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Social Inequalities and the Oral Health in Brazilian Capitals

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Abstract *Despite the improvement of the lives of Brazilians, still persists a panorama of iniquities in health in Brazil. This ecological study evaluated the relationship of socioeconomic conditions and public health policy with oral health conditions in Brazilian capitals. Factor analysis was performed with the socioeconomic indicators, revealing two common factors: economic deprivation and sociosanitary condition. Then, was executed multiple linear regression analysis for the oral health indicators (average DMFT 12 years, mean missing teeth and rate of decay of free population) with two factors in common and fluoridation of water supply. Multiple linear regression analysis to the DMFT of the capitals was estimated by the sociosanitary conditions and fluoridation, adjusted by economic deprivation; whereas the model for the average missing teeth was estimated only for fluoridation and economic deprivation, and finally, the model for the rate of caries-free population in the Brazilian capitals was estimated by economic and sociosanitary condition set by fluoridated water supplies. Therefore, the results indicate the need for social actions that impact on people's living conditions to reduce tooth decay.*

Key words *Social inequity, Inequalities in health, Oral health, Social indicators*

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Introduction

Health defined as being a result of the social production organization modes, the effect of the composition of multiple factors, such as housing, food, education, work, income, environment, access to goods and essential services among others[1]. In this sense, the Brazilian population health levels express the social and economic organization of the country. Oral health as an integral part of human health, it is also in this context includes, suffering the same influence factors and in particular of the socioeconomic conditions of the population.

The study of relationship between social conditions and health conditions of populations pervade the literature some years ago, as reported in the classical studies of John Snow and Engels, Louis and Virchow, revealing the restlessness in associating the health situation of the poorer classes of society with their living conditions that would be responsible for their higher risk of morbidity/mortality. In this respect, differences in social conditions of a population reflect a differentiation in epidemiological profiles between social groups. Therefore, living conditions, environment and health conditions form an in dissociable triad of factors with multiple and complex interactions[2].

The National Commission on social determinants of health (2008)[3] States that the socioeconomic, cultural and environmental conditions of a population generates a stratification of individuals and population groups, giving them different social positions, which is directly related to health conditions.

In this way, important variations in the distribution of diseases in populations have attributed to historical forms through which men distribute wealth in concrete societies. Such disparities expressed by means of income, education, and social class, corresponding, in this case, the materialization of inequalities[4]. Living conditions, as well as their needs, exceed the limits of the material conditions of survival and life style, encompassing more than aspects related to purchasing power, but also the public policies that aim to ensure the fulfillment of basic needs for survival, uniting the political dimension to the living conditions[5].

In Brazil, it is still possible to observe a structural heterogeneity, which attaches importance to the living conditions and work in the determination and differentiation of epidemiological patterns linked to exclusion social[6]. This fact is most likely associated with the ticket late in the industrial and technological development in Brazil, resulting in accelerated urbanization with emphasis on economic development and contempt for social development[3].

This Brazilian conjuncture, the oral health framework, despite its improvements in recent decades, still constitutes public health problem[7,8]. Decayed teeth, absences dental, prostheses badly adapted or even external fistula or scar from an abscess, not rare problems in low-income Brazilian, cause low self-esteem and in many cases generate difficulty of insertion in the job market and loss of job opportunity[9]. Such diseases affect especially the population socioeconomically less favored[6,7,10].

Currently, the National Oral Health Policy, popularly known as Smilling Brazil, has adopted as one of the fronts to reduce inequalities in dental health, encouraging expansion of deployment of fluoridated water supply. In 2009, the Ministry of health[11] takes the fluoridation of public water supplies as an essential element of health promotion strategy, guiding the National Oral Health Policy. According to the document "Guidelines of the National Oral Health Policy", this understanding corresponds to the construction of healthy public policies and the development of strategies directed to the equity in oral health.

Thus, more than meeting the primary data of oral morbidity, it is necessary to know and understand the relationship of the disease with the social and economic conditions of the population effectively promote oral health. Because promoting health is a complex strategy that involves understanding the relationship of man or of populations with their patterns of development, their relationships with their socio-cultural environment, with their needs, rights, and living conditions.

Therefore, the objective of this study was to evaluate the relationship of socioeconomic conditions and national public policy of fluoridation of the water supply, oral health conditions of the population of 12 years in the Brazilian capital.

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Method

It is an ecological study, having as analysis unit the 27 Brazilian capitals. Data collected regarding oral health, Oral Health Public Policy and socioeconomic conditions of the Brazilian capitals. Oral health data were obtained from the Ministry of Health, through the national oral health survey conducted in 2010 (SB Brazil 2010). The variables used to assess oral health conditions of the population have been DMFT to 12 years, average of missing teeth and rate of caries-free population to 12 years. The data corresponding to the oral health public policy (fluoridation of the water supply) obtained from the Ministry of Health, through the records of the surveillance Information System of the Quality of Water Intended for Human Consumption (Sisagua). We used only the presence/absence of fluoridation of the water supply of the capitals. The data regarding the socioeconomic conditions of the population (average household density, rate of urbanization, ratio of proper sanitation, illiteracy rate, average *per capita* household income, the proportion of people with low income, unemployment rate and life expectancy) have had as a source the Brazilian 2010 Census of the Brazilian Institute for Research and Statistics (IBGE). This data were used from the general results of the sample (ratio of proper sanitation, illiteracy rate, average per capita household income, the proportion of people with low income, unemployment rate and life expectancy) and data of the universe (average household density and rate of urbanization).

Through the software SPSS *Statistics* 17.1, descriptive analysis and normality of all variables. Then, factor analysis with independent variables obtained the analysis of the main components with the goal reducing the number of variables and simultaneously creates a smaller set that could express all together. The overall objective of the factorial analysis technique is to find a way to condense the information contained in various original variables in a set of new composite dimensions reduced or statistical variables with minimal loss of information[12]. Tests of Kaiser-Meyer-Olkin (KMO) and Bartlett used to assess the adequacy of the use of factor analysis considering the data set analyzed. The KMO considered appropriate when greater than 0.5 and Bartlett with the rejection of the null hypothesis. The commonality of each variable observed, since this represents the amount of variance explained by the factor solution for each variable, therefore its values could not be less than 0.5, being the ideal values those closest to one. The load factor considered was above 0.5 to contribute significantly to the factor, following rotation orthogonal varimax method.

The eight independent variables metrics reduced to two new statistical variables, which employed along with the fluoridation of water supply, in the subsequent analyses. Then, Pearson correlation test between the variables, 0.05 level of significance, carried out to observe the existence of statistically significant correlations, the type of relationship (positive or negative) and the strength of the relationship (the sparsely of cases) between the dependent variables and the new independent variables obtained in factor analysis. The new independent statistics variables showed significant value in the array above 0.20 correlation selected for multiple linear regression analysis, taking into account that the order of entry of independent variables in the regression model defined according to the ascending order of significance of the correlation with the dependent variable. The variable presence of fluoridated water, being a dichotomous variable, was not included in the correlation matrix and for the determination of their order of entry in multiple linear regression model has been a test of difference of averages, *student* test, for obtaining the value of their statistical significance, which served as a parameter to rank its entry in multiple linear regression. Multiple linear regression models estimated by the method of least squares and obtained through the *stepwise* method.

Three multiple linear regression models proposed according to the socioeconomic characteristics and oral health public policy relevant. The first explanatory model for the DMFT index to 12 years of Brazilian capitals, the second explanatory model for the average missing teeth to 12 years in the capital and the third model for the rate of caries-free population to 12 years. In the last step, the waste of the final models evaluated in order to observe the presence of *outliers*, homoscedasticity, and normality.

Results

According to the descriptive analysis of the data, a little less than half of the Brazilian capitals DMFT values to 12 years higher than the Brazilian average (2.6), especially the capital of the State of Rondônia, Porto Velho, which obtained the lowest index among Brazilian capitals, being of 4.15. As to the percentage of the population free of caries, excelled the capital of Santa Catarina, Florianópolis, which featured 68.40% of its population with DMFT to 12 years equal to zero, the largest Brazilian population rate free of caries. With respect to the number of missing teeth (12 years), the national average was very low, reaching Campo Grande to present an average very near any teeth lost (Table 1).

In the analysis of the socioeconomic conditions, a high urbanization of Brazilian cities, with nine 100% urbanized capitals. However, such content not reflected in sanitation. An average of proper sanitation only of 67.65% obtained, having the capital of Amapá just 16.33% of your city properly sanitized, while Vitória presented 97.45% of his city in optimum conditions of sanitation. As for the household density, small variations observed between the capitals, as well as average household income *per capita*. However, the rate of people with low income varied greatly between the capitals. In nine Brazilian State capitals, there was an average equal to zero percent of people earning less than half the minimum wage. However, in Maceió, 86.16% of people live with up to half a minimum wage. An average rate of unemployment of 8.58% obtained between the capitals. The rate of illiteracy presented a wide variation between the capitals, with better index in Rio de Janeiro, only 4.12% of the illiterate population, and worst in Rio Branco, 21.40% of illiteracy.

Regarding oral health public policy, 17 Brazilian cities presented fluoridation of its water supply, totaling 63% of capital. Finally, the capitals showed an average life expectancy of 72.39 years (Table 2).

The principal component factor analysis performed on the set of eight independent metrics variables (household density, urbanization rate, rate of proper sanitation, illiteracy rate, household income *per capita*, the ratio of people of low income, unemployment rate and life expectancy) obtained the value of KMO test of 0.814 and

Table 1. Descriptive statistics for the variables depend on DMFT, caries-free individuals and average of missing teeth.

Dependent Variables	Average	DP	Minimum	P_{25}	Median	P_{75}	Maximum	IC 95%
DMFT 12 years	2.06	0.75	0.77	1.40	1.66	2.45	4.15	1.76 -2.31
Caries-free	44.00	11.63	25.60	32.10	44.70	50.60	68.40	39.1- 48.9
Missing teeth	0.12	0.08	0.00	0.03	0.08	0.15	0.31	0.06 - 0.18

Source: SB Brasil, 2010.

Tabela 2. Estatística descritiva para as variáveis independentes de estudo.

Independent Variables	Average	DP	Minimum	P_{25}	Median	P_{75}	Maximum
Household density	3.34	0.34	2.80	3.07	3.30	3.60	4.20
Rate of urbanization	98.09	2.60	91.18	96.57	99.49	100.00	100.00
Sanitation rate	67.65	23.42	16.33	53.53	68.69	89.87	97.45
Illiteracy rate	7.92	4.37	4.12	5.13	6.43	8.97	21.40
Household income *per capita*	943.00	289.75	631.00	673.00	875.00	1204.00	1573.00
People with low income	38.40	31.67	0.00	0.00	43.17	68.94	86.16
Unemployment rate	8.58	2.54	4.86	6.56	7.70	10.88	13.06
Life expectancy	72.39	2.31	67.60	71.00	72.20	74.30	75.80

Source: Brazilian demographic census, 2010.

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Bartlett's sphericity test statistically significant ($p < 0.0001$), thus confirming the appropriateness of the analysis.

Varimax rotation loads were higher in the first factorials factor, which formed by the household density variables, household income *per capita*, and the ratio of people of low income, unemployment rate, and life expectancy. By the nature of the variables, this factor named "economic deprivation". The second factor constituted by the urbanization rate, rate of proper sanitation and illiteracy rate, being so called "sociosanitary condition" (Table 3).

The two new statistical variables, economic deprivation and sociosanitary condition, showed statistically significant correlation with the DMFT to 12 years (respectively, $p = 0.030$ and $< p\ 0.0001$). As expected, economic deprivation showed a positive correlation with the DMFT to 12 years ($r = -0.419$), while the sociosanitary condition showed a negative correlation with respect to DMFT to 12 years (-0.676). A significant difference in the average DMFT to 12 years of capitals with and without fluoridated water supplies ($p < 0.0001$).

When evaluating the correlations between the average missing teeth of the capitals and their living conditions, the following results obtained: absence of statistically significant correlation with sociosanitary condition ($p = 0.170$; $r = -0.277$), while economic deprivation showed a statistically significant positive correlation with the average of missing teeth ($p = 0.002$; $r = 0.570$). Difference in average log of missing teeth statistically significant among the capitals with and without fluoridated water supplies ($p < 0.0001$) observed.

In relation to the rate of population free of caries, economic deprivation presented a negative correlation ($p = 0.012$; $r = -0.474$), while the sociosanitary condition showed a positive correlation ($p = 0.002$; $r = 0.572$). There was a significant difference in caries-free population rate in the capital with and without fluoridated water supplies ($p < 0.0001$).

The final model of multiple linear regression analysis to the DMFT to 12 years explained 70.4% of the DMFT variability to the 12 years of the Brazilian capitals (Table 4). The final model of multiple linear regression analysis for the average missing teeth explained 42.5% average variability of missing teeth in the Brazilian capitals (Table 4). While the final model for the rate of caries-free population in Brazilian capitals explained 55.4% of the variability of caries-free population rate in the Brazilian capitals (Table 4).

Table 3. Factorial load obtained by varimax rotation.

Variables	Economic deprivation	Sociosanitary condition
Household density	**0.772**	-0.422
Rate of urbanization	-0.038	**0.901**
Adequate sanitation	-0.610	**0.690**
Illiteracy rate	0.146	**-0.830**
Per capita household income	**-0.873**	0.331
Low-income individuals	**0.616**	-0.481
Unemployment rate	**0.887**	0.163
Life expectancy	**-0.862**	0.151
% variance explained	58.64%	19.10%
% cumulative	58.64%	77.74%

Source: own authorship.

Discussion

In recent decades, epidemiological indices of various countries point to the decline of main oral disease, tooth decay[13]. The Brazilian epidemiologic context of the prevalence of dental caries has been following global trends, showing a significant decrease in the number of teeth attacked by caries and lost and growing proportion of children free of the disease in 2010. As we noted, among children of 12 years living in Brazilian capitals 44% are free of caries and feature an average of teeth caries of 2.06, attacked by one of these just 0.12 suffered dental extraction.

However, such a reduction has accompanied by the polarization of the disease in those economically less privileged groups[8,14]. As discussed thoroughly by technicians, managers and representatives of civil society during the second National Oral Health Conference, held in 1993, the oral health as an integral part of overall health, is directly related to the conditions of sanitation, food, housing, work, education, income, transport, leisure, liberty, land tenure, access to health services and information[15]. This assertion clearly proven from data of epidemiological survey last conducted in 2010. Analyzing the regional variations in the profile of oral health and socioeconomic conditions, we observed adverse posi-

Table 4. Final model of multiple linear regression to the DMFT to 12 years, mean of missing teeth* and rate of caries-free population.

Final Model	Estimate (IC 95%)	Significance	R2 adjusted
DMFT 12 years[a]			**0.704**
Constant	2.310 (2.001; 2.620)	< 0.0001	
Sociosanitary condition	-0.403 (-0.585; -0.221)	< 0.0001	
Fluoridation	-0.613 (-1.030; -0.196)	0.006	
Economic deprivation	0,177 (-0.014; 0.369)	0.068	
Mean of missing teeth*[b]			**0.425**
Constant	-0.911 (-1.117; -0.706)	< 0.0001	
Fluoridation	-0.330 (-0.602; -0.058)	0.019	
Economic deprivation	0.142 (0.009; 0.274)	0.038	
Caries-freec			**0.554**
Constant	38.698 (32.852; 44.544)	< 0.0001	
Sociosanitary condition	5.468 (2.026; 8.909)	0.003	
Economic deprivation	-3.985 (-7.608; -0.362)	0.033	
Fluoridation	6.750 (-1.131; 14.631)	0.09	

* Mean of missing teeth logarithm. [a] DMFT average estimate 12 years = 2.310-0.403 sociosanitary condition – 0.613 fluoridation. [b] Log estimate missing teeth = -0.911 + 0.142 economic deprivation – 0.330 fluoridation. [c] Estimate rate of caries-free population = 38.698 + 5.469 sociosanitary condition – 3.985 economic deprivation.
Source: own authorship.

tions to the capitals of the North and Northeast regions in relation to the other.

As is well known, the process of spatial occupation and economic development of the regions North, Northeast, and Center-West of the country was so different from the South and Southeast regions, as well as the financing of public health at the beginning of the implantation of the Unified Health System[16]. Accordingly, the standard of occupation and use of those territories reflected the complex historical, social and economic processes of these collectivities that justify the variation of social development of these regions and consequently the different profiles of oral health[17,18].

Worst situations of life, among them, high density, low rate of household sanitation, high illiteracy rate, a high proportion of low-income and lower life expectancy were found in the capital cities with highest rates of caries and tooth loss and lower rates of caries-free youth. Such findings are according to numerous studies that have examined the relationship between caries experience and the living conditions of the populations[10,14,19] . These investigations it was found that the rent is a factor of vulnerability to caries[20,22], as well as poverty[6,23,24] and employment[22,25]. In addition to these, other factors also have shown association with the prevalence of caries and its sequels, as education[26,27] and housing infrastructure[20,28-31] .

However, most studies relating oral aggravations and socioeconomic indicators have taken into consideration only isolated factors, not paying attention to the fact that oral health has a complex relationship with a number of conditions relating to the physical and social environment, which vary over time and space, and that their interpretation requires a more comprehensive analysis[6,32,33]. Therefore, faced with the need for collective understanding of oral disease, focusing on the social dimension in its distinguished cutouts, the factor analysis and regression analysis made it possible to establish groups of indicators that represent the complexity of the specific reality, avoiding the redundancy between variables.

Therefore, the two factorials variables formed, economic deprivation and sociosanitary condition, seize a bit of each individual variable, which feature an intimate connection with health, forming a more complex constructor that can affect oral health conditions of the young Brazilian capitals resident populations in order to understand how and to what extent these living conditions can change the prevalence of caries and its sequel. In addition, we evaluated the influence of concomitant association, these living conditions with fluoridation of the water

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supply, proven effective method for reducing caries rates in order to reproduce the global context that reflected the closest to conditions to which people are exposed in their daily lives and can influence the caries experience.

The variation of the portion of the population of the Brazilian capitals to 12 years who has not presented caries experience was explained by the entire group of health and socioeconomic indicators, where the magnitude of the determination of each variable was adjusted by the presence fluoridation of the water supply, ratifying the strong relationship of the health-disease process with the numerous interwoven factors and representing the living conditions of society found in other accounts[7,14,31,34].

However, only the actual social conditions, sociosanitary condition, and fluoridation of the water supply were able to explain the variation in the DMFT index to 12 years in the capitals of the country, being the only economic deprivation an adjustment factor. As reviewed by further investigation, the increase in wealth of a population, after a certain level, does not necessarily reflect on the improvement of living and health[6,24].

On the other hand, the sociosanitary conditions were not associated to dental losses of children of 12 years of Brazilian capitals. Together, economic deprivation and fluoridation of water explained the variation of dental loss in this portion of the population. However, they could only explain less than half of the variation of tooth loss in 12 years. Probably this result is due to the low prevalence of tooth loss in this age group, or even by their determination given by other social factors that were not included in our study. Therefore, there is need for further investigation and clarification regarding your related factors.

In this context, it is important to note that the public water supply fluoridation is still a measure proven effective in preventing dental caries and its sequels[7,28,35]. Even in the presence of social and economic factors, it still shows essential in the process of reducing the experience and prevalence of dental caries of children resident in Brazilian capitals. However, in spite of its effect and this is the main prevention strategy to tooth decay in the country with collective range, only 53% of the Brazilian population resident in the capitals had this benefit in 2005[36]. Add to that the fact that the lowest portion of the capitals with fluoridated water supply focuses on socially disadvantaged regions: one Midwestern capital, three Northern capitals and fourth capitals of Northeast; contrary to the stated by other studies[7,37] that affirm the importance of fluoride supply system deployment especially in economically underprivileged groups as a measure of reducing social inequalities in dental health.

It is clear that a limitation of this study was the use of interval estimates of oral health as punctual. However, such transgression not prevents in our analysis only points to a cautious interpretation of the results, given this methodological limitation. Unfortunately, Brazil does not yet have a population-based database of oral health conditions of the population due to the substantial needs of financial and human resources to enable the collection of these data in view of Brazil's continental dimension. The SB Brazil 2010, therefore, constitutes the most accurate source of information regarding the oral health of the Brazilian capitals and on single data source available with representativeness for the same.

In this sense, we also remember that this study because of its methodology does not allow allocation of outcomes at the individual level to not incur ecological fallacy. However, we stress the importance of aggregate studies for policy and health planning, as there is to identify and consider the areas with greater injuries and the existing inequities between them for better distribution of effort and financial and human resources.

So, the sorrow of present a reductionist model facing the complex web of circumstances and social actors involved in the process of dental illness and given the difficulty or inability to grasp the totality of reality, we highlight the main social and economic factors, and public policy that can interfere with the experience and prevalence of caries and tooth loss in the young population of the Brazilian capitals providing interventions that go beyond the health sector, characterized as intersectoral, whose effects may be reflected in economic and social development synergistically and consequently in improving the health and quality of life of the Brazilian population. Yet, evaluate the relationship between the factors associated with the health-disease process and their differences between the various social groups are an arduous task. However, the recognition of the importance of contextual factors in caries experience of the population of the Brazilian capitals contributes to the planning of health and social interventions aimed at the improvement of oral health. Therefore, these findings contribute to assist the construction of public policies in Brazil aimed at reducing social inequalities in dental health.

Conclusion

Social and economic conditions, as well as public policies are related to the experience, prevalence, and mutilation of tooth decay in children of 12 years living in Brazilian capitals in 2010. Soon, comprehensive economic and social measures, aimed reducing social exclusion, especially for the most vulnerable populations, are indispensable for a better and uniform pattern of oral health in the Brazilian capitals.

Collaborations

JV Silva was responsible for the conception, design and analysis and interpretation of data. MAF Ferreira contributed to the interpretation of data, critical review and approval of the final version. FA Machado made a critical review of the article.

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