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Impact of diet on the oral health of children and adolescents: a data mining analysis

Impacto da dieta na saúde bucal de crianças e adolescentes: uma análise de mineração de dados

Impacto de la dieta en la salud bucal de niños y adolescentes: un análisis de minería de datos

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Abstract
The aims were to describe and assess, through a data mining analysis, the worldwide scientific literature on the impact of diet on the oral health of children and adolescents. Searches were performed in the Medline/PubMed, Scopus, EMBASE, and Web of Science. Observational studies that evaluated the influence of children's and adolescents' diet on oral outcomes were included, while studies with preventive treatments, self-examination, studies only with adults or elderly people, and studies unavailable in full were excluded. The primary data obtained were: year, country, type of study, age group, diet (consistency, composition, consumption time, and exposure frequency), outcomes (caries, biofilm, or periodontal disease), and the association (positive, null or negative) between diet and the outcomes. The analyses were performed in the VantagePoint™ and SPSS software. A total of 1330 studies were identified, of which 227 were selected. These studies were published from 1980-2021, with the most significant number developed in Brazil (n=26). Most studies were cross-sectional (n=139), performed only with children (n=141), and assessed caries (n=193). The consistency of the diet did not impact the occurrence of these conditions. We observed positive associations between caries and sugars/sweets (n=118), snacks (n=40), night dietary habits (n=30), and exposures ≥3×/day (n=11). Therefore, the studies indicated that diet consistency did not impact oral health, but sugars/sweets, snacks, night dietary habits, and frequent exposures were positively associated with caries.
Keywords Adolescent; Bibliometrics; Child; Dental caries; Diet; Oral health.

Resumo
Objetivou-se descrever e avaliar, por meio de análise de mineração de dados, a produção científica mundial sobre o impacto da dieta na saúde bucal de crianças e adolescentes. As buscas foram realizadas no Medline/PubMed, Scopus, EMBASE e Web of Science. Estudos observacionais que avaliaram a influência da dieta de crianças e adolescentes nos desfechos bucais foram incluídos, enquanto estudos com tratamentos preventivos, autoexame, estudos apenas com adultos ou idosos e estudos indisponíveis na íntegra foram excluídos. Os principais dados obtidos foram: ano, país, tipo de estudo, faixa etária, dieta (consistência, composição, momento de consumo e frequência de exposição), desfechos (cárie, biofilme ou doença periodontal) e a associação (positiva, nula ou negativo) entre a dieta e os desfechos. As análises foram realizadas nos softwares VantagePoint™ e SPSS. Foram identificados 1.330 estudos,

dos quais 227 foram selecionados. Esses estudos foram publicados no período de 1980-2021, sendo o maior número desenvolvido no Brasil (n=26). A maioria dos estudos foi transversal (n=139), realizada apenas com crianças (n=141) e avaliou a cárie dentária (n=193). A consistência da dieta não influenciou na ocorrência dessas condições. Observou-se associações positivas entre cárie e açúcares/doces (n=118), lanches (n=40), hábitos alimentares noturnos (n=30) e exposições ≥3×/dia (n=11). Portanto, os estudos indicaram que a consistência da dieta não impactou na saúde bucal, mas açúcares/doces, lanches, hábitos alimentares noturnos e exposições frequentes foram positivamente associados à cárie.
Palavras-chave: Adolescente; Bibliometria; Criança; Cárie dentária; Dieta; Saúde bucal.

Resumen
El objetivo fue describir y evaluar, a través del análisis de minería de datos, la producción científica mundial sobre el impacto de la alimentación en la salud bucal de niños y adolescentes. Las búsquedas se realizaron en Medline/PubMed, Scopus, EMBASE y Web of Science. Se incluyeron estudios observacionales que evaluaron la influencia de la dieta de niños y adolescentes en los resultados orales, mientras que se excluyeron estudios con tratamientos preventivos, autoexamen, estudios solo con adultos o ancianos y estudios no disponibles en su totalidad. Los principales datos obtenidos fueron: año, país, tipo de estudio, grupo de edad, dieta (consistencia, composición, momento de consumo y frecuencia de exposición), resultados (caries, biopelícula o enfermedad periodontal) y la asociación (positiva, nula o negativa) entre la dieta y los resultados. Los análisis se realizaron utilizando el software VantagePoint™ y SPSS. Se identificaron 1330 estudios, de los cuales se seleccionaron 227. Estos estudios fueron publicados en el período 1980-2021, siendo el mayor número desarrollado en Brasil (n=26). La mayoría de los estudios fueron transversales (n=139), realizados solo con niños (n=141) y evaluaron la caries dental (n=193). La consistencia de la dieta no influyó en la aparición de estas condiciones. Se observaron asociaciones positivas entre caries y azúcares/dulces (n=118), refrigerios (n=40), hábitos alimentarios nocturnos (n=30) y exposiciones ≥3×/día (n=11). Por lo tanto, los estudios indicaron que la consistencia de la dieta no tuvo un impacto en la salud bucal, pero los azúcares/dulces, los refrigerios, los hábitos alimenticios nocturnos y las exposiciones frecuentes se asociaron positivamente con la caries.
Palabras clave: Adolescente; Bibliometría; Niño; Caries dental; Dieta; Salud bucal.

1. Introduction

The assessment of the population's diet is indispensable for promoting and protecting health, according to the objectives proposed by the World Health Organization through the Global Strategy on Healthy Eating, Physical Activity, and Health (Vuori, 2018). In addition, it is crucial to know that nutritional and dietary factors are associated with oral health imbalance, including dental caries and periodontal diseases (Gondivkar et al., 2019).

Oral diseases are predictable to affect about 3.5 billion people worldwide, with dental caries and periodontal diseases being the most frequent conditions. Globally, 2.3 billion people experience dental caries in permanent dentition, and more than 530 million children have this condition in primary teeth (GBD, 2018). On the other hand, aggressive juvenile periodontitis of early onset is a severe periodontal condition that affects individuals during puberty, leading to premature loss of teeth. It affects about 2% of young people (GBD, 2018).

Dental caries is a multifactorial disease modulated by biological and social aspects, such as education, social class, behavior, and attitude (Fejerskov, 2004). Furthermore, dysbiosis happens from frequent exposures to fermentable carbohydrates in the diet, mainly sucrose (Takahashi & Nyvad, 2011; Tanner et al., 2018). Modifying factors, such as food consistency, can increase an individual's risk of dental caries (Moynihan, 2016; Van Loveren, 2019). Thus, some studies have demonstrated an association between diet and dental caries (Sanders et al., 2020; Samman et al., 2020; Llena et al., 2020).

Periodontal diseases, in turn, are characterized by a change in the supragingival and subgingival biofilm microbial ecology and in the progressive destruction of the host's tooth support structures (Kinane et al., 2017). The diet and lower ingestion of nutrients, such as vitamins, may be linked with the progression of periodontal disease, especially in immunologically compromised patients (Gondivkar et al., 2019; Martinon et al., 2021; Spahr & Divnic-Resnik, 2022).

However, studies are still required to compile the existing literature on the topic and to show the probable influences of specific diet components on developing dental caries and periodontal diseases. Thus, the present study aims to describe and assess the profile of worldwide scientific literature on the impact of diet on the oral health of children and adolescents over the

years through a bibliometric analysis. In addition, for simplifying the understanding of clinicians and researchers on this theme.

2. Methodology

2.1 Eligibility criteria

We included observational studies carried out in children and adolescents, which evaluated the relationship between diet and oral outcomes (dental caries, dental biofilm, and periodontal disease). All types of diet or food components were accepted in the present study, including macro and micronutrients.

We excluded studies that did not analyze the association between the described oral outcomes and diet. Studies with preventive treatments in the studied population, self-examination, and studies performed only with adults or the elderly were also excluded. Those that investigated data about the impact of maternal diet or from the family circle on children's oral health and studies unavailable on digital platforms were also excluded. Finally, we did not consider studies that only cited the impact of diet on oral outcomes throughout the text but did not investigate the association among these variables.

2.2 Literature search strategy

Two examiners performed a systematic search in the primary databases (Medline/PubMed, Scopus, EMBASE, and Web of Science).

Search strategies containing MeSH terms and free terms combined with Boolean operators (OR, AND) were developed to Medline/PubMed and modified following the syntax rules of each database (Table 1). No restrictions were applied to the language and were investigated studies published until November 2021, when the search strategy was concluded.

Table 1 - Search strategy according to the different databases used in this study.

Database	Strategy
PubMed	((((Child[MeSH] OR Child, Preschool[MeSH] OR Child[Tiab] OR Children[Tiab] OR Preschool Child[Tiab] OR Preschool Children[Tiab] OR Adolescent[MeSH] OR Adolescent[Tiab] OR Adolescents[Tiab] OR Adolescence[Tiab] OR Teens[Tiab] OR Teen[Tiab] OR Teenagers[Tiab] OR Teenager[Tiab] OR Youth[Tiab] OR Youths[Tiab] OR Adolescent, Female[Tiab] OR Female Adolescents[Tiab] OR Adolescent, Male[Tiab] OR Male Adolescents[Tiab] OR Students[MeSH] OR Students[Tiab] OR Student[Tiab] OR School Enrollment[Tiab] OR Enrollment, School[Tiab])) AND ((Diet Records[MeSH] OR Diet Records[Tiab] OR Diet Record[Tiab] OR Food Diaries[Tiab] OR Food Diary[Tiab] OR Dietary Record[Tiab] OR Dietary Records[Tiab] OR Carbohydrate Loading Diet[MeSH] OR Carbohydrate Loading Diet[Tiab] OR Carbohydrate Loading Diets[Tiab] OR Carbohydrate Loading[Tiab] OR Carbohydrate-Restricted Diet[MeSH] OR Carbohydrate-Restricted Diet[Tiab] OR Carbohydrate-Restricted Diets[Tiab] OR Carbohydrate Restricted Diet[Tiab] OR Low Carbohydrate Diet[Tiab] OR Low Carbohydrate Diets[Tiab] OR Low-Carbohydrate Diet[Tiab] OR Low-Carbohydrate Diets[Tiab] OR Low Carbohydrate Diet[Tiab] OR Low Carbohydrate Diets[Tiab] OR Cariogenic Diet[MeSH] OR Cariogenic Diet[Tiab] OR Cariogenic Diets[Tiab] OR Carbohydrates[MeSH] OR Carbohydrates[Tiab] OR Carbohydrate[Tiab]))) AND ((Biofilms[MeSH] OR Biofilm*[Tiab] OR Bacterial Adhesion[MeSH] OR Adhesion Bacterial[Tiab] OR Adhesin Bacterial[Tiab] OR Dental Deposits[MeSH] OR Deposits Dental[Tiab] OR Tartar[Tiab] OR Dental Plaque[MeSH] OR Dental Plaque[Tiab] OR Plaque accumulation[Tiab] OR Dental Caries[MeSH] OR Dental Caries[Tiab] OR Dental Decay[Tiab] OR Carious Dentin[Tiab] OR Carious Dentins[Tiab] OR Dental White Spot[Tiab] OR Dental White Spots[Tiab] OR White Spot[Tiab] OR White Spots[Tiab] OR Periodontal Diseases[MeSH] OR Periodontal Diseases[Tiab] OR Periodontal Disease[Tiab] OR Parodontosis[Tiab] OR Parodontoses[Tiab] OR Pyorrhea Alveolaris[Tiab]))) AND ((Observational[Tiab] OR Prospective Studies[MeSH] OR Prospective Study[Tiab] OR Cohort Studies[MeSH] OR Cohort[Tiab] OR Follow-up Studies[MeSH] OR Follow-up Study[Tiab] OR Case-control Studies[MeSH] OR Case Control[Tiab] OR Retrospective Studies[MeSH] OR Cross-sectional Studies[MeSH] OR Cross-sectional[Tiab] OR Disease Frequency[Tiab] OR Prevalence Study[Tiab]))
Scopus	(TITLE-ABS-KEY (Child) OR TITLE-ABS-KEY (Children) OR TITLE-ABS-KEY (“Preschool Child”) OR TITLE-ABS-KEY (“Preschool Children”) OR TITLE-ABS-KEY (Adolescent) OR TITLE-ABS-KEY (Adolescents) OR TITLE-ABS-KEY (Adolescence) OR TITLE-ABS-KEY (Teens) OR TITLE-ABS-KEY (Teen) OR TITLE-ABS-KEY (Teenagers) OR TITLE-ABS-KEY (Teenager) OR TITLE-ABS-KEY (Youth) OR TITLE-ABS-KEY (Youths) OR TITLE-ABS-KEY (“female adolescent") OR TITLE-ABS-KEY (“Female Adolescents”) OR TITLE-ABS-KEY (“Male Adolescent”) OR TITLE-ABS-KEY (“Male Adolescents”) OR TITLE-ABS-KEY (Students) OR TITLE-ABS-KEY (Student) OR TITLE-ABS-KEY (“School Enrollment”)) AND (TITLE-ABS-KEY (“Diet Record”) OR TITLE-ABS-KEY (“Diet Records”) OR TITLE-ABS-KEY (“Food Diaries”) OR TITLE-ABS-KEY (“Food Diary”) OR TITLE-ABS-KEY (“Dietary Record”) OR TITLE-ABS-KEY (“Dietary Records”) OR TITLE-ABS-KEY (“Carbohydrate Loading Diet”) OR TITLE-ABS-KEY (“Carbohydrate Loading Diets”) OR TITLE-ABS-KEY (“Carbohydrate Loading”) OR TITLE-ABS-KEY (“Carbohydrate-Restricted Diet”) OR TITLE-ABS-KEY (“Carbohydrate-Restricted Diets”) OR TITLE-ABS-KEY (“Carbohydrate Restricted Diet”) OR TITLE-ABS-KEY (“Low Carbohydrate Diet”) OR TITLE-ABS-

	KEY ("Low Carbohydrate Diets") OR TITLE-ABS-KEY ("Low-Carbohydrate Diet") OR TITLE-ABS-KEY ("Low-Carbohydrate Diets") OR TITLE-ABS-KEY ("Low Carbohydrate Diet") OR TITLE-ABS-KEY ("Low Carbohydrate Diets") OR TITLE-ABS-KEY ("Cariogenic Diet") OR TITLE-ABS-KEY ("Cariogenic Diets") OR TITLE-ABS-KEY (Carbohydrate) OR TITLE-ABS-KEY (Carbohydrates)) AND (TITLE-ABS-KEY (Biofilms) OR TITLE-ABS-KEY (Biofilm) OR TITLE-ABS-KEY ("Adhesion Bacterial") OR TITLE-ABS-KEY ("Adhesin Bacterial") OR TITLE-ABS-KEY ("Deposits Dental") OR TITLE-ABS-KEY(Tartar) OR TITLE-ABS-KEY ("Dental Plaque") OR TITLE-ABS-KEY ("Plaque accumulation") OR TITLE-ABS-KEY ("Dental Caries") OR TITLE-ABS-KEY ("Dental Decay") OR TITLE-ABS-KEY ("Carious Dentin") OR TITLE-ABS-KEY ("Carious Dentins") OR TITLE-ABS-KEY ("Dental White Spot") OR TITLE-ABS-KEY ("Dental White Spots") OR TITLE-ABS-KEY ("White Spot") OR TITLE-ABS-KEY ("White Spots") OR TITLE-ABS-KEY ("Periodontal Diseases") OR TITLE-ABS-KEY ("Periodontal Disease") OR TITLE-ABS-KEY (Parodontosis) OR TITLE-ABS-KEY (Parodontoses) OR TITLE-ABS-KEY ("Pyorrhea Alveolaris")) AND (TITLE-ABS-KEY (Observational) OR TITLE-ABS-KEY ("Prospective Studies") OR TITLE-ABS-KEY ("Prospective Study") OR TITLE-ABS-KEY ("Cohort Studies") OR TITLE-ABS-KEY (Cohort) OR TITLE-ABS-KEY ("Follow-up Studies") OR TITLE-ABS-KEY ("Follow-up Study") OR TITLE-ABS-KEY ("Case-control Studies") OR TITLE-ABS-KEY ("Case Control") OR TITLE-ABS-KEY ("Retrospective Studies") OR TITLE-ABS-KEY ("Cross-sectional Studies") OR TITLE-ABS-KEY (Cross-sectional) OR TITLE-ABS-KEY ("Disease Frequency") OR TITLE-ABS-KEY ("Prevalence Study"))
EMBASE	(Child*:ti,ab,kw OR 'Preschool Children':ti,ab,kw OR 'Preschool Child':ti,ab,kw OR Adolescen*:ti,ab,kw OR Teen*:ti,ab,kw OR Youth*:ti,ab,kw OR 'Female Adolescent':ti,ab,kw OR 'Female Adolescents':ti,ab,kw OR 'Male Adolescent':ti,ab,kw OR 'Male Adolescents':ti,ab,kw OR Student*:ti,ab,kw OR 'School Enrollment':ti,ab,kw) AND ('Diet Record':ti,ab,kw OR 'Diet Records':ti,ab,kw OR 'Food Diaries':ti,ab,kw OR 'Food Diary':ti,ab,kw OR 'Dietary Record':ti,ab,kw OR 'Dietary Records':ti,ab,kw OR 'Carbohydrate Loading Diet':ti,ab,kw OR 'Carbohydrate Loading Diets':ti,ab,kw OR 'Carbohydrate Loading':ti,ab,kw OR 'Carbohydrate-Restricted Diet':ti,ab,kw OR 'Carbohydrate-Restricted Diets':ti,ab,kw OR 'Carbohydrate Restricted Diet':ti,ab,kw OR 'Low Carbohydrate Diet':ti,ab,kw OR 'Low Carbohydrate Diets':ti,ab,kw OR 'Low-Carbohydrate Diet':ti,ab,kw OR 'Low-Carbohydrate Diets':ti,ab,kw OR 'Low Carbohydrate Diet':ti,ab,kw OR 'Low Carbohydrate Diets':ti,ab,kw OR 'Cariogenic Diet':ti,ab,kw OR 'Cariogenic Diets':ti,ab,kw OR Carbohydrate*:ti,ab,kw) AND (Biofilm*:ti,ab,kw OR 'Adhesion Bacterial':ti,ab,kw OR 'Adhesin Bacterial':ti,ab,kw OR 'Deposits Dental':ti,ab,kw OR Tartar:ti,ab,kw OR 'Dental Plaque':ti,ab,kw OR 'Plaque accumulation':ti,ab,kw OR 'Dental Caries':ti,ab,kw OR 'Dental Decay':ti,ab,kw OR 'Carious Dentin':ti,ab,kw OR 'Carious Dentins':ti,ab,kw OR 'Dental White Spot':ti,ab,kw OR 'Dental White Spots':ti,ab,kw OR 'White Spot':ti,ab,kw OR 'White Spots':ti,ab,kw OR 'Periodontal Diseases':ti,ab,kw OR 'Periodontal Disease':ti,ab,kw OR Parodontos*:ti,ab,kw OR 'Pyorrhea Alveolaris':ti,ab,kw) AND (Observational:ti,ab,kw OR 'Prospective Study':ti,ab,kw OR Cohort:ti,ab,kw OR 'Follow up':ti,ab,kw OR 'Case Control':ti,ab,kw OR 'Retrospective Study':ti,ab,kw OR Cross-sectional:ti,ab,kw OR 'Disease Frequency':ti,ab,kw OR 'Prevalence Study':ti,ab,kw)
Web of Science	(TS=(Child OR Children OR "Preschool Child" OR "Preschool Children" OR Adolescent OR Adolescents OR Adolescence OR Teens OR Teen OR Teenagers OR Teenager OR Youth OR Youths OR "Female Adolescent" OR "Female Adolescents" OR "Male Adolescent" OR "Male Adolescents" OR Students OR Student OR "School Enrollment")) AND (TS=("Diet Record" OR "Diet Records" OR "Food Diaries" OR "Food Diary" OR "Dietary Record" OR "Dietary Records" OR "Carbohydrate Loading Diet" OR "Carbohydrate Loading Diets" OR "Carbohydrate Loading" OR "Carbohydrate-Restricted Diet" OR "Carbohydrate-Restricted Diets" OR "Carbohydrate Restricted Diet" OR "Low Carbohydrate Diet" OR "Low Carbohydrate Diets" OR "Low-Carbohydrate Diet" OR "Low-Carbohydrate Diets" OR "Low Carbohydrate Diet" OR "Low Carbohydrate Diets" OR "Cariogenic Diet" OR "Cariogenic Diets" OR Carbohydrate OR Carbohydrates)) AND (TS=(Biofilms OR Biofilm OR "Adhesion Bacterial" OR "Adhesin Bacterial" OR "Deposits Dental" OR Tartar OR "Dental Plaque" OR "Plaque accumulation" OR "Dental Caries" OR "Dental Decay" OR "Carious Dentin" OR "Carious Dentins" OR "Dental White Spot" OR "Dental White Spots" OR "White Spot" OR "White Spots" OR "Periodontal Diseases" OR "Periodontal Disease" OR Parodontosis OR Parodontoses OR "Pyorrhea Alveolaris")) AND (TS=(Observational OR "Prospective Studies" OR "Prospective Study" OR "Cohort Studies" OR Cohort OR "Follow-up Studies" OR "Follow-up Study" OR "Case-control Studies" OR "Case Control" OR "Retrospective Studies" OR "Cross-sectional Studies" OR Cross-sectional OR "Disease Frequency" OR "Prevalence Study"))

Source: Authors.

2.3 Selection procedures

We imported the study titles found in each database through the VantagePoint™ software (Search Technology, Inc., Florida, USA), and duplicates were removed. Then, we used the Google Spreadsheets tool to analyze each article for eligibility and specific data extraction. Studies that did not have enough information in the title and summary were analyzed in full text to verify eligibility.

2.4 Data extraction

With the help of VantagePoint™ software, the year of publication and scientific journal of each record was automatically extracted. The titles were organized in the Google Spreadsheets tool. Three examiners independently evaluated the articles and extracted the following additional data: country of the study, age group of the population (child – until nine years; adolescent – 10 to 19 years) (WHO, 2021), type of study (cohort, cross-sectional or case-control), oral index, an instrument used for diet analysis (questionnaire, interview, and diet diary), and duration of the study (≤ 3 years / > 3 years), oral outcomes (dental caries, dental biofilm, and periodontal disease).

Food data were extracted and classified considering the following food groups (SBP, 2018): carbohydrates; vegetables and legumes; fruits; meats, eggs, and leguminous; milk and dairy products; oils and fats; sugar and sweets. In addition, the diet consistency (solid, pasty, and liquid), specific components, such as macro and micronutrients, the consumption time (between meals or snacks and night dietary habits), and the exposure frequency were identified. When they were mentioned, data were obtained on the breast milk in the diet.

Full texts of the articles were evaluated. Any divergence over the studies was resolute by consensus between the three examiners. Disagreements between the authors were resolved by discussion, with a fourth author when necessary.

2.5 Data analyses

Descriptive analyses were made using VantagePoint™ and SPSS version 21 software (IBM, Chicago, IL). Some variables (age group, outcomes, oral indices, diet, and association results) allowed the selection of more than one classification in the same study. This selection could make the value of the total frequency of these variables greater than the number of studies included.

With the support of the tech mining software VantagePoint™, we could extract bibliometric analyses of the frequency of journals (with four or more publications), type of study, countries (where the study was performed), year (stratified by decades), age group, outcomes, and results of associations. Food groups were identified when the primary study's authors mentioned the diet description and specified it in the statistical analyses. However, the dietary items cited by the studies did not indicate a diet restricted to these foods.

Descriptive analysis to show the characteristics of the studies was performed through the SPSS software, considering the following variables: type of study (cohort / cross-sectional / case-control), age groups (children/adolescents/children and adolescents), outcomes (dental caries / dental biofilm / periodontal disease), oral indexes, instruments for dietary data collection, and duration of the study ($\leq$ 3 years / > 3 years).

The relationship between diet and oral health was assessed using the association and correlation results provided in each selected study. Associations were considered in any statistical causal or non-causal relationship between different variables, and correlations, as linear relationships between other variables. The impact of diet on oral outcomes was classified as: positive (diet components as a risk factor for the clinical consequence), harmful (diet components as a protective factor against the clinical outcome), and null (absence of any impact of the diet on the clinical outcome).

The diet consistency was classified as: solid (retentive foods, such as cookies, cakes, chocolate, candies, and bread), pasty (creamy foods, such as milkshakes, yogurts, sweet puddings, soup, and ice cream), and liquid (drinks, such as soda, fruit juice, and milk). Specific components involved macronutrients (e.g., fats and proteins) and micronutrients (e.g., calcium, fluoride, and vitamins). Both were recorded when the authors of the primary studies performed statistical analyses specifically citing these nutrients and not just the food group. Breast milk data were obtained from the studies that associated this data with oral health, including exclusive and non-exclusive breastfeeding. The consumption time was recorded concerning the intake of food and drinks between meals (snacks) and relative to the night dietary habits, including bottle feeding, breast milk, and sugary foods or beverages. The frequency classification of exposures was performed according to the data (daily or weekly) informed by the authors. If possible, similar frequencies were grouped (as 2×/day and $\geq$2×/day; 3×/day and $\geq$3×/day); however, due to the variability and range of classifications, there may be overlap between some groups.

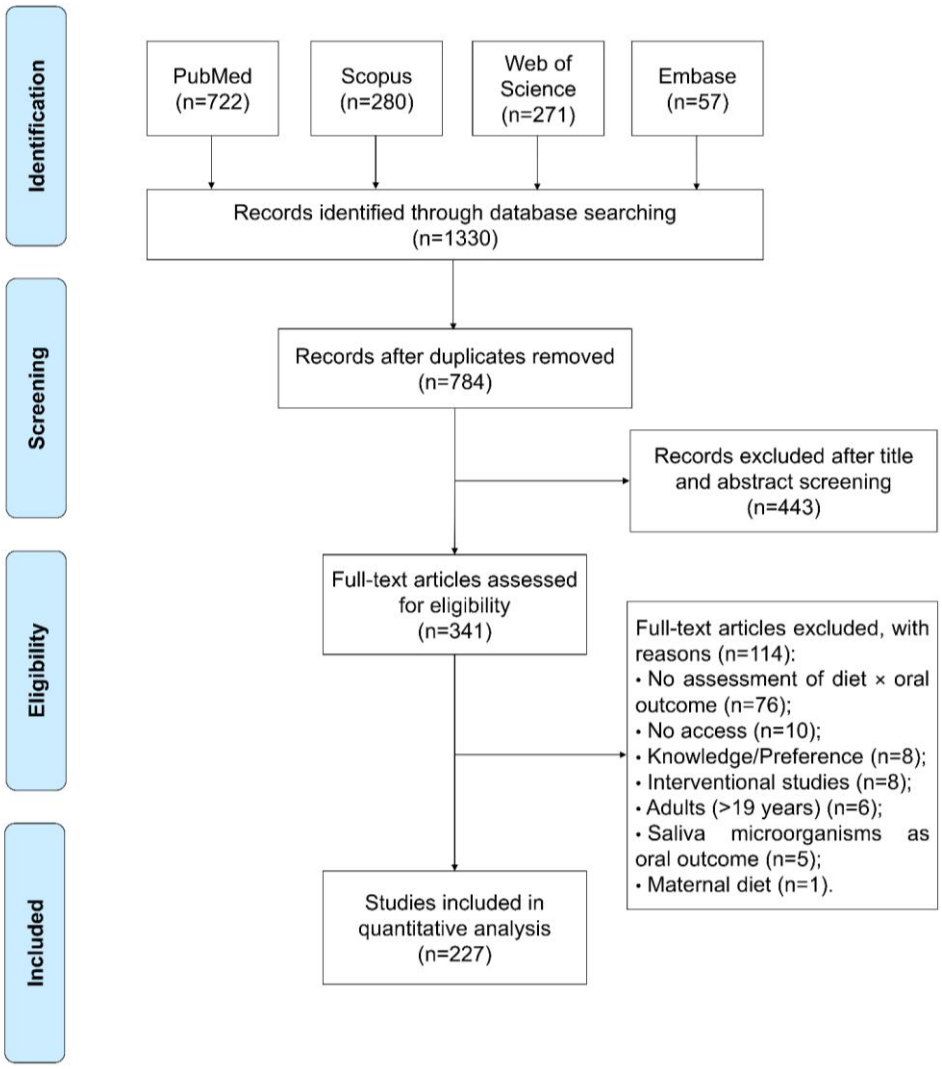
We performed descriptive analyses regarding the considered outcomes concerning the results of association/correlation, specific components, consumption time (between meals and night dietary habits), and exposure frequency. Analyses regarding the distribution of variables related to the diet (consistency, food group, specific components,

consumption time, and exposure frequency) and the results of association/correlation (positive, null, or negative) were also performed.

3. Results

The search in the world literature resulted in 1330 articles, of which 546 were excluded because they were duplicates. Thus, 784 studies were assessed according to the eligibility criteria, and after the title and abstract screening, 443 studies were excluded. Therefore, we selected 342 studies read in full to evaluate eligibility, of which 227 were for the final analyses (Figure 1). The percentage of titles excluded after the applied eligibility criteria was 28.9%.

Figure 1 - Flowchart of search results in databases.



Source: Authors.

3.1 Journals, year of publication, and countries

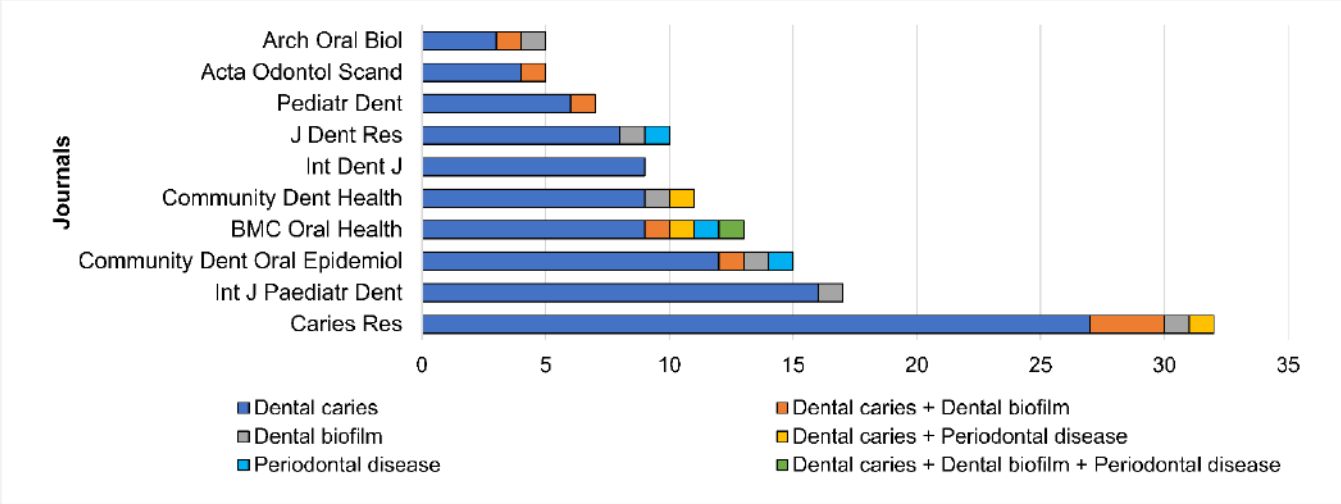
The journal with the largest number of publications was Caries Research (n=32; 14.1%), followed by the International Journal of Paediatric Dentistry (n=17; 7.5%) and Community Dentistry and Oral Epidemiology (n=15; 6.6%) (Figure 2).

The studies were published from 1980 to 2021, with the most significant number of publications between 2010 and 2021 (n=119; 52.2%). During the 1980s, only four articles (1.7%) were published. Over the years, an increase in the number of

studies on dental caries and dental biofilm has been observed. In turn, periodontal diseases were only existing in the studies from 2000 to 2021 (Figure 3).

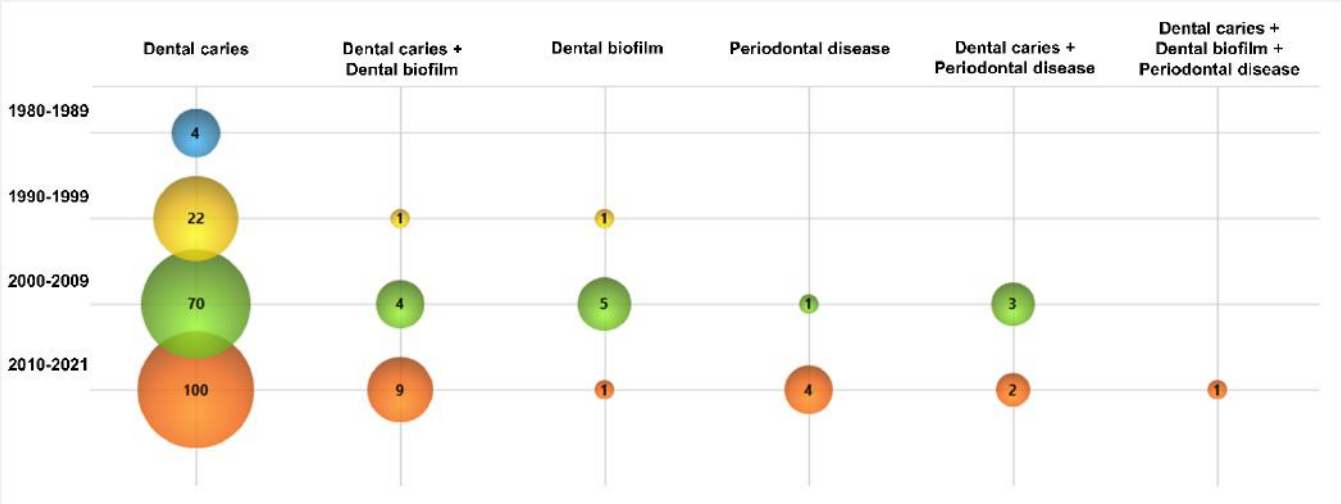
Among the 57 identified countries, 14 presented five or more studies in their territory. Brazil (n=26; 11.5%), the United States of America (n=21; 9.3%), and Australia (n=14; 6.2%) were the most productive countries on the theme (Figure 4).

Figure 2 - Frequency of studies according to the journals with more publications and oral outcomes.



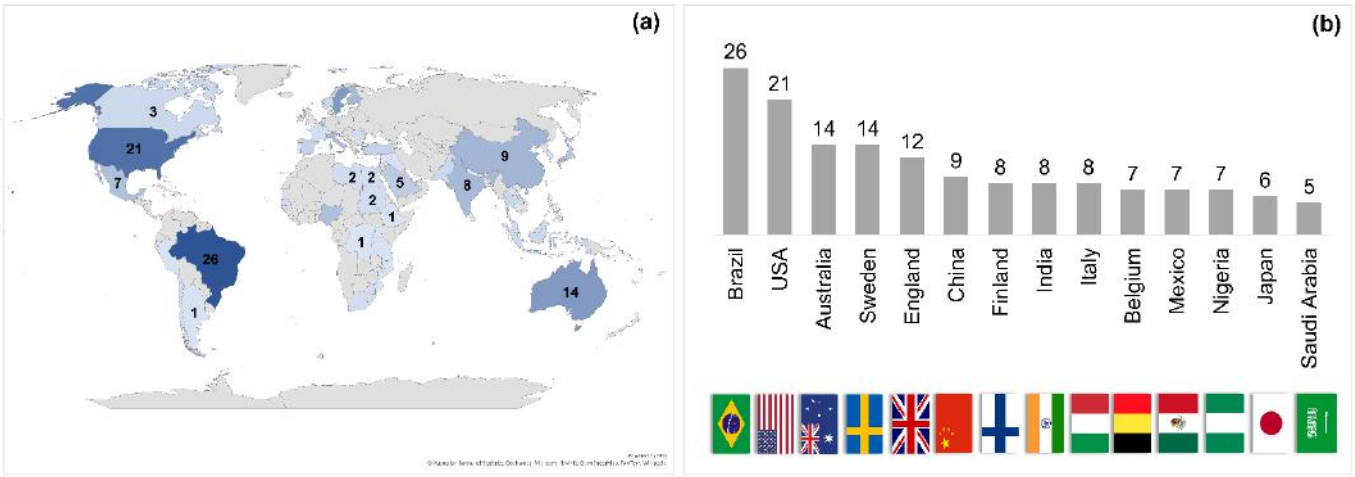
Source: Authors.

Figure 3 - Bubble chart of the investigated outcomes over the years.



Source: Authors.

Figure 4 - (a) Map of countries that publish on the topic. The darker the shade of blue, the greater the number of studies carried out in the country; (b) The countries with the largest number of publications**.**



Source: Authors.

3.2 Type of study, age group, outcomes, and oral indexes

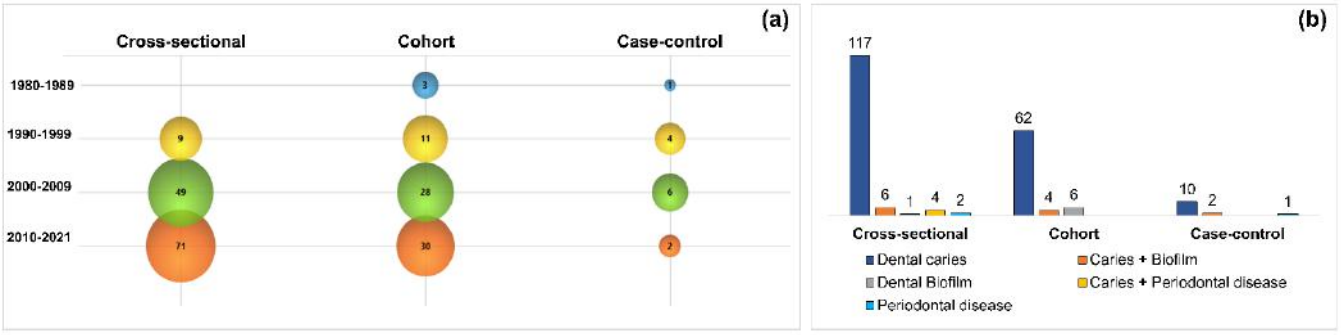
Most studies were cross-sectional (n=139; 61.2%), followed by cohorts (n=73; 33.2%) and case controls (n=15; 6.6%). The number of cross-sectional studies and cohorts has been increasing over the years (Figure 5a).

Studies with population groups formed only by children (n=141; 62.1%) were the most frequent, followed by adolescents (n=46; 20.3%) and children + adolescents (n=40; 17.6%) (Table 2). There was a progressive growth in the number of publications with both age groups between 1980 and 2021.

The most studied outcomes were dental caries (n=193; 85.0%) and dental caries + dental biofilm (n=17; 7.5%). The impact of diet on periodontal disease alone was evaluated in only four articles (1.8%). No cohort study included in this bibliometric review investigated the relationship between diet and periodontal disease (Figure 5b). A positive association/correlation between diet, on oral outcomes was demonstrated in most studies (n=193; 85.0%), followed by an absence of impact (null) (n=23; 10.1%), positive/null (n=8; 3.5%) and negative association (n=3; 1.3%). Positive association/correlation was observed between diet and dental caries (n=164; 85%), dental caries + dental biofilm (n=15; 88.2%), dental biofilm (n=5; 71.4%), and periodontal disease (n=4; 100%).

A total of 195 studies (85.9%) reported the clinical indexes used for outcomes evaluation. DMFT / dmft (n=126; 55.5%), DMFS / dmfs (n=46; 20.3%) (decayed, missing, and filled permanent or primary teeth or surface, respectively), and ICDAS (International Caries Detection and Assessment System) (n=23; 10.1%) were the most indexes used to perform the caries diagnosis. Regarding biofilm, PI (plaque index), VPI (visual plaque index), and OHI-S (Oral Hygiene Index Simplified) were used for 7 (3.1%), 4 (1.8%), and 5 (2.2%) studies, respectively. Periodontal diseases were assessed by the CPI (community periodontal index) / CPITN (community periodontal index treatment needs) in 4 studies (1.8%) (Table 2).

Figure 5 - (a) Bubble chart of the types of studies over the years; (b) Frequency of study' type by outcome.



Source: Authors.

3.3 Instruments for dietary data collection and duration of studies

Among the instruments for data collection reported (n=209; 92.1%), the questionnaire was the main one (n=158; 75.6%), followed by the diet diary (n=32; 15.3%), interview (n=15; 7.2%) and the questionnaire + diet diary (n=4; 1.9%) (Table 2). Isolated questionnaires were used mainly in cross-sectional studies (n=105; 66.5%), while diet diaries were used more in cohort studies (n=17; 53.1%). Most studies did not specify the questionnaire used (n=86; 53.1%). Twenty-four studies (14.8%) used questionnaires based on previous, pre-tested, pre-coded, and standardized studies; 19 (11.7%) used the food frequency questionnaire (FFQ); 15 (9.3%) used the 24-hour dietary recall; 10 (6.2%) reported the use of validated questionnaires, but not specified; and, 8 (4.9%) used other questionnaires, such as the block kids food frequency questionnaire and food consumption frequency.

Regarding the duration of the studies, 82 articles (36.1%) provided this information, and most of them (n=47; 57.3%) were carried out for three years or less (Table 2).

Table 2 - Frequency and percentage of data extracted.

Variables	N	%*
Types of study		
Cross-sectional	139	61.2
Cohort	73	33.2
Case-control	15	6.6
Age groups		
Children	141	62.1
Adolescents	46	20.3
Children and adolescents	40	17.6
Outcomes		
Dental caries	193	85.0
Dental caries and dental biofilm	17	7.5
Dental biofilm	7	3.1
Dental caries and periodontal disease	5	2.2
Periodontal disease	4	1.8
Dental caries, dental biofilm and periodontal disease	1	0.4
Oral indexes**		
DMFT / dmft	126	55.5
DMFS / dmfs	46	20.3
ICDAS	23	10.1
PI	7	3.1
OHIS	5	2.2
VPI	4	1.8
CPI / CPINT	4	1.8
Others	27	11.9
Instruments		
Questionnaire	158	75.6
Diet diary	32	15.3
Interview	15	7.2
Questionnaire and diet diary	4	1.9
Study duration		
≤ 3 years	47	57.3
> 3 years	35	42.7

*The percentages consider the values valid (the missing data has not been counted). **DMFT / dmft: decayed, missing due to caries, and filled teeth in the permanent and primary teeth, respectively; DMFS / dmfs: decayed, missing, and filled surfaces in the permanent and primary teeth, respectively; ICDAS: international caries detection and assessment system; PI: plaque index; OHIS: simplified oral hygiene index; VPI: visible plaque index; CPI: community periodontal index; CPITN: community periodontal index treatment needs. Source: Authors.

3.4 Consistency, composition, consumption time, and frequency of diet exposure

Few studies evaluated the impact of specific diet components on periodontal disease. None assessed this outcome regarding the consumption time (between meals and night dietary habits) and exposure frequency (Table 3).

The consistency of the diet was analyzed and grouped into solid (n=136; 59.9%), pasty (n=36; 15.9%), and liquid (n=176; 77.5%). Similar results of association/correlation with the outcomes were observed among the different consistencies (Table 4).

Sugars and sweets were shown to be the leading food group present in the reported diets (n=136; 59.9%), with a higher frequency of positive association with dental caries (n=118; 86.8%), dental biofilm (n=12; 8.8%) and periodontal disease (n=5; 3.7%). Moreover, carbohydrates (n=33; 75.0%) and milk and dairy products (n=25; 61.0%) were also observed with a high association/correlation with the outcomes. Among the studies that evaluated vegetables and legumes (n=9; 4.0%),

none showed a positive association/correlation, 6 (66.7%) were null, and 3 (33.3%) considered this group as a protective factor for oral outcomes (Table 4).

Specific components were reported in 15 studies (6.6%), which evaluated mainly fluoride (n=7; 3.1%) and vitamins (n=4; 1.8%). Most of these studies found a negative (n=8; 61.5%) or a null impact (n=4; 30.8%) on the oral outcomes. Breast milk was cited as having a positive association/correlation in 16 (51.6%) of 35 studies (Table 4).

Consumption time between meals (n=59; 26.0%) was commonly associated with the outcomes (n=43; 86.0%). Night dietary habits were described in 42 (18.5%) studies and, in general, were considered a risk factor for the outcomes (n=31; 77.5%). We have observed a positive association between dental caries and snacks (n=40) or night dietary habits (n=30). The exposure frequency ≥3×/day was the most common (n=16; 7.0%), which was associated with dental caries (n=11; 68.8%), and dental biofilm (n=5; 31.2%) in all studies (Table 4).

Table 3 - Distribution of variables related to diet according to the outcomes evaluated.

Variables	**Outcomes**					
	Dental caries (DC) n (%)	Dental biofilm (DB) n (%)	Periodontal disease (PD) n (%)	DC + DB n (%)	DC + PD n (%)	DC + DB + PD n (%)
Association / correlation						
Positive	164 (85.0)	5 (71.4)	4 (100.0)	15 (88.2)	4 (80.0)	1 (100.0)
Null	20 (10.4)	1 (14.3)	0 (0.0)	1 (5.9)	1 (20.0)	0 (0.0)
Negative	3 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Positive / null	6 (3.1)	1 (14.3)	0 (0.0)	1 (5.9)	0 (0.0)	0 (0.0)
Total	193 (100.0)	7 (100.0)	4 (100.0)	17 (100.0)	5 (100.0)	1 (100.0)
Specific components						
Fluoride	7 (35.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Vitamins	3 (15.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)
Iron	3 (15.0)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)
Fats	2 (10.0)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)
Calcium	2 (10.0)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)
Starch	1 (5.0)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)
Protein	1 (5.0)	0 (0.0)	1 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)
Others	1 (5.0)	0 (0.0)	2 (28.5)	0 (0.0)	0 (0.0)	0 (0.0)
Total	20 (100.0)	0 (0.0)	7 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)
Consumption time						
Between meals	51 (22.5)	3 (1.3)	1 (0.4)	2 (0.9)	1 (0.4)	1 (0.4)
Night dietary habits						
Bottle feeding	11 (32.3)	1 (50.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)
Breast milk	5 (14.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Bottle feeding / breast milk	5 (14.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Not specified	3 (8.8)	1 (50.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)
Sugary foods	3 (8.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Fruit juice	3 (8.8)	0 (0.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)
Sugary drinks	2 (5.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sugary foods and drinks	1 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Milk and juice at bedtime	1 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sweets before bed	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)
Total	34 (100.0)	2 (100.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)
Exposure frequency						
≥3×/day	11 (20.7)	2 (66.7)	0 (0.0)	3 (33.4)	0 (0.0)	0 (0.0)
≤1×/day	9 (17.0)	1 (33.3)	0 (0.0)	1 (11.1)	0 (0.0)	0 (0.0)
≥1×/day	8 (15.1)	0 (0.0)	1 (100.0)	1 (11.1)	1 (100.0)	0 (0.0)
≥2×/day	7 (13.2)	0 (0.0)	0 (0.0)	2 (22.2)	0 (0.0)	0 (0.0)
≥1×/week	6 (11.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
>4×/day	5 (9.4)	0 (0.0)	0 (0.0)	2 (22.2)	0 (0.0)	0 (0.0)
Frequent or several times/day	3 (5.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
>3×/week	2 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Free demand	2 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	53 (100.0)	3 (100.0)	1 (100.0)	9 (100.0)	1 (100.0)	0 (0.0)

Source: Authors.

Table 4 - Distribution of variables related to diet according to the association/correlation with oral health.

Variable	N (%)	Association / Correlation		
		Positive	Null	Negative
Consistency				
Liquid	162 (71.4)	138 (85.2)	19 (11.7)	5 (3.1)
Solid	118 (52.0)	100 (84.7)	14 (11.9)	4 (3.4)
Pasty	27 (11.9)	23 (85.2)	4 (14.8)	0 (0.0)
Food groups				
Sugars and sweets	136 (59.9)	121 (89.0)	14 (10.3)	1 (0.7)
Carbohydrates	44 (19.4)	33 (75.0)	10 (22.7)	1 (2.3)
Milk and dairy products	41 (18.1)	25 (61.0)	11 (26.8)	5 (12.2)
Fruits	20 (8.8)	7 (35.0)	11 (55.0)	2 (10.0)
Meat, eggs and grains	13 (5.7)	1 (7.7)	10 (76.9)	2 (15.4)
Vegetables and legumes	9 (4.0)	0 (0.0)	6 (66.7)	3 (33.3)
Oils and fats	6 (2.6)	2 (33.3)	3 (50.0)	1 (16.7)
Specific components				
Fluoride	5 (0,2)	1 (20,0)	2 (40,0)	2 (40,0)
Vitamins	4 (1,8)	0 (0,0)	1 (25,0)	3 (75,0)
Iron	4 (1,8)	0 (0,0)	1 (25,0)	3 (75,0)
Calcium	4 (1,8)	0 (0,0)	1 (25,0)	3 (75,0)
Fats	3 (1,3)	0 (0,0)	2 (66,7)	1 (33,3)
Starch	2 (0,9)	0 (0,0)	0 (0,0)	2 (100,0)
Protein	2 (0,9)	0 (0,0)	1 (50,0)	1 (50,0)
Fibers	2 (0,9)	0 (0,0)	0 (0,0)	2 (100,0)
Others	3 (1,3)	0 (0,0)	0 (0,0)	3 (100,0)
Breast milk	31 (13,7)	16 (51,6)	9 (29,0)	6 (19,4)
Consumption time				
Between meals	50 (22,0)	43 (86,0)	7 (14,0)	0 (0,0)
Night dietary habits				
Bottle feeding	10 (4,4)	8 (80,0)	2 (20,0)	0 (0,0)
Sugary drinks	6 (2,6)	5 (83,3)	1 (16,7)	0 (0,0)
Breast milk	5 (2,2)	4 (80,0)	0 (0,0)	1 (20,0)
Bottle feeding / breast milk	5 (2,2)	4 (80,0)	1 (20,0)	0 (0,0)
Not specified	5 (2,2)	3 (60,0)	2 (40,0)	0 (0,0)
Sugary foods	3 (1,3)	3 (100,0)	0 (0,0)	0 (0,0)
Formula milk	2 (0,9)	1 (50,0)	1 (50,0)	0 (0,0)
Fruit juice	1 (0,4)	1 (100,0)	0 (0,0)	0 (0,0)
Sugary foods and drinks	1 (0,4)	1 (100,0)	0 (0,0)	0 (0,0)
Sweets before bed	1 (0,4)	1 (100,0)	0 (0,0)	0 (0,0)
Milk and juice at bedtime	1 (0,4)	0 (0,0)	1 (100,0)	0 (0,0)
Exposure frequency				
≥3×/day	16 (7,0)	16 (100,0)	0 (0,0)	0 (0,0)
≤1×/day	11 (4,8)	8 (72,7)	3 (27,3)	0 (0,0)
≥1×/day	10 (4,4)	10 (100,0)	0 (0,0)	0 (0,0)
≥2×/day	9 (4,0)	9 (100,0)	0 (0,0)	0 (0,0)
>4×/day	7 (3,1)	6 (85,7)	1 (14,3)	0 (0,0)
≥1×/week	6 (2,6)	6 (100,0)	0 (0,0)	0 (0,0)
Frequent or several times/day	4 (1,8)	3 (75,0)	1 (25,0)	0 (0,0)
>3×/week	2 (0,9)	2 (100,0)	0 (0,0)	0 (0,0)
Free demand	2 (0,9)	2 (100,0)	0 (0,0)	0 (0,0)

Source: Authors.

4. Discussion

Observational studies in dentistry are important tools to evaluate the population's behavior and the risk factors involved in oral diseases, including dental caries and periodontal diseases (GBD, 2018). Moreover, this study is able to help in the evaluation of possible links between nutrition and oral health in the pediatric population and to propose prevention based on dietary guidelines for disease control (Cataldo et al., 2019). Bibliometric reviews, in turn, can contribute in the quantitative analysis of these studies, a useful method for predicting research trends (Geaney et al., 2015). Because of the vast literature on the topic, the present study was carried out along the lines of a bibliometric review to simplify the understanding of clinicians

and researchers on the profile of studies performed worldwide that evaluate the impact of diet on the oral health of children and adolescents.

The selected studies were published between 1980 and 2021, with a progressive increase in publications, especially on dental caries, over the years. This increase can be elucidated by the academic-scientific progress in dentistry, the ease of manuscripts' propagation, the service of online scientific journals, and the new paradigms about oral diseases and their associations with nutritional conditions. Studies on this topic and periodontal disease as an oral outcome appeared after the 2000s. There is still little evidence of the association of specific food groups with periodontal disease. However, there is currently a greater interest in studying the preventive and modulating role of antioxidant nutrients and systemic conditions associated with malnutrition (Choudhari et al., 2018; Javid et al., 2019).

Brazil, the United States, and Australia were the countries that contributed to the subject. The capacities of research and technological advances between different countries can be reflected in the geographical distributions of the productivity of scientific research (Liu et al., 2020). Although Brazil is an emerging country, its great representativeness in developing pediatric dentistry studies has already been reported in other bibliometric analyses (Patil et al., 2020; Liu et al., 2020; Ohta et al., 2020).

Regarding the types of study, cross-sectional design was the most frequent, followed by cohorts and control cases. The findings of cross-sectional studies are based on the analysis of patient records collected at a given time, making it possible to recognize the problem and determine control measures (Belbasis et al., 2018). However, one of the limitations of these studies is to make causal inferences based on instantaneous data from just a moment (Levin et al., 2006), given that the eating pattern may change over time. Thus, cohort studies are believed to be more appropriate to assess these changes, as they follow the population group in the medium or long term, requiring more studies of this type to determine the impact of diet on oral health.

Children were more common as the studies' participants, which may be associated with their dietary pattern, which ingest more sugary products and, therefore, presents a higher risk behavior for dental caries. For example, the number of overweight children in Brazil and the United States has been increasing. Although obesity is a multifactorial disorder, the increase in sugars and processed foods in the diet is an important etiological factor (Feferbaum et al., 2012). Individuals with a diet rich in carbohydrates and fermentable sugars have a prolonged low pH on the biofilm. Low pH favors cariogenic microbiota growth and leads to enamel integrity loss, resulting in dental caries (Takahashi & Nyvad, 2011). Therefore, we can expect changes in the quality of oral health. Children present high-risk behavior for dental caries due to consuming a sugary diet, aggravated by the precarious control of dental biofilm and the lower frequency and quality of oral hygiene, which, in turn, are determining and modifying factors of periodontal diseases (Menegaz et al., 2019).

Among the outcomes, dental caries was the most studied since it is one of the most prevalent oral diseases in the world. This result is in line with the bibliometric analysis by Ohta et al. (2020), who investigated publications in pediatric dentistry. They observed that cariology had the most notable scientific production in this specialty. Periodontal disease, including gingivitis, and bleeding on probing and probing depth (Jaghasi et al., 2012; Moreira et al., 2020), on the other hand, was the least studied outcome, demonstrating that further research is needed to investigate the impact of diet on the development of periodontal conditions in children and adolescents (Al-Zahrani et al., 2015). Although children are less affected by periodontal diseases compared to adults and the elderly, it is one of the causes of early tooth loss. It represents a widespread public health problem, and knowledge of the factors associated with its development is imperative (Carvajal et al., 2020). Among periodontal diseases during childhood and adolescence, gingivitis induced by the accumulation of dental biofilm deserves more emphasis, considering that this is the most common condition and is frequently associated with caries lesions (Liu et al., 2022).

Questionnaires were the most used instruments for obtaining dietary data. This instrument makes it possible to estimate the foods commonly eaten over a recall period and generally classify the individuals studied according to consumption gradients. As it refers to the previous intake, this method does not consider changes in individuals' consumption patterns over time. Given its practicality and ease of application, it has been widely used in epidemiological studies (Rezazadeh et al., 2020). However, just like the other instruments, the questionnaire has limitations since it depends on the recall of patients and guardians regarding their food, being able to collect incorrect statements or underreported data (Newens et al., 2015).

Another point to be discussed is that in the present bibliometric analysis, most studies were carried out with unspecified questionnaires, and a small number of authors mentioned the use of validated instruments, which can compromise the results and make comparisons between studies difficult. The most used specific questionnaires were the FFQ and the 24-hour dietary recall. These methods, like the others, have different characteristics that bring advantages and limitations. Thus, food intake is difficult to measure. Therefore, a association of methods has been suggested, such as the FFQ with the 24-hour dietary record. The diet diary was the second most used instrument among the included studies. This method has been considered the most adequate to collect information about diet data since it is sensitive to possible changes in diet, although it is poorly used among dentists (Arheiam et al., 2018). Therefore, new tools are still required to minimize the already known limitations, and technological resources, such as mobile phone applications, can be used (Shim et al., 2014).

DFMT / dmft and DMFS / dmfs were the most used clinical indexes. Both were employed to assess dental caries, which can be justified by the greater number of studies exploring this outcome. In addition, they are World Health Organization reference indexes, which supports their extensive use in selected studies (WHO, 1997). However, the indexes used for diagnosing dental caries correspond to another limitation since most studies used indexes that do not include the diagnosis of active non-cavitated lesions. These, in turn, can detect with greater sensitivity and, at an early stage, a possible impact of the cariogenic diet, past or current, on the integrity of dental tissues. Therefore, the choice of instruments for data collection is particularly important to achieve the proposed objectives. Thus, studies with better methodological designs on this theme are still required to produce a high level of scientific evidence.

Diet consistency did not impact oral health. This lack of influence may have occurred because most studies assessed foods and beverages containing sugars. Furthermore, no study compared foods of different consistencies with each other. Divergences were observed between the studies regarding the classification of food groups, especially concerning sugars and carbohydrates. The different terms used to define the groups affect the comparison between countries, associations of the impact on oral health, recognition between the risk factors with the outcomes, and make it difficult to develop preventive measures that apply to different populations (Newens et al., 2015).

Although there is evidence in the literature about the role of sugar in the development of dental caries (Chi & Scott, 2019), the impact of sugars and sweets was null in some studies (Evans et al., 2013; Miranda et al., 2013; Mitrakul et al., 2016; Ju, Jamieson & Mejia, 2016; Ribeiro et al., 2017; Mitrakul et al., 2017; Bell et al., 2019; Folayan et al., 2020) or even considered as a protective factor against oral outcomes studied (Downer et al., 2008; Mapengo et al., 2010; Pires et al., 2020; Priyadarshini & Gurunathan, 2020). These results should be carefully analyzed. They can be explained by factors inherent to the studies, such as the instrument used to collect dietary data, the frequency with which it was performed, and the frequency of clinical examination. Most studies presented a cross-sectional design and did not monitor patients over time, or even in longitudinal studies in which dietary data were collected using a questionnaire only at the baseline.

Specific diet components, such as fluoride and vitamins, presented a null or negative impact on oral outcomes (Saido et al., 2015; Mitrakul et al., 2016; Guizar et al., 2016; Mitrakul et al., 2017; Carvalho Silva et al., 2021). Fluoride may exhibit a protective effect in the caries process due to its property to interfere with remineralization (Buzalaf et al., 2011). Still, it is

known that its effect on the control of dental caries is a topic, and the role of the fluoride ingested is secondary. Therefore, monitoring the amount of fluoride ingested from infant formula during the first years of life is necessary to avoid dental fluorosis (Buzalaf, 2018). Although some studies suggest that vitamin D promotes tooth resistance to caries (Guizar et al., 2016; Saido et al., 2016; Carvalho Silva et al., 2021), there is no robust evidence (Hujoel, 2013). It is known that vitamin D deficiency can cause changes in enamel structure during tooth formation, and these changes can increase an individual's risk of caries. However, the present study's authors believe there is no direct relationship between vitamin D and caries prevention.

Some studies have evaluated breastfed children and observed the risk for dental caries (Tanaka et al., 2013; Özen et al., 2016; Feldens et al., 2017; Stephen et al., 2017). Others demonstrated that breastfeeding was a protective factor against dental caries (Nunes et al., 2014; Elidrissi & Naidoo, 2016; Pires et al., 2020; Devenish et al., 2020), and a minority showed no impact (Dasanayake et al., 2002; Wan et al., 2003; Mohebbi et al., 2008). However, some of these studies did not include possible confounding factors in their analyses, such as the association of breastfeeding with the use of a bottle, night breastfeeding by children who had already undergone food introduction, the consumption of other products, or the lack of oral hygiene habits. These confounding factors resulted in a greater risk of dental caries. Not including that confounding factors can be a limitation of these findings since breastfeeding is not always performed exclusively. Besides breastfeeding and supplemental feeding, other factors such as consumption frequency and timing can impact dental caries risks. However, there is evidence that diet and feeding advice for mothers of children up to one year of age reduces the risk of dental caries (Riggs et al., 2019) and that breastfeeding up to two years of age does not increase the risk for caries in early childhood (Moynihan et al., 2019).

Consumption time between meals (Nunes et al., 2012; Özen et al., 2016; Llena et al., 2020; Pires et al., 2020) and night dietary habits were considered risk factors for oral outcomes (Tanaka et al., 2013; Özen et al., 2016). As for night dietary habits, most studies reported the consumption of sugary beverages offered in bottle feeding. However, it is known that oral hygiene does not usually follow dietary habits before bed or during the night. Thus, falling asleep with a sugary bottle feeding in the mouth stimulates the formation of carious lesions. In addition, during the night, there is a reduction in salivary flow, which limits its ability to control enamel demineralization, favoring microbial proliferation in the oral environment and the development of dental biofilm (Krzyściak et al., 2014).

The exposure frequency ≥3×/day was the most commonly associated with dental caries and dental biofilm (Jaghasi et al., 2012; Armfield et al., 2013; Elidrissi & Naidoo, 2016). The primary studies' authors considered different criteria for the classification of the frequency of food intake. Most studies observed only sugary food intake, others counted only main meals, and others included both. Considering that the population has three main meals a day (breakfast, lunch, and dinner), any other additional diet exposure occurs between meals. Thus, a higher frequency of food intake is also associated with snacks. It is known that the frequency of consumption is one of the modifiers factors of dental caries, especially when in the presence of sugars, resulting in a higher risk of developing the disease, which explains the association observed in the present study (Ccahuana-Vásquez et al., 2007; Moynihan, 2016; Van Loveren, 2019). Therefore, oral health education should comprise guidelines for patients to limit the frequency of intake of free sugars, especially between meals and at night.

Despite the results found, it is important to highlight that the present study did not purpose to assess the methodological quality of the selected articles. In addition, not all studies included had sufficient information for all data analysis, making it impossible to compare them. The different forms of classification and terminology of food groups, as well as the lack of more accurate information on how food is presented, made it difficult to assess the impact of diet on oral health.

In this context, developing and validating more objective instruments and classifications regarding the diet is recommended, which can simplify the development of research in the area to allow reproducibility and standardization in future studies. New instruments for analyzing the diet, which reduce the risk of memory bias, based on technological

resources, such as applications or software, can assist both the professional and the patient in recognizing the risk factors of the diet on oral health. In addition, based on the results discussed, the association/correlation of dietary patterns on periodontal diseases in children and adolescents is still poorly explained in the world literature, requiring studies that elucidate the relationship of this condition with specific food groups.

5. Conclusion

The number of publications on the diet's impact on oral health has been increasing worldwide, especially over the past two decades, particularly in Brazil, published mainly in Caries Research, with children, for dental caries evaluation, through cross-sectional studies and carried out utilizing questionnaires. The studies showed that diet consistency did not impact oral health. Still, sugars and sweets, snacks, night dietary habits, and frequent exposures were associated with oral outcomes, mainly dental caries. But there is still scarce literature on the topic of periodontal disease. Thus, further longitudinal studies with validated and targeted collection instruments for registering specific components of the diet and its relation with oral health are still needed.

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