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Original Article

Food Insecurity and Oral Health: A Systematic Review

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Abstract

Objective: To carry out a systematic review of the scientific literature addressing the possible association between food insecurity and oral health. **Material and Methods:** An electronic search limited to studies conducted with humans was performed in six databases (Pubmed, Web of Science, Scopus, Lilacs, BBO, Cochrane Library) and IADR abstracts, with no language or publication date restrictions. The search strategy resulted in 614 titles/abstracts. Seven cross-sectional studies were selected from this total. Data extraction and quality assessments were performed independently by two raters using the Newcastle-Ottawa Scale. **Results:** The following outcomes were associated with food insecurity: dental pain at night or in the previous month, the use of prosthesis, prior experience with restorations and extractions, untreated dental caries and related poor oral health. Two of the four selected papers were conducted by the same group of researchers using the same sample, which may have led to citation bias. The oral status of the individuals was assessed by self-reports rather than clinical examinations in four papers. The studies used between two and eighteen questions to assess FI. The duration of FI was not determined in any study, which makes it more difficult to associate FI with chronic diseases. **Conclusion:** Although the scientific evidence suggests an association between the cumulative history of oral problems (untreated caries, related poor oral health, dental pain, restorations, extractions and use of prosthesis) and FI, there is a lack of prospective cohort studies to support this hypothesis.

Keywords: Food insecurity; Oral health; Systematic review, Dental caries.
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Introduction

Nutritional and food security refers to regular ongoing access to enough quality food by all members of the family for an active, healthy life without compromising the satisfaction of other basic needs. In contrast, food insecurity (FI) encompasses the anguish of individuals facing uncertainty in regularly obtaining food and the experience of hunger stemming from not eating for a full day [1].

FI is considered a socioeconomic problem. Studies have demonstrated that families with a low income, those that rent their homes and those with only one parent are more prone to FI [2]. In the USA, nearly half of all poor families and one out of every 10 non-impoverished families are in a situation of FI, demonstrating that, despite the strong association with low income, FI can also be found in families with poorly managed finances [3], unexpected economic changes in the family structure and the emergence of factors that temporarily compete with the food budget [4].

Economic difficulty can result in food instability and lead to increased vulnerability to health problems [5]. Indeed, a reduction in dietary variety and quantity of food is a strategy employed by families to circumvent this problem, which leads to a loss of nutritional quality [1]. Individuals who experience economic instability resort to a diet high in carbohydrates and lipids, which is detrimental to health [6]. Studies have shown that adults in situations of FI are more susceptible to heart disease, diabetes, hypertension, increased inflammation [7] and obesity [8]. Moreover, children in families experiencing FI are more prone to psychosocial [9], cognitive [10] and behavioral [11] problems as well as stomachache, headache [12], asthma [13), a reduction in the intake of important nutrients [14] and developmental deficiencies [15].

Inadequate food and the deprivation of certain nutrients can also affect oral health. Severe enamel hypoplasia and chronic periodontal disease are associated with a lack of vitamin D [16], scorbutic gingivitis (scurvy) is associated with vitamin C deficiency [17] and dental caries is associated with a carbohydrate-rich diet [18]. Thus, due to a diet low in nutrients and high in carbohydrates, individuals in situations of FI may experience poor oral health. However, no systematic review has critically assessed this topic.

The aim of the present study was to conduct a systematic review of the literature on the oral health of individuals in situations of food insecurity. The hypothesis is that such individuals have poorer oral health than those in situations of food security.

Material and Methods

Observational studies (cross-sectional, case-control, cohort) involving human subjects and experimental studies involving of healthy individuals were included, with no restrictions regarding age group, language or publication date. The following were the exclusion criteria: literature reviews and studies addressing the term "food insecurity" but not addressing the effects on oral health.

Search strategy

A search was performed in the following databases in June, 2013 and updated in August, 2014: Pubmed, Web of Science, Scopus, Lilacs (Literature on Health Sciences in Latin America and the Caribbean), BBO (Brazilian Library of Dentistry), Cochrane Library (including: Cochrane database for Systematic Reviews, Database of Abstracts of Reviews of Effectiveness, Cochrane Controlled Trials Register and Cochrane Review Methodology Database). References list of abstracts from the International Association for Dental Research (IADR) were searched in an attempt to find studies that were not retrieved from the electronic databases, those that were not published or those that were ongoing.

The results included all articles retrieved from each database from the date of availability of the respective databases until August 2014. The search was limited to studies involving human subjects and was carried out by two researchers (GCS and CCM). The following search strategy was used: ((Oral Health [MeSH] OR Dental Clinics [MeSH] OR Diagnosis, Oral [MeSH]) AND (food insecurity OR food security OR food preferences [MeSH] OR food [MeSH])). Reference lists from studies included for full-text analysis were searched manually for papers not retrieved from the electronic databases.

Data extraction and quality assessment

A total of 614 studies were retrieved from the databases. The abstracts and titles were read and selected by two independent raters (GCS and FMF). Inter-rater agreement of eligibility was 100%. Seventeen papers were selected for full-text analysis. The inclusion criteria were any mention of oral problems or FI and insufficient data in the abstract to make a clear decision. Authors of abstracts retrieved from the IADR search were contacted in attempt to obtain additional data. This process led to the inclusion of only one study [19], as the remaining authors did not answer. The exclusion criteria in the full-text analysis were literature reviews and articles that did not address the topic of FI and oral problems. Two raters analyzed the studies (GCS and FMF) and selected seven complete papers for the systematic review (Figure 1).

Data extraction and quality assessment of the papers were carried out independently by two raters (GCS and FMF). The Newcastle-Ottawa Scale (case-control) adapted to cross-sectional studies was used to assess the quality of the articles [20]. This scale allocates points for the assessment of three items: "Selection", "Comparability" and "Exposure". Disagreements were decided by consensus among the raters. All seven studies had cross-sectional designs and the data were grouped individually, as they addressed different oral health outcomes. Due to this heterogeneity, the papers could not be grouped for a meta-analysis and a narrative summary of the data was therefore performed (Table 1).
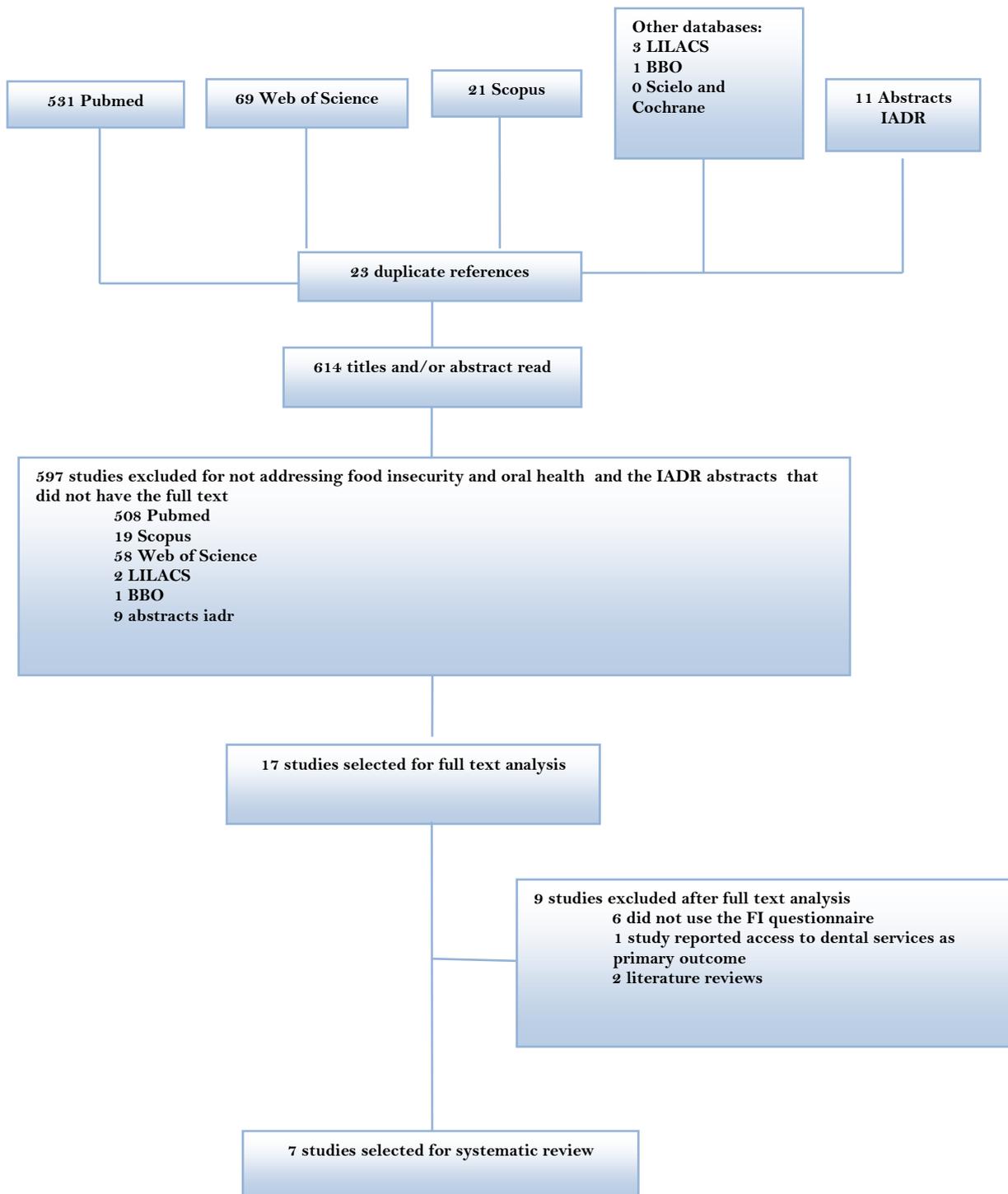
531 Pubmed

69 Web of Science

21 Scopus

Other databases:
3 LILACS
1 BBO
0 Scielo and Cochrane

11 Abstracts IADR

23 duplicate references

614 titles and/or abstract read

597 studies excluded for not addressing food insecurity and oral health and the IADR abstracts that did not have the full text
    508 Pubmed
    19 Scopus
    58 Web of Science
    2 LILACS
    1 BBO
    9 abstracts iadr

17 studies selected for full text analysis

9 studies excluded after full text analysis
    6 did not use the FI questionnaire
    1 study reported access to dental services as primary outcome
    2 literature reviews

7 studies selected for systematic review

Figure 1. Flowchart showing selection process of studies on food insecurity and oral health.

Table 1. Cross-sectional studies on food insecurity and oral health according to author, year of publication, sample size, objective and conclusion.

Authors	Sample	Country of the study	Objective	Oral health aspects assessed	Sampling	FI assessment	Results	Quality Points (total)
Jamieson and Koopu, 2006	3275 children from 5 to 14 years	New Zealand	Determine the association of dental pain at night with ethnicity, socio-demographic factors, FI and prior experience with restoration and extraction	Self-report of prior experience with restoration, extraction or dental pain at night	Random cluster, stratified by ethnicity	Electronic form sent to parents/guardians with eight questions on FI	FI was associated with a higher prior experience with dental pain at night (Pearson's correlation, $p < 0.05$)	4 (9)
Jamieson and Koopu, 2007	3275 children from 5 to 14 years	New Zealand	Determine the association of prior experience with restoration and extraction with ethnicity and other factors, including FI	Self-report of prior experience with restoration and extraction	Random cluster, stratified by ethnicity	Electronic form sent to parents/guardians with eight questions on FI	FI was associated with a higher prior experience with restoration and extraction (chi-square, $p < 0.05$)	4 (9)
Muirhead et al, 2009	1049 low-income workers from 18 to 64 years; final sample: 843	Canada	Determine the association between oral health and FI	Self-report of oral health perception, number of teeth present, use of prosthesis, dental pain and impact of oral conditions on quality of life	Stratified by province	Used the three items on FI from the questionnaire *Canadian Community Healthy Survey* (2003)	In comparison to individuals with food security, low-income individuals with FI use prostheses more often (OR= 2.09, 95%CI = 1.30-3.37; $p = 0.002$) and experience more dental pain (OR = 1.94, 95% CI = 1.25 -3.04; $p = 0.003$) (logistic regression models)	7 (9)

Santin et al, 2012	538 children from 12 years	Brazil	Determine the association between untreated dental caries and FI according to income strata	Oral examinations were performed by a single, previously calibrated examiner	Random cluster, stratified by city region and school	Brazilian version of the FI Scale (specific version for homes with children and/or adolescents, with 15-items)	Being in a situation of household FI was associated with a greater frequency of untreated dental caries among low-income schoolchildren (PR= 1.51, 95%CI = 1.01-2.29; p = 0.045,) (Poisson regression models)	8 (9)
Chi e Tucker-Seeley, 2013	1359 adults over 50 years old	United States	Evaluate the relationship between financial hardship and self-report oral health for older men and women.	Self-report about the conditions of mouth and teeth	A subsample of older adults from the 2008 wave of the Health and Retirement Study	Used two questions about FI: "Did you (or other family members) receive government food stamps?" and "Have you always had enough money to buy the food you need?"	Food insecurity was associated with a 12% greater prevalence of poor self-reported oral health (adjusted PR= 1.12, 95%CI = 1.04 - 1.21) (Poisson regression models)	7 (9)
Chi et al., 2014	2206 children aged 5 to 17 years	United State	Determine the associations of household socioeconomic status (SES) and food security with children's oral health outcomes.	Oral examinations by a previously calibrated examiners	Secondary data of NHANES 2007-2008.	The questionnaire of US Department of Agriculture 18-item Household Food Security Survey	Dental caries was associated with two highest strata of FI (adjusted PR = 2.00; 95%CI= 1,09 − 3,65 and PR = 1.70; 95%CI= 1,00 − 2,90)	7 (9)
Frazão et al., 2014	203 schoolchildren 7- t 9 yr-old schoolchildren	Brazil	Determine the relationship between FI and untreated dental caries	Oral examinations were performed by a single, previously calibrated examiner	A cross-sectional survey nested in a population based cohort study	Brazilian version of the FI Scale (specific version for homes with children and/or adolescents, with 15-items	Dental caries was associated with high FI scores (adjusted PR=1.53; 95%CI = 1.07 − 2.21) (Poisson regression models)	8 (9)

CI: Confidence interval; FI: Food insecurity; PR: Prevalence ratio; NHANES: National Health and Nutrition Examination Survey;
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Results

Among a total of 614 titles/abstracts, seven cross-sectional studies addressed associations between FI and oral health and were selected for the present systematic review. Chart 1 displays the characteristics of the studies. Two were from the same group of researchers using the same sample, although the analyses and outcomes were different. The outcomes associated with FI found in the papers were related to greater experience of dental pain [5], dental pain at night [21], greater prior experience with restoration and extraction [22], greater frequency of prosthesis use [5], untreated dental caries [19,23,24] and related to a poor oral health [25].

Dental pain was associated with FI in two studies: dental pain at night was significantly associated with FI by a weak correlation (Pearson's correlation, $p < 0.05$) [21]; dental pain in the previous month was significantly associated with FI in a logistic regression model [adjusted odds ratio (OR) = 1.94; 95% confidence interval (CI) = 1.25-3.04; $p = 0.003$] [5]. The use and frequency of prosthesis was also associated with FI in a logistic regression model (adjusted OR = 2.09; 95% CI = 1.30-3.37; $p = 0.002$) [5]. The association of FI with restorations and extractions was assessed by bivariate analysis (chi-square test, $p < 0.05$) [22]. Untreated dental caries was associated with FI in the lower income strata in a Poisson regression model (adjusted PR = 1.51; CI = 1.01-2.29; $p = 0.045$) [19]. In the other study, children from households with low or very low food security had significantly higher caries prevalence (PR = 2.00 and PR = 1.70, respectively) than did children living in fully food-secure households [24]. Dental caries was 1.5 times more likely to be associated with high food-insecurity scores after adjusting for socioeconomic status and sex [23]. The self-reported about the conditions of mouth and teeth was associated with the FI in a Poisson regression models with robust standard errors (adjusted PR= 1.12, 95%CI = 1.04 - 1.21) [25]. Quality ranged from 4 to 8 of a total of 9 points.

Discussion

Strength of the evidence

The aim of the present systematic review was to investigate the relationship between food insecurity and oral health. The principal findings of the papers included into this review indicate an overall association between FI and poor oral health. The results suggest that children in a situation of FI may have more untreated dental caries [19,23,24] and dental pain resulting from caries [5, 21] as well as greater prevalence rates of restorations and extractions [22]. Although no causal relationship can be established from the cross-sectional study design, these outcomes allow some suppositions. Assuming an association between FI and caries in childhood, if oral problems are not controlled, dental caries may evolve in such a way that FI could have consequences regarding the use of dentures in adulthood and old age [5]. In adults, those who were in the worst situation of FI reported poorer oral conditions [5,25]. The harm to oral health leads to an increase in expenditures on dental services. Indeed, the USA alone has 17 million people in a situation of FI [26].

The present results reflect previous findings indicating that socioeconomic factors can have a negative effect on oral health. Although poverty and FI do not comprise the same concept, there is an important association between these aspects. Studies have demonstrated that low income and a low degree of schooling may be associated with greater tooth loss and the use of dentures [27] as well as greater prevalence rates of dental caries [28], periodontal disease [29] and oral lesions [30].

Considering previous research on this issue, the link between FI and poor oral health further highlights the notion that individuals tend to choose an unhealthy diet that is often highly processed and high in fat and sugar [31] when other basic needs compete with food needs, as healthy diets rich in fruits and vegetables are more expensive [32]. Thus, frequent sugar intake, which is a known risk factor for the demineralization of teeth, may be associated with the increased number of carious lesions and consequent future tooth loss in individuals in a situation of FI.

A compromised dentition hampers chewing and may limit the type of foods an individual ingests, with a reduction in the intake of proteins, carotenes, vitamins A, B and C, retinol, folic acid, calcium, iron, zinc and fiber [33] and an increase in the consumption of fats [34]. Moreover, studies have shown that nutritional deficiencies can lead to periodontal disease [11], which is another determinant of tooth loss.

It is important to view the cause-and-effect relationship between FI and oral health with caution, as both conditions have multiple correlating factors. The results reported previously [22] demonstrate an association between food insecurity and greater experience with restorations and extractions. However, the associations were only tested using bivariate analysis. Confounding factors, such as household income and age, were not considered, which may have led to misinterpretations [21]. Although the study by Chi and Tuckeer-Seeley [26] not submit as main objective the association between FI and oral health, the presence of FI was associated in older adults, of both sexes, with self-reported poor oral health.

Two of the selected studies were attributed four points on the Newcastle-Ottawa scale due to a lack of control for confounding factors, the non-reporting of sample losses and the use of self-reports rather than a clinical examination for the evaluation of oral health [21,22]. Three studies received seven points. One of them did not control the age [24], the other collected the main variable by self-report [25] and in the third study the sample was not randomized and the data on oral health and FI were collected through telephone interviews, with no clinical examinations performed [5]. Although FI in the seventh and eighth studies was determined by self-reports, these papers were attributed eight points due to the fact that a clinical examination was performed for the collection of the response variable [19,23].

While three studies [19,23,24] conducted a clinical oral examination performed by a calibrated dentist, the other four studies assessed oral health through self-reports [5,21,22,25]. Some authors [21,22] used an electronic form for items on oral health, which was filled out by either the children aged 10 to 14 years or parents/guardians for children aged five to nine years, Chi et al. [25] realized an interview and Muirhead et al. [5] conducted a telephone interview. Although the

authors cite the validation of these methods, oral health assessment through self-reports is questionable, as the participants may omit important characteristics or overestimate some aspects of oral health. Self-reports of oral health refer more to the perception of oral health than to conditions. Therefore, a clinical examination performed by a previously calibrated examiner is a more efficient method of collecting clinical data.

The oral health outcomes assessed in the studies selected were basically the result of dental caries, which is a cumulative condition that varies greatly with age. The samples contained a wide range of age groups: children aged five to 14 years [21,22], 12-year-olds [19], five to 17 years [24] and seven to nine years, and individuals from 18 to 64 years [5] and over 50 years old [24]. As age can be a confounding factor, the results should be stratified by this variable. Moreover, the variables studied (untreated dental caries, pain, restorations, extractions and prosthesis) may be the consequences of the cumulative nature of dental caries associated with FI.

FI was assessed through two items for old adults [25], eight items based on responses from parents/guardians of children aged five to 14 years [21,22], through three items in the third study [5], through a 15-item questionnaire in the two studies [5,23] and 18-item questionnaire in the seventh study [22]. Assessments using a small number of items are not sufficient for understanding all the dimensions of FI, which can range from a decrease in the quantity of healthy food to food replacement and even complete restriction. Another important aspect to consider is the period of reference. The questionnaire used by some researchers [5,24] determined situations faced in the previous 12 months and it was not possible to identify the duration of food insecurity within this period.

The dietary profile of the respondents, which provides a greater understanding of the influence of FI on oral health, is another important aspect not addressed in these studies [5,21-25]. Thus, it is not possible to determine whether an association between FI and poor oral health exists or whether it is due to the restricted consumption of nutritional foods, increased consumption of specific groups of foods, such as carbohydrates (including sucrose), or a combination of these two conditions. Only one study evaluated a dietary aspect (sugar frequency), which was determined through an item addressing one's sugar consumption throughout the day [19].

The samples analyzed in some of the studies had very specific characteristics, which limits the extrapolation of the results to the general population. The papers focused on ethnic groups in New Zealand [21,22], low-income workers in Canada [5] 12-year-olds in Brazil [19] and schoolchildren in Brazilian Amazon [23]. Samples from the general population or other groups could provide different results.

Limitations

The limited number of studies can be considered a limitation of the present systematic review. Searches were carried out in seven databases, with no restrictions regarding language or publication date. Attempts were made to find studies that had FI hidden inside the paper but not as

main risk factor. This led to the selection of 17 papers for the analysis of the full texts, only seven of which were included in the review. Attempts were made to find seven unpublished papers and other studies through direct contact with the authors.

Two of the three selected studies were conducted by the same group of researchers [21,22] using the same sample, which may have led to citation bias. Moreover, the present systematic review may be subject to publication bias [35], as all studies included reported positive associations between FI and oral health. Indeed, there is a lack of papers reporting a non-significant association between FI and oral health.

It was not possible to conduct a meta-analysis due to the different outcomes analyzed. The substantial heterogeneity among the papers, differences in the age of the samples and methodological differences raise doubts regarding the strength of the evidence.

Suggestions for future research

All seven studies employed a cross-sectional design, which does not allow an assessment of whether FI precedes oral problems or an identification of the duration of FI, both of which could possibly affect the final results. As the majority of oral conditions are chronic and cumulative, the effects on oral health are expected to be greater after a longer period of food insecurity. Prospective observational (longitudinal) studies would be more adequate for assessing the period in which individuals are subjected to FI and associating this period with chronic diseases. Studies are needed that exercise greater care in the definition and measurement of oral outcomes and FI as well as the control of confounding variables, such as age. Furthermore, considering the impact of FI on oral health suggested by the present review, other oral health outcomes besides caries and tooth loss, such as periodontal disease and mucosal lesions, should be assessed in future studies.

Conclusions

Although the scientific evidence suggests an association between the cumulative history of oral problems (untreated caries, reported poor oral health, dental pain, restorations, extractions and use of prosthesis) and FI, there is a lack of prospective cohort studies to support this hypothesis. The role of FI in oral health should be further investigated. Prospective observational (longitudinal) studies involving clinical examinations and dietary analyses are essential to gaining a better understanding of the influence of food insecurity on oral health.

Acknowledgements

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