J. Health Inform. *2017 Abril-Junho; 9(2): 51-6* **Artigo Original**

Mapping of adolescents with gingivitis and dental calculus

Mapeamento de adolescentes com gengivite e cálculo dental

Mapeo de adolescentes con gingivitis y cálculo dental

Emilio Prado da Fonseca[1], Efigênia Ferreira Ferreira[2], Mauro Henrique Nogueira Guimarães Abreu[2], Andréa Clemente Palmier[2], Andréa Maria Duarte Vargas[2]

ABSTRACT

Keywords: Adolescents; Maps; Oral Health

Objective: The aim of this study was to map the distribution of periodontal disease in adolescents in the Jequitinhonha Valley. **Methods:** We constructed maps with varying Community Periodontal Index (CPI). The cities were selected based on population size and performance of oral health services. The sampling plan was composed of 450 individuals between 15 and 19 years, randomly selected in number corresponding to the proportion of the adolescent population in each municipality. **Results:** Of the 450 adolescents examined were 16 (3.5%) code 0 (Healthy), 232 (51.5%) of the code 1 (bleeding), 38 (8.44%) code 2 (Calculus) and 164 (36.44%) code 6 (bleeding and calculus). The pattern of mosaic maps was kind and may indicate that the worst periodontal conditions of adolescents were distributed throughout the region. **Conclusion:** maps described the oral health status of adolescents and can provide information for planning oral health.

RESUMO

Descritores: Adolescentes; Mapas; Saúde Bucal

Objetivo: Este estudo foi mapear a distribuição da doença periodontal nos adolescentes do Vale do Jequitinhonha. **Métodos:** Foram construídos mapas com variáveis do Índice Periodontal Comunitário (IPC). Os municípios foram selecionados com base no porte populacional e no desempenho do serviço de saúde bucal. O plano amostral foi composto por 450 indivíduos entre 15 e 19 anos, selecionados aleatoriamente, em número correspondente à proporção da população adolescente de cada município. **Resultados**: Dos 450 adolescentes examinados foram 16 (3,5%) de código 0 (Saudável), 232 (51,5%) do código 1 (sangramento), 38 (8,44%) de código 2 (Calculus) e 164 (36,44%) de código 6 (sangramento e cálculo). O padrão dos mapas foi do tipo mosaico e pode indicar que as piores condições periodontais dos adolescentes estavam distribuídas por toda a região. **Conclusão:** Mapas descreveram a condição de saúde bucal de adolescentes e pode fornecer subsídios para o planejamento em saúde bucal.

RESUMEN

Descriptores: Adolescentes; Mapas; Salud Bucal

Objetivo: Este estudio fue determinar la distribución de la enfermedad periodontal en adolescentes del Valle de Jequitinhonha. **Métodos:** Se construyeron mapas con diferentes Índice Periodontal Comunitario (IPC). Las ciudades fueron seleccionadas en base al tamaño de la población y el desempeño de los servicios de salud oral. El plan de muestreo estuvo compuesto por 450 personas entre 15 y 19 años, seleccionados al azar en el número correspondiente a la proporción de la población adolescente en cada municipio. **Resultados:** De los 450 adolescentes examinados fueron 16 (3,5%) de código 0 (sano), 232 (51,5%) del código 1 (sangrado), 38 (8,44%) Código 2 (cálculo) y 164 (36,44%) de código 6 (sangrado y cálculo). El patrón de mapas mosaico era amable y puede indicar que las peores condiciones periodontales de los adolescentes se distribuyeron en toda la región. **Conclusión**: Los mapas describen el estado de salud bucal de los adolescentes y pueden proporcionar información para la planificación de la salud oral.

[1] PhD Student, Piracicaba Dental School, Universidade de Campinas - UNICAMP, Campinas (SP), Brazil.
[2] Dentistry School, Universidade Federal de Minas Gerais - UFMG, Belo Horizonte (MG), Brazil.

Autor Correspondente: **Emilio Prado da Fonseca**
e-mail: **emiliopraddo@ig.com.br**

Artigo recebido: **28/01/2016**
Aprovado: **25/05/2016**

INTRODUCTION

The incorporation of geographical concepts by public health studies is observed in the idea of geographic space as the place where social change occurs, as well as the deleterious effects on health of populations caused by social inequalities[1-6]. Many technologies and techniques are used for the survey and manipulation of geographic information, among which stand out georeferencing and geoprocessing. In the late 90's and early 21st century, geoprocessing started to become a popular and socially-oriented methodology, being increasingly used in health as an important tool for planning, monitoring and evaluation of actions, policies and programs, besides contributing on the analysis of relationships between environment and health-related events, identifying regions and groups at high risk of disease, as well as in planning prevention and control of new or reemerging diseases[6-13].

GIS (Geographic Information System) is a comprehensive system that combines several technologies for processing, handling, storage and presentation of spatial data by means of computational programs[14]. Involves knowledge on cartography, digital cartography, geography, statistics and computing[15-16]. Geoprocessing programs have as main feature the ability to manipulate graphical data (maps) and relate them to non-graphical data, each local – for example, city, district, neighborhood (area), health center (point), avenue (line) – can be linked to a table with information from those – for example, number of cases occurring in some area, medical specialties in a health center, bus routes that pass though an avenue[14,16]. The utilization of geographic space in oral health research was improved with access to computational cartographic tools. Its use is possible for data analysis based on the spatial distribution and geographic locations related on the oral health status of populations, as well as for planning and evaluation of actions, implementation of policies and strategies that might improve local health systems[17-21]. It also allows the elaboration of map models able to check and predict the occurrence and distribution of dental hazards in areas with specific spatial conditions[17,21]. This fact is relevant to oral epidemiology because periodontal diseases have a high prevalence in populations of adolescents in Brazil and worldwide[22-23].

Recent studies have shown important results for planning oral health[21-23]. Geoprocessing can also be useful to evaluate dental care services by their distribution in areas or cities, type of service offered, and yet, by mean of programs to attract professionals to regions where demand is high, as well as evaluating access to dental care for individuals according to their ethnicity and socioeconomic status[10-11,23].

The aim of this study was to propose the elaboration of maps to describe the gingival condition of adolescents living in Jequitinhonha Valley based on the Community Periodontal Index (CPI), which is recommended by the World Health Organization.

METODOLOGY

Concerning health, spatial distribution refers to the use of quantitative methods in studies in which the object of interest is geographically defined, such as spatial distribution of occurrence of oral diseases and their relation to health services, in order to identify spatial patterns of morbidity or mortality and associated factors, describe diffusion processes of diseases, and generate knowledge about etiology, its prediction and control[3-4,10,14]. The state of Minas Gerais is divided into 12 mesoregions. Jequitinhonha mesoregions comprises 52 municipalities with low socioeconomic

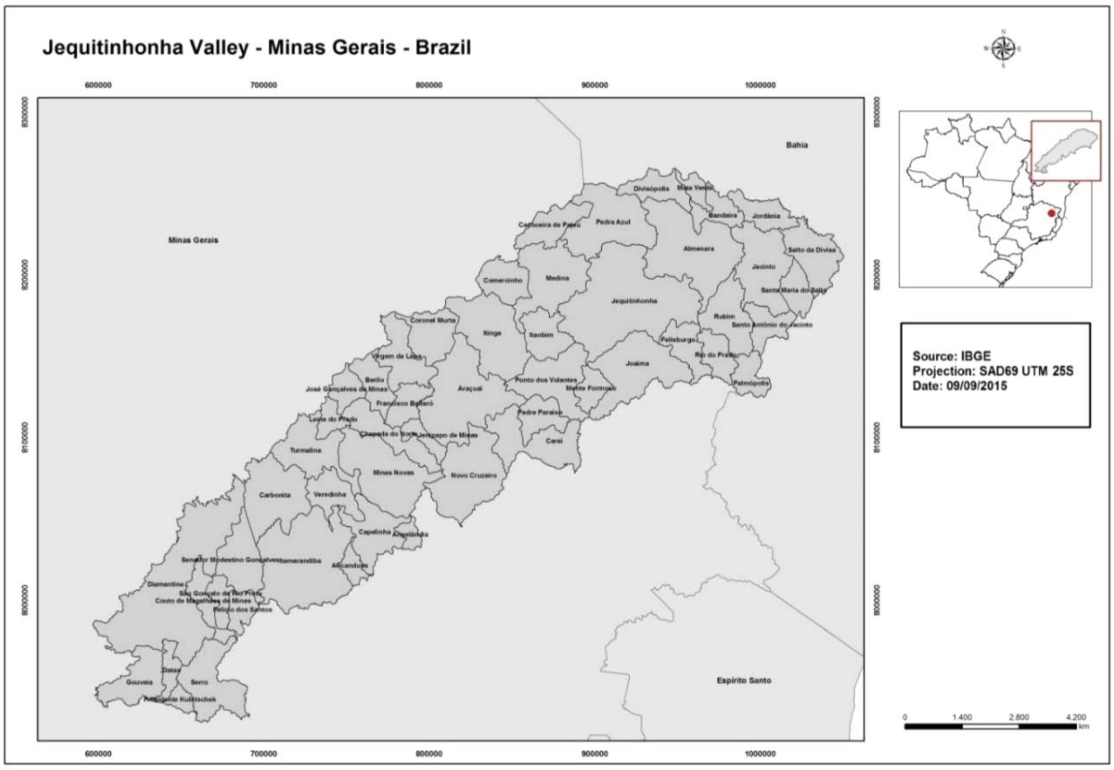

Figure 1 - Geographical location of Jequitinhonha Valley, Brazil, 2015.

development indexes and municipality was used as the spatial unit because it is an administrative unit reference for primary data in health(5,16). We used to Universal Transverse of Mercator (UTM) projection with Zone 25S and numeric scale in Kilometers(5,14-15,24) (Figure 1).

The population of this study was composed of individuals aged 15 to 19 years and the choice of adolescents is justified for being this one of the age groups recommended for evaluation of oral health status(22). The sampling plan by conglomerates was performed in two stages: 1 (municipalities) and 2 (individuals). To address the diversity among the municipalities, they were selected based on population size and performance of oral health services in each municipality. With these two variables, a 3x3 matrix was drawn, and thirteen municipalities listed at the main diagonal were included in the sample. The sample included 464 adolescents but were lost of 14 (3.01%) individuals. Thus the 450 adolescents aged 15 to 19 years were randomly selected as the proportion of the population in the age group corresponding to each municipality and blocks drawn according to the Brazil Oral Health Manual - 2010 (SB Brasil 2010)(22). Adolescents and their tutors were informed about the goals and methods of the study and signed a consent form. All questions were answered before beginning the clinical examinations. Adolescents selected were functionally independent, with no cognitive or mental difficulties and who agreed to participate. It was informed individuals that they could desist from the study without this entailed them any kind of injury.

Of ensuring the uniform and consistent interpretation of clinical data was first carried out a training and calibration of researchers(22,25). Clinical examinations were performed in the homes of adolescents under natural light, in a reserved place, in order to preserve the privacy of the examination(22,25). The bio-security standards have been duly followed and the researcher used personal protective equipment(22).

The examination of the gingival condition was based on the protocol for calculating the Community Periodontal Index (CPI) and adolescents were classified according to the codes and the worst condition found in: Healthy, Bleeding, Calculus, Bleeding and Calculus(25). Those individuals who have been diagnosed with any dental injury were referred for treatment in their municipalities.

To perform spatial analysis first it was built a database with attributive (non-graphic) data – or table – in *Windows Excel®* program (*2010* version), with numerical and categorical attributes/variables extracted from a cross-sectional study, conducted in 2010 and made available by UFMG's Dentistry College, containing data from 13 municipalities and 450 adolescents living in Jequitinhonha Valley, State of Minas Gerais(5,15). Later, bases were projected on a digital graphic base of the State of Minas Gerais, made available by the Instituto Brasileiro de Geografia e Estatística (IBGE) using *TerraView®* software (4.2.1 version) provided by the Instituto Nacional de Pesquisas Espaciais (INPE). Then, graphical base was built with municipal geographically referenced alphanumeric data included in the study. The connection between the two bases was made by a common code or "primary key", which was the municipality's name(14-15). Each information plan contains series of layers that represent a topic or class information, for example, CPI code (Healthy, Bleeding, Calculus, Bleeding and Calculus)(25).

Through the coordinate system, we performed the georeferencing of control points on Earth's surface at the intersection of latitude and longitude (positioning)(6,7,13,23). This process, named geocoding, is the one by which the relationship between graphical and non-graphical bases is established(6,14). The result of geocoding and intersection between graphical and non-graphical information or any spatial analysis, are coropletic maps(5,15,24). For data storage, point and polygon vectorial model was used.

QParte superior do formuláriParte inferior do formuláriouantitative and qualitative coropletic maps were elaborated, associating colour grading (from weakest to strongest) with area (from the smallest to the largest). Legend classification was also patterned in a maximum of five extracts with quantiles intervals(15,24). A coropletic

Table 1 - Spatial distribution of adolescents according to CPI Index, Jequitinhonha Valley, Brazil, 2015

Cities	CPI Index				Total
	Healthy	G. Bleeding	D.Calculus	Bleeding+Calculus	
Felisburgo	0	6	1	9	16
Gouveia	0	23	0	5	28
Itamarandiba	6	40	13	19	78
J.de Minas	2	8	0	8	18
Jacinto	2	14	4	7	27
Jequitinhonha	1	24	2	18	45
Palmópolis	1	12	0	4	17
Pedra Azul	0	18	7	31	56
Salto da Divisa	1	9	0	7	17
Serro	0	20	4	26	50
St. Ato Jacinto	1	13	0	8	22
Turmalina	0	28	4	11	43
V. da Lapa	2	17	3	11	33
Total	16	232	38	164	450

map can generate different spatial patterns depending on the type of information that will be inserted in the map legend[24]. The scale and object selected are important choices to map design and visual results[6]. This study was approved by ethics committee COEP/UFMG (number ETIC 908/09).

Table 2 - Characteristics of adolescents of the study, Jequitinhonha Valley, Brazil, 2015

Variables (n = 450 adolescents)		N (%)
Gender	Male	208 (46,22)
	Female	242 (53,78)
Work Activity	Yes	167 (37,11)
	No	283 (62,89)
Age in Years	15	108 (24)
	16	112 (24,89)
	17	86 (19,11)
	18	75 (16,67)
	19	69 (15,33)
Self-Reported Skin Color	White	56(12,44)
	Black	49(10,88)
	Yellow	17(3,77)
	Mixed/Brown	284(63,12)
	Indigenous	11(2,44)
	Not Answered	33(7,34)
Schooling	Elementary School	169 (37,55)
	High School	264 (58,67)
	College	17(3,78)
Household Incomes **	Minimum Wage	160 (35,55)
	1 to 3 Wages	236 (52,44)
	Greater Than 3 wages	43 (9,56)
	Not Answered	11 (2,45)

RESULTS

Regarding CPI Index, Table 1 shows that the 450 adolescents examined were 16 (3.5%) code 0 (Healthy), 232 (51.5%) code 1 (Bleeding), 38 (8.44%) code 2 (Calculus) and 164 (36.44%) code 6 (Bleeding and Calculus). Among the participating municipalities, 8 (61.53%) had individuals with code 0 (Healthy), 13 (100%) code 1 (Bleeding), 8 (61.53%) code 2 (Calculus) and 13 (100 %) code 6 (Bleeding and Calculus). A total of 31 (6.88%) adolescents have never been to the dentist, and the municipalities of Turmalina and Serro were those who had the greatest number of individuals, 5 (16.12%). Recent toothache was present in 112 (24.88%) adolescents. (Table 1).

The prevalence of sociodemographic variables of 450 adolescents interviewed showed that 242 (53,78%) adolescents are female, 283 (62,89%) no working activity, 112 (24,89%) sixteen years old, 284 (63,12%) brown skin color, 264 (58,67%) high school, 236 (52.44%) household income ranges from one and three minimum wages. (Table 2).

Considering the five municipalities that did not have any individual with code 0 (Healthy), three are located in better performance and larger populations extract (Pedra Azul, Turmalina and Serro). The absence of individuals with code 0 was observed in all three categories of cities from the sampling plan. There was a concentration for code 1 (Bleeding) in four cities with better service performance and population size (Itamarandiba, Jequitinhonha, Serro and Turmalina), and in a city with medium-sized population and service performance (Gouveia). Code 2 (Calculus) was more concentrated in the municipalities of better performance and population size (Itamarandiba and Pedra Azul), as well as concerning code 6 (Bleeding and Calculus) (Figure 2).

DISCUSSION

The way the territory is occupied and used may reflect

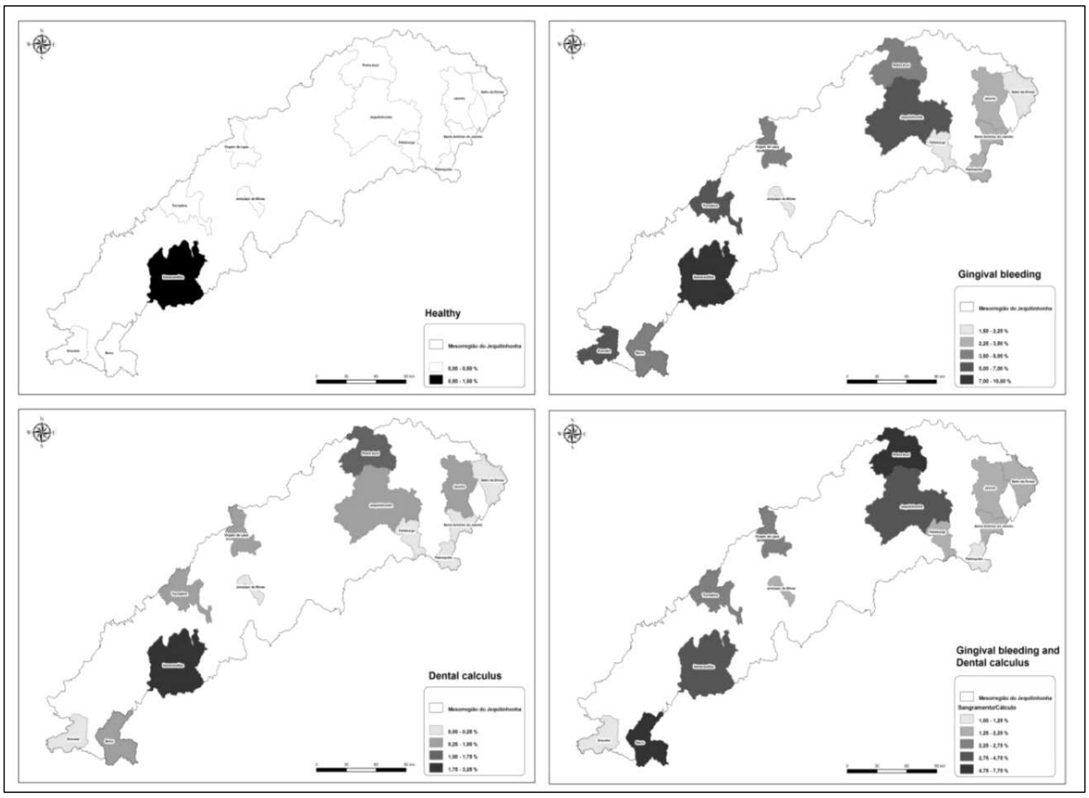

Figure 2 - Distribution of adolescents living in Jequitinhonha Valley according to CPI Index, Brazil, 2015.

life conditions and oral health of populations. Historical and social construction process of Brazilian territory produced inequities in health(1-3,17). Georeferenced oral epidemiological studies may help to understand how these inequalities were formed and how to deconstruct them(3,17,19). The socially-constructed environment is no longer backdrop of the disease process of population(2,3,6,8,14,17). Oral epidemiology needs to incorporate "social space" into the dynamics of disease process of communities and populations(3-4,10,14). Each 'social space' has a reality, problems, demands and the mechanisms by which individuals and communities organize to achieve oral health.

Individuals with similar social profiles (income, education, work, sex, age group) may provide different levels of oral health depending on their individual attributes and also territorial housing, the places they travel, work and relationships established in living territory(1,4,22-24). Our study corroborates this assertion.

Analysis on diseases distribution is done using three dimensions: person, time, space(4,14). The use of study models that address the role of environment in health outcome brings more consistency and reliability to epidemiological findings(4). Moreover, the complexity in relating social factors to oral problems requires increasingly careful analyses and measures, and also the use of numerous tools, to clearly explain the health-disease process in different populations. The identification of regions with different concentrations of fluoride naturally present in water has shown impacts over the prevalence and severity of dental caries, highlighting the environmental influence on population's oral health(13,17-20). Because this was a cross sectional study, it was not possible to analyze periodontal health-disease process in adolescents living in Jequitinhonha Valley. This would require the completion of a longitudinal study. The worse periodontal conditions of adolescents were distributed throughout the Jequitinhonha region and concentrated in municipalities with larger populations and better service performance. This fact can be associated with local economic, environmental and social factors.

Individuals, communities and populations are at risk, individually and collectively, depending on age, sex, educational level, socioeconomic status or geographic location(15,17,22-23). That is, research in oral health needs to consider social, collective and spatial dimensions for understanding health-disease process and disease behaviors in studied populations(2,4,8,20). The distribution of oral health services also uses geographical issues such as territory, district planning and decentralization of the Brazilian Unified Health System (SUS)(5,10,12,15,21).

The main limitations to the use of geoprocessing in oral health are a lack of databases with geographic information, georeferenced cartographic databases, continuous qualification and training of human resources for their use and the high cost of programs(1,4,15). Our study did not present these limitations, because the bases and the program were freely available for using. Alternative for qualification is outsourcing the making of maps, but it was not the case in our study. However, the current situation of scientific and technological development allows the use of geoprocessing tools for spatial approaches in oral health and promotes the improvement of oral epidemiological research in Brazil(4).

One way to solve problems on analysis of spatial information involves the development and use of maps, although its production process is complex, especially considering aspects of field data collection, storage and updating. Our study proposes a discussion on the use of geoprocessing technology for mapping to support epidemiological studies and management of oral health. Maps are images and forms of health communication that can be used to enhance the interpretation of results of oral epidemiological research(18-19,24). By locating populations and individuals with greater demand for dental services, it's possible to tailor financial, material and human resources as the local and regional specifics. Besides, they can help the management planning of oral health in decision making and corrective or preventive monitoring spatiotemporal aggravations as caries, oral cancer, fluorosis(18-20). Our study confirms previous studies and adds the possibility of using coropletic maps for periodontal epidemiological studies.

Maps produced with geoprocessing technology also allow constant data updates, manipulation and analysis of gathered information(9-10). However, they contain specific qualitative and quantitative information that characterizes an event or condition occurred in a specific territory, therefore allowing an analysis until a certain level, and requiring other approaches in subsequent studies(5,12,15).

Map patterns were mosaic-like and may indicate that there is a unique source for the results, and that, in this case, may be related to poverty(15). However, care must be taken not to confuse results with a random fluctuation due to municipalities samples(15). It's possible to control this effect by aggregating data or spatial statistic analysis, for greater stability(14-16).

One of the usual problems is to georeferenced health data, to get information about where one case happened and how to locate it on the map. There are several strategies to solve this: if a well-detailed map is available, containing the grid of streets, localities of the city and numbering blocks, the software itself allows the location of the health event. This occurs due to the limitations of information health systems.

Cartographic data type will depend on what is intended with the project, and the covered territory. Many information is important, such as location of health units and other urban equipment (schools, parks); urban infrastructure services (represented by lines: public systems of water supply and sewage, traffic routes, bus lines) and morphology of environment. Periodontal condition may be related to oral health service management because municipalities with better service performance and population size showed the worst results.

Georeferencing data on oral health is important for the interpretation of epidemiological studies, especially when they are related to population's socioeconomic profile and permit location of cases according to its distribution in a given geographical area(2,14,15,21,25). It is also possible to analyze spatial data on oral health(18,20), in order to provide appropriate tools that allow municipal managers to implement strategic planning of oral health in the territories over which they have responsibility.

The application of GIS to create maps for oral epidemiological research offers great possibilities, providing researchers with new ways to manage their information, thus becoming a powerful tool for connection between health and environment[19,25]. However, georeferencing of epidemiological data does not establish causal associations, but allows the characterization of studied objects and the identification of socioeconomic and environmental situations that potentially promote the occurrence of health events[7].

CONCLUSION

Maps of periodontal condition are an effective strategy to describe the situation of health and disease in adolescents. This facilitates the understanding and dissemination of information resulting from epidemiological research, and provides information for planning actions. GIS is a set of computational resources still little used by oral health studies, despite its many using possibilities. It is a valuable tool to be exploited by research in oral health and by public heath, because it helps policies in line with the principles of Brazilian Health System decentralization and territorialization.

ACKNOWLEDGMENTS

To IBGE for providing cartographic databases and INPE for availability of free software *TerraView*® (4.2.1 version).

REFERENCES

1. Miranda AC, Barcellos C, Moreira JC, Monken M. Território, ambiente e Saúde. Rio de Janeiro: Fiocruz; 2002.
2. Chiesa AM, Westphal MF, Kashiwagi NM. Geoprocessamento e promoção da saúde: desigualdades sociais e ambientais em São Paulo. Rev Saude Publica. 2002;36(5):559-67.
3. Moreira RS, Nico LS, Tomita NE. A relação entre o espaço e a saúde bucal coletiva: por uma epidemiologia georreferenciada. Cien Saude Colet. 2007;12(1): 275-84.
4. Pereira SM, Pereira AC, Ambrosano GMB, Meneghim MC, Vettorazzi CA. O uso dos Sistemas de Informação Geográfica (SIG) em saúde. In: Pereira AC. Tratado de Saúde Coletiva em Odontologia. Nova Odessa: Napoleão; 2009. p. 383-94.
5. Carvalho MS, Pina MF, Santos SM. Conceitos básicos de Sistema de Informação Geográfica e Cartografia aplicada à Saúde. Brasília: OPAS; 2000.
6. Barcellos C, Bastos FA. Are geoprocessing, environment and health a possible combination? Cad. Saude Publica. 1996;12(3): 389-97.
7. Barcellos C, Ramalho WM, Gracie R, Magalhães MAFM, Fontes MP, Skaba D. Georreferenciamento de dados de saúde na escala submunicipal: algumas experiências no Brasil. Epidemiol Serv Saude. 2008;17(1):59-70.
8. Briggis DJ, Elliot P. The use of geographical information system in studies on environment and health. World Health Stat Q. 1995; 48(2):85-94.
9. Camara G, Monteiro AMV. Geocomputation techniques for spatial analisys: are they relevant to health data? Cad. Saude Publica. 2001;17(5):1059-81.
10. Scholten HS, Lepper MJC. The benefits of the application of geographical information system in public and environmental health. World Health Stat Q. 1991; 44(3):160-70.
11. Skaba DA, Carvalho MS, Barcellos C, Martins PC, Terron SL. Geoprocessamento dos dados da saúde: o tratamento dos endereços. Cad. Saude Publica. 2004; 20(6):1753-6.
12. Sunohara ASA. Mapeo de sal con flúor en los mercados de la provincia de Trujillo utilizando el sistema de información geográfica. Rev Estomatol Hered. 2006;16(1): 5-8.
13. Tomazelli J, Czeresnia D, Barcellos C. Distribuição espacial dos casos de AIDS em mulheres no Rio de Janeiro de 1982 a 1997: uma análise espacial. Cad. Saude Publica. 2003;19(4):1049-61.
14. Werneck GL. Georeferenced data in epidemiologic research. Cienc Saude Colet. 2008;13(6):1753-66.
15. Brasil. Ministério da Saúde. Capacitação e atualização em geoprocessamento em saúde. Sistemas de informação geográfica e análise espacial na Saúde Pública. V.2. Brasília: Ministério da Saúde; 2007.
16. Lawson AB, Williams FL. A introductory guide to disease mapping. New York: John Wiley and Sons; 2001.
17. Antunes JLF, Frazão P, Narvai PC, Bispo CM, Pegoretti T. Spatial analysis to identify differentials in dental needs by area-based measures. Community Dent Oral Epidemiol. 2002;30(2):133-42.
18. McPhail CWB, Grainger RM. A mapping procedure for the geographic patology of dental caries. Int Dent J. 1969;19(3):380-92.
19. Morgan MZ, Treasure ET. Mapping caries prevalence and water distribution in Wales-Iechyd Morgannwg Health Authority as a case study. Community Dent Health. 2003;20(1):94-9.
20. Oliveira CE, Bernini GF, Miyazaki LCY, Tomita NE. Características sociodemográficas da mortalidade por câncer de boca em Bauru, SP, no período de 1991 a 2001: uso do geoprocessamento. Rev Bras Epidemiol. 2008;11(2):185-95.
21. White DA, Anderson RJ, Bradnock G, Gray MM, Jenkins P. The use of a geographical Information system in investigating dental services. Community Dent Health. 2000;17(2):79-84.
22. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Coordenação Nacional de saúde Bucal. Projeto SB Brasil 2010- Condições de saúde bucal da população brasileira: resultados principais. Brasília: Ministério da Saúde; 2011.
23. Gesser HC, Peres MA, Marcenes W. Condições gengivais e periodontais associadas a fatores socioeconômicos. Rev. Saude Publica. 2001;35(3):289-93.
24. Dent BO. Cartography, thematic map design. Boston: William C Brown Pub; 5th ed; 1996.
25. World Health Organization. Oral health surveys: basic methods. 4th ed. Geneva: WHO;1997.