# Spatial distribution of decayed and restored teeth in an adult population

## Distribuição espacial de dentes cariados e restaurados numa população adulta

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## ABSTRACT

**Objective**: To analyze the spatial distribution of decayed and restored teeth in adults according to the Social Exclusion Index (SEI) and the proximity of public dental service. **Methods**: This ecological study used secondary data from an epidemiological survey of oral health and from the Piracicaba Research and Planning Institute (IPPLAP). The oral examinations of the DMFT index examined in households by a single examiner calibrated in 2011, by probability sampling, 248 adults (aged 20 to 64 years) representing the residents in Piracicaba-SP, Brazil. Data on social exclusion and health units with dental service were extracted from IPPLAP. We performed georeferencing of the census tracts selected by draw in the epidemiological survey and their respective districts, in addition to the health units with dental service in a radius of 500 m and 1000 m. Spearman's rank correlation coefficient was analyzed (p<0.05). **Results**: The smallest value of SEI, that is, the highest social exclusion, showed no correlation with decayed teeth (p=0.09), but had strong positive correlation with restored teeth (r=0.79; p<0.0001). Presence of public dental service in the vicinity of 500 m and 1,000 m showed no correlation, respectively, with the average number of decayed (p=0.07 and p=0.58) and restored (p=0.26 and p=0.56) teeth. **Conclusion**: Although the correlation between social exclusion and caries in adults was not observed, its case management, namely, the restored teeth, showed correlation with social inequalities. Presence of public dental service showed no correlation with components of caries experience evaluated in this study.

**Keywords**: Adult; DMFT Index; Oral Health; Geographic Information Systems; Epidemiology.

## RESUMO

**Objetivo**: Analisar a distribuição espacial dos dentes cariados e restaurados em adultos segundo o Índice de Exclusão Social (IEX) e a proximidade de serviço odontológico público. **Metodologia**: Este estudo ecológico utilizou-se de dados secundários de um levantamento epidemiológico de saúde bucal e do Instituto de Pesquisa e Planejamento de Piracicaba (IPPLAP). Os exames bucais do índice de dentes permanentes cariado perdidos e obturados (CPOD) examinou em domicílios por um único examinador calibrado em

2011, por amostragem probabilística, 248 adultos (20 a 64 anos) representativos dos residentes em Piracicaba-SP, Brasil. Os dados sobre exclusão social e as unidades de saúde com serviço odontológico foram extraídos do IPPLAP. Realizou-se o georreferenciamento dos setores censitários sorteados no levantamento epidemiológico e seus respectivos bairros, além das unidades de saúde com serviço odontológico em um raio de 500m e 1000m. Foi realizada a análise de correlação de Spearman (p<0.05). **Resultados**: O menor valor do IEX, ou seja, maior exclusão social, não apresentou correlação com dentes cariados (p=0,09), mas teve correlação positiva forte com dentes restaurados (r=0,79; p<0,0001). A presença de serviço odontológico público em proximidade de 500 e 1000m não apresentou correlação, respectivamente, com a média de dentes cariados (p=0,07 e p=0,58) e restaurados (p=0,26 e p=0,56). **Conclusão**: Apesar de não ser verificada correlação entre cárie e exclusão social em adultos, sua resolutividade, ou seja, os dentes restaurados apresentaram correlação com as desigualdades sociais. A presença de serviço odontológico público não apresentou correlação com os componentes de experiência de cárie avaliados nesse estudo.

**Termos de indexação**: Adulto. Epidemiologia. Sistemas de Informação Geográfica. Saúde bucal.

## INTRODUCTION

Tooth decay (dental caries) is a sucrose-dependent, multifactorial, behavioral and polarized disease [1-3]. Its consequences are physical, social and psychological injuries, and it has financially impacted developed and developing countries [4-7].

Tooth decay (dental caries) is the most prevalent disease in the world; it affects about 35% of people and is the main problem of oral health in the world population [5-7]. Thus, dental caries still remains as a public health problem. According to the Global Burden of Disease, both in 1990 and in 2010, untreated caries remains among one of the hundred conditions that most impacted the population health [5].

Despite advances in world public health, the incidence of dental caries has not reduced in recent decades and presents uneven distribution in the populations [5-7]. In Brazil, despite the reduction of caries experience in the children population [2], this tendency is not seen in other age groups and also presents an increase in older populations such as in adults [8,9].

For verification of oral diseases distribution, the Geographic Information System (GIS) has been used to analyze the relationship among oral diseases, access to dental services and social exclusion [10]. The analysis of the relationship between geographic space and oral health conditions has increased in the last decades [10-15], but little is known about the spatial distribution of dental caries [12].

Adults are individuals of great relevance to epidemiological studies in Dentistry, whether by their increased exposure to risk factors or by their history of use and access to dental services [4,6,15]. The index of permanent decayed, missing and filled teeth (DMFT) is the main method of evaluation of caries experience

[8], however, the components of decayed teeth (D) and restored (F) separately evaluated are underexploited and need to be better studied in the public health level, mainly in the adult population.

In this perspective, the objective of this study was to verify the spatial distribution of the components of decayed and restored teeth in adults and correlate it with the Social Exclusion Index and the proximity to public dental service.

## METHODS

### Study design and ethical aspects

This ecological study used secondary data from the epidemiological survey of the study "Tooth loss impact on quality of life of adults" [16] carried out in the city of Piracicaba, SP, Brazil, as well as data from the Piracicaba Institute of Research and Planning (IPPLAP) [17].

This study was previously approved by the Research Ethics Committee of the Piracicaba Dental School - University of Campinas (177/2009).

### Population and sample

Piracicaba-SP, Brazil, considered as a large city, held a population of 364,571 inhabitants in 2010 and a Municipal Human Development Index (IDHM) of 0.785, considered as high [18].

Sample calculation of the aforementioned study was accomplished through probability sampling for 202,131 adults residing in Piracicaba-SP aged between 20 and 64 years, according to methodology carried out by Batista et al.,16 with a sample of 248 adults distributed in 30 census tracts.

## Data collection

Data were collected from June to September 2011, with the participation of one individual per residence, in a total of 248 participants at the end of the survey [16]. Experience of dental caries was evaluated through the index of permanent decayed, missing and filled teeth (DMFT), following the codes and criteria of the World Health Organization [19]. The research was conducted by a previously calibrated single examiner, in agreement with an intra-examiner between 96.5% and 100.0%, and Kappa index from 0.89 to 1.00 [16].

The data for the georeferencing used as geographical unit the city of Piracicaba-SP and its processing and mapping were built by the computer program TerraView 4.2.2. Primarily, the 30 census tracts selected by draw and the dental care units were georeferenced, where it was possible to verify in a radius of 500 m (figure 1A) and 1,000 m (figure 1B) the proximity of the census tract with the public dental service.

Data referring to the Social Exclusion Index (SEI) per district held by the Piracicaba Research and Planning Institute (IPPLAP) consist of four dimensions, namely: sex equity, human development, quality of life and autonomy of income, and its calculation is based on secondary data from the Census of IBGE and is expressed in an ordinal scale ranging from -1 to 1, where the closer to -1, the greater the district social exclusion [17].

## Study variables

The average number of decayed (D) and restored (F) teeth were calculated for each census tract participating in the study, in number of 30 sectors, and also for their respective districts, in a total of 24 districts.

The presence of dental service in proximity was dichotomized in absence or presence (0 or 1) of public service with dental service, respectively, in a 500-meter and 1,000-meter radius of the census tract of the residence surveyed.

The Social Exclusion Index (SEI) was used in accordance with the index value per district in a scale represented by values ranging from -1 to 1.

## Data analysis

Data tabulated in Excel® were analyzed through the software Bioestat 5.0 for Windows, with a significance level of 5%. The study outcome was the average number of decayed, missed and filled teeth. Spearman's rank correlation coefficient was analyzed between average of each component of DMFT index with the social exclusion index (from -1 to 1) in 23 districts and the proximity of public dental service in two categories (0 for absence and 1 for presence of public dental service) respectively for the 500-m and 1,000-meter radius, in the 30 census tracts surveyed. A linear scatter plot was made for meaningful data ($p < 0.05$).



Census tract
- Outside coverage area
- Inside coverage area
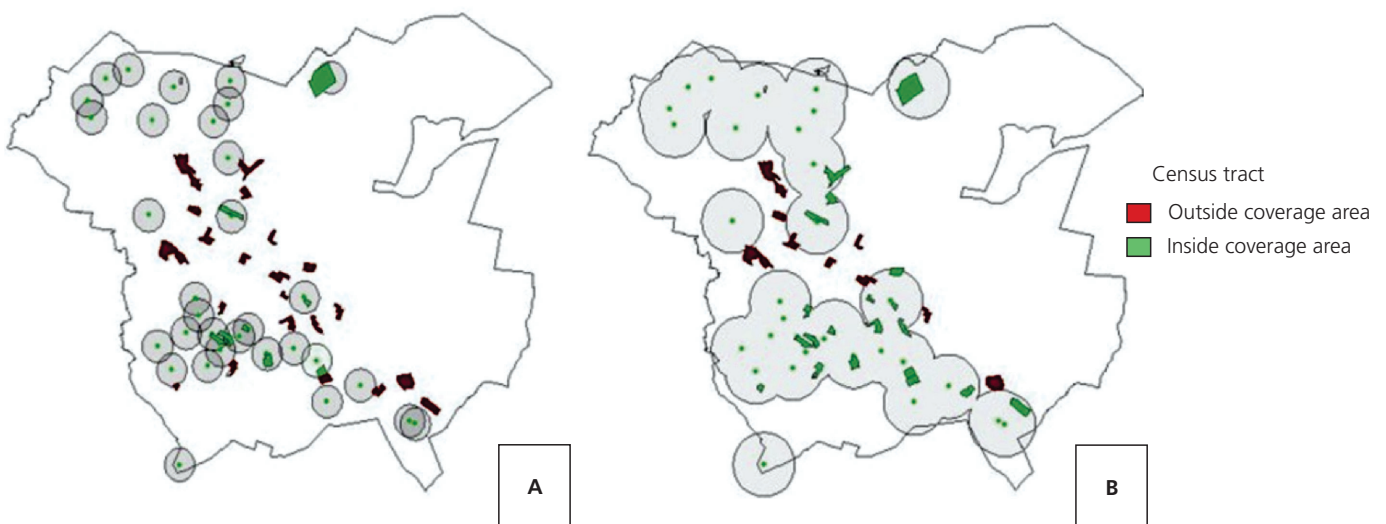
**Figure 1**. Selection of census tracts with the presence of public dental service in a radius of 500 m (A) and 1,000 m (B). Piracicaba (SP), 2015.
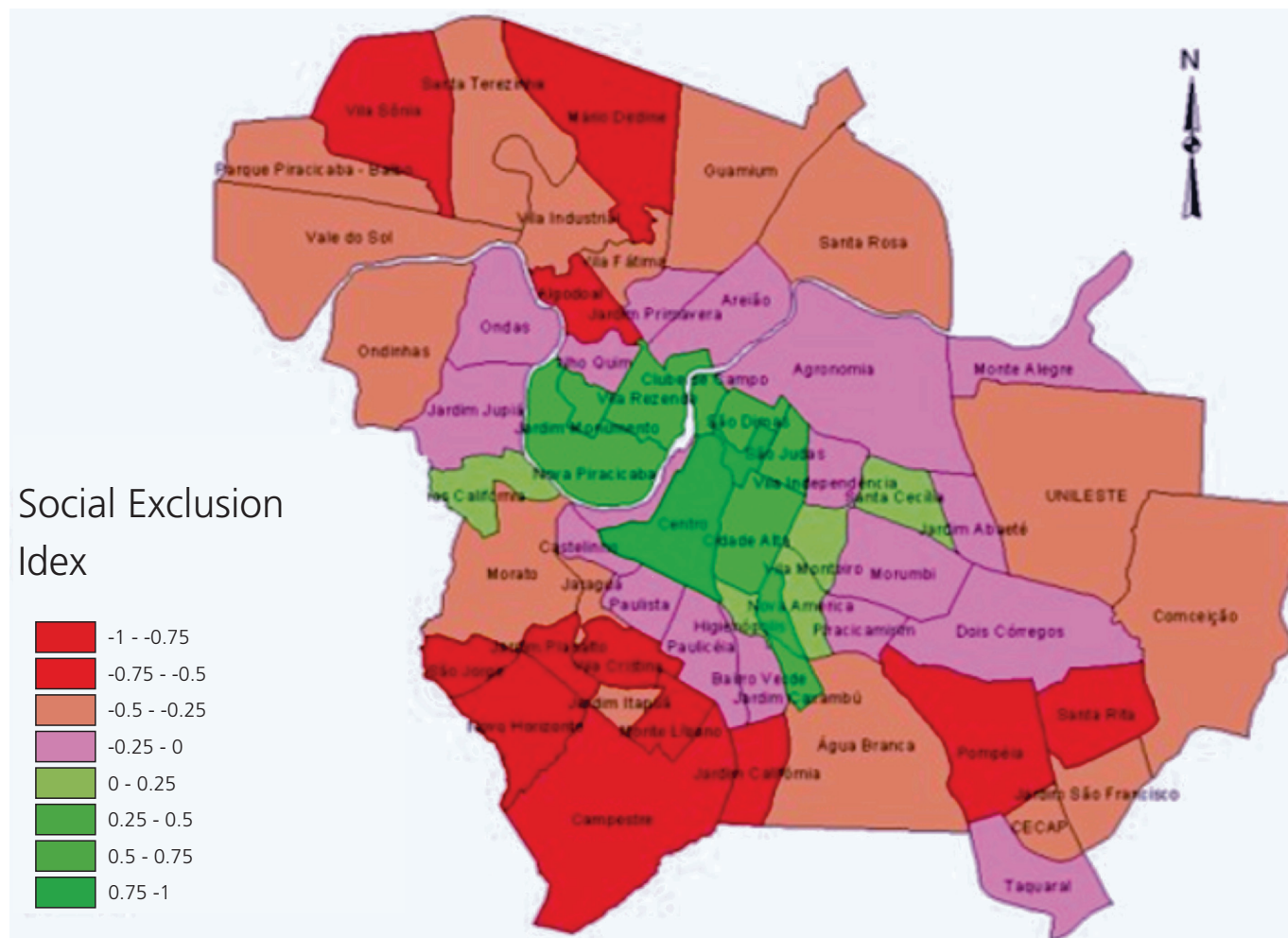
**Figure 2**. Distribution of the Social Exclusion Index (SEI) [17]. Piracicaba (SP), 2003.

## RESULTS

Figure 3 shows the geographical distribution of health units with dental service in the city and the distribution of the averages of decayed and restored teeth per census tract selected by draw in the study.

Figure 4 shows the geographical distribution of the averages of decayed and restored teeth by city district.
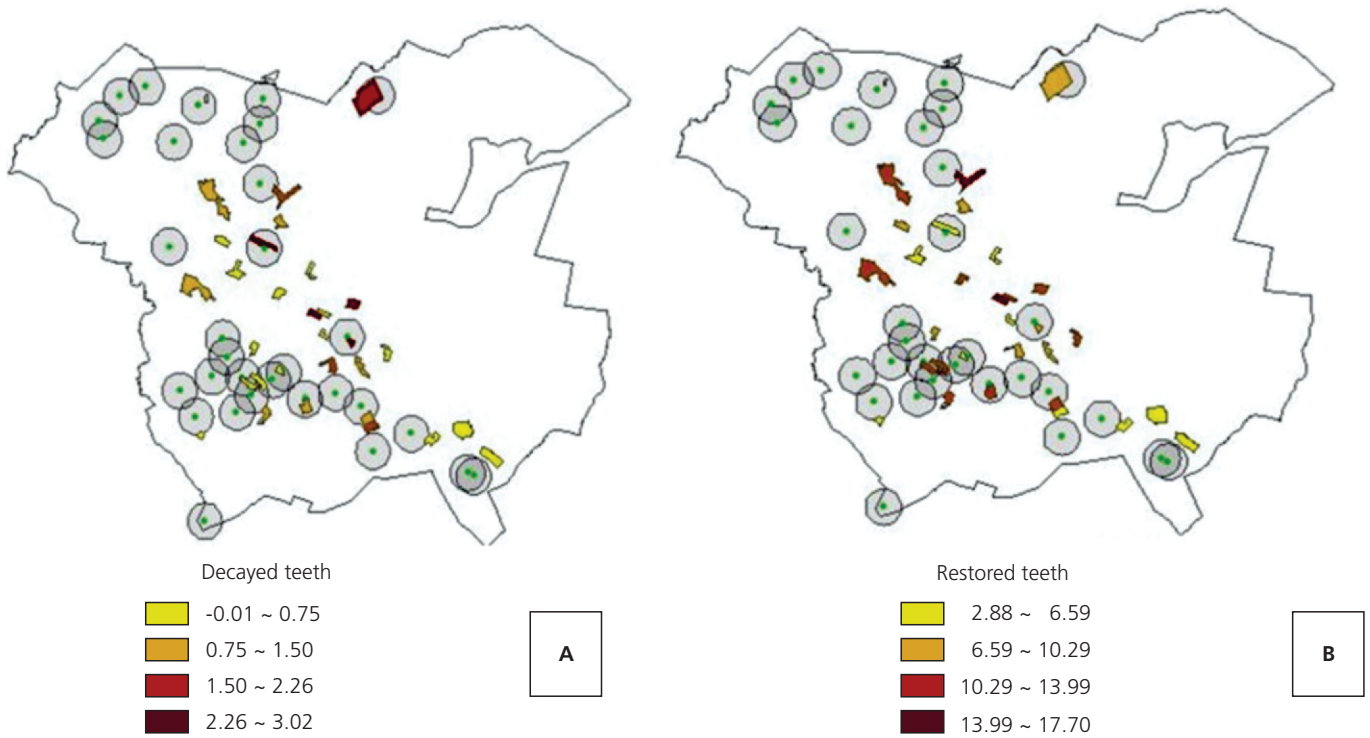
Table 1 shows there was no correlation between the proximity of the public dental service of the census tract, respectively in 500 and 1,000 m, with the oral health conditions evaluated. However, the smallest value of SEI, i.e., greater social exclusion, showed no correlation with the average number of decayed teeth (p=0.09), but showed strong positive correlation with restored teeth (r=0.79; p<0.0001).

Table 1. Values of Spearman's rank correlation coefficient (r) and significance level (p-value) between the average number of decayed and restored teeth by the Social Exclusion Index (SEI) per districts of the city and by the proximity of the public dental service to the census tract. Piracicaba (SP), 2011.
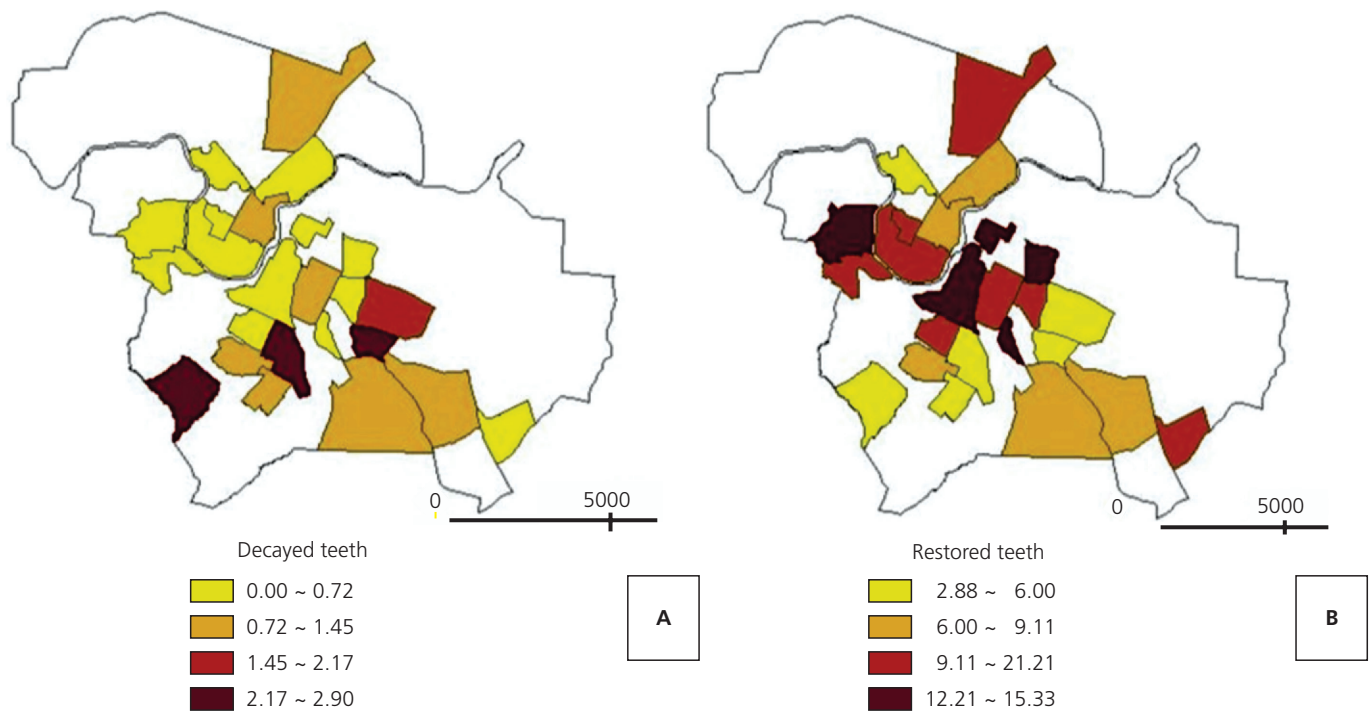
Figure 5 shows the linear scatter plot between the average number of restored teeth per district and the SEI, as they presented significant correlation (p<0.05) among variables.

## DISCUSSION

In present study, it was possible to develop a Geographic Information System (GIS) containing data on the distribution of census tracts selected by draw and health

Decayed teeth

- ☐ -0.01 ~ 0.75
- ☐ 0.75 ~ 1.50
- ☐ 1.50 ~ 2.26
- ☐ 2.26 ~ 3.02

A

Restored teeth

- ☐ 2.88 ~ 6.59
- ☐ 6.59 ~ 10.29
- ☐ 10.29 ~ 13.99
- ☐ 13.99 ~ 17.70

B

**Figure 3**. Distribution of health units with presence of dentists within a radius of 500 m and 1,000 m and the average number of decayed (A) and restored teeth (B) of the census tracts. Piracicaba (SP), 2011.



Decayed teeth

- ☐ 0.00 ~ 0.72
- ☐ 0.72 ~ 1.45
- ☐ 1.45 ~ 2.17
- ☐ 2.17 ~ 2.90

A

Restored teeth

- ☐ 2.88 ~ 6.00
- ☐ 6.00 ~ 9.11
- ☐ 9.11 ~ 21.21
- ☐ 12.21 ~ 15.33

B

**Figure 4**. Distribution of the average number of decayed (A) and restored teeth (B) per district. Piracicaba (SP), 2011.

**Table 1**. Values of Spearman's rank correlation coefficient (r) and significance level (p-value) between the average number of decayed and restored teeth by the Social Exclusion Index (SEI) per districts of the city and by the proximity of the public dental service to the census tract. Piracicaba (SP), 2011.

| Variables | Average number of decayed teeth (D) | | Average number of restored teeth (F) | |
|---|---|---|---|---|
| | r | p-value | r | p-value |
| Social Exclusion Index* | 0.35 | 0.09 | 0.72 | <0.01 |
| Public dental service at a 500-meter distance** | 0.37 | 0.07 | 0.23 | 0.26 |
| Public dental service at a 1,000-meter distance** | 0.11 | 0.58 | 0.59 | 0.56 |

Note: *The index of each district selected by draw was used as measurement unit. **This aspect did not analyze the health unit of reference to the domicile of the individual surveyed, but the proximity.
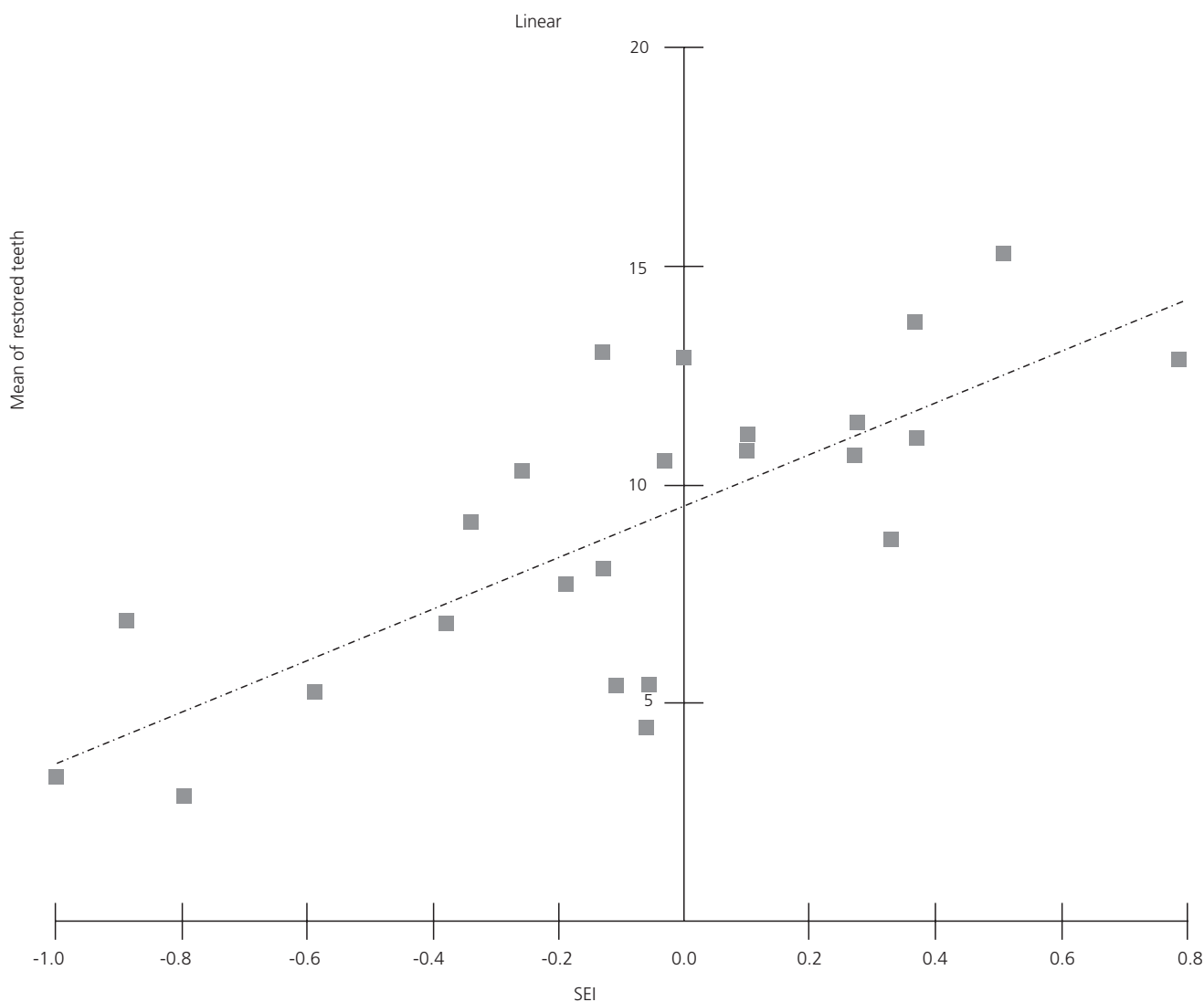


**Figure 5**. Linear scatter plot of the average number of restored teeth in relation to the Social Exclusion Index (SEI) per districts of Piracicaba (SP), 2011.

units of Piracicaba with the presence of dental service in the primary health care. Geoprocessing and spatial analysis have been increasingly used in epidemiological studies, and becomes an important tool for strategic action planning in health, providing better financial, human and material resources, especially for vulnerable groups.

In 2011, Piracicaba had 34 health units with dental service [15]. In a previous study [15] on the same population, it was reported the uneven geographic distribution of health units with the presence of Oral Health Team in Piracicaba (SP), with an extensive territory without dental services coverage, called assistance voids. This shows us that it is necessary to rethink the criteria established for the distribution of the offering of public dental services inside the cities, determined mainly by the population contingent. As verified in this study by the generated maps, despite the central region of Piracicaba being the most populated, the central districts were not the regions with the highest average numbers of dental caries, but with higher average numbers of restored teeth, that is, the region with the largest contingent of individuals does not necessarily present greater need for dental treatment.

Knowledge of individual and contextual factors associated with the condition of oral health of individuals is important to determine health promotion strategies, in addition to the health care system offered and the environment where the individual is inserted are important in determining strategies [20], considering that the population approach is essential for verifying health care, including dental care [4].

Through mappings, it was possible to observe the distribution of average numbers of decayed and restored teeth in line with the distribution of socioeconomic variables. To verify the surveyed individuals at a contextual level, we used the Social Exclusion Index (SEI) per districts of Piracicaba (SP). In this study, social exclusion showed no correlation with decayed teeth, but had correlation with restored teeth. This finding associated with the knowledge of a previous study with these same adults found correlation between social exclusion and missing teeth [15], with these results we can infer that the districts that present greater social exclusion showed lower average number of restored teeth and higher average number of missing teeth. These findings denote that where there is less effective dental care assistance for early stages of caries disease, there is inevitably tooth loss.

Even though oral diseases report high prevalence in the world population, they are preventable in most cases and result of bad habits in health [21], however, it is known that the inappropriate individual behavior is influenced by social context, therefore, the illness of people is associated with the Social Determinants of Health (SDH) [22]. Therefore, health promotion strategies encompass all

these determinants [23]. In practice, these intersectorial strategies are a complex process to be able to effectively modify the health condition of individuals. Other strategies held in Piracicaba showed correlation between the SEI and the oral health conditions, such as dental caries in preschool children [11], missing teeth in adults [15] and xerostomia in older adults [14]. These strategies strengthen the understanding of use of the SEI as an important index for verification of the social context and the need for the use of this index for securely establishing priority areas and public policy planning in oral health [14,15]. These results are relevant, for they show that structural aspects, such as socioeconomic aspects and the development of autonomy of the individual must be taken into consideration in health promotion strategies, besides providing the expansion of dental services.

However, for this study, the average number of decayed and restored teeth showed no spatial (or geographical) relationship with the proximity of public dental services. These data also confirm the absence of spatial correlation of missing teeth [15]. This lack of correlation between components of caries experience and the proximity of public dental service offered in Piracicaba can be explained by the fact that the national Brazilian oral health policy is still incipient, which may not have significantly impacted on the adult age group or even low adhesion of individuals who were historically excluded from health services and suffered traumatic and mutilating treatment. These people accumulated dental needs throughout life, which could reflect in the postponement of demand of the service or in case of emergency dental care, but they also may not have recognized the public dental service as a gateway for case management of the problems caused by dental caries.

More than offering dental services, health promotion policies as determined by the Otawa Letter [24] should promote empowerment through educational strategies that increase the community autonomy by increasing the power of choices to the point of knowing the rights and duties of citizens so that the latter are able to properly use the services that are offered, and also decide on their health. Dental care must be actuated in such a way as to meet the demands of society and promote its autonomy. Although the health services accessibility may seem an important aspect for health systems, for Dentistry it could culminate in overtreatment and restorative repetitive cycle [25], and over time it could determine tooth loss. At

the same time, the lack of dental services can cause late access to dental care, establishing a progression of oral diseases, and it can also result in tooth loss [26].

Even though this study cannot establish causality, it can establish the correlation between contextual factors by transverse methodology, especially of the influence of health determinants for occurrence of caries and their treatment, the restoration. Also noteworthy among the study limitations is the lack of precision between the time of residence of individuals and the public dental service deployment, which could describe in a timely manner about the relationship between oral health conditions assessed and offer of dental services.

As well as this study showed that the less excluded districts had higher average number of restored teeth, a previous study with this same population found that the most excluded districts presented a higher average number of tooth loss [15]. These results reinforce and qualify the need of inversion in the form of oral health care of adults. There is a clear need for prioritization of primary health care in socially excluded areas for the recovery of damages caused by dental caries in the early stages, so that these damages do not result in more complex treatment needs and, mainly, in tooth loss [9]. This stimulus has been verified in Brazil in recent years through the creation of the National Oral Health Policy in 2004, with expansion of the offering of dental services and inclusion of the Oral Health Team in the Family Health Strategy, with appreciation of care at the level of promotion, prevention and recovery of oral problems in the primary health care.

## CONCLUSION

Despite the fact that the spatial distribution of dental caries of adults has shown no correlation with social exclusion in the city, it showed correlation with its case management, that is, with the restored teeth. There was no correction between decayed and restored teeth with the presence of public dental service in proximity to the census tract.

This spatial analysis of caries experience provides consistent subsidies to be used in the planning and implementation of oral health public policies consistent with the needs of the population studied. These results reinforce the need for prioritization of primary oral health, and a health care system that presents strategies of access, equity and promotion of oral health for adults.

Collaborators

MF SILVA-JUNIOR and EP FONSECA performed the data analysis and writing the article. MJ BATISTA collected the data and performed the final review of article. MLR SOUSA guided at all stages of the collection and did the final review of the article.

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