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Spatial distribution of trachoma cases in the City of Bauru, State of São Paulo, Brazil, detected in 2006: defining key areas for improvement of health resources

Carlos Alberto Macharelli[1], *Silvana Artioli Schellini*[2],
Paula Araujo Opromolla[3] *and Ivete Dalben*[1]

[1]. Departamento de Saúde Pública, Faculdade de Medicina de Botucatu, Universidade Estadual Paulista, Botucatu, SP. [2]. Departamento de Oftalmologia, Otorrinolaringologia e Cirurgia de Cabeça e Pescoço, Faculdade de Medicina de Botucatu, Universidade Estadual Paulista, Bauru, SP. [3]. Divisão de Saúde, Núcleo de Informação da Vigilância Epidemiológica, Secretaria de Estado da Saúde de São Paulo, São Paulo, SP.

ABSTRACT

Introduction: The objective of this study was to analyze the spatial behavior of the occurrence of trachoma cases detected in the City of Bauru, State of São Paulo, Brazil, in 2006 in order to use the information collected to set priority areas for optimization of health resources. **Methods**: the trachoma cases identified in 2006 were georeferenced. The data evaluated were: schools where the trachoma cases studied, data from the 2000 Census, census tract, type of housing, water supply conditions, distribution of income and levels of education of household heads. In the Google Earth® software and TerraView® were made descriptive spatial analysis and estimates of the Kernel. Each area was studied by interpolation of the density surfaces exposing events to facilitate to recognize the clusters. **Results**: Of the 66 cases detected, only one (1.5%) was not a resident of the city's outskirts. A positive association was detected of trachoma cases and the percentage of heads of household with income below three minimum wages and schooling under eight years of education. **Conclusions**: The recognition of the spatial distribution of trachoma cases coincided with the areas of greatest social inequality in Bauru City. The micro-areas identified are those that should be prioritized in the rationalization of health resources. There is the possibility of using the trachoma cases detected as an indicator of performance of micro priority health programs.

Keywords: Trachoma. Geographic Information Systems-GIS. Health indicator. Health management.

INTRODUCTION

Trachoma, a chronic recurrent keratoconjunctivitis, is a chronic inflammatory eye disease of sudden or insidious onset that may persist for many years if left untreated, with the risk of scarring in the conjunctiva that may cause repeated trauma to the cornea, leading to the development of corneal opacities, reduced vision, and eventually blindness[1].

Trachoma is present in approximately 50 countries, accounting for 1.3 million blind individuals and 1.8 million individuals with compromised vision, with the risk of blindness to a further 8.3 million people worldwide[2,3].

The disease has been known for millennia as an underlying cause of blindness. References to its occurrence are found from the earliest human records, in different cultures and historical periods. In the second half of the 19th century and the early 20th century it was thought to be widely disseminated around the world. With the improvement of living conditions and economic development, it disappeared from Europe, North America, and Japan. However, it remains an important public health problem, causing visual impairment and blindness in many underdeveloped countries, particularly in Africa, the Middle East, the Indian subcontinent, and Southeast Asia. To a lesser extent, it also occurs in Latin America and Oceania[4,5].

Surveys in school children showed that trachoma is present in all Brazilian states, an observation confirmed by recent research carried out in order to map the distribution of neglected diseases in Latin America and the Caribbean[6].

In spite of the sharp decline in the incidence of trachoma in recent decades, the illness persists, affecting in particular the poor in all regions of the country, including major cities[7].

In the State of São Paulo in the early 1980s, the disease was again detected in some municipalities in the state, leading to various control measures[8]. At that time, the prevalence ranged from 1.5% in Franco da Rocha (1989) and 9.6% in Guaraci (1989) to 18.6% in children younger than 10 years in the rural area of Bebedouro (1986)[8].

The disease has a noticeable distribution pattern, based on dissemination of ocular secretion from infected children via hands, contaminated clothing, and vectors such as flies[2]. It is positively associated with poverty and lack of hygiene[1].

Socio-demographic factors, as well as the existence of clusters of cases, are also implicated in the dissemination of

Address to: Dr. Carlos Alberto Macharelli. Deptº de Saúde Pública/FMB/UNESP. Distrito de Rubião Junior s/n, 18618-970 Botucatu, SP, Brasil.
Phone: 55 14 3880-1332
e-mail: karlm@fmb.unesp.br
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the disease, due to habits and factors related to the development of the environment, for example, the density of flies[9], lack of water, many people living in the same house, and distance from water supply[14].

In the City of Bauru, State of São Paulo, in 1936, the prevalence of trachoma in school children was 6.5%[10]. From 1984 to 1990, there were no cases of trachoma in the city. However, in 1991, 19 cases were recorded in Bauru, whereas in 1992, only 1 case was recorded[8], with no further cases until 2005.

In 2006, a study was undertaken in state schools in Bauru to actively identify cases in school children from the 1st to the 5th grade, and a prevalence of 3.8% was found. Thus, it became clear that trachoma was present in the City of Bauru, but the specific distribution of the disease within the borough was not known[7].

The consensus is that social inequalities are a major factor in the distribution of disease and mortality in society. However, to merely identify the causal factors of disease is insufficient; it is also necessary to locate the populations where these factors exist in order to direct the allocation of health resources, thereby increasing the efficiency of public resources. Geoprocessing is a tool that allows one to geographically locate events, capturing data attributes of people and displaying them spatially to treat them as characteristics of the territory. This transformation results in the abstraction and simplification of the social and environmental processes that can influence the occurrence of diseases[11].

Geoprocessing is defined as a set of technologies for the collection and processing of spatial information with a certain objective, performed by specific systems for each application. The digital cartographic databases that are often the end product of geoprocessing projects in other sectors are only the starting point of the spatial analysis of health. To be used as a means of analysis, health databases must be geo-referenced[12,13], integrated with environmental and socioeconomic data, and subjected to an assessment of their spatial distribution[14-16].

The objective of the present study was to analyze the spatial behavior of trachoma cases detected in the City of Bauru in 2006 in order to use the information collected to define priority micro-areas for the optimal use of health resources.

METHODS

This study was conducted using cases detected by a cross-sectional study conducted by Ferraz[17], with stratified random sampling involving schools, to evaluate cases of trachoma in the City of Bauru, State of São Paulo. In this study, 66 cases of inflammatory trachoma were detected in the schools in Bauru. Ferraz[17] tested for trachoma in children aged 6 to 14 years, attending school, from the 1st to 5th grades, from state schools in the City of Bauru, State of São Paulo. Data was collected in the schools in the academic year 2005, between the months of April and June. The schools were chosen at random, taking into account the number of schools, classes, and students from the region under study, and representing the city sectors (center, mid-periphery, and periphery). This subdivision of sectors was performed according to a previous study conducted by Lombardi[18], who divided the city into 3 concentric areas **(Figure 1)** as follows. The *central region* (sector 1) has a radius of 2 miles from the center of the city, where there is a predominance of commercial areas, and includes 6 schools. The *intermediate or mid-periphery region* (sector 2) has a radius of between 2 and 4km from the center, and includes 10 schools. The *peripheral region* (sector 3) extends outward from a 4-kilometer radius from the city center. Fifteen schools are included in this sector.

The sample size was defined taking into account the estimated population of students (14,057), for the year 2005, provided by the Regional Board of Education, having established 12 schools, selected by drawing lots within each sector, and assessing 1,054 students from the schools in the 3 sectors mentioned.

The students had a mean age of 8.5 years, were mostly male (66%), and were equally affected either unilaterally (47%) or bilaterally (53%).

Figure 1 depicts the digital map of the City of Bauru with concentric circles enclosing the areas in which the schools were chosen by lot. For this, we took into account the number of schools, classes, and students from the region of study, besides representing sectors of the city (center, mid-periphery, and periphery). This subdivision of sections was performed according to a previous study carried out by Lombardi[18].

Methodology used in the geoprocessing of trachoma cases

Taking into account the connection of trachoma with conditions related to the environment, living conditions, and socio-economic levels, schools with trachoma cases detected in the survey performed by Ferraz as well as the homes of people with trachoma were geo-referenced.

Geo-referencing was performed employing a global positioning system (GPS) (Personal Navigator©; GARMIN Corporation, Olathe, Kansas), configured to display latitude and longitude in degrees, minutes, and seconds, with reference to the datum SAD69. These coordinates were then transformed into decimal degrees for analysis in the geographic information systems (GIS) used (TerraView). The spatial analysis was performed with TerraView, using the scores of cases, schools, and *Instituto Brasileiro de Geografia e Estatística* (IBGE) 2000 census data contained in the CD-ROM *Base de informações por setor censitário, Censo demográfico 2000[19], Resultados do Universo. Bauru. IBGE, 2002*. These data were retrieved by Estatcard: *Sistema de Recuperação de Informações Georreferenciadas*. Version 2.1. IBGE.

The following variables were used: type of housing, water supply conditions, distribution of family income, and educational levels of household heads.

The georeferencing of a given address is defined as the process of association of that address to a map and can be accomplished in 3 basic ways: association with a point, line, or area. The result of this process is the creation of graphics objects that can be used for spatial analysis.

Descriptive spatial analyses and Kernel[15] estimates were performed using Google Earth software (Google Inc., Menlo Park, CA) and TerraView. Kernel[15] analysis is an analysis

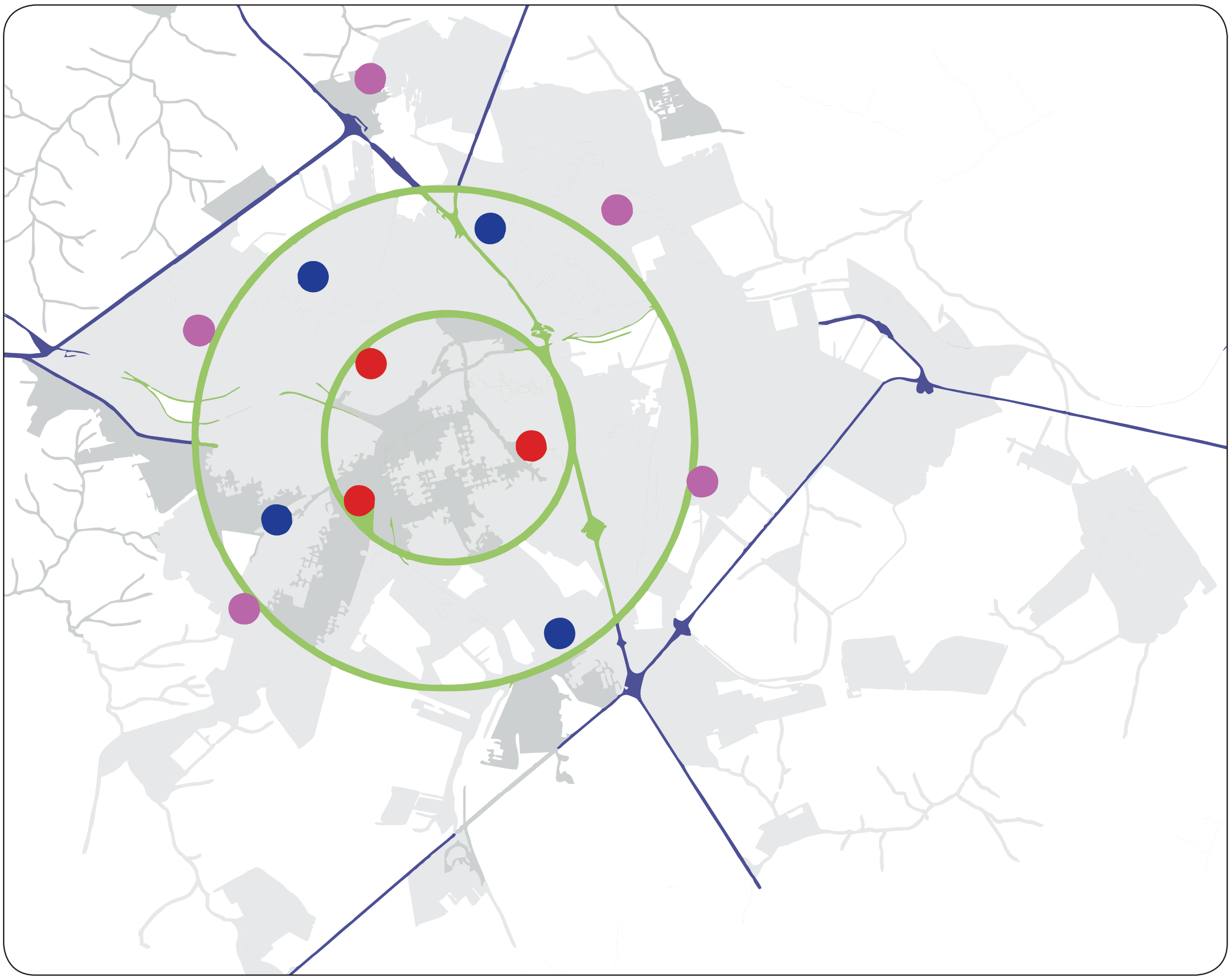

FIGURE 1 - Map of the City of Bauru, State of São Paulo, Brazil, showing the division of the three sectors by green circles, and the 12 randomly selected public schools.

technique that softens the surface by calculating densities for each area, by interpolation, exposing the surface density of events, and facilitating the detection of clusters.

Description of the region under study

The City of Bauru is located in the central region of São Paulo. It is an important development hub for the region. It is one of the cities in the state that brings together the best structures for the establishment of industrial and commercial ventures, with a strong regional trade. The area encompassed by the city is 634km^2, having average elevation of 526meters. Sanitation and water treatment services are present in the greater part of the county. The number of households with a water supply network is 88,854, out of a total of 90,600 houses (98%). There are 86,770 households with a toilet or bathroom connected to the sewage network (95%).

According to the data collected in Census 2000, an analysis of the living conditions of the inhabitants of Bauru shows that heads of households earned an average of R$1,065.00 per month, and 40% earned up to 3 times the minimum wage. These individuals had on average 7.5 years of education, 49.8% of them had completed primary education, and 5.3% were illiterate[19].

With regard to demographic indicators, the average age of household heads was 46 years and those under 30 years accounted for 14% of the total. Women household heads accounted for 25.9%, and children under 5 years accounted for 8% of the total population[19].

Ethical considerations

This study was reviewed by the Ethics Committee on Human Research (PROTOCOL=29/08) at the *Universidade Sagrado Coração de Jesus*, Bauru-SP, and approved for implementation on May 25, 2008.

RESULTS

The study by Ferraz[20] detected 66 cases of trachoma, all of them inflammatory. Most of the individuals with trachoma resided in the outskirts of Bauru, and 42% of the cases were detected in the northwest of the city.

The density of occurrence of trachoma, according to the percentage of heads of household with income of up to 3 times the minimum wage per month **(Figure 2)** was estimated using the Kernel[15] method. The gradation of colors (from yellow to red)

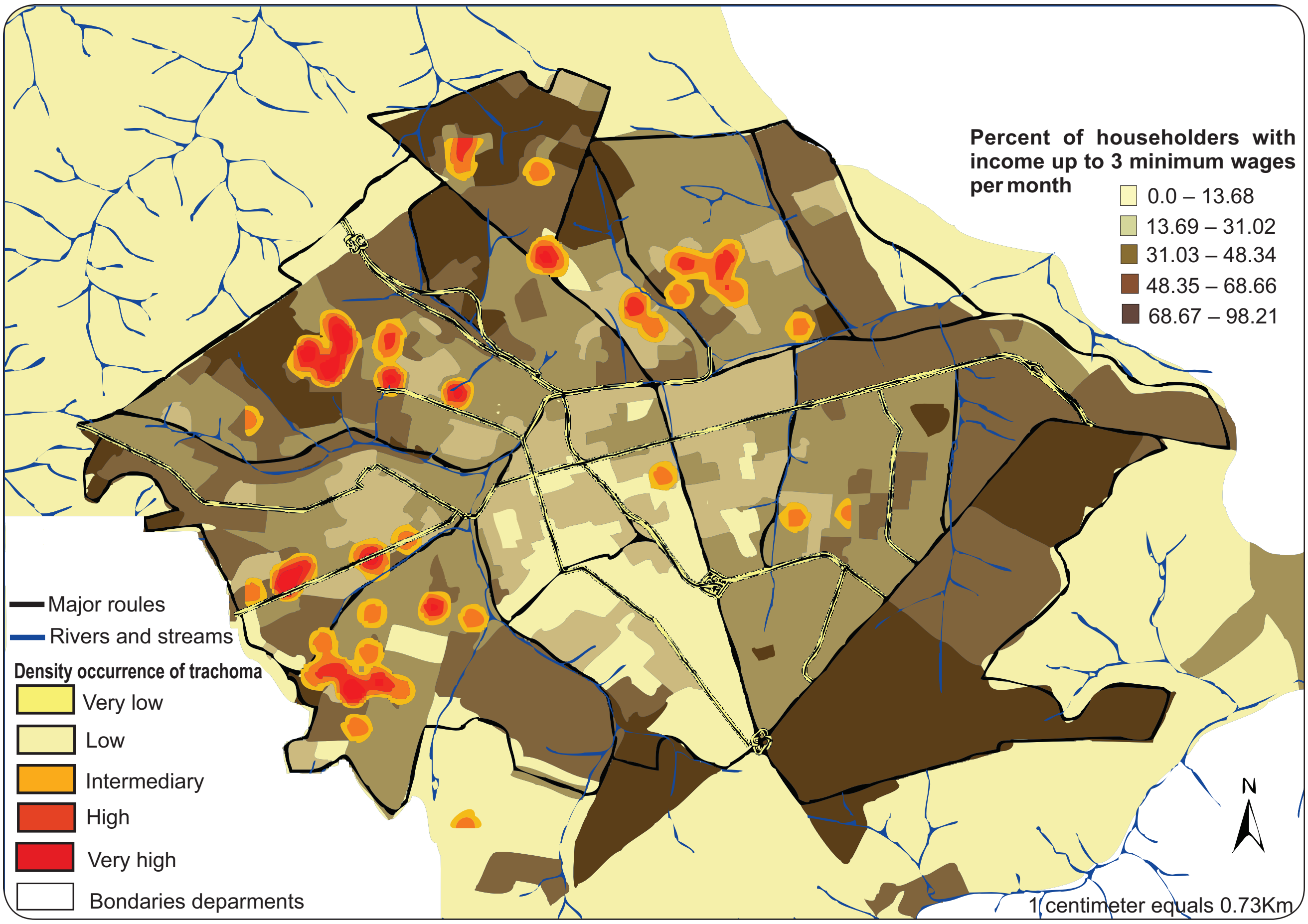

FIGURE 2 - Density distribution of the occurrence of trachoma according to family income in the urban area of City of Bauru, State of São Paulo, Brazil.

quantifies the density of cases per unit area, and the background (beige to brown) indicates the percentage of heads of families with up to 3 times the minimum wage income in that census tract. A higher density of occurrence of cases can be observed in areas where there is a greater concentration of low income, which may represent an association between the occurrence of these cases and low income.

The schooling of household heads is shown in **Figure 3**, where it is possible to see that a low educational level also suggests an association with trachoma.

DISCUSSION

Epidemiology has been challenged to develop conceptual and methodological frameworks able to apply biological knowledge to social phenomena[21]. Spatial analysis is a form of analysis that is applicable to the study of health-disease processes in populations[22]. Places within a city or region are the result of the accumulation of historical, environmental, and social situations that may promote conditions for the production of disease. In this sense, one of the important issues for the diagnosis of health situations is the development of indicators that detect and reflect conditions of health risk[23,24].

The analysis of health conditions corresponds to an aspect of health surveillance that prioritizes the analysis of the health of defined population groups according to their living conditions[23]. Income, education, and access to water are not variables related to individuals, but characterize the profile of a population group[1]. People live in groups and only group analysis can capture behaviors, values, or even the transmission of infections that occur on this scale[25].

The spatial distribution of a disease represents the observed or empirical realization of the underlying generating processes and its study captures the dynamics of the epidemiological structure. The epidemiological profiles of different spaces are created by the interaction of social relations that characterize the organization and are modified over time, according to the historical moment of the developmental stage of productive forces and social relations, which are the factors that determine the organization of space[26].

The basic idea behind this effort to model socioeconomic indicators is to discuss the occurrence of disease in population groups, according to their spatial location. Although usually only issues related to the dispersion of industrial pollutants are considered environmental risk factors, the environment is actually something broader. Even when socioeconomic variables are eventually considered possible risk factors associated with disease, they are usually treated as traits of the individual[25].

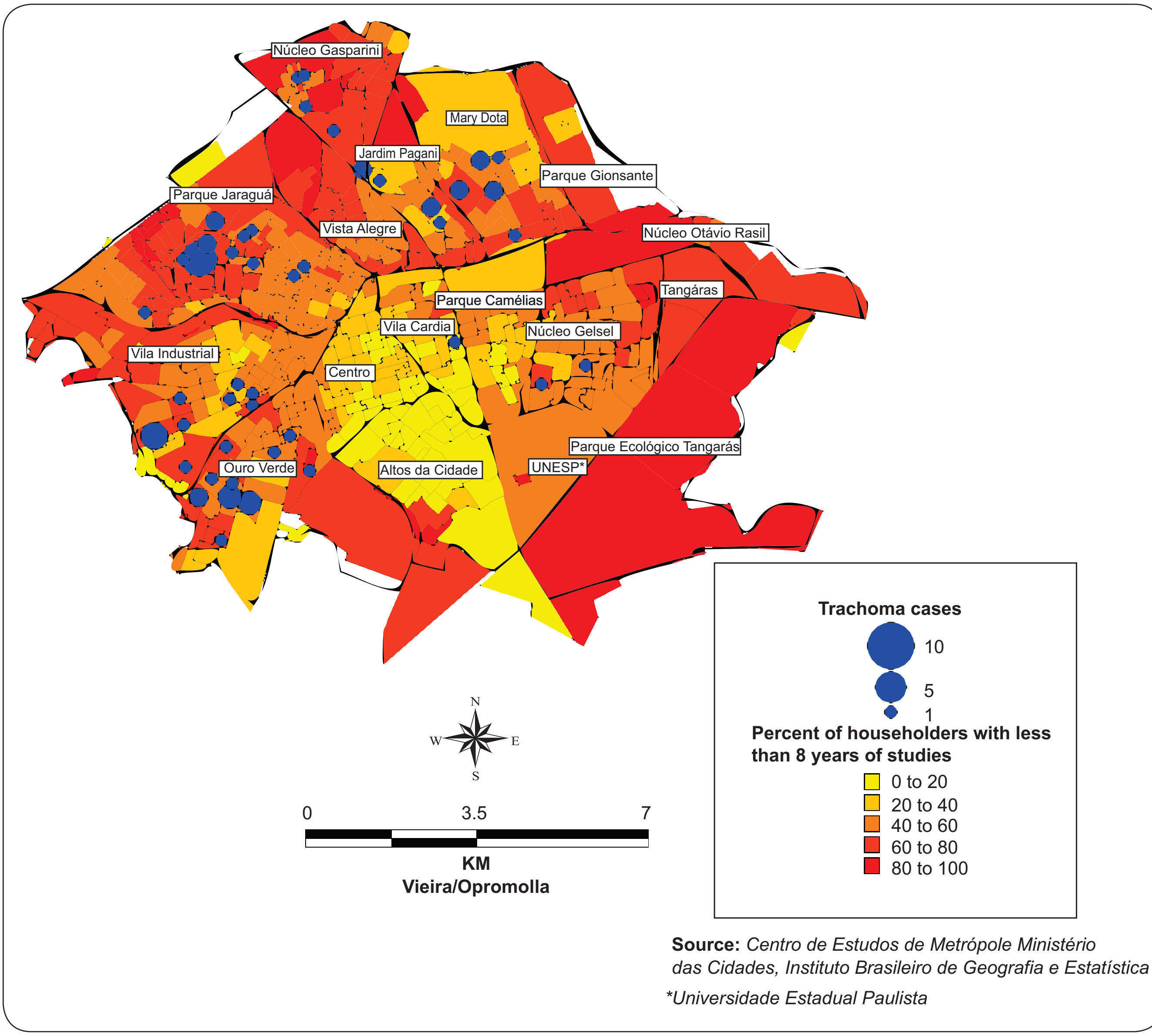

FIGURE 3 - Distribution of cases of inflammatory trachoma in the City of Bauru, State of São Paulo, Brazil, taking into account the education of the head of the family.

In the case of trachoma, the environment is undoubtedly of paramount importance. Numerous studies have associated the disease with a lack of water and sanitation[1,9]. However, presently, in Brazil, most of the urban population has access to water, through the expansion of supply networks, either due to investment by sanitation companies, through individual efforts connecting networks, or even the creation of small unofficial supply networks[27]. The contamination of surface and ground water by sewage, garbage, or industrial use may pose a risk to the population served by the supply network. In Bauru, the vast majority of households are connected to the supply network, thereby ensuring the quality of the water supply. Thus, sanitation becomes a complex object that can hardly be represented by a single indicator[28].

Considering the large coverage of the municipal sewerage network, this variable would not seem to Influence the occurrence of cases in this study; However, it would be interesting posteriors more detailed analysis unveils situations That Are Observed When considering not only the overall average coverage of the municipal water supply service, sewage, and solid waste collection, such as discontinuation of water supply and waste collection daily.

The methodology used herein simplifies the search for the disease, since it allows the detection of affected children much more easily than a search performed based on the detection of cases on a sample of households. However, assuming that not all children attend school, with those in this situation possibly having the lowest income level, the assessment based on schoolchildren may not be the most reliable method. In spite of this consideration, this is the method most used for this purpose when it comes to the study of trachoma.

With the identification of trachoma cases, and the subsequent geocoding and spatial analysis of their homes, it was possible to detect small areas with deficiencies in social, environmental, and economic conditions, which are more prone to the maintenance of communicable diseases. A similar method was used in Sudan, making it possible to establish risk areas linked to the transmission of trachoma, and to establish detection and treatment plans[1].

Trachoma is still a public health problem in Bauru. The cases detected show that there are micro-scale regions where sanitation is still unsatisfactory and efforts should be undertaken to improve it.

We propose that *detected trachoma cases* be an indicator of priority regions for health action, leading to greater optimization of resources in these areas.

The methodology used in this study has a great potential for disease surveillance in cities with low infestation. Through GIS techniques can more precisely identify areas of risk, provided there is a constantly updating database of cases reported as suspected. For the proposed methodology has maximum efficiency in the detection of areas of risk of transmission, you must fill in the appropriate addresses s databases. In municipalities that have no basis for parks to address location, the GPS could be adopted to the geographical location of outbreaks and cases. Thus, you can take immediate preventive measures (removal of focus) in the area of influence of cases

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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