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Review article

Tooth loss in adults and income: Systematic review and meta-analysis

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ABSTRACT

Objective: To systematically review the literature in order to identify an association between income and tooth loss in adults.
Methods: An electronic search was conducted on PubMed, Scopus, Embase, Web of Knowledge, Scielo and LILACS. Studies were included if they reported the relationship between socioeconomic status (assessed by income) and tooth loss (clinical examination or self-reported) among adults aged from 18 to 60-years-old.
Results: We, found 1007 articles through March 2014; 11 studies were then included. The results of meta-analyses with random-effects model that subjects of lower levels of income presented greater chance of tooth loss (OR 2.52; 95%CI 2.11–3.01). This association also remained significant when only adjusted results were pooled; however, attenuation in the magnitude of such association was noted (OR 1.66; 95% CI 1.48–1.86) as well as no heterogeneity. Meta-regression analysis revealed that the sample size explained about 9% of heterogeneity in the crude model.
Conclusion: Our results evidenced a relationship between income and tooth loss in adults. Longitudinal studies with broader socioeconomic measures are encouraged.

1. Introduction

Among several socioeconomic position measures employed in epidemiology, income is one of the most relevant for reflecting material conditions and for being the most direct way of measuring socioeconomic position [1]. In most situations, the lower the income the higher the prevalence of health problems [2]. Thus, those living in poverty concentrate greater load oral diseases, such as dental caries and periodontitis [3], and systemic conditions, such as diabetes, cardiovascular disease and obesity [4]. Given that, the association between income and unfavorable health conditions is beyond dispute in the literature.

Oral health conditions provide an excellent model for investigating the impact of income on health conditions, since the most common dental disorders are easily-recognized indicators of past disease experience, with an etiology that comprises a complex mix of social, biological and behavioral factors [5]. The practices that create the oral health inequities are embedded in the usual patterns of ordinary life [6], and follow the general health conditions: some are socially determined and differ across the economic hierarchy, presenting worse oral health status [7].

Tooth loss is a worldwide public health issue, especially in low- and middle-income countries [4,8]. It is associated with general health conditions such as blood pressure, obesity and malnutrition, also considered a potential risk factor to cardiovascular disease [9–12]. Furthermore, this condition impacts negatively on the quality of life [13], affecting daily activities like chewing, swallowing, phonation, esthetics and social life [10,13,14]. According to Marcenes and colleagues, severe teeth loss is ranked in the 36th position among the 100 chronic diseases that affect life expectation, reflecting the importance of this condition considering not only oral, but also the systemic health [8].

Many reports have demonstrated the close relationship between income and tooth loss, emphasizing the relevance of such topic. However, in some of them this association is not noted, due to issues such as small sample size and lack of statistical power. Based on that, it is a concern that no systematic review has thus far explored such association. Therefore, this study aimed to conduct a systematic

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review and meta-analysis in order to investigate the association between income and tooth loss in adults.

2. Methods

2.1. Review question

The review question was based on the modified "PICO question" for observational studies as follows: "Is there an association between income and tooth loss in adults aged 18–60-years-old?".

2.1.1. Search strategy

An electronic search was conducted in March 2014, in a structured way to identify manuscripts that analyzed the association between income and tooth loss in adults. Electronic database searches of PubMed via Medline, Scientific Electronic Library Online (SciELO), Web of Knowledge and Scopus were performed up to and including March 2014 using MeSH terms and other keywords in several combinations. No date restriction was applied.

We combined each of the following terms for income: "Factors, Socioeconomic" [Mesh] or "Factors, Socioeconomic" or "Factor, Socioeconomic" or "Socioeconomic Factor" or "Standard of Living" or "Living Standard" or "Living Standards" or "Low-Income Population" or "Low Income Population" or "Low-Income Populations" or "Population, Low-Income" or "Populations, Low-Income" or "Income" [Mesh] or "Poverty" [Mesh] or "Inequalities" or "Inequality", with each of the terms for tooth loss: "Tooth Loss" [Mesh] or "Loss, Tooth". Even thought this systematic review was aimed to assess the effect of income on tooth loss among adult subjects, we did not restrict the selection of studies on adults at this stage of the review.

All titles of the searches and abstracts of the papers that satisfied the eligibility criteria described below were assessed. After an initial screening, lists of selected papers were compared and in the case of disagreements, decisions were made following discussion based on the inclusion and exclusion criteria described below. The selected literature was independently reviewed by two authors and classified as suitable or not to be included in this systematic review. The full text of the papers considered by title and abstract to be pertinent for this review was then read. Later, additional publications were screened by the same two authors using a hand search of the reference lists of the studies that were found to be relevant in the previous step. Cases of disagreement between authors were discussed until a consensus was reached. Predefined data-collection worksheets were employed for the assessment of each selected publication.

2.1.2. Inclusion and exclusion criteria

Studies were included if they reported the relationship between income and tooth loss (clinical examination or self-reported) among adults aged from 18 to 60-years-old. Manuscripts published in English, Portuguese or Spanish were eligible for inclusion. All types of study design were included. Reviews, letters to the editor, abstracts from conferences were not considered.

2.1.3. Data extraction

Data were independently extracted by same two authors, using a standardized worksheet containing the following information: author, year of publication, geographic location (treated as a dichotomous variable—low/middle income; high-income countries), study design (cross-sectional, longitudinal), age of enrolled population, sample size ($\leq$1,000; >1,000), outcome definition (mean/median number of teeth lost; functional dentition; more than 15 teeth lost), main exposures definition (income), cut-of points of outcome and exposures, crude effect size with 95%CI, adjusted effect size with 95%CI, and type of adjustment. Only articles presenting crude and/or adjusted effect size measure with theirs respective 95%CI for income were eligible to be included in the meta-analysis. Authors were contacted in order to clarify any queries on the study methodology or result.

2.1.4. Qualitative evaluation of selected studies

All articles were classified according to an adaptation of the Downs and Black scale [15]. From the 27 original items in the checklist, 17 were employed, according to the modification performed by Wehrmeister and coworkers [16]. In essence, the authors did not consider the items that were specific for interventional studies. More information regarding the evaluated items can be found in Fig. 1. Each item scored one point, except for one item that could result at most two points. The total scoring could therefore range from 0 to 18 points. Articles were classifies as follows: high chance of bias (0–5 points), moderate chance of bias (6–11 points) and low chance of bias (12–18 points). Two referees evaluated selected papers independently and disagreements were decided by consensus after a discussion.

2.1.5. Statistical analysis

Different meta-analyses were conducted considering: (1) crude association between income and tooth loss; (2) adjusted association between income and tooth loss. When different categories of income were present, only the estimate comparing the most extreme categories was considered for meta-analysis. In case of time-series, just the most recent result was considered. When Prevalence Ratio was the association measure presented in the article, the one was converted into Odds Ratio using the formula proposed by Zhang and Yu [17]. For each model, a pooled effect was obtained using both fixed- and random-effects models. Heterogeneity among studies was evaluated using I^2 test. If heterogeneity was statistically significant ($P < 0.05$), a random-effects model was used. When heterogeneity was present ($I^2 > 50\%$), meta-regression was also performed to evaluate the contribution of study characteristics to the between-study variability [18]. Study characteristics were included as covariates in the meta-regression analysis, one at a time, rather than using an overall score of study quality. This approach allows the identification of aspects of study design that are potential sources of heterogeneity. All analyses were performed using the software STATA 12.0 (StataCorp., College Station, TX, USA).

1. Is the hypothesis/aim/objective of the study clearly described?
2. Are the main outcomes to be measured clearly described in the Introduction or Methods section?
3. Are the characteristics of the patients included in the study described clearly?
4. Are the distributions of principal confounders in each group of subjects to be compared described clearly?
5. Are the main findings of the study described clearly?
6. Does the study provide estimates of the random variability in the data for the main outcomes?
7. Have the characteristics of patients lost to follow-up been described?
8. Have actual probability values been reported (for example, 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?
9. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?
10. If any of the results of the study were based on 'data dredging', was this made clear?
11. Were the statistical tests used to assess the main outcomes appropriate?
12. Were the main outcome measures used accurate (valid and reliable)?
13. Were the patients in different groups recruited from the same population?
14. Were study subjects recruited over the same period of time?
15. Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?
16. Were losses of patients to follow-up taken into account?
17. Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?

Fig. 1. Modified version of Downs and Black scale.