

# Spatialization of Medical Care in the Private Network of the Metropolitan Region of Belo Horizonte (Brazil) from 2007 to 2016

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## ABSTRACT

The spatial distribution of doctors is a subject of great value to society, since it is a factor that relates to the social welfare of the population in any locality, since they are the main providers of health services. In addition, the guarantee of universal access to health services is a worrying challenge. This work contributes to minimizing the impact of the imbalance of medical distribution. For this, there were elaborated and displayed temporal cartographic information of the Metropolitan Region of Belo Horizonte (RMBH), located in the state of Minas Gerais, Brazil, which demonstrate the dynamics of the organization over the last years. In this way the approach of the geography of health was used, using the tools of statistics under the optics of spatial analysis and technological support of geographic information systems. The distribution of health care has presented significant concentration in the capital, without change over the years even with the growth of the population contingent in the surrounding cities.

Key words: Geography of health. Supplementary health. Spatial statistics. Spatial analysis. Geographic distribution of doctors. Belo Horizonte metropolitan area.

## INTRODUCTION

One of the most prominent themes in the field of population studies is the process of spatial deconcentration of the inhabitants. In the case of Brazil, which has a relatively recent urbanization, it was observed a tendency to disperse the population, even with the progressive population growth in the metropolitan centres [1].

Spatially distributed data analysis has been increasingly considered in health management, as it presents new grants for planning and evaluating actions based on spatial distribution analysis.

Spatial analysis is no longer held in the hands of geographers. The maps have become indispensable resources for the research, making geographic knowledge and the location of these events valued, not only in geography, but also in diverse areas such as health.

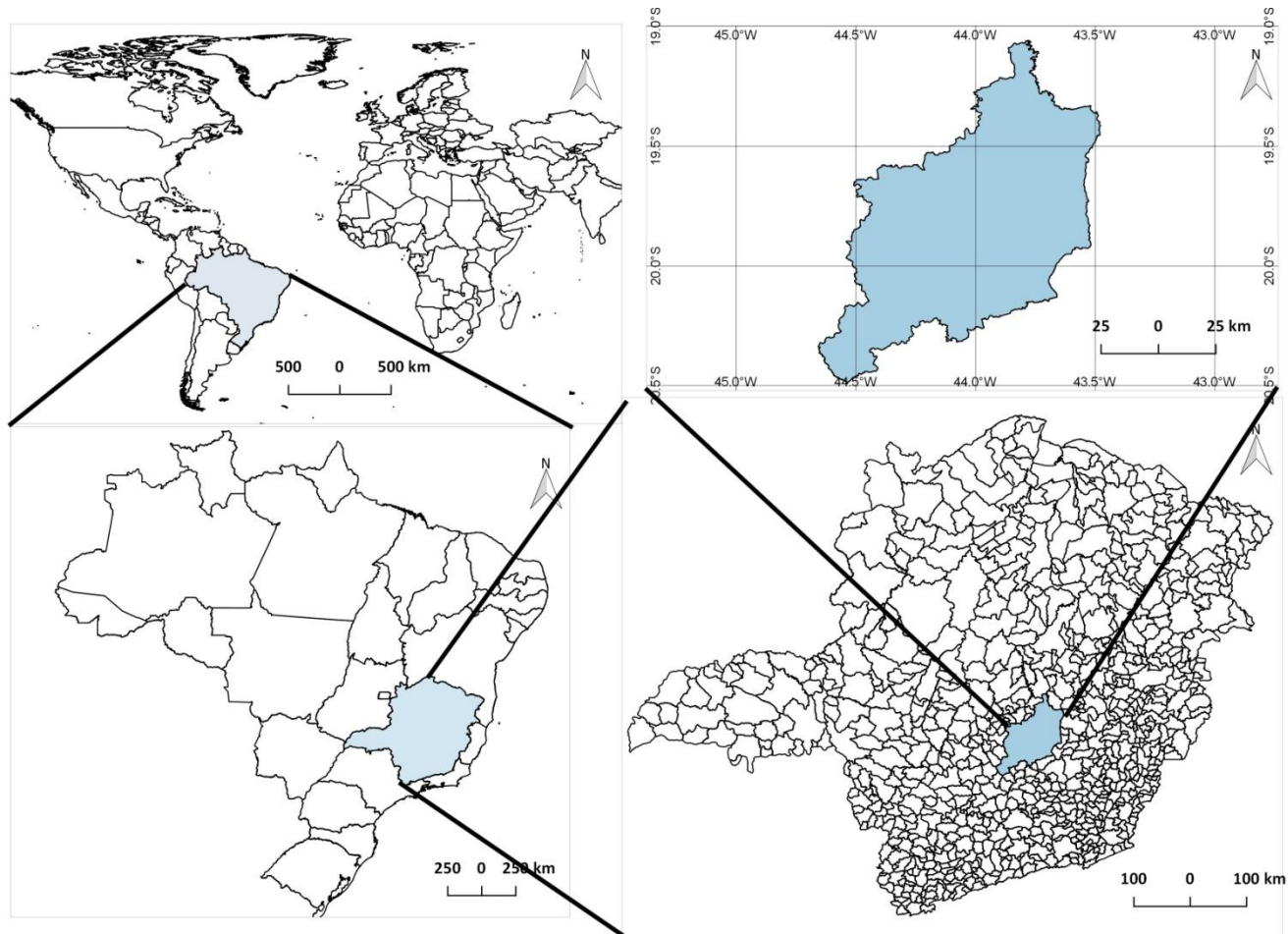
The deadlocks related to the accessibility of health are present in several contexts, emphasizing the geographical factors, socioeconomic inequalities and factors related to the organization of supply and demand [2].

Studies have been carried out in some countries, such as Canada, the United States, Norway, Mexico, Chile and Japan, with the objective of understanding what would be the determining factors of the geographical distribution of doctors. [3] [4] [5] [6] [7] [8]. However, these works were carried out from the perspective of public health, the increasing insufficiency of their attendance network, which often does not support the demand of the population, allowed the strengthening of a market that grows every day; Private health. This market on the other hand represented by the supplementary health carriers, acts as an exhaust valve for Brazilian health [9].

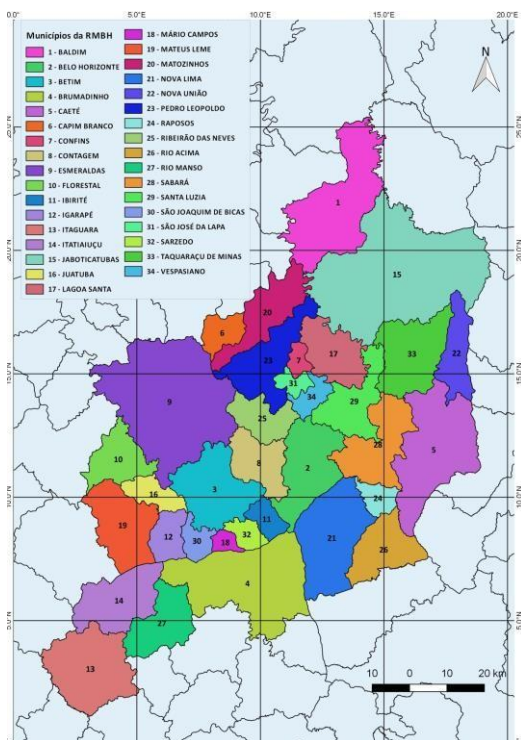
In Brazil, there are around 48 million of beneficiaries of supplementary health plans, equivalent to 23% of the national population, according to the ANS (National Agency for Supplementary Health). RMBH is located in the central region of the state of Minas Gerais, Brazil – Map 1 – and consists of 34 municipalities, including the state capital, Belo Horizonte – Map 2. It is the third largest urban agglomeration in Brazil, with almost 6 (six) million inhabitants. Of this total, there are two (two) million beneficiaries of supplementary health plans, according to the ANS, representing around 33% of the population of the region. This study contemplates data of 1.2 million beneficiaries (23% of the population of RMBH), attended by 5,600 physicians in the additional private network (28% of physicians operating in RMBH), according to data from CFM (Federal Council of Medicine).

In this research were used mapping techniques that allowed to describe various phenomena in health by means of exploratory analysis and the geographical representation of the results. The use of thematic cartography makes possible to obtain knowledge from the recognition of patterns and spatial relationships, stimulated by visualization [10].

The general objective is to analyze the spatial distribution of additional health care points over the last ten years in the metropolitan region of Belo Horizonte. The specific goals are: 1) to identify the spatial distribution of doctors in the course of the years 2007 to 2016; 2) to consider the spatial distribution of physicians by attendance; 3) to build cartographic models to represent the observed results.



**Map 1** - Location of the Metropolitan Region of Belo Horizonte in Minas Gerais, Brazil and the world. Source: IBGE, 2017 – Prepared by Carlos Miguel F. SILVA in 2018.



**Map 2** - Political division of RMBH. Source: IBGE, 2017 – Prepared by Carlos Miguel F. SILVA in 2018.

## METODOLOGY

Six methodological steps were carried out to meet the objectives proposed in this research: 1) data extraction tabulated in relational database, 2) construction and execution of routines for the treatment of extracted data, 3) Geocoding of the attendance points, 4) data processing with spatial statistics, 5) generation of maps for visualization of information and 6) generation of analytical reports from the information collected.

1) The first step was the data collection which consists of the search for information through secondary data queries, more specifically in historical databases of medical supplementary health care. This step has been raised and defined the data entities that keep the records needed for querying. In the sequence, data extraction was performed using structured Query Language (SQL) routines.

2) The second step was the processing of data, with a view to the quality and coherence of them. In this way, the second step was intended to carry out an audit to ratify the data extracted from the database. No information, inaccuracies or incompleteness of the data has been established. The search for data validation was a process of paramount importance to confirm the veracity and credibility of the results.

Validation testing routines were created and performed on the extracted information. Only the data approved in all tests were used in the study. The first test only found the doctors who

performed some medical care during the study period. The second test evaluated the city in which these services were realized, restricting only the physicians who held services within the RMBH. The third Test verified the type of attendance, being used at work, only the consultation services, being revoked the surgical, ambulatory or even hospitalization. The fourth Test, removed the records of doctors who do not have the complete record, relative to gender and date of birth attributes. It is important to note that the selected data complied with the address of the medical care location, according to the address of realization at the time of the meeting. In addition, the quantification of these calls was fundamental, due to the high level of details collected, in order to enable the visualization of the information on maps.

3) The third methodological step dealt with the geocoding of the addresses, process where the addresses are converted in text format (as street name and number) in geographical coordinates (latitude and longitude). This allowed the insertion of location markers on the maps (positioning). An Application Programming Interface (API) made available for free by Google Maps was used.

4) The fourth methodological step contemplated the processing of data with spatial statistics. The statistical analysis can be carried out from central tendency measures, dispersion measures and correlation measures [11] [12].

The first calculation performed was about the middle center which can be pointed out as the balancing point of a given plan. The second survey was related to the weighted middle center. While the middle center represents the gravitational center of a set of points, regardless of the intensity of the occurrence of the points, the weighted middle center takes into account the weights of the associated phenomena. In this work, the weighting was determined by the average medical production at a certain point of attendance (average amount of attendance at a certain point of attendance). In this way, it is not enough to know the location of a health care point, it is also relevant to take into account the volume of attendances. The third effective clearance was the standard distance. Knowing the middle center is not enough, because different distributions can present the same central point. In this way, variability or dispersion measures are beneficial. At the standard distance, however it represents the dynamic radius, or standard radius, which represents the variability of a set of points around a central middle value. Along the method, a circumference is reached, equidistant in the middle center, whose radius is called the standard distance; its concept resembles the standard deviation. The fourth and last calculation performed was at the weighted standard distance. The Standard Distance Calculation does not take into account the relevance or weight existing in the service locations. Previously, only the location of the points was used.

This distance should be used when the significance of some phenomenon located in the points is relevant.

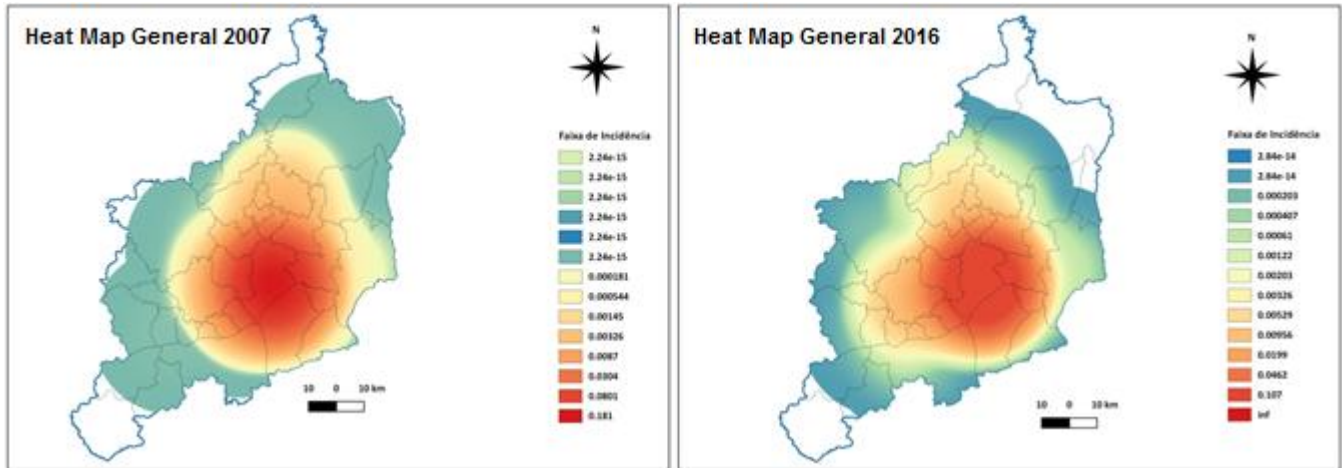
5) The fifth step took care of the confection of cartograms and maps. For this purpose, several cartographic bases were used in conjunction with alphanumeric data extracted in the first step. The SIG chosen was the QGIS (Quantum GIS) 12.8. It is a friendly, open source geographic information system, licensed under the GPL General Public License. The cost benefit of this application was convenient for the choice in conducting this research step. The map of the metropolitan region of Belo Horizonte was built from a consultation to its 34 municipalities. In this way, the region was established linking all the areas, which has its headquarters in the municipality of Belo Horizonte. The main cartographic bases were obtained for free from IBGE (Brazilian Institute of Geography and Statistics) and also from the IEDE (State infrastructure of spatial data of Minas Gerais).

6) The sixth and final step was the generation of the Geographical Distribution of Doctors Atlas in RMBH, from the analysis and representation of the data collected and treated in the previous steps.

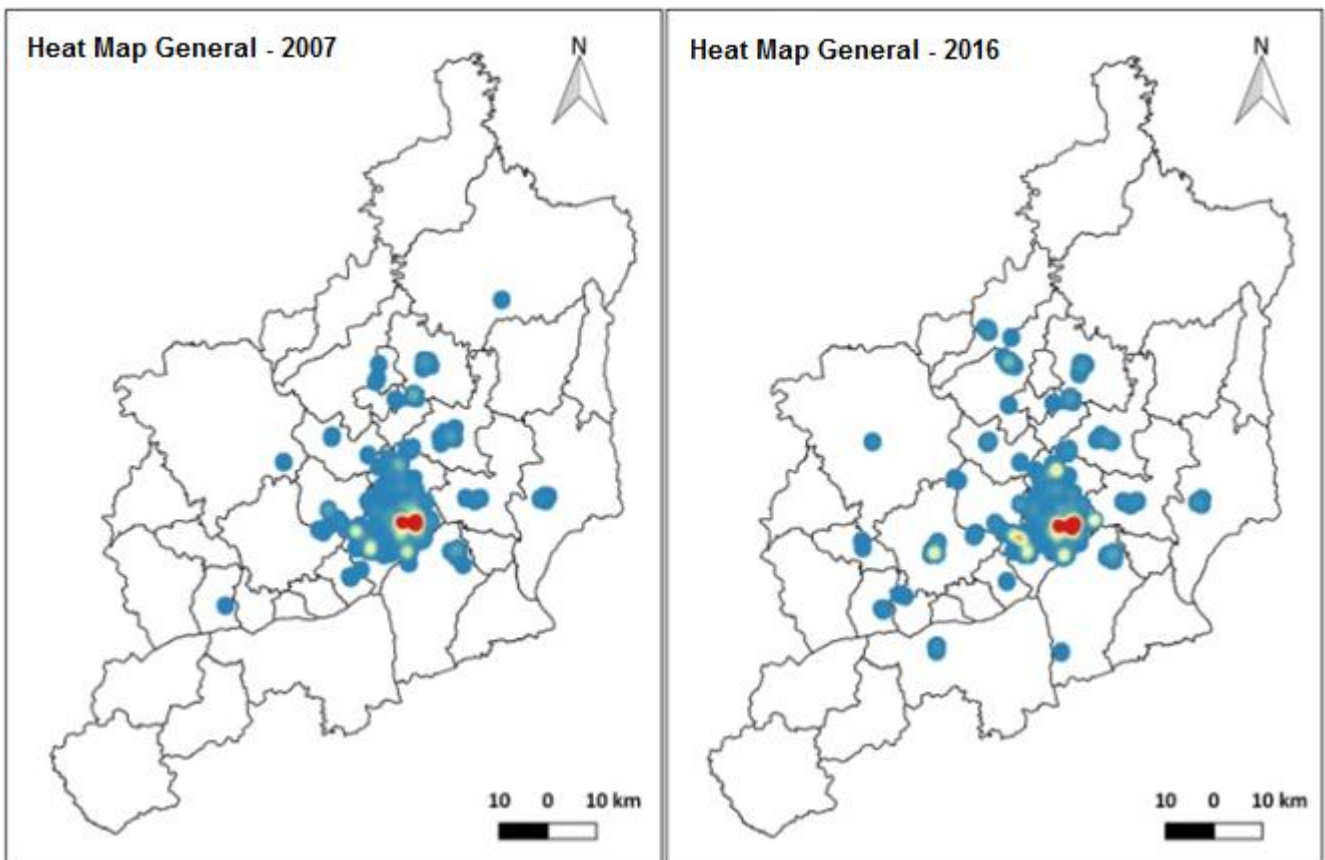
## RESULTS

On map 3 are presented the heat maps of the general distribution of the attendances in RMBH in a comparison between the years 2007 and 2016. The abundance of details on this map, in this technique, makes possible to visualize broadly the intensity of the attendance in these two years of study. It is a matter of great importance to highlight a slight deconcentration in the year 2016 compared to 2007. In addition, a Northwest and West shift in the region. On map 4 are presented the heat maps of the attendances general distribution, now with a higher level of details with the objective of identifying the details more accurately. It can be found, therefore, a certain level of spreading calls in the three focuses; however these decentralized occurrences are not significant enough to infer a better distribution.

The map 5 displays the weighted average center and the weighted standard distance. It is understood, year by year, a growth in the standard distance, as well as a shift from the middle center in the West, slightly Northwest. The standard distance, shown in the maps, is the first indication of improvement in the distribution over the years, as its radius increases gradually, having retractions in 2015 and 2016, as can be seen in Graphic 1. The increase in the radius implies a greater area of scope of the distribution about the studied phenomenon.

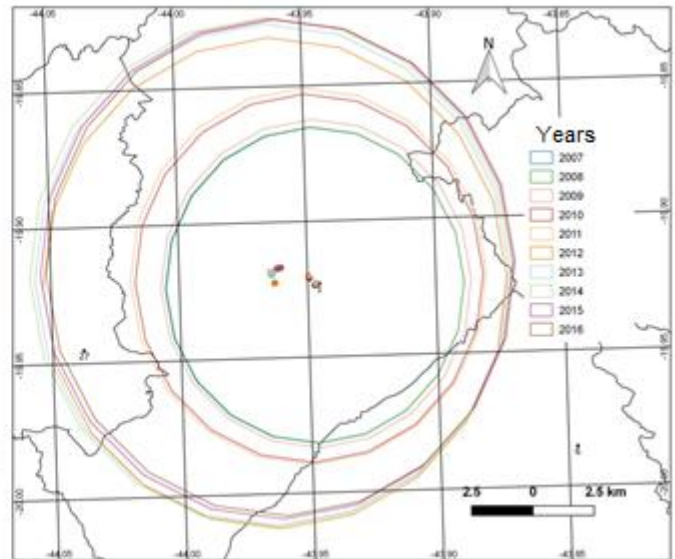
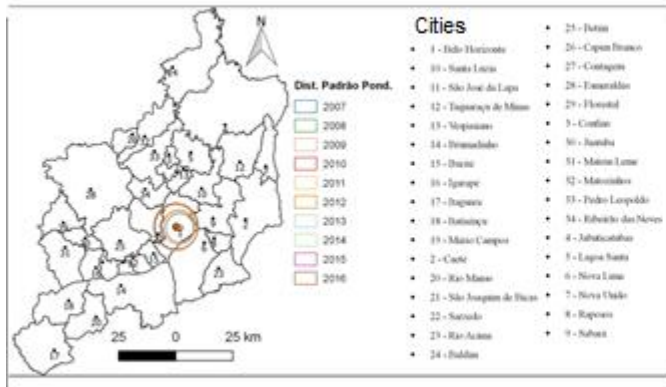


**Map 3** -Heat map of the supplementary health care in the years 2007 and 2016-high granularity. Source: IBGE, 2017 – Prepared by Carlos Miguel F. S. Viegas in 2018.

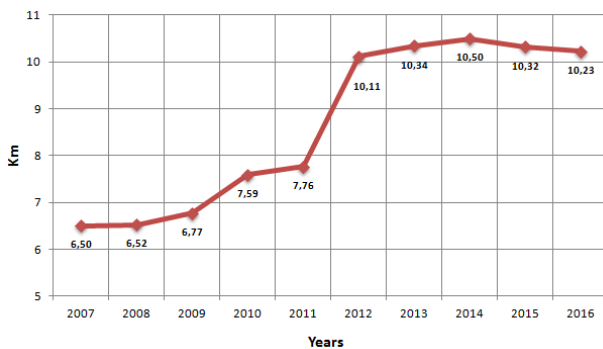


**Map 4** - Heat map of the supplementary health care in the years 2007 to 2016-low granularity. Source: IBGE, 2017 – Prepared by Carlos Miguel F. S. Viegas in 2018.





**Map 5-** Weighted average center and weighted standard distance of supplementary health care from 2007 to 2016. Source: IBGE, 2017 – Prepared by Carlos Miguel F. S. Viegas in 2018.



**Graphic 1** - Weighted standard distance of supplementary health care in the years 2007 to 2016. Prepared by Carlos Miguel F. S. Viegas in 2018.

## CONCLUSIONS

This study allowed determining the distribution of supplementary health care in RMBH over the last 10 years. The fact that this study was quantitative and used cartographic elements made possible to achieve the proposed objective effectively, enabling the understanding of the "where" in the research theme.

The distribution of attendance has an expressive concentration in the State Capital without having to undergo major changes over the course of the years in study. Although all 34 municipalities, except the capital have increasing population quotas, coming to overcome (added) the population of the capital; this phenomenon is not reflected in the distribution of additional health care points. Certainly the distribution has undergone changes over the years, but has not reached the expected balance. Consequently, it is not possible to assert in proportional equality, even in the long term, especially if the parameters remain similar, since for many years the capital has supplied the region with health services and equipment, with its consolidated concentration. The use of cartography was the

differential in this work, because it allowed understanding the dynamics of health care, which are extremely concentrated, but softly directed in the West direction. Such a scenario could be changed in the future in case of any aggregation action of new doctors or structural measures focusing on the attendance of the surroundings and areas bordering with the capital, such as health centres or even in the expansion of the concept of family doctor.

It is suggested as future studies: a) The analysis of the displacement of the economically active population in front of the supplementary health equipment; b) Study between the distribution of public health equipment in front of the supplementary; c) Finally, it would be of great value a study focused only on the more complex attendance in the health care network, such as surgeries and complex exams.

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