Pathways of socioeconomic inequalities in self-perceived oral health

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Abstract: Although there is a large body of evidence of the influence of social determinants on oral health, information on the mechanisms by which these determinants operate is poorly documented. Therefore, we aimed to investigate the pathways through which socioeconomic inequalities may influence self-perceived oral health (SPOH) in Brazilian adults. This cross-sectional study used data from the National Health Survey (NHS) of 2019, with a representative sample of adults aged 18 to 59 years (n = 65,803). The outcome was SPOH, assessed by a global self-item. Structural equation modeling was used to test direct and indirect pathways connecting a latent variable for socioeconomic position (SEP) to SPOH via psychosocial, behavioral, and biological factors. Higher SEP was directly associated with better SPOH [standardized coefficient (SC) = 0.069; $p < 0.01$] fewer depressive symptoms (SC = -0.059; $p < 0.01$), fewer missing teeth (SC = 0.131; $p < 0.01$), and more healthy behaviors (SC = 0.643; $p < 0.01$). Fewer depressive symptoms (SC = -0.141; $p < 0.01$), more healthy behaviors (SC = 0.242; $p < 0.01$), and fewer missing teeth (SC = 0.058; $p < 0.01$) were directly associated with good SPOH. Among specific indirect effects of SEP on SPOH, the behavioral pathway was the one that best explained this association (SC = 0.155). Socioeconomic inequities in SPOH are mediate by psychosocial, behavioral, and biological factors. This has implications for positioning health strategies in the social context in which people live, to facilitate healthy choices and promote good oral health.

Keywords: Self-Assessment; Social Determinants of Health; Socioeconomic Factors.

Introduction

Oral health inequalities are a major public health concern.[1] Oral diseases disproportionately affect poorer and more vulnerable groups of society and are linked to socioeconomic status and systematic social disadvantage produced by the broader social determinants of health.[2] The Commission on Social Determinants of Health[3] (CSDH) proposed a conceptual framework depicting how socioeconomic and political contexts shape socioeconomic positions (SEP) and, consequently, generate health inequalities. A number of models have conceptually adapted the CSDH framework for oral health,[1,2,4] illustrating that SEP may affect oral health through intermediary determinants that include psychosocial, behavioral,

and clinical factors, framing a socially patterned distribution of oral health outcomes.[1]

Different pathways have been suggested to explain how SEP may lead to these inequalities in oral health.[5] The neo-materialist theory assumes that health is responsive to absolute levels of material resources, such as food, housing conditions, access to health services, and amenities.[6,7] Shortage of material resources and unequal accumulation of negative exposures would generate higher levels of oral disease in groups from lower SEP.[8] The behavioral theory puts in perspective the higher likelihood of people from low socioeconomic backgrounds in engaging in unhealthy behaviors.[9] Key oral health-related behaviors including oral hygiene practices and dental visit patterns are closely related to socioeconomic status.[10] The psychosocial theory supports the idea that individuals from disadvantaged socioeconomic backgrounds potentially experience higher levels of psychosocial distress, which, ultimately, influence health by triggering a specific chain of events, reducing resilience, and increasing vulnerability to disease[9]. Depression, a highly prevalent mental disorder, is associated with the acquisition and perpetuation of poor oral health behaviors, with far-reaching negative consequences for self-perceived oral health (SPOH) and oral health status.[11]

There are a number of studies that consider both theories (materialist and psychosocial), and there is a consensus in the literature that individuals with lower socioeconomic conditions possibly have higher levels of psychosocial stress and less social support, which can lead to worse oral health outcomes.[5,12] These factors are capable of reflecting a set of non-economic resources, such as emotional and social aspects, which can influence healthy habits and coping behavior[5].

Although there is a large body of evidence of the influence of social determinants on oral health, the mechanisms by which those determinants come into effect using population-based studies with robust samples and country level representativeness is poorly documented.[13,14] It was recently observed that reducing inequalities in dental care and health behaviors is necessary but not sufficient to fight socioeconomic inequalities in oral health.[13] Therefore,

a thorough understanding of the relationships among the determinants of oral disorders[15] and the development of effective public health interventions and programs is essential. Conceptual frameworks are helpful in the understanding of these complex systems and disentangling the direct or indirect effects of inequalities on oral diseases. Structural equation modeling provides an appropriate inference framework to test more complex mediation models in a single analysis, allowing for the assessment of pathways between multiple independent variables, mediators, or outcomes, including latent variables.

Based on the conceptual theoretical model proposed by Peres et al.[2] we explored the pathways through which socioeconomic inequalities may influence SPOH in adults, assessing the direct and indirect effects of socioeconomic, psychosocial, behavioral, and clinical factors. We hypothesized the following pathways: 1 - SEP is directly associated with SPOH; and 2 - SEP is indirectly associated with SPOH via a) psychosocial, b) behavioral, and c) clinical factors.

Methodology

Study design and sample

This cross-sectional study used data from the 2019 National Health Survey (NHS), a population-based survey representative of the Brazilian population residing in private households. In this survey, it is possible to estimate data for urban and rural areas, by large national regions, all federation units (UFs), capitals, and metropolitan regions. The present study adopted a three-stage cluster sampling, in which the primary sampling units (PSUs) were the census tracts or set of tracts and the second stage units were private households, selected by simple random sampling. As third-stage units, residents aged 15 years and over were selected.

To scale the sample size with the desired level of precision for estimates, some indicators from the 2013 edition of the NHS, such as data on chronic diseases, violence, health service use, health insurance, smoking, physical activity, and alcohol consumption, among others were considered. The interviews were carried out between August 2019 and March 2020, using mobile devices. Upon arrival at the selected

household, the interviewer explained to the residents the objectives, the data collection procedure, and the importance of their participation in the survey. At that time, a list of all individuals residing in the household was filled out. Then, a resident 15 years of age or older, randomly selected from the list, answered the individual questionnaire. The interviews were scheduled at a time that was most convenient for the residents. Two or more visits were planned for each household. A total of 94,114 interviews were carried out (non-response rate of 6.4%). More details about the methods are available elsewhere.[13] Only adults aged 18 to 59 years were included in the analyses of this study.

The NHS dataset is available for public access and use on the official website of the Brazilian Institute of Geography and Statistics (IBGE) (https://www.ibge.gov.br/estatisticas/sociais/saude.html). The NHS was approved by the National Research Ethics Commission (CONEP 3.529.376). An informed consent form was obtained from all participants at the time of the interview.

Variables

Outcome

SPOH was assessed with the question 'In general, how do you rate your oral health (teeth and gums)?' The variable was categorized as 'poor' (for participants who rated their oral health as fair, bad, or very bad) or 'good' (for participants who rated their oral health as very good or good.[17]

Socioeconomic position (SEP)

The latent variable SEP was derived from three observed variables: education, wealth index, and per capita household income. Education was categorized as 'no education', 'incomplete elementary school', 'complete elementary school', 'incomplete high school', 'complete high school', 'incomplete higher education' or 'complete higher education.[18] The wealth index was created through principal component analysis.[19] A set of original variables regarding the ownership of durable goods were transformed to generate one summary measure of household wealth,[20] later categorized in quintiles. Per capita household income

was analyzed as a continuous variable. Higher values in the latent variable represented a greater SEP.

Psychosocial factors

We included the presence of depressive symptoms as a psychosocial factor, assessed using the "Patient Health Questionnaire-9 (PHQ-9)". This questionnaire was validated in Brazil and proved to be adequate for tracking depressive episodes in epidemiological studies.[21] The PHQ-9 is composed of nine questions that assess the presence of each of the following symptoms for the definition of episodes of major depression: depressed mood, anhedonia, sleep problems, tiredness or lack of energy, change in appetite or heaviness, feelings of guilt or worthlessness, problems with concentration, feelings of sluggishness or restlessness, and suicidal thoughts. The frequency of each symptom in the last two weeks is evaluated on an ordinal scale varying from 0 to 3 corresponding to the following answers: 'never', 'several days', 'more than half the days', and 'almost every day', respectively. The scores were summed up and a total score ranging from 0 to 27 was obtained.[21]

Health-related behaviors

The latent variable health-related behaviors was derived from three observed variables: tooth brushing frequency, recorded as 'less than once a day, 'once a day', 'twice a day', and 'three times a day or more'; flossing, recorded as 'no' or 'yes';[22] and dental service use, assessed with the question 'When was your last visit to the dentist?', with answers categorized as whether or not dental services were used in the year prior to the interview.[23] Scores were assigned to the response options so that higher values in the latent variable indicated better oral health behaviors.

Clinical factor

We included tooth loss as the clinical variable in the analyses. The variable was self-reported by participants, who, at the time of the interview, answered a question about the total number of missing teeth. The variable was categorized as 'lost 20 or more teeth', 'lost between 10 and 19 teeth', 'lost between 1 and 9 teeth' or 'no tooth loss'.

Conceptual model and hypotheses

Prior to data analysis and based on previous studies on social determinants of oral health,[1,2] we specified the theoretical causal model that guided the statistical analyses (Figure). The model is based on the following main concepts: a) high SEP is related to fewer depressive symptoms, healthier oral health behaviors, and a lower number of missing teeth; b) fewer depressive symptoms is related to healthier oral health behaviors; and c) fewer depressive symptoms, healthier oral health behaviors, and a lower number of missing teeth are related to better SPOH. SEP was hypothesized as the latent cause of levels of observed indicators for household income per capita, wealth index, and education. We hypothesized that higher SEP directly leads to better SPOH and indirectly via fewer depressive symptoms (psychosocial pathway), healthier oral health-related behaviors (behavioral pathway), and a lower number of missing teeth (clinical factor).

Statistical analysis

Data were analyzed using the software STATA 14.0 (Stata Corporation, College Station, TX, USA) and Mplus version 6.12. All analyses were performed considering the sample weight due to the complex sample. Preliminary analyses depicting the characteristics of the sample were performed.

To test our model, we used structural equation modeling (SEM). In the first stage, the latent variables were specified separately using confirmatory factor analysis models, considering all standardized factor loadings above the benchmark of 0.3[25]. The second stage involved fitting the path analytic models, which included the latent constructs, to jointly estimate the standardized direct and indirect associations with SPOH. With the inclusion of both continuous and categorical variables in the model, the maximum likelihood estimator for complex samples with robust standard error was used. Modification indices (MI) and factorial loads allowed for the adjustment of the parsimonious model. The comparative fit index (CFI), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), and Tucker-Lewis Index (TLI) were used to assess goodness of fit, with CFI and TLI ≥0.9, RMSEA ≤ 0.05, and SRMR ≤ 0.08 indicating good model fit. Non-significant paths, that is, paths that did not contribute to the model were removed one by one in a stepwise way.[24] Results were adjusted for age and sex. Standardized coefficients (SCs) were interpreted as small (SC between 0.10 and 0.30), medium (SC between 0.30 and 0.50), and strong (SC > 0.50).[24]
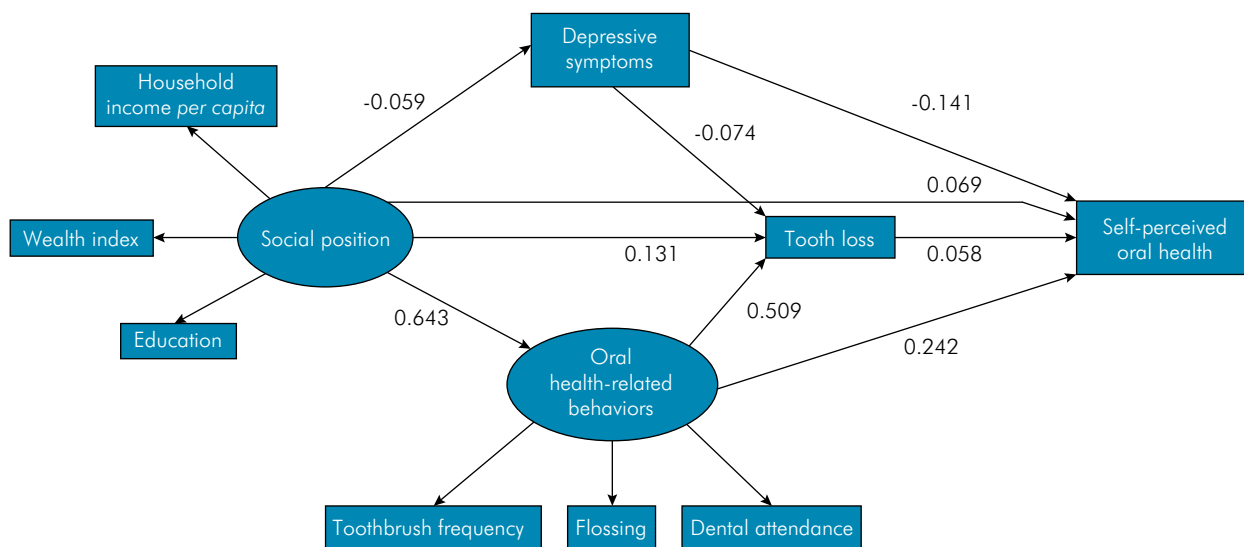
Figure. Path diagram with standardized parameters of the model on self-perceived oral health. Arrows depict direct effects. Variables are coded so that high values indicate high socioeconomic position, more depressive symptoms, healthy behaviors, less missing teeth, good self-perceived oral health. The model was also adjusted for age and sex. National Health Survey (NHS), 2019.

Results

In this analysis, we included 65,803 adults aged between 18 and 59 years, with a mean age of 38.1 (standard error = 0.1). Table 1 shows the demographic, socioeconomic, psychosocial, behavioral, and clinical characteristics of the sample. Most of the participants were female (52.2%) and 34.0% had complete secondary education. The mean household income per capita was R$1502.93. About 55.1% of the participants lost between 1-9 teeth, and 70.6% reported good SPOH.

Figure and Table 2 display the standardized estimated effects of the structural model with the best fit to the data. Higher SEP was directly associated with better SPOH (SC = 0.069; p < 0.01) fewer depressive symptoms (SC = -0.059; p < 0.01), fewer missing teeth (SC = 0.131; p < 0.01), and more healthy behaviors (SC = 0.643; p < 0.01). Fewer depressive symptoms (SC = -0.141; p < 0.01), more healthy behaviors (SC = 0.242; p < 0.01), and fewer missing teeth (SC = 0.058; p < 0.01) were directly associated with good SPOH. The values of the parsimonious model indicated an adequate fit, with RMSEA = 0.028, CFI = 0.971, TLI = 0.926, and SRMR = 0.022.

Table 3 shows the direct, indirect, and the total effects of SEP on SPOH in the parsimonious SEM model. The total effect of SEP on SPOH was SC = 0.244. Among the specific indirect effects on SPOH, the behavioral pathway was the one that best explained this association (SC = 0.155).

Discussion

Our findings support the hypothesis that a higher SEP is directly associated with better SPOH and indirectly associated via psychosocial, behavioral, and clinical variables. The behavioral pathway showed the highest contribution to the indirect effects of SEP on SPOH, while the psychosocial and clinical pathways were much less expressive. This study provides a relevant contribution to existing evidence about determinants of SPOH by unveiling the relative importance of different mediators selected based on a sound conceptual framework.

Our study confirmed the direct association of depressive symptoms on perceived oral health in

Table 1. Characteristics of the participants of the National Health Survey (NHS), 2019. N = 65,803.

Variables	Weighted (%) or mean ± SE
Sex	
Male	47.8
Female	52.2
Education	
No formal education	03.1
Incomplete elementary school	23.8
Complete elementary school	08.0
Incomplete secondary school	07.8
Complete secondary school	34.0
Incomplete higher education	06.2
Complete higher education	17.1
Household income per capita (in Reals)	
Mean (SD)	1,502.93 (24.67)
Wealth index	
1st quintile	21.3
2nd quintile	19.8
3rd quintile	18.2
4th quintile	24.8
5th quintile	16.0
Depressive symptoms	
Mean (SD)	3.4 (0.03)
Time since last dental visit	
More than a year	46.9
Less than a year	53.1
Flossing	
No	30.5
Yes	69.5
Toothbrushing frequency	
Not every day	0.2
Once a day	03.8
Two times per day	30.1
Three times per day	66.0
Tooth loss	
20 or more teeth	04.4
10–19 teeth	05.7
1–9 teeth	55.1
None	34.8
Self-perceived oral health (outcome)	
Poor	29.4
Good	70.6

Taking into account the sample weight; SE: standard error.

Table 2. Standardized estimated effects of indicators in the initial and final structural model. National Health Survey (NHS), 2019.

Direct effects	Initial model	Final model
Self-perceived oral health		
SEP	0.075 (p < 0.01)	0.069 (p < 0.01)
Depressive symptoms	-0.140 (p < 0.01)	-0141 (p < 0.01)
Oral health-related behaviors	0.241 (p < 0.01)	0.242 (p < 0.01)
Tooth loss	0.077 (p < 0.01)	0.058 (p < 0.01)
Depressive symptoms		
SEP	-0.056 (p < 0.01)	-0.059 (p < 0.01)
Oral health-related behaviors		
SEP	0.664 (p < 0.01)	0.643 (p < 0.01)
Depressive symptoms	0.006 (p = 0.49)	-
Tooth loss		
SEP	0.053 (p < 0.01)	0.131 (p < 0.01)
Depressive symptoms	-0.072 (p < 0.01)	-0.074 (p < 0.01)
Oral health-related behaviors	0.294 (p < 0.01)	0.509 (p < 0.01)
Model fit		
RMSEA (90% CI)	0.043 (0.042–0.044)	0.028 (0.026–0.029)
CFI	0.905	0.971
TLI	0.819	0.926
SRMR	0.042	0.022

Taking into account the sample weight. Adjusted for age and sex. SEP: socioeconomic position; RMSEA: root mean square error of approximation; CI: confidence interval; CFI: comparative fit index; TLI: Tucker-Lewis index; SRMR: standardized root mean square residual.

Table 3. Standardized coefficients for direct and indirect effects of socioeconomic position on self-perceived oral health. National Health Survey (NHS), 2019.

Variable	Standardized coefficients	p-value
Pathways connecting high SEP to self-perceived oral health		
Total effect	0.244	< 0.001
Direct effect	0.069	< 0.001
Specific indirect effects		
Via depressive symptoms	0.008	< 0.001
Via oral health-related behaviours	0.155	< 0.001
Via tooth loss	-0.008	< 0.001
Via oral health-related behaviours → tooth loss	0.019	< 0.001

SEP: socioeconomic position. Taking into account the sample weight. Ajusted for age and sex.

adults. Depression is strongly related to negative affective experiences, reflecting the extent to which a person maintains himself/herself in a constant negative mood, state of fear, sadness, anger, and guilt.[25] This pessimistic view of life might be reflected in reports of their oral health. Nevertheless, its role as a mediator in the relationship between SEP and SPOH, despite being statistically significant, was not strong. Individuals of lower SEP could be at a higher risk of health impairments due to the physiological influence of chronic stress, which, ultimately, induces unhealthy behaviors.[26] Environmental stressors have been recognized as contributors to the development of depression,[27] which also contributes to poorer oral health.[28] However, it is also possible that the combination of several psychosocial stressors would have a higher impact on health outcomes.[29,30]

There are recent theoretical and methodological advances in social epidemiology that include the application of different models of social determinants, an intersectionality framework, to better understand oral diseases.[1] Broader socio-historical processes, as

well as their relationship with economic exploitation, social stigmatization, and political marginalization, have been explored in the context of oral health.[7,31] Previous studies have found that vulnerable and socially excluded groups in society persistently experience significantly worse oral health and lower access to dental services than the general population.[26,31] However, research on psychosocial determinants has not yet explored the full range of potentially relevant factors, and psychosocial factors are often not taken into account in explaining the health-disease process.[11] Therefore, future studies investigating these determinants are needed.

Our findings reinforce the hypothesis that oral health-related behaviors lie in the causal pathway between SEP and oral health. Better income and education not only permit access to timely and comprehensive health care, but also provide opportunities for numerous choices that affect health.[32] Rather than dismissing the importance of oral health behaviors, it is important to reassert that such behaviors are shaped in social environments, such as social norms, peer influences, and marketing strategies, which are distinct among different socioeconomic groups.[6] Therefore, it makes more sense to strive for a general change in circumstances that facilitate the adoption of healthier behaviors than to focus only on behavioral interventions.

The mediation role of the clinical factor, although statistically significant, was of small magnitude. This result suggests that there are other factors that are relevant to determining SPOH than tooth loss in Brazilian adults. The self-assessment of oral health comprises a complex set of factors that include not only individual factors and personal experiences, but also the environment to which people are exposed.[33] Further, resilience, the individual ability to adapt, may play an important role as a potentiating agent in the positive adaptation to clinical impairments, such as tooth loss,[34] which perhaps modulates the contribution of the clinical pathway.

The direct influence of SEP on SPOH was also of a small magnitude, which was unexpected. We speculate that it could be partly due to the nature of exposures. The SEP indicators were either acquired early in life (educational attainment) or a result of accumulating years of affluence (income and wealth), therefore, better suited to a cumulative measure of disease and treatment over the life course than on a current oral health rating, such as SPOH.[13]

One of the strengths of our study is that we used a large, nationally representative sample of the Brazilian adult population, and the NHS methodological robustness guarantees the high quality of our data. Furthermore, SEM is a statistical method that allows the assessment of complex relationships between one or more independent variables and one or more dependent variables, which allows a deeper understanding of these interactions. Still, our findings must be interpreted with caution, since the cross-sectional design of the study does not allow us to infer causality in the associations. Also, relevant variables might have not been included, such as resilience or further clinical factors, and alternative models might exist. Wearing a dental prosthesis could influence the impact of tooth loss on SPOH, which was not assessed and is therefore a limitation of this study. Future studies would benefit from assessing these interactions.

Conclusion

Our findings support the hypothesis that a higher SEP is associated with better SPOH via psychosocial, behavioral, and clinical variables. Understanding the pathways of socioeconomic determinants of SPOH may support policymakers to tackle oral health inequalities. Our findings add to the body of evidence that health is sensitive to social conditions, as SEP is a paramount determinant of oral health-related behaviors, which strongly influences SPOH and psychosocial and clinical factors. Individual behaviors cannot be separated from the context in which they occur. This has implications for positioning health strategies within the social context in which people live, facilitating healthy choices and promoting good oral health.

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