayed a possible influence of income on the relationship between the variables in children and adolescents. Only the data of 7 studies [15, 16, 20, 34, 35, 42, 51] were considered inconclusive during interpretation (Table 1).

When comparing income regions, one study [28] showed that mean BMI and DMFT were the lowest in low-income countries. The prevalence of overweight status in 0–5-year-old children was significantly lower in low-income countries when compared to middle-income countries, and income regions significantly modified the association between the prevalence of early childhood caries (ECC) [23]. The dental caries was associated with worse scenarios of income, whereas overweight presented the inverse behavior [29]. Caries experience dropped significantly with SES increase, and BMI was positively associated with the outcome, indicating a possible relationship between the conditions [32]. The high SES category showed that overweight children experienced fewer caries than normal-weight children [37]. When assessing homeless children, a study [43] found a positive association between BMI and dental caries (Table 1; online suppl. Table S4).

Among secondary findings, gender [37, 42], soft drink consumption [33, 49], and age [30, 33, 34] were found to be associated with caries prevalence. Parents' educational level was associated with nutritional status [20, 29] and dental caries [51]. Adolescents with past caries experience were at higher risk of developing new caries [37]. Regarding type of school, public school pre-adolescents showed higher levels of dental disease [47, 50] and had a lower BMI than students in private school [29, 47]. When assessing income regions, the association between the prevalence of ECC and per capita sugar consumption was different. The percentage of infants who were exclusively breastfed up to 6 months was significantly lower in high-income countries when compared to low-income countries [23]. Oral hygiene was shown to be an important risk factor for dental caries in several studies [27, 42], and BMI was inversely associated with parents' education [20, 49] (online suppl. Table S4).

Hypotheses for Relationship between Dental Caries, Nutritional Status, and Income

Figure 2 represents the word cloud hypotheses suggested by the studies for the relationship between dental caries, nutritional status, and income. To explain the

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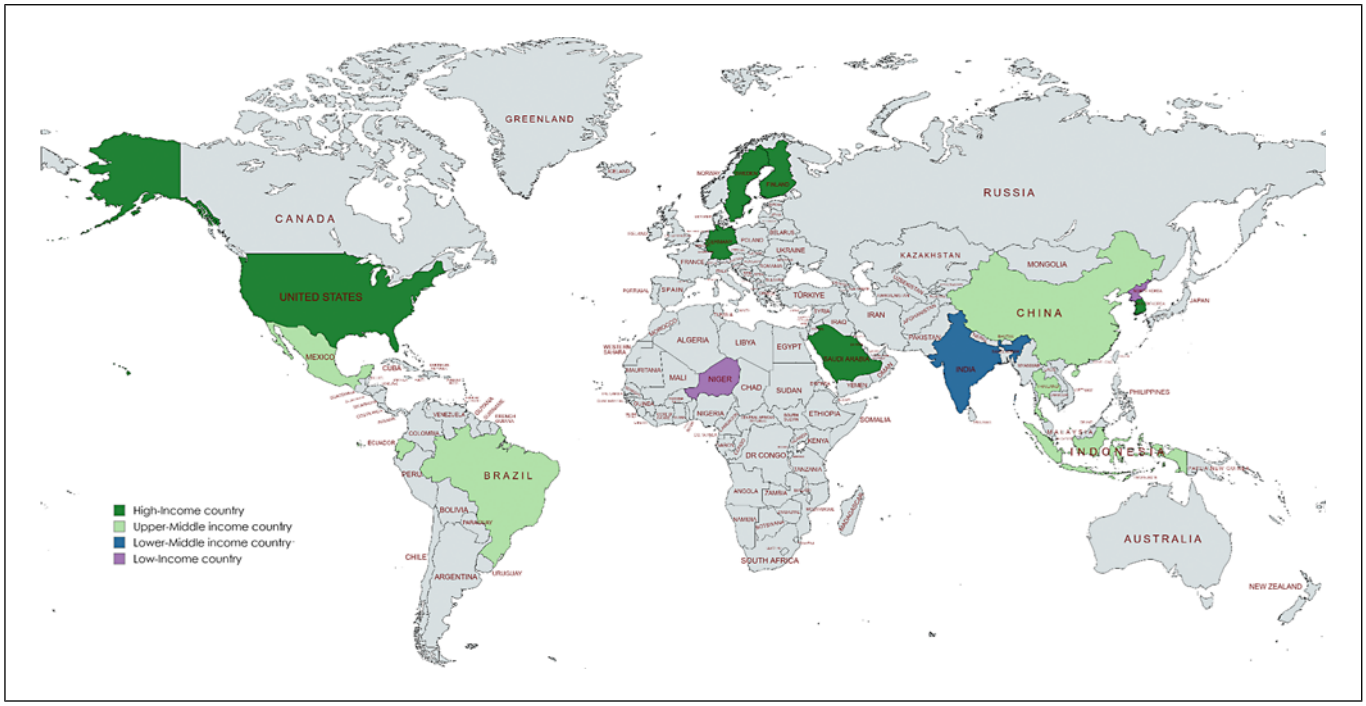


Fig. 1. Countries of origin of the included studies classified by income.

nature of the results found about relationship between dental caries, nutritional status, and income, the authors proposed diverse hypotheses, such as maternal education affecting nutritional and oral health status; sugar intake playing a role of risk factor for both dental caries and nutrition; the lack of access to health being a leading cause to poor nutrition and oral healthcare; the role of puberty on dental caries and nutritional status in pre-adolescents and, finally, the cycle of low income inducing low access to health education, therefore poor health choices (online suppl. Table S3).



Fig. 2. Word cloud of the hypotheses for the relationship between dental caries, nutritional status, and income in the included studies.

Discussion

This review examined the role of income in the association between dental caries and nutritional status across countries with varying income levels, suggesting a clearer influence of income in high-income settings, while findings from low- and middle-income countries remain largely inconclusive. The findings further summarize regional variations in income's impact, highlight key statistical patterns, and discuss secondary factors affecting caries and nutrition.

According to the findings of this review, an emerging pattern suggests that SES may shape the relationship between nutritional status and dental caries in more complex ways than previously assumed. While children from lower socioeconomic backgrounds generally exhibited a higher prevalence of dental caries overall [18], certain findings challenge this linear association. For

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example, ECC was found to be more prevalent among children from higher income families, particularly those who were overweight or obese [17]. In contrast, underweight children were more commonly observed in lower income groups and tended to show higher rates of caries in their primary teeth. Meanwhile, children from higher socioeconomic backgrounds faced increased risks of both overweight status and dental caries in their permanent teeth [46], highlighting how different health risks may cluster differently across income levels.

Low SES appears to be linked with a greater risk of both dental caries and obesity among American children, suggesting these conditions may share common underlying factors [49]. In this population, low-income male adolescents tend to show higher rates of dental caries in their permanent teeth, although a clear connection between caries and obesity was not established. Interestingly, an increase in DMFT scores was observed alongside higher BMI, hinting at a potential association between oral health and nutritional status [49]. Similarly, findings from the United Arab Emirates indicate that SES may play a role in shaping BMI among children and adolescents, highlighting the broader influence of economic conditions on health [33].

Low SES appears to contribute to a greater vulnerability to both dental caries and obesity among children, suggesting overlapping social determinants that may underlie these health issues [49]. The observed association between increased DMFT scores and higher BMI hints at interconnected pathways between oral health and nutritional status, influenced by socioeconomic factors [49]. Similarly, evidence from the United Arab Emirates reinforces the notion that socioeconomic conditions play a critical role in shaping BMI among youth, further emphasizing the pervasive impact of income on health outcomes [33].

These observations align with broader international patterns where SES intersects with dental and nutritional health in complex ways. For example, the persistence of an association between caries and stunting in Chinese preschoolers – even after accounting for family income – suggests that factors beyond economic resources may mediate this relationship [26]. In contrast, findings from Indonesia, where stunting correlates with SES but not directly with caries, point to varied contextual influences that shape health outcomes differently across settings [20]. Among low-income populations, such as primary school children in Saudi Arabia, the link between dental caries and poor nutritional status further underscores the compounded risks faced by disadvantaged groups [19]. Additionally, the inverse patterns seen in Brazil and Germany – where overweight status and caries prevalence vary according to socioeconomic strata – highlight the complexity of these interactions and suggest that both affluence and deprivation can present distinct health challenges [29, 32]. These suggestions emphasize the need to consider contextual socioeconomic factors and their nuanced effects when addressing the intertwined burdens of dental caries and nutritional health globally.

In a global analysis, the prevalence of being overweight was significantly lower in low-income countries compared to middle-income and high-income countries, where the prevalence of ECC was also lower in high-income countries than in middle-income countries [23]. Investigations primarily involving children from lower middle and middle socioeconomic groups found that dental caries was associated with lower height, weight, and BMI among children in Bangladesh, even after adjusting for confounding factors. Similar findings indicated that stunting was associated with dental caries and family income [46].

When interpreting the data regarding countries of origin of the papers included, the patterns found suggest that the influence of income on the relationship between dental caries and nutritional status may be more apparent in high-income countries possibly due to greater socioeconomic disparities in diet, oral health behaviors, and access to dental care. In contrast, in low-, lower-middle-, and upper-middle-income countries, other overriding factors, such as generally limited access to oral health services, uniformly poor dietary quality, and inadequate health infrastructure, may possibly mask or diminish the role of income as a differentiating factor. Consequently, in these settings, the overall burden of dental caries and malnutrition may be widespread across income levels, leading to inconclusive or nonsignificant associations between income and these conditions in the reviewed studies.

Higher income families are shown to be often better positioned to provide healthier food and living conditions for their children and adolescents. In contrast, children from low-income families may rely on easily accessible, high-carbohydrate diets, leading to increased caries experience and poorer nutritional outcomes [15]. Changes in income, coupled with rising food prices, can worsen access to food, which is a critical factor for both conditions and overall health.

When comparing upper-middle-income countries in the Americas and European regions, subtle differences in the relationship between dental caries and obesity are suggested. In the Americas, evidence suggests an inverse

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association, where children with obesity tend to exhibit a lower prevalence of dental caries [27, 38]. This pattern may reflect underlying social determinants, as children affected by caries were more often linked to households with employed caregivers, while both underweight and obese children commonly presented with caries [27]. In contrast, studies from Europe and adjacent regions report no consistent association between dental caries and obesity among pre-adolescents, although certain populations display higher obesity rates coupled with poorer dental health relative to their European counterparts [47]. Moreover, socioeconomic disparities within these regions, illustrated by differences between public and private school students, point to the influence of contextual factors such as nutrition and access to care on oral health outcomes [47]. These observations underscore the complexity of the interplay between nutritional status and dental health, suggesting that regional socioeconomic and cultural contexts critically shape these associations.

The influence of income inequalities on the relationship between dental caries and nutritional status appears to operate through distinct contextual mechanisms. In high-income countries, wider socioeconomic disparities in diet quality, oral health behaviors, and access to dental services tend to magnify differences between groups, making the influence of income more apparent. Within these settings, children from higher income families may experience overweight and caries linked to high sugar intake, whereas those from lower-income families often present undernutrition and untreated caries. In contrast, in low- and middle-income countries, where structural barriers to healthcare and poor diet quality are widespread, the effect of income is less differentiated, leading to inconclusive findings. Therefore, income inequalities shape this relationship both across and within countries by determining access to healthy foods, preventive oral care, and health education.

The indication of a possible influence of income on the coexistence of alterations in nutritional status and dental caries, as shown in this study, highlights the importance of viewing children and adolescents as whole individuals. It emphasizes the necessity of considering their family's socioeconomic reality when assessing outcomes such as nutrition and oral health. While observational studies cannot establish causality, the included studies have proposed hypotheses to explain their findings, which could significantly influence future research.

This scoping review represents the synthesis of evidence with attention to socioeconomic context on the influence of income inequalities on the relationship between dental caries and nutritional status in children and adolescents. It summarizes the existing literature, highlighting gaps and providing insights for the scientific community and clinicians. It is important to take into consideration the role played by the methodological aspects of the included studies which were not systematically assessed in this scoping review due to the nature of the study. Understanding the potential impact of income inequalities on dental caries and nutritional status emphasizes the need for coordinated healthcare strategies for children and adolescents. The findings suggest that more attention is needed from healthcare providers and public policies should focus on improving access to health knowledge and individualized health services for underserved groups.

Conclusion

This scoping review is the first attempt to systematically compile the evidence on the association between dental caries and nutritional status across different socioeconomic contexts. Although the evidence remains inconclusive in specific contexts, most of the included studies suggest a potential influence of income inequalities on the relationship between dental caries experience and nutritional status in children and adolescents. The influence of income on the relationship between dental caries and nutritional status is more clearly in high-income countries, whereas structural barriers and more uniform disparities in lower-income settings may obscure this effect. These findings provide insights into the potential impact of income inequalities on health for the scientific community. Additionally, the findings emphasize that more public policies should focus on improving access to health knowledge and individualized health services for underserved groups.

Statement of Ethics

This scoping review and its protocol were registered in full at Open Science Framework (https://doi.org/10.17605/OSF.IO/XHQ25).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

The review idealization, design, studies selection, data collection, and analysis were performed by T.O.F. and L.A.A.A. The first draft of the manuscript was written by T.O.F. L.M.N.N., L.A.A.A., E.C.K., L.S.A., and T.O.F. critically revised the final draft and commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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