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ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Social determinants of health and dental caries in Brazil: a systematic review of the literature between 1999 and 2010

Determinantes sociais da saúde e cárie dentária no Brasil: revisão sistemática da literatura no período de 1999 a 2010

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ABSTRACT: ***Objective***: To review epidemiological studies conducted in Brazil that investigated the distribution of dental caries according to socioeconomic status and demographic characteristics. ***Methods***: The systematic review included articles published between 1999 and 2010 available in six bibliographic sources, without any other restriction. We analyzed the bibliometric and methodological characteristics of the studies, and the direction and statistical significance of associations tested. ***Results***: Of the 1,128 references identified, 67 were incorporated into this study. There was a higher percentage of publications in the last two years and most of the studies were conducted in the South and Southeast of the country with a young population. The cross-sectional design, using a complex sampling procedure, was the most commonly adopted. The DMFT and dmft indexes were the most commonly used to measure dental caries, while sex/gender, income, education, race/skin color and type of school were the most common socioeconomic exposures. ***Conclusions***: Most studies identified a high rates of dental caries among the poorest, least educated, black and brown and female individuals. A more detailed methodological and theoretically sound study of the relationship between dental caries and socioeconomic conditions is needed.

Keywords: Dental caries. Health inequalities. Review. Epidemiology. Brazil. Oral health.

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RESUMO: ***Objetivo***: Revisar pesquisas epidemiológicas conduzidas no Brasil que investigaram a distribuição da cárie dentária segundo condições socioeconômicas e demográficas. ***Métodos:*** Na revisão sistemática, foram incorporados os artigos publicados entre 1999 e 2010 disponíveis em seis fontes bibliográficas, sem qualquer outra restrição. Analisaram-se as características bibliométricas e metodológicas dos estudos, além da direção e significância estatística das associações testadas. ***Resultados***: Das 1.128 referências identificadas, 67 foram incorporadas ao presente estudo. Observou-se maior volume de publicações no último biênio analisado, a maior parte dos estudos foi conduzida no sul e sudeste do País com populações jovens. O delineamento transversal, utilizando amostragem complexa foi o mais comum. Os índices CPO-D e ceo-d foram os mais empregados para medir cárie dentária, e sexo/gênero, renda, escolaridade, raça/cor e tipo de escola foram as exposições socioeconômicas mais frequentes. ***Conclusões***: A maior parte dos estudos identificou ocorrência mais elevada de cárie dentária entre os grupos mais pobres, menos escolarizados, de raça/cor parda e preta e do sexo/gênero feminino. Maior detalhamento metodológico e aprofundamento teórico da relação entre a cárie dentária e as condições socioeconômicas são necessários.

Palavras-chave: Cárie dentária. Desigualdades em saúde. Revisão. Epidemiologia. Saúde bucal. Brasil.

INTRODUCTION

Dental caries is responsible for a high load of oral disease, affecting, in the early 21st century, between 60% and 90% of school-aged children and a significant proportion of the world's adults[1]. Its distribution differs between continents and internally in them, with a significantly high magnitude in the Americas and lower in Africa. Regions that are more or less developed economically also show divergent trends in the occurrence of dental caries. Epidemiological studies conducted from the 1980s reveal a decreased in caries (medium DMFT index) in 12-years-old adolescents with high- and middle-income countries[2-5], while there is some stability and even a slight increase in the extent of caries in pre-school aged children[6-9].

Several negative effects of decay on the lives of individuals have been described in the literature. Sheiham[10] stressed that the disease adversely affects the welfare of children, while Acharya and Tandon[11] described that the experience of dental caries in early childhood impacts negatively on their quality of life and that of their parents. In addition, dental caries is a major cause of tooth loss, especially among youth and adults[12,13].

Biological, behavioral and socioeconomic factors are associated with the occurrence of dental caries. The relationship of this disease with the presence of *Streptococcus mutans*,

accumulation of dental plaque, insufficient oral hygiene for plaque removal, frequent and regular consumption of sucrose-rich foods and nocturnal feeding is well established[14,15]. The main preventive and therapeutic measure against caries is the constant exposure to therapeutic concentrations of fluoride, especially through fluoridated toothpaste and water[16]. Socioeconomic conditions have been identified as distal determinants of caries development, modulating the exposure to risk and protective factors mentioned, in addition to oral health services.

The unequal distribution of dental caries has been reported in studies with different designs and in different countries[17-19]. In this context, the study of socioeconomic inequalities in the distribution of dental caries is one of the research priorities of the World Health Organization (WHO) in the 21st century[20]. The WHO, the World Dental Federation and the International Association for Dental Research (IADR) highlighted the reduction of inequalities in oral health between social classes and between countries with different income levels as their global oral health goal for the year 2020[21]. In 2009, under the direction of the IADR, the group Global Health Inequalities (GOHIRA) was created, as an initiative to investigate oral health inequalities at a global level[22].

In 2006, the National Commission on Social Determinants of Health[1], was created in Brazil to encourage and coordinate the production of evidence on health inequities. Considering the high concentration of wealth and riches in the country, which puts it among the most unequal in the world, and the existence of a health care system that has equity as one of its principles, knowing the studies that investigated social inequalities in the occurrence of dental caries in a systematic way is of great relevance to the areas of research and health planning.

This study aimed to identify and analyze the epidemiological studies conducted in Brazil that investigated the association between dental caries and conditions related to socioeconomic status, color/race and sex/gender.

METHODS

This systematic review comprised an electronic search in six bibliographic sources: Web of Science, Scopus, PubMed, LILACS (Latin American and Caribbean Health Sciences Literature), SciELO (ScientificElectronic Library Online) and BBO (Brazilian Dental Bibliography). Whenever possible, the MeSH (Medical Subject Headings) and DeCS (Descriptors in Health Sciences) thesauri were consulted to construct the search keys. In situations where it was not possible to use controlled terms, the search was carried out using free terms, which were selected based on the experience of the authors of this review.

[1a] Brazil. Decree of March 13th, 2006. Establishes, under the Ministry of Health, the Commission on Social Determinants of Health - CNDSS. Available at: http://www.determinantes.fiocruz.br/decreto.htm.

The search was restricted to articles published between 1999 and 2010, excluding books, book chapters, papers, theses and dissertations. There was no limitation on the language used in publications. Search strategies in each bibliographic source were as follows:

- *Web of Science*: TS=(dent* car*) AND TS=((Brazil) OR (Brasil)) Timespan=1999-2010;
- *Scopus*: INDEXTERMS("dental caries") AND INDEXTERMS("Brazil") AND INDEXTERMS("socioeconomic factors" OR "educational status" OR "social class" OR "socioeconomics" OR "state government" OR "geographic locations" OR "skin pigmentation" OR "race relations" OR "ethnic difference" OR "race difference" OR "population groups" OR "ethnic groups" OR "race" OR "minority groups" OR "sex" OR "sex factors" OR "sex difference" OR "sex ratio" OR "urban health" OR "rural health" OR "urban population" OR "rural population") AND PUBYEAR AFT 1999;
- *Pubmed*: ("tooth demineralization"[MeSH Terms] AND "Brazil"[MeSH Terms]) AND ("socioeconomic factors"[MeSH Terms] OR "geographic locations"[MeSH Terms] OR "skin pigmentation"[MeSH Terms] OR "race relations"[MeSH Terms] OR "population characteristics"[MeSH Terms] OR "ethnic groups"[MeSH Terms] OR "sex"[MeSH Terms] OR "sex factors"[MeSH Terms] OR "urban health"[MeSH Terms] OR "rural health"[MeSH Terms] OR "urban population"[MeSH Terms] OR "rural population"[MeSH Terms]) AND ("1999"[EDAT] : "2010"[EDAT]);
- LILACS: ([MH]"Cárie dentária") and ([MH]"BRASIL") [Categoria DeCS];
- SciELO: carie [All Indexes] or desmineralizacao dental [All Indexes] or desmineralizacao do dente [All Indexes]. In this source, the equivalent in English and Spanish of the search keys were also used;
- BBO: ([MH]"Cárie dentária") and ([MH]"BRASIL") [DeCS Category].

All articles identified were exported from their sources to the bibliographic management program EndNote, version 8. Duplicate references were excluded, and the reading of the titles and abstracts was performed by the first two authors of the study, independently. Studies considered eligible had the following characteristics: (1) presented epidemiological design, regardless of the type; (2) conducted analysis of the distribution of dental caries by sex/gender, race/color or socioeconomic status. In this case, both the outcome and the exposure could have been analyzed by any indicators; (3) the study subjects resided in Brazil. In order to resolve any disagreements, the pair of reviewers sought consensus and, when necessary, they read the article in its entirety to decide on its continuation on or exclusion from the review.

The selected articles were read in their entirety and their data was extracted according to a previously prepared sheet that was pre-tested in three articles. This information was collected from each article independently and compared between the pair of reviewers; disagreements were resolved by consensus. All data collected were typed in the software EpiData 3.1, with automatic controls for consistency and range to minimize potential typos.

In the first section of the data production instrument, information was gathered on the year of publication, the institutional affiliation of the first author, the journal in which the study was published, the region of the country in which the study subjects resided, the sample size (excluding losses and refusals) and the minimum and maximum ages of the participants. Another aspect examined was whether the studies made the theoretical basis that related the exposure to outcome studied explicit, that is, whether the authors, supported by the literature, presented any theoretical elaboration on how dental caries is associated with socioeconomic conditions. Next, the type of study (cross-sectional, ecological, case-control, cohort or not set), the sampling process (equiprobabilistic, complex, convenience, census or not described), whether or not parameters were defined for the calculation of sample size and criteria for participant eligibility were recorded. Also, we analyzed which indicators were used to measure the outcome and exposures, as well as if they had been defined in the study. We also verified whether reproducibility measures of the measurement of outcome were estimated, and whether strategies for quality control in the production of data were used. Losses and refusals were also evaluated, in addition to whether the reasons for them were reported, whether reproducibility values of the measurement of outcome were presented and if the estimates of the occurrence of the outcomes were presented with their respective confidence intervals or accompanied by another measure of accuracy. Finally, for each exposure and outcome assessed in the studies, we checked if there was a statistically significant association ($p < 0.05$) and its direction (positive, negative, U-shaped, nonexistent or not described) and registered that fact. Data were analyzed using software Stata 9, through estimation of absolute and relative frequencies of the analyzed variables.

RESULTS

A total of 1,128 references were initially identified, including 434 duplicates. Finally, 67 studies were analyzed in this review (Figure 1). The main reason for exclusion of the references identified was the fact that these studies did not address the epidemiological associations of interest for this review. The most recent biennium (2009 – 2010) was the one that concentrated a higher proportion of studies, 55.3% of which were published between 2007 and 2010 (Table 1). Almost seven in every ten studies were conducted in the South or Southeast regions, and approximately one third of the first authors were linked to *Universidade de São Paulo* or to *Universidade Estadual de Campinas*. The studies were published in 26 different journals, with the highest proportions in *Cadernos de Saúde Pública* (11.9%) and Community Dentistry & Oral Epidemiology (11.9%). The study population was predominantly young (mean age of maximum equivalent to 17 participants) and the median of the sample sizes embedded in each survey was of 480, ranging from 19 to 46,407.

Most studies showed cross-sectional designs (79.1%) (Table 2). The complex sampling was most frequently employed, and 58.2% of the articles reported the parameters used to calculate the sample, and 77.6% described the eligibility criteria for participants. In almost all articles, the outcome was clearly defined and its measures of reproducibility were reported in most of them. Still, it is noteworthy that 15.2% of the studies did not indicate the sampling procedure employed. Furthermore, the theoretical basis of the relationship between exposure and outcome was described in only one fifth of the studies and only 3.0% reported the quality control of the data produced.

Table 3 shows the outcomes and socioeconomic exposures employed in the studies reviewed. The DMFT indices were the most common outcomes (80.4%). Sex/gender, income, education (the participant's, maternal or paternal), race/color and type of school (public or private) were the most frequent exhibitions. A wide range of other forms of socioeconomic measures was used in smaller quantities, in particular aggregate measures such as proportion of households with water supply, income concentration index, human development index and unemployment rate.

When testing the association of dental caries with maternal education, it was found that in 82.6% of cases, the direction was negative (statistically significant in 57.9% of cases) (Table 4). A similar pattern was observed when paternal education and the participant's

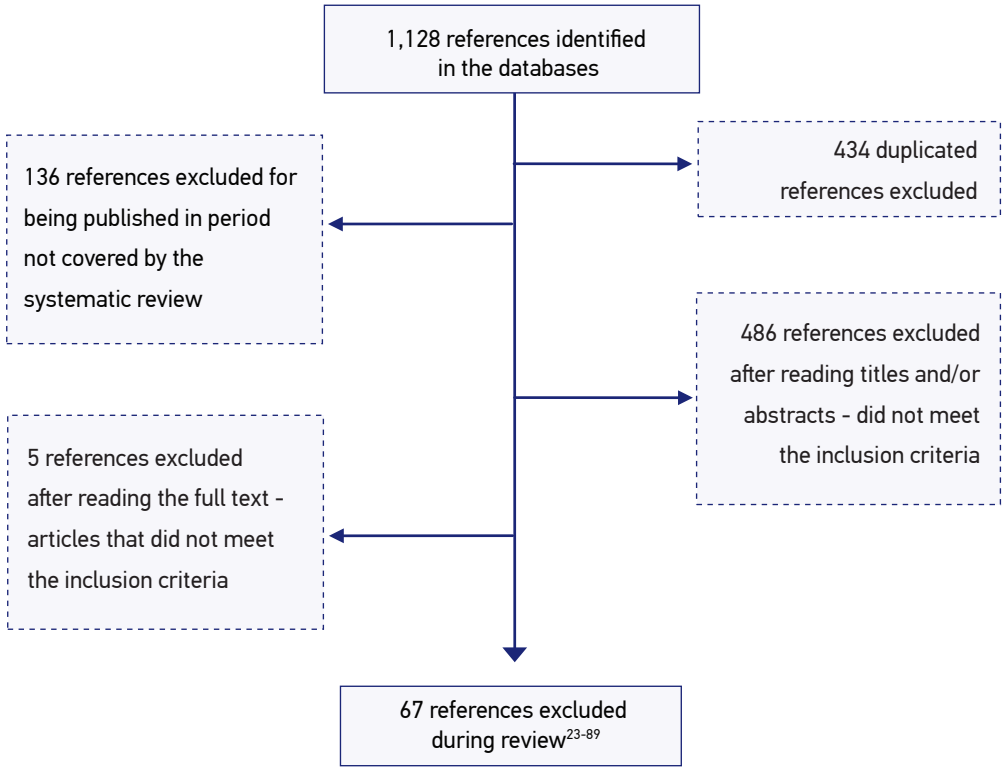

Figure 1. Flow diagram of systematic review on dental caries and socioeconomic conditions.

education were analyzed. Inverse association was also observed mostly when income was the socioeconomic variable of exposure. Regarding race / color, most studies reported higher incidence of the outcome among blacks and browns. When the data was analyzed by sex / gender, an overwhelmingly higher occurrence of dental caries in females was observed. However, only 25% of these associations are statistically significant.

Table 1. Distribution of studies on dental caries according to bibliographic characteristics. Brazil, 1999 – 2010.

Characteristics	n	%
Year of publication		
1999 – 2000	2	3.0
2001 – 2002	9	13.4
2003 – 2004	10	14.9
2005 – 2006	9	13.4
2007 – 2008	10	14.9
2009 – 2010	27	40.4
Region covered by the study		
Midwest	8	11.9
Northeast	7	10.4
North	3	4.5
Southeast	28	41.8
South	18	26.9
Nationwide	3	4.5
Institution affiliation of the first author		
Universidade de São Paulo	13	19.4
Universidade Estadual de Campinas	8	11.9
Universidade Federal de Santa Catarina	7	10.4
Fundação Nacional de Saúde	4	6.0
Universidade Federal da Paraíba	3	4.5
Others*	32	47.8
Journal		
Cadernos de Saúde Pública	8	11.9
Community Dentistry & Oral Epidemiology	8	11.9
Revista Panamericana de Salud Publica	6	9.0
Journal of Applied Oral Sciences	5	7.5
Revista Brasileira de Epidemiologia	4	6.0
Others**	9	30.0
Sample size		
Minimum - maximum	19 – 46,407	
Median of sample size	480	
Age range of participants (years)		
Mean minimum age (SD)	10.2 (9.2)	
Median minimum age	11.0	
Mean maximum age (SD)	17.3 (17.1)	
Median maximum age	12.0	
Total	67	100.0

*25 other institutions contributed with one (n = 18) or two (n = 7) publications each.
**21 other journals presented three (n = 6), two (n = 3) or one (n = 12) publications each.

DISCUSSION

The association between low socioeconomic conditions and higher levels of dental caries is well documented in the literature. However, Brazilian studies have methodological limitations that need to be discussed. Moreover, national surveys still focus on the child and adolescent population and in Brazil's richest regions. Such concentration in Southern and Southeastern Brazil follows other areas of health and science in general[90]. This reality can express unequal access to research fostering, and reflects the accumulation of higher education and research institutions in the richest States in the nation and the concentration of research groups in the South-Southeast axis of the country[91]. However, a greater diversification in the regions and in institutions that lead the researches is desirable, producing knowledge nearer markedly inequitable places.

The accumulation of studies exclusively with children and adolescents reproduces historical aspects of health and dental care, that is preferentially directed to these age groups. It can also be related to a greater operational ease in conducting research with this age group, as children and teenagers are accessible in schools. Although researches with this population are clearly important, it is necessary to expand the investigation to all age groups. Changes in the population's age structure, with an increasing life expectancy and a shift in the disease load toward chronic diseases, stress the need to also investigate adults and the elderly. Public policies and actions directed to them, in particular by incorporating specialized care under the National Health System, are being

Table 2. Distribution of studies on dental caries according to methodological characteristics. Brazil, 1999 – 2010.

Characteristic	n	%
Design		
Cross-sectional	53	79.1
Ecological	8	11.9
Cohort	6	9.0
Sampling process		
Equiprobabilistic	15	22.7
Complex	26	39.4
Convenience	6	9.1
Census	9	13.6
Not described	10	15.2
The theoretical basis of the relationship between exposure and outcome was described	13	19.4
The eligibility criteria for participants were described	52	77.6
The parameters for the calculation of sample size were described	39	58.2
The reproducibility of the outcome measures were presented	50	74.6
The outcomes were clearly defined	64	95.5
Quality control of data collection was reported	2	3.0
Total	67	100.0

implemented in Brazil. Thus, researches on inequalities in the distribution of dental caries in these groups are needed.

Most studies investigated were cross-sectional, which was expected, due to its ease of implementation, speed of data acquisition and lower cost when compared to longitudinal studies[92]. However, a well-known limitation of this design is determining causal relationships, due to its inability to establish temporal relationships between causes and effects. Still, it is noteworthy that the most commonly used socioeconomic indicators in studies show little variation throughout life.

Also in relation to the methodological characteristics of the studies, it is noteworthy that 15.2% of them did not describe their sampling process, almost 4 in 10 did not show the parameters used in the calculation of the sample and only 3.0% reported quality control of

Table 3. Distribution of studies on dental caries according to indices used to study outcome and independent variables investigated. Brazil, 1999 – 2010.

Variables	n	%
Outcomes		
DMFT	51	58.6
dmft	19	21.8
D component of the DMFT	8	9.2
DMFS	3	3.4
SiC	3	3.4
dmfs	1	1.2
M component of the DMFT	1	1.2
Care Index	1	1.2
Total*	87	100.0
Forms of measures of socioeconomic and demographic characteristics		
Sex	36	13.9
Income	34	13.1
Maternal education	23	8.8
Paternal education	17	6.5
Respondent's education	17	6.5
Race/color	13	5.0
Type of school (public/private)	10	3.9
Overcrowding	9	3.5
Human Development Index	7	2.7
Income concentration (Gini or Theil Index)	7	2.7
Possession of household goods	7	2.7
Location of residence (urban/rural)	6	2.3
Child Development Index	4	1.5
House ownership	3	1.2
Car ownership	3	1.2
Tardiness in school	3	1.2
Others**	40	15.6
Total*	259	100.0

*One study can present more than one outcome and/or exposure.
**35 other indicators were cited, appearing in one (n = 35) or two publications (n = 5).

data collection. It is noteworthy that the absence of certain methodological information in the articles does not necessarily imply that they were not observed during the study. The gap may have originated from editorial processes that suppressed this information or simply because the authors opted not highlight them. However, this information is essential for the discussion of the internal validity of the study and should be available to the reader for evaluation of possible limitations and potentials of the study.

The lack of theoretical discussion of the relation between socioeconomic conditions in studies contrasts with the existing intellectual production on the subject. From more general explanatory models on the relationship between socioeconomic status and health levels[93] to other models, specific to dental caries[94], the literature provides different views on the determination of the health-disease process. The lack of explanation of how the study authors understand this relationship, in many cases, limits articles to their statistical dimension, without discussion on the impact of the findings to science or public policies.

Apart from sex / gender, education, income and race / color were the most used demographic indicators. In any way, regardless of the indicator used, the reason for the selection of certain dimensions as opposed to others was rarely justified, a fact already observed in other reviews[95]. Education usually results from the individual's schooling until the beginning of the third

Table 4. Statistical significance and direction of the association between socioeconomic and demographic characteristics of interest to the review and dental caries*. Brazil, 1999 – 2010.

Characteristic	Direction of the association with dental caries	Frequency with which this direction of association was observed (%)	Statistically significant % ($p < 0.05$)
Maternal education	Negative	19 (82.6)	57.9
	Positive	1 (4.3)	100.0
	Not described	3 (13.1)	33.3
Income	Negative	32 (65.3)	65.6
	Positive	10 (20.4)	80.0
	Inverted U	2 (4.1)	-
	Not described	5 (10.2)	-
Race/color	More frequent in browns or blacks	14 (77.8)	35.7
	More frequent in non blacks	1 (5.5)	-
	Not described	3 (16.7)	-
Sex	More frequent in males	12 (25.5)	25.0
	More frequent in females	28 (59.6)	42.8
	Not described	7 (14.9)	57.1
Paternal education	Negative	15 (83.3)	55.6
	Positive	-	-
	Not described	3 (16.7)	-
Respondant's education	Negative	10 (62.6)	90.0
	Positive	3 (18.7)	100.0
	Not described	3 (18.7)	-

*Only the sociodemographic and demographic characteristics whose association with dental caries was tested 13 or more times across all studies included in the review were presented.

decade of life, and has little variation from then on. In addition to this advantage, it is of easy reference by the interviewer and its impact can occur either in the increase of knowledge and ability to take on healthy habits or in their insertion in the job market, in better positions and with higher incomes[96]. Income can also be easy to reference. However, the quality of information can vary. For tributary or security reasons or ever due to embarrassment, the respondent may be reluctant to express their real income. On the other hand, not all financial resources are earned through income, usually understood as direct labor compensation. The ability to purchase goods and services that promote or rehabilitate health establishes a clear link between this indicator and levels of health[96]. These two socioeconomic variables are often employed in health studies in general, as well as the participant's occupation[95].

Among the limitations of this review, we highlight the non-incorporation of dissertations and theses, of studies listed in the references of articles selected, of studies published in other bibliographic databases other than those previously listed, and unpublished studies. Moreover, in our analysis, the results adjusted for confounding factors of magnitude of the associations were not described, only its direction and statistical significance.

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