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Spatial analysis of dental trauma in 12-year-old schoolchildren in Curitiba, Brazil

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Abstract – The purpose of this study was to build epidemiological indicators on the experience of dental trauma in 12-year-old schoolchildren in the city of Curitiba, Brazil, exploring its geographical and population distributions. A geographic information system (GIS) was used, built by means of ArcView GIS 3.2 software and geographical databases of streets and districts defined within the boundaries of the city of Curitiba, provided by Curitiba's Institute of Research and Public Planning (IPPUC). The database used in the study was compiled based on an epidemiological survey undertaken in 1998 on a sample of 2126 schoolchildren 12 years old, residing in outlying urban suburbs distributed over 29 micro-areas in the city of Curitiba. The cases selected for this study were those with a history of dental trauma, thereby comprising a subsample of 327 schoolchildren. The spatial location of the schoolchildren's homes enabled the events to be visualized on a cartographic basis. The variables of gender, aetiology of the trauma and areas of substandard living conditions were included in the analysis and construction of thematic maps, thus making possible a descriptive analysis of the spatial distribution of dental trauma in the city. Intra-urban differentials were identified in the prevalence of dental trauma in 12-year-old schoolchildren in Curitiba. A greater concentration of occurrences was observed in the eastern region of the city, especially in areas of substandard living conditions. It was possible to conclude that socio-environmental and geophysical factors are associated with the determination of dental trauma in the city of Curitiba, pointing to the need for the development of public policies especially aimed at areas and populations at greater risk.

The new public health agenda, relating to social epidemiology, has indicated the need to take into account the social and environmental factors affecting health in urban societies. This interest is translating itself into a growing increase in the number of publications found in the specialized literature that emphasize contexts of urban health (1).

Intra-urban differentials in disease distribution, principally concentrated in poor areas, give evidence to phenomena that connect health and society and generate an interesting debate on what the determinants of this trend might be (2).

The development of improved operational and analytical methods in many branches of epidemiology shows itself to be necessary to face currently existing challenges. In the light of this understanding, it is not surprising to observe the introduction of theoretical approaches and innovative methods in oral epidemiology as well. The academic community, health policymakers and health-care professionals who monitor oral health tendencies have gradually come to perceive the shortfalls of current epidemiological models (3, 4).

Spatial epidemiology seeks to describe and analyse geographic variations in diseases or injuries in relation to demographic, environmental, behavioural, socio-economic, genetic and infectious risk factors (5), identifying the way in which the determinants of these events are distributed among the populations in time and space. The use of a geographic information system (GIS) enables the spatial visualization of the variables of the population studied, in the quest to understand the complex relationship between health and environment.

The aim of spatial health analysis involves ecological studies, which seek to understand how a context affects the health of population groups, as well as the analysis of the availability of and access to health services, and also the identification of priority areas for differentiated health care (6).

Currently, some health sectors are using this type of epidemiological methodology and analysis, principally in cases of transmissible diseases and those which are compulsorily notifiable. However, activities of this nature undertaken in dentistry are yet inexpressive.

The use of methods of analysis of spatial distribution in the study of dental trauma, given the important involvement of environmental factors, represents progress in the understanding of this condition, as it enables the exploration and analysis of occurrence patterns and distribution of the city's geographical areas, identifying relationships and trends that apparently are not

recognized in conventional analyses. This is key information for the definition of public policies on treatment and prevention appropriate to the population's needs (7).

Therefore, exploring the geographical and population distributions of dental trauma in Curitiba is important to obtain information on the epidemiological reality that will serve as a basis for the definition of public policies on oral health promotion.

The purpose of this study was to build epidemiological indicators of the experience of dental trauma in 12-year-old schoolchildren in the city of Curitiba, exploring its geographical and population distributions based on available information on individual aspects of the schoolchildren and on physical and social aspects of the city.

Material and methods

This study used a GIS, built by using ArcView GIS 3.2 software and geographical databases of streets and districts defined within the boundaries of the city of Curitiba, provided by Curitiba's Institute of Research and Public Planning (IPPUC).

The database used in the study was compiled based on an epidemiological survey undertaken in 1998 (7) on a sample of 2126 schoolchildren 12 years old, residing in outlying urban suburbs distributed over 29 micro-areas in the city of Curitiba. A multistage sampling design was used to select the micro-areas considering aspects such as family income, the level of education of the head of the family and the development of public policies. From a clustered sample of schools in the micro-areas, a random sample of schoolchildren was selected.

The main outcome was defined as any permanent tooth with fractured enamel or dentine, and/or avulsed or restored fractured teeth, occurred in any time and with clinical evidence at the moment of the diagnosis carried out by the authors. Data were recorded using the British Association for the Study of Community Dentistry (BASCD) criteria (8). The cases selected for this study were those with a history of dental trauma, thereby comprising a subsample of 338 schoolchildren. However, 11 cases were not able to be included owing to it not being possible to geographically locate the addresses recorded, because of incorrect recording or the inexistence of the address in IPPUC's official database. As such, the final sample was comprised of 327 schoolchildren. The estimated overall prevalence of dental trauma for the population concerned was of 14.4%.

The spatial location of the homes of the schoolchildren was carried out by comparing the address on the record form to the street database provided by IPPUC. The geographical coordinates of each point were calculated by means of the interpolarization of numbers along the stretches of streets using the GIS. This enabled the events to be visualized on a cartographical basis.

Three variables were included in the analysis of the data: gender, aetiology of the trauma and areas of substandard living conditions, i.e. a gathering of poor dwellings without access to urban planning policies, characterized as areas of greater socio-environmental risk with regard to human health. Information on the aetiology of the dental trauma was categorized into seven groups, including accident (falls and/or collisions) at home, accident at school, accident on public highways relating to traffic of vehicles, sporting accident, trauma when eating, fighting, in addition to the recording of other types of occurrences, which included the situation of the person not being able to relate the cause of dental trauma. The first cause reported by the child was recorded. Thematic maps relating to these variables were then drawn up, followed by a descriptive analysis of the spatial distribution of dental trauma in the city.

Results

The spatial distribution of the selected sample of dental trauma in the city of Curitiba-PR demonstrated clear intra-urban differentials when analysed by regions in the city.

Census data of researched regions, including total population and demographic density is presented in Table 1. Northern and western regions had the smaller and greater demographic densities respectively (9).

Figure 1 shows the distribution of dental trauma by neighbourhoods and regions in Curitiba. It is possible to observe that there was an irregular distribution of the cases within the selected micro-areas, with greater occurrence in the eastern and northern regions of the city. However, case distribution is characterized by a greater concentration in the areas of the city's eastern region. A smaller concentration of cases can be observed in the city's western and southern regions.

Figure 2 enables the visualization of differences in the experience of dental trauma in schoolchildren according to gender.

The blue points represent the cases of dental trauma in males, totalling 204 cases (62%), whilst the red points represent the cases of dental trauma in females, totalling 123 cases (38%). A greater number of cases of dental trauma in boys were observed in all the city's regions.

The results of the analysis of the trauma case distribution according to reported aetiology can be observed in Table 2. The frequency of cases classified as 'other' stands out. This category includes situations where the schoolchild was not able to explain the cause associated with the dental trauma.

Figure 3 presents the geographical distribution of the cases associated with factors relating to the socio-environmental context. The red points represent cases of dental trauma related to accidents in the home environment; the green points are cases of dental trauma

Table 1. Census data of researched regions, including total population and demographic density, Curitiba, 1998

Regions	Total population	Demographic density
North	209 421	33.6
South	177 254	44.3
East	172 886	48.7
West	291 080	56.9

Source: IPPUC (9).

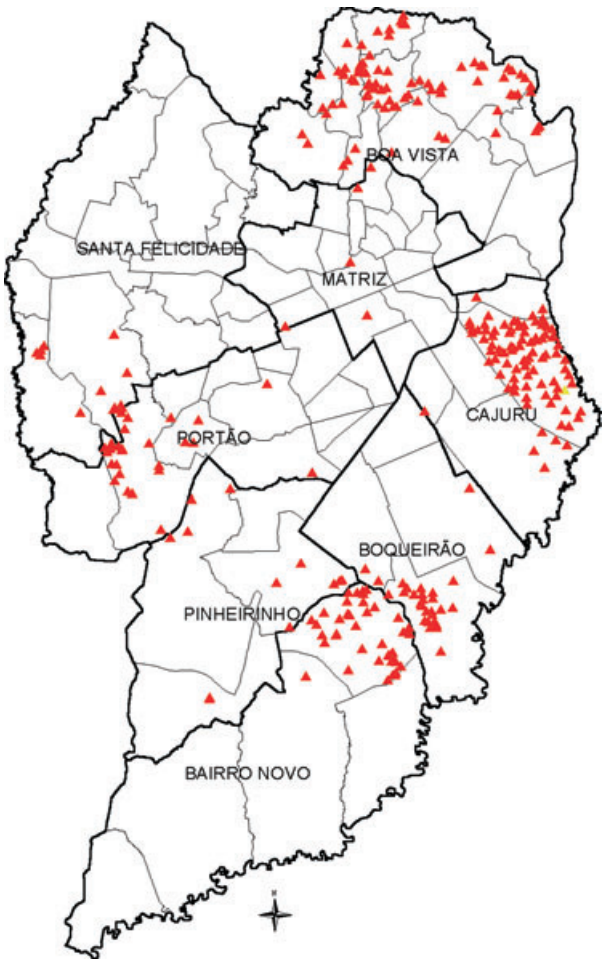

Fig. 1. Map of the distribution of cases of dental trauma in the city of Curitiba.

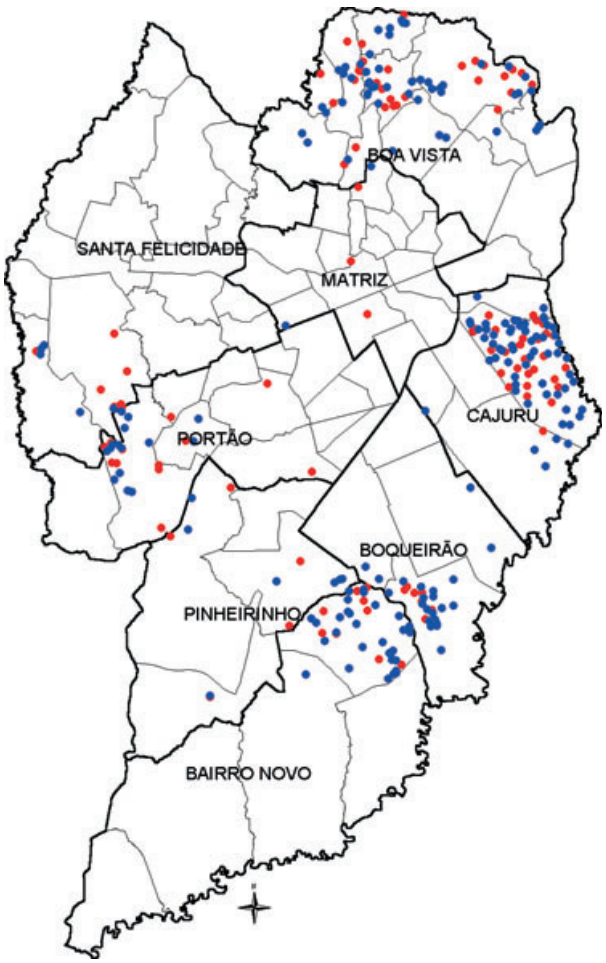

Fig. 2. Map of the distribution of cases of dental trauma according to gender.

caused by accidents at school; the yellow ones are cases of trauma associated with accidents on public highways; and the blue ones refer to cases of dental trauma associated with fighting. The largest concentration of trauma associated with fighting and accidents at home can be observed in the eastern region of the city.

The spatial analysis comparing the cases of dental trauma with the regions considered by IPPUC to be areas of substandard living conditions is presented in Fig. 4. It can be observed that despite the greater occurrence of trauma cases in the northern region when compared with the southern region, a greater agglomeration of cases can be seen in the southern region and is associated with the greater number of areas of substandard living conditions located there.

With the aid of an Orthophoto, an aerial photograph taken by satellite, it was possible to highlight cases in an area of substandard living conditions located in the eastern region, which presented the largest concentration of cases in the city.

Table 2. Frequency distribution of aetiological factors relating to dental trauma

Reported cause of the trauma	Frequency, *n* (%)
Accidents at home	12 (3.7)
Accidents at school	18 (5.5)
Accidents on public highways	19 (5.8)
Sporting accidents	90 (27.5)
Trauma whilst eating	46 (14.0)
Fights	25 (7.7)
Others	117 (35.8)
Total	327 (100)

Discussion

Dental trauma is a public health problem in our society, affecting a considerable part of the population. It causes aesthetic, emotional and functional problems for the patients and in some cases it is irreversible (10–13).

As observed in this study, the distribution of dental trauma in the city of Curitiba was unequal in the regions analysed and the highest prevalence of this form of injury was found in the city's eastern region. Despite the differences on population density within the studied regions, the occurrence of dental trauma appears to be related to socio-environmental features of the regions. The geographical distribution results illustrate the findings of Moysés (7) which demonstrated intra-urban

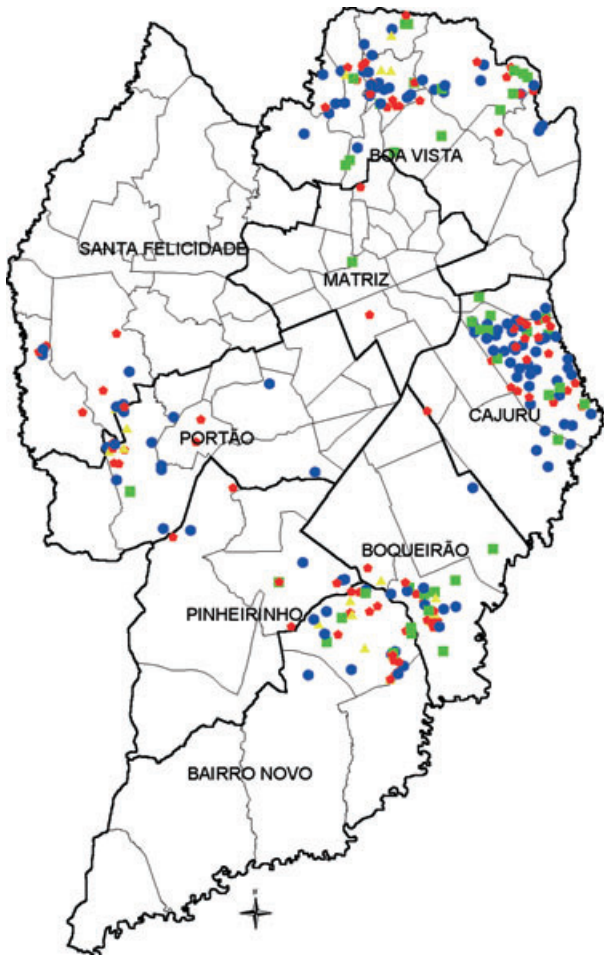

Fig. 3. Map of the distribution of cases of dental trauma according to aetiolology.

differences in dental trauma in the city of Curitiba in Brazil. In this study, the authors characterize the city's regions according to the implementation of public policies, physical environment and social cohesion, comparing them with the outcomes on oral health of a schoolchildren population who lived there. The eastern region was considered to have the worst performance with regard to the aspects relating to the physical environment, social policies, population density (overcrowding) and social cohesion, when compared with the other regions, and thus characterized itself as being the region with the greatest risk to the health of its dwellers. In addition, in this region it was observed a lower percentage of caries-free schoolchildren, as well as the highest percentage of schoolchildren with toothache and dental trauma. This corroborates its characterization as a context of risk to the quality of life of the population that lives there.

This finding reinforces the discussion made by Locker (14), when describing the relationship observed between the experience of tooth decay and dental trauma in children in Canada. For Locker, this association may reflect the exposure of subgroups to environments or behaviours risk of multiple oral problems.

The factors associated with dental trauma described in recent literature range from individual aspects, such as large incisal overjet, with inadequate lip coverage, age and gender, violence, accidents, collisions and falls, as well as aspects related to the home, school, neighbourhood and the city environment (7, 13, 15–17).

Moysés (7) found an association between the level of the implementation of public health policies in the city of Curitiba relating to the physical environment, social policies and social cohesion in different communities and the experience of dental trauma in 12-year-old schoolchildren. These political components accounted for 42% of the variation in the experience of dental trauma in the population studied.

Patussi et al. (18) demonstrated a relationship between dental trauma and social capital in Brazilian teenagers, arguing that the level of social capital may explain inequities in the experience of trauma dental, especially in boys.

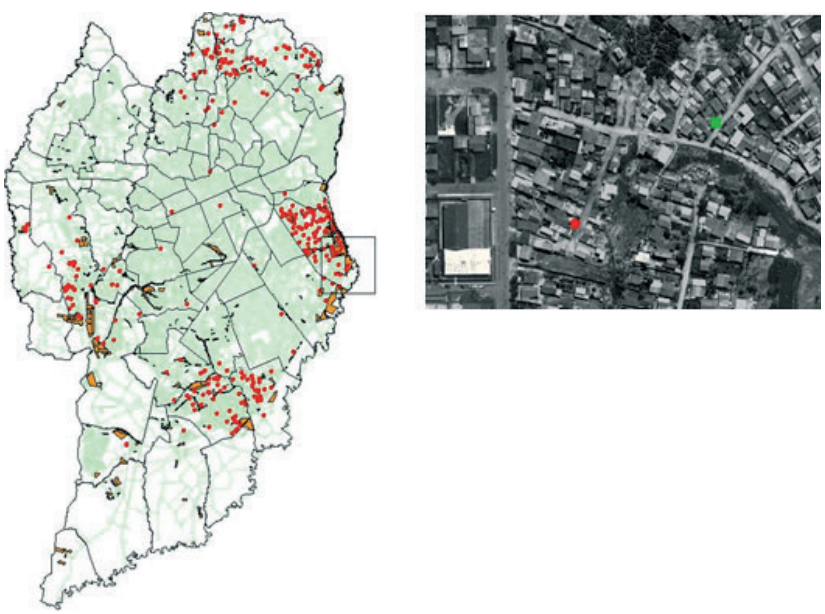

Fig. 4. Map of cases of dental trauma associated with areas of substandard living conditions in the city of Curitiba.

The present study has demonstrated that the male gender was the most affected in Curitiba, having approximately 62% of the cases. Recent studies in Brazil and in other countries confirm that boys are most affected (7, 12, 13, 15, 16, 19).

The findings confirm that socio-environmental aspects are determinants of dental trauma in 12 year-old schoolchildren in the city of Curitiba, as evidence was found of a significant prevalence of accidents which happened at home, at school and on public highways. The violence manifested by the reporting of dental trauma associated with fighting was also relevant in this study. It is important to emphasize that non-accidental traumatic lesions, often unreported, can be associated with what is characterized as the *maltreated child syndrome*. The possibility of traumatic oral and facial lesions being related to maltreatment has been raised in the literature (20, 21). The data examined in this study indicated 117 cases (35.8%) of children who were not able to explain the cause of dental trauma, perhaps because of being embarrassed about what happened. Further investigation of these cases could confirm this hypothesis.

Oral health promotion and protection systems need to be based on evidence derived from epidemiological information and which include data ranging from basic territorial and population information, such as georeferenced data on prevalence, as well as information on the effectiveness of healthcare and protection strategies. The analysis of spatial distribution in the study of dental trauma enables the expansion of knowledge on the socio-environmental determination of these injuries and favours the planning and implementation of oral health promotion strategies appropriate to the needs of children in Curitiba.

Conclusion

The spatial analysis of dental trauma distribution among schoolchildren in regions of the city of Curitiba indicates the occurrence of intra-urban differentials, with a greater agglomeration of cases in the eastern and southern regions of the city, which are overrepresented by substandard living conditions. Boys have greater prevalence of dental trauma in all of the city's regions analysed.

Factors relating to the socio-environmental context are noticeably distributed in an unequal manner in the regions analysed. A greater concentration of cases of trauma associated with fighting and accidents at home could be observed in the city's eastern region, in areas of substandard living conditions.

Socio-environmental and geophysical factors are associated with the population's quality of life and with the determination of dental trauma in the city of Curitiba, pointing to the need to implement health policies especially aimed at areas of increased risk.

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