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The potential impact of neighborhood empowerment on dental caries among adolescents

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Abstract – *Objective:* Empowerment has been considered a dimension of social capital. It refers to social interaction processes that enable people to enhance their individual and collective skills and to exert greater control over their lives. This relationship has not been explored in relation to dental health. The objective of this study was to investigate the association between neighborhood empowerment and dental caries in adolescents. *Methods:* A multilevel study was designed to assess the individual and neighborhood effects on the oral health of adolescents. Four sources of data were used: (a) clinical examinations (WHO), (b) students' questionnaires, (c) parents' questionnaires and (d) census data. The study population was 1302, 14/15-year-old students from 39 public schools of two cities of the Distrito Federal (DF), Brazil. Data analysis used logistic multilevel modeling at two levels: students (sources a and b) and neighborhood as defined by catchment areas of schools (sources c and d). *Results:* High DMFT (DMFT > median, DMFT ≥3) rates were significantly lower in areas with higher levels of empowerment. This relationship was independent of socioeconomic variables at the individual and area levels and of all other individual risk factor variables such as sex, fluoride, sugar consumption, tooth brushing and dental attendance [OR for low compared with high empowerment was 1.54 (95% CI = 1.09–2.18), $P = 0.014$]. *Conclusions:* Neighborhood empowerment may play an important role in explaining inequalities in the levels of dental caries. New perspectives are needed so that more effective interventions can be implemented using area-based perspectives.

Key words: dental caries; empowerment; oral health; social capital

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A growing body of recent research suggests that communities with high levels of social capital, the norms and networks that enable people to act collectively (1), have better general health and lower levels of mortality, morbidity and violence than those in low social capital communities (2). This relationship has not been fully explored for dental health. Two investigations carried out in Brazil were the only dental studies to consider social cohesion or capital, as the main exposure (3, 4). They suggest that social capital may be an important factor associated with dental caries. Moyses (3) found that social cohesion was the strongest predictor for dental caries in deprived areas of Curitiba. Using meta-analysis and meta regression techniques he found that for each standard deviation increase in a social cohesion index there was an associated 5.6% (95% CI: 2.3–8.8%) increase in percentage of caries-free children. Social cohesion was measured by items such as community participation in health and social care meetings, ratio of community associations and local health committees. Although Pattussi et al. (4), using ecological data from 19 Districts of the Distrito Federal of Brazil, did not find significant associations between indicators of social cohesion and dental caries, they did find that children from areas with high levels of income inequality, expressed by the Gini coefficient, had higher levels of caries experience. A 0.1 increase in the Gini

coefficient was associated with a 9.4% (95% CI: 3.7–15.1%) reduction in the percentage of caries-free children and a 0.3 (95% CI: 0.1–0.6) increase in the mean DMFT. This finding is important because high levels of income inequality are associated with low social capital levels (5, 6). The objective of this study was to investigate the association between neighborhood empowerment, a scale of social capital, and oral health, assessed in terms of dental caries, in adolescents.

Methods

A multilevel study was designed to assess the individual and neighborhood effects on the oral health of adolescents. Four sources of data were used: (a) clinical examinations, (b) student questionnaires, (c) parent questionnaires, and (d) census data. Data was hierarchically structured in two levels: students (sources 'a' and 'b') and neighborhood defined as the catchment area of schools (sources 'c' and 'd'). The study population was 14/15-year-old students from public schools of the Distrito Federal (DF), Brazil.

A pilot study was done on 140 students in 10 schools. This was designed to assess the logistics of the study, the quality of the data collection forms, and to get reliable estimates for use in the sample size calculations.

A two stage sampling method was adopted. It consisted firstly of taking a random sample of first stage units (schools) and then taking a random sample of second stage units (students). Inclusion criterion for students was to be born in 1987 and the exclusion criterion was to live outside the catchment area of school. Sample size calculation was based on the pilot study estimators and used the method for proportions with cluster randomization (7). A prevalence of high DMFT (DMFT > median, DMFT ≥3) of 44.3% in high social capital areas and 59.3% in low social capital areas (15% difference), and intra-class correlation coefficient of 0.047 were used in the calculation. The minimum sample size was estimated to be 1000 children in 40 schools assuming 90% power and a significance level of 5%. The sample size was increased to allow for possible nonrespondents. A total of 1500 adolescents in 40 schools were invited to take part in the study. Dental caries was measured by DMFT according to WHO criteria (8). All examinations were carried out by one examiner (MPP). Duplicate examinations were conducted on 5.5% of the sample (72 of 1302). The distribution of the data was not normal, showing a highly positive skewed distribution similar to many studies among children and young adults in industrialized and nonindustrialized countries since the 1980s (9). Therefore, the DMFT was transformed into a dichotomous variable using the median as cut-off point, and coded as low (DMFT 0 to 2) and high (DMFT ≥3).

Students answered self-complete questionnaires in schoolrooms and any difficulty in understanding, phrasing and sequence of questions was checked with each child. Oral health behavior questions asked about exposure to systemic fluoride, tooth brushing frequency, dental attendance and sugar consumption. To measure exposure to systemic fluoride, subjects were asked if they had ever lived in another State apart from Distrito Federal (DF) that has been fluoridated since 1960. Information on water fluoridation of the other areas children was obtained from the State Health Authority and published literature. Subjects were then classified into two groups (exposed to systemic fluoride for 10 or more years or for <10 years). Tooth brushing habits were assessed by the question: 'Some people brush their teeth after each meal, others do it less often such as not every day? And you, how many times a day do you brush your teeth?' The responses to this were divided based on the median (three times and more and once or twice a day). Dental attendance was assessed by asking whether the adolescent attended the dentist in the last 12 months (yes or no). Sugar consumption was assessed using the 24 h-dietary recall. Only the daily frequency of sugar consumption between meals was considered and was defined by counting the number of eating occasions in which sugary food and drinks were consumed at any time, excluding breakfast, lunch and dinner. Sugary food and drinks were defined as those containing hidden as well as added nonmilk extrinsic sugars (10). This variable was categorized using the upper tertile as the cut-off point (sugar consumed three times or less; or four or more times between meals).

A standard Brazilian socioeconomic classification based on household items and on the level of education of the head of household was adopted (11). This comprises a group of specific indicators such as number of bathrooms, number of full-time domestic servants, number of cars owned by the family, possession of domestic items such as television sets, radio sets, VCRs, vacuum cleaners,

washing machine, fridges, freezers; and level of education of the head of household. A set of points is assigned to these indicators and a final score defines the socioeconomic groups; A (highest), B, C, D, and E (lowest). Because of the small number of observations in classes A and E, data were categorized into three groups: high social class (classes A and B), middle social class (corresponding to class C) and low social class (classes D and E).

Questionnaires were sent to children's parents via children and parents assessed the level of empowerment in their area of residence. Students whose parents had a low level of education were advised to help their parents with their questionnaires because all students had at least 7 years of formal education. Empowerment was defined as social interaction processes that enable people to enhance their individual and collective skills and to exert greater control over their lives. Based on the literature on this subject, a scale was created comprising five items on the perceived occurrence with which people signed petitions, made formal complaints, contacted local authorities, attended meetings, joined groups and talked about issues to improve their neighborhood (12). Responses were measured on five-point Likert scale [from 'I have never done that' (code = 0) to 'in the past 3 months' (code = 4)] and items were added up so that each parent had a score ranging from 0 (lowest empowerment) to 20 (highest empowerment). The internal consistency and validity of this index was assessed by principal component analysis, Cronbach alpha and inter-item correlations. The final score for each parent was aggregated at the neighborhood level. Areas were then categorized into low, moderate or high empowerment using the tertiles of the neighborhood distribution and this score was assigned to each adolescent.

Census data for the year 2000 was obtained from the Brazilian Institute of Geography and Statistics (IBGE). This information was used to calculate the Poverty Gap Index (13) for each neighborhood. This variable was calculated using the software Povcal (The World Bank, Washington, DC, USA). This software was designed by the World Bank and enables calculation of the poverty index from grouped data. This area indicator was chosen because it was strongly correlated ($r > 0.9$) with other census variables such as percent of people with secondary school, percent of illiterate, mean years of study and mean income of the head of the household, and percent of people under the poverty line. The variable was the categorized based on the tertiles.

The statistical analysis was carried out using SPSS version 10.1 (SPSS Inc., Chicago, IL, USA) and MLwiN version 1.10 programs (Centre for Multilevel Modelling, Bristol, UK). As the outcome was binary, a multilevel logistic model based on a logit (logarithm of the odds) function was used. Both the Marginal Quasi Likelihood (MQL) first order approximation procedures and Predictive Quasi Likelihood (PQL) second order approximation procedures were used. However, because they produced similar results, only the results based on PQL second-order procedures are reported and discussed. A total of 1256 children with complete data on all variables were included in the main analyses. The following models were fitted: model 1 – unadjusted effect of empowerment, model 2 – empowerment adjusted for area (neighborhood poverty) and individual (social class) level socioeconomic variables, model 3 – empowerment adjusted for the socioeconomic variables and other individual risk factor variables. The aim of these analyses was to assess whether the relationship between social capital and dental caries was confounded with any of these variables. The level of statistical significance was considered to be 5% in all cases. The protocol of the research was approved by Regional Education and Health Authorities and by the Bioethics committee of the University of Brasilia and of the Ministry of Health of Brazil.

Results

The response rate was 87% (1302 of 1500) for students and 63% (816 of 1302) for parents. Consistency of examiner was almost perfect with Kappa values above 0.9 for all examined teeth. The empowerment index showed acceptable reliability and internal consistency. Cronbach alpha coefficient was 0.66 and the coefficient did not increase significantly when any specific item was omitted. The corrected item-total correlation, did not produce values under the minimum recommended value of 0.3 (14). All items loaded into only one factor after varimax rotation.

Of the 1302 adolescents who took part in the study 52.3% were male and 47.7% were female (Table 1). The proportion of 14 and 15 year olds was almost the same, 50.1 and 49.9%, respectively. Over 86% of these adolescents had lived in the Distrito Federal for 10 or more years and almost 70% of the sample was from households whose head had less than secondary school.

Table 1. Distribution of variables and unadjusted multilevel logistic regression of high DMFT (DMFT > median or DMFT ≥3) and individual and area variables in adolescents. Distrito Federal, Brazil, 2002

	n	*n* with High DMFT	%	OR	95% CI	*P*-value
Individual factors						
Sex						
Female	621	292	47.0	1	–	–
Male	681	294	43.2	0.85	0.68–1.06	0.099
Systemic fluoride						
≥10 years exposure	1125	486	43.2	1	–	–
<10 years exposure	176	100	56.8	1.78	1.29–2.45	< 0.001
Tooth brushing						
≥3 times per day	802	374	46.6	1	–	–
<3 times per day	500	212	42.4	0.83	0.66–1.04	0.085
Sugar consumption						
Low ≤3 times/day	1038	445	42.9	1	–	–
High ≥4 times/day	264	141	53.4	1.56	1.19–2.06	0.002
Dental attendance (last 12 m)						
Yes	678	352	51.9	1	–	–
No	624	234	37.5	0.54	0.44–0.68	< 0.001
Social class						
High	401	170	42.4	1	–	–
Middle	565	248	43.9	1.05	0.81–1.36	0.728
Low	291	146	50.2	1.35	0.99–1.84	0.048
Area factors						
Empowerment						
High	366	148	40.4	1	–	–
Moderate	480	209	43.5	1.11	0.83–1.49	0.474
Low	456	229	50.2	1.49	1.11–2.00	0.009
Poverty						
Low	430	181	42.1	1	–	–
Moderate	480	217	45.2	1.11	0.82–1.49	0.215
High	392	188	48.0	1.23	0.91–1.68	0.151

High DMFT rates were negatively associated with empowerment. The unadjusted odds ratio (OR) was 1.49 (95% CI 1.1–2) for low compared with high empowerment areas (Table 1). At the individual level, adolescents who were exposed to systemic fluoride for <10 years, those with high sugar consumption (greater than or equal to four times per day) between meals, those who went to the dentist in the last 12 months and those from the low social class had higher levels of dental caries than others (Table 1).

The association between empowerment and high DMFT was independent of socioeconomic variables at the individual and area levels and of all other individual risk factor variables (sex, fluoride, sugar consumption, tooth brushing and dental attendance) (Table 2). All individual factors identified as being associated with high DMFT prevalence remained independently associated in the final model.

Discussion

The objective of this study was to investigate the association between neighborhood empowerment and dental caries in adolescents. Adolescents from areas with higher, compared with lower levels of empowerment scores had lower levels of dental caries experience. To some extent this finding agrees with those from the studies suggesting that social capital may be an important factor influencing the level of dental caries (3, 4).

What would be a plausible explanation of the relationship between neighborhood empowerment and prevalence of high DMFT? The mechanisms underlying the relationship between social capital and health have yet to be fully explained. It has been argued that social capital may benefit health by influencing health-related behaviors through rapid diffusion of health information and a higher probability of positive behavioral norms adopted by the population (15). In this investigation, social capital could act by influencing health-related behaviors that affect dental caries.

In addition, social capital could have an effect on self-esteem, which in turn affects oral health behaviors that affect oral diseases. A study in 3370 Swedish children showed that those who had low levels of self-esteem had significantly poorer oral health behaviors than those with high levels of

Table 2. Multilevel logistic regression of the effect of empowerment on high DMFT, controlling for area and individual factors ($n = 1256$)

	Model 1	Model 2[a]	Model 3[a]
Individual factors			
Sex (male)			0.87 (0.69–1.09)
Systemic fluoride (<10 year)			1.76 (1.24–2.49)
Tooth brushing (less than three times per day)			0.82 (0.64–1.04)
Sugar (greater than or equal to four times per day)			1.63 (1.22–2.18)*
Dental Attendance (No)			0.48 (0.38–0.61)*
Middle class		1.02 (0.78–1.34)	1.11 (0.85–1.47)
Low class		1.32 (0.96–1.81)	1.48 (1.05–2.08)*
Area factors			
Empowerment (moderate)	1.11 (0.83–1.49)	1.12 (0.83–1.51)	1.20 (0.86–1.67
Empowerment (low)	1.49 (1.11–2.00)*	1.47 (1.08–2.01)	1.54 (1.09–2.18)*
Poverty (moderate)		0.97 (0.72–1.31)	1.08 (0.78–1.53)
Poverty (high)		1.05 (0.76–1.45)	1.30 (0.91–1.87)

Values are OR (95% CI). Reference categories are as in Table 1.
*Values are significant at 5% or less.
[a]Variables adjusted for all other variables in the model.

self-esteem. Furthermore, self-esteem, social support and parent's political interest were significantly associated with one another (16).

The empowerment subscale involved items such as frequency of people talking about issues, signing petitions, attending meetings/joined groups, contacting local councilor/member of parliament, and making formal complaints about problems in the neighborhood. These questions represent actions taken by neighbors to improve their neighborhood. Those actions require communities to have and realize collective, as opposed to individual goals. They depend on the willingness to intervene for the common good, a condition that entails mutual trust and solidarity among local residents. It has been argued that cohesive communities are more capable of organizing themselves to lobby for the provision of appropriate local services (17).

Social capital may also operate on health by creating a more participative, humane, efficient, appropriate and better coordinated health care system. Health care systems are complex sociopolitical institutions and not merely delivery points for biomedical interventions (18). This may have to do with what Steinberg and Baxter have called 'community accountability' (19). They defined community accountability as 'the structures and processes communities use to make health system change consistent with local standards of behavior, shared values, or community goals.' Using qualitative research methods, Hendryx et al. (20) showed that where communities lack common values and strong sense of community, few accountability mechanisms are present. Accountability mechanisms are more likely to arise and be successful when social capital components are present. Moreover, it could also help communities or populations to make more efficient use of existing local physical capital resources. Alongside policy and economic forces, community values can be a strong factor in shaping health system change towards health promotion (21). One can speculate that social capital could act on oral health by fostering and facilitating the implementation of oral health promotion programs and services.

Regarding other risk factors, exposure to fluoridated water for <10 years, high frequency of sugar consumption (four or more times a day between main meals) and attending a dentist in the last year were positively associated with high DMFT scores. The contribution of fluoride to dental caries reduction is well recognized (22, 23). Despite the limitations in study designs, a recent systematic review of 214 studies confirmed the benefits of water fluoridation in the reduction of dental caries levels (24, 25). The links between sugar consumption and dental caries are also well established (26–28). This investigation showed that a higher DMFT was associated with going to the dentist in the last year. Dental care 'philosophy' may increase DMFT levels. For example, the policy changes towards a less interventionist approach adopted in New Zealand in the mid-1970s were one of the factors contributing to the rapid decline in DMFT in that country (29).

Social class was significantly associated with high DMFT. There is extensive evidence on the links between individual and area socioeconomic variables with dental caries (30). The relatively low poverty level of the population (mean = 7%,

SD = 2.3) and the loss of information caused by the reduction of this variable may partly explain the lack of association with high DMFT prevalence in this study.

Kappa scores for the oral exams indicated almost perfect consistency of the examiner and reproducibility of the data. With regard to nonclinical data, the overall response rate for students was very good. For the parent's questionnaires, the response rate was less good, 63%, and varied considerably between neighborhoods, 33% to 86%. Areas with lower response rates have a less precise and valid measure of neighborhood characteristics and this was not accounted for in our analyses. Non-respondents may have a different perception of the neighborhood compared with respondents. To some extent this may have been minimized because response rates were not significantly associated with any area level exposure variables or with the outcome.

This study is an improvement on most previous studies on social determinants of dental caries because it uses a multilevel approach both in study design and data analysis. It has been argued that the debate on the linkages between individual health and contextual factors cannot be adequately addressed without adopting a multilevel approach (6). The wide confidence interval for the empowerment variable, and the close distance from the lower limit of the confidence interval to the unity, is a warning not to over interpret the findings.

Finally, the relationship between empowerment and dental caries was demonstrated in this study, but no causal inferences should be made. Cross-sectional studies are limited to identifying associations rather than causal relationships. Thus, ideally this relationship should be addressed by means of a prospective study, in which empowerment and dental caries are measured repeatedly.

For many years dentistry has emphasized lifestyle for preventing oral conditions. The effects of biological and behavioral factors on dental caries are well accepted. The results of our study to certain extent confirm their effect. However, that approach may miss an important factor in the equation, namely, the role of context that shape those behaviors. If we want to change behaviors, change the environment. New perspectives are needed (31). This study suggests that neighborhood factors such as empowerment may play an important role in explaining inequalities in the levels of dental caries.

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