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# SPATIAL DISTRIBUTION OF UNDERGRADUATE COURSES IN BIOMEDICINE IN BRAZIL

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**ABSTRACT**

**Introduction:** The presence of Higher Education Institutions triggers an economic-social change that modifies the productive structures of the regions where they are located. In the year 2000, 13 undergraduate courses in Biomedicine were described according to the National Institute of Educational Research Anísio Teixeira. **Objective:** To systematize the Institutions of Higher Education that have undergraduate courses of the Biomedicine Undergraduate Courses in Brazil through the localization indicators. **Method:** Descriptive and transversal study, with data collection obtained through the virtual system in the portal of the Ministry of Education for undergraduate courses in Biomedicine registered in Brazil from April to May 2016. The spatial analyzes carried out by means of georeferencing. **Result:** By the year 2016, 333 Higher Education Institutions were identified in the face-to-face modality and a non-homogeneous distribution of courses, with greater centralization in the South and Southeast. **Conclusion:** It is expected that this distribution of Higher Education Institutions with the Biomedicine Course may serve as an incentive to conduct research on the professional training of biomedical and its importance for public health, thematic still little researched in Brazil.



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## INTRODUCTION

Higher Education Institutions (HEIs) are fundamental to the regional development process insofar as they have the mission of generating and transmitting knowledge, training intellectuals and fostering innovations and technologies (Campos *et al*., 2006). With this, the presence of the Institutions of Higher Education triggers an economic-social change through the creation of an intellectually differentiated environment, which modifies the productive structures of the regions where they are located. This can be attributed to the university's impact in terms of knowledge generation, whose effects are materialized in the medium and long term and to the economic increment, that is, by owning a budget and also executing expenses (Campos *et al*., 2006). The distribution of higher education institutions encourages the permanence of professionals in the places of origin.

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In addition, many indirect jobs are generated in different sectors, resulting from the dynamization of the local economy and, mainly, the contracting of services by the university, such as security and cleaning services (Righi and Ruppenthal, 2013). Historically, the implementation of higher education courses in Brazil has undergone a trajectory under the political influence and values and interests of society (BispoJúnior, 2009). From the 1930s, the process of political-economic reorganization evidenced the need for a skilled workforce, which implied a demand for health services and a consequent increase in the number of courses in this area in the country.

In 1996, with the approval of Law No. 9,394, of the National Education Guidelines and Bases (LDB), it culminated a policy of incentives for the growth of higher education, generating an accelerated process of expansion of education, especially in the private sector with the MEC for the opening of new courses (Brasil, 1996). This growth occurred in a disorderly manner, resulting in institutions that offered courses with low quality, concentrating on capitals and economically more developed centers. However, other economically

disadvantaged regions, which also require training at the higher level, continued without HEIs (Rocha *et al*., 2010). This fact resulted in an inequality in the distribution of the courses, being a relevant and at the same time worrying factor, as it reflects in the assistance to the population where there is clearly the lack of professionals in several regions (BispoJúnior, 2009). It was in this scenario that the Biomedicine courses appeared. The biomedical course started in December 1950 in Brazil, with the initial objective of training professionals qualified to act as teachers in basic disciplines of medical and dental schools, as well as in scientific research in the areas of basic sciences, in which the was able to contribute to research in the field of applied sciences (CFBM, 2015). Currently the biomedical professional has a vast field of exploration, consisting of 35 areas of practice, however, about 80% of the biomedical, formed by the Institutions of Higher Education (IES), act in clinical analysis. This is due to some reasons, among them is the fact that a specialization is not necessary to act in this area (BispoJúnior, 2009). The HEIs that have Biomedicine courses follow the National Curricular Guidelines (DCNs), which consist of compulsory standards that must be followed in Basic Education for orientation and curricular planning of secondary schools and higher education. These norms are governed by the National Council of Education (CNE) (Rocha *et al*., 2010). In the year 2000, after 34 years since the formation of the first course of Biomedicine, 13 undergraduate courses were described in the biomedical modality according to the research carried out at INEP (National Institute of Educational Research Anísio Teixeira) and by the monitoring of the Federal Biomedicine Council (CFBM). Of these, two were offered in public institutions and 11 by private institutions (ABBM, 2018, Brasil, 2016).

Education is one of the three fundamental items for human development according to the Human Development Index (HDI). The latest report, published by the United Nations Development Program (UNDP) in 2016, gave Brazil the 79th place in the ranking that covers 188 countries, from the least developed, indicating that the average number of years of study in Brazil is lower (Brazil, Argentina, Paraguay and Uruguay) and in the BRICS (Brazil, Russia, India, China and South Africa) (UNDP, 2016). The report was prepared in 2016 and is based on the 2015 data. To prepare the report, the UN is based on indicators of knowledge (average years of schooling and expected years of schooling), health (life expectancy), and standard of living (gross national income per capita) collected in international databases such as the World Health Organization (WHO) and the International Labor Organization (ILO) (UNDP, 2016). Although the United Nations Development Program establishes the importance of education as one of the evaluation items of the HDI, and considering the presence of HEIs as a contributory factor for the increase in schooling, no information was found in the literature on the Brazilian territorial distribution of the undergraduate courses in Biomedicine that related the area of coverage with the number of inhabitants by regions according to the Index of Municipal Human Development (IDHM / IBGE). The use of geoprocessing and geostatistical techniques favors the identification of possible patterns of spatial distribution in a given geographic area, associating the geographical location of the event with possible determinants (Ribeiro *et al*., 2014). Thus, this study aimed to systematize the Institutions of Higher Education that have the undergraduate courses of the Biomedicine Undergraduate Courses in Brazil through the localization indicators. Considering that a better territorial distribution of courses can influence a more adequate distribution of professionals according to regional needs.

## MATERIALS AND METHODS

Descriptive and cross-sectional study. With data collection obtained through interactive queries to the virtual system in the portal of the Ministry of Education E-MEC (www.emec.gov.br) of Higher Education Institutions that have undergraduate courses in Biomedicine registered in Brazil in the months of April to May 2016 and used the classification of the Municipal Human Development Index (IDHM) according to the United Nations Development Program (Brazil, 2015; UNDP, 2016). The Municipal Human Development Index (IDHM) is a number that varies between 0 and 1. The closer to 1, the greater the human development of a federative unit, municipality, metropolitan region or UDH. The reading of the IDHM 2010 is done according to Table 1.

**Table 1. Range and description Human Development Index – IDHM**

| IDHM Range | Description |
|---|---|
| 0,800 - 1,000 | Very high |
| 0,700 - 0,799 | High |
| 0,600 - 0,699 | Medium |
| 0,500 - 0,599 | Low |
| 0,000 - 0,499 | Verylow |

Source: PNUD, 2017.

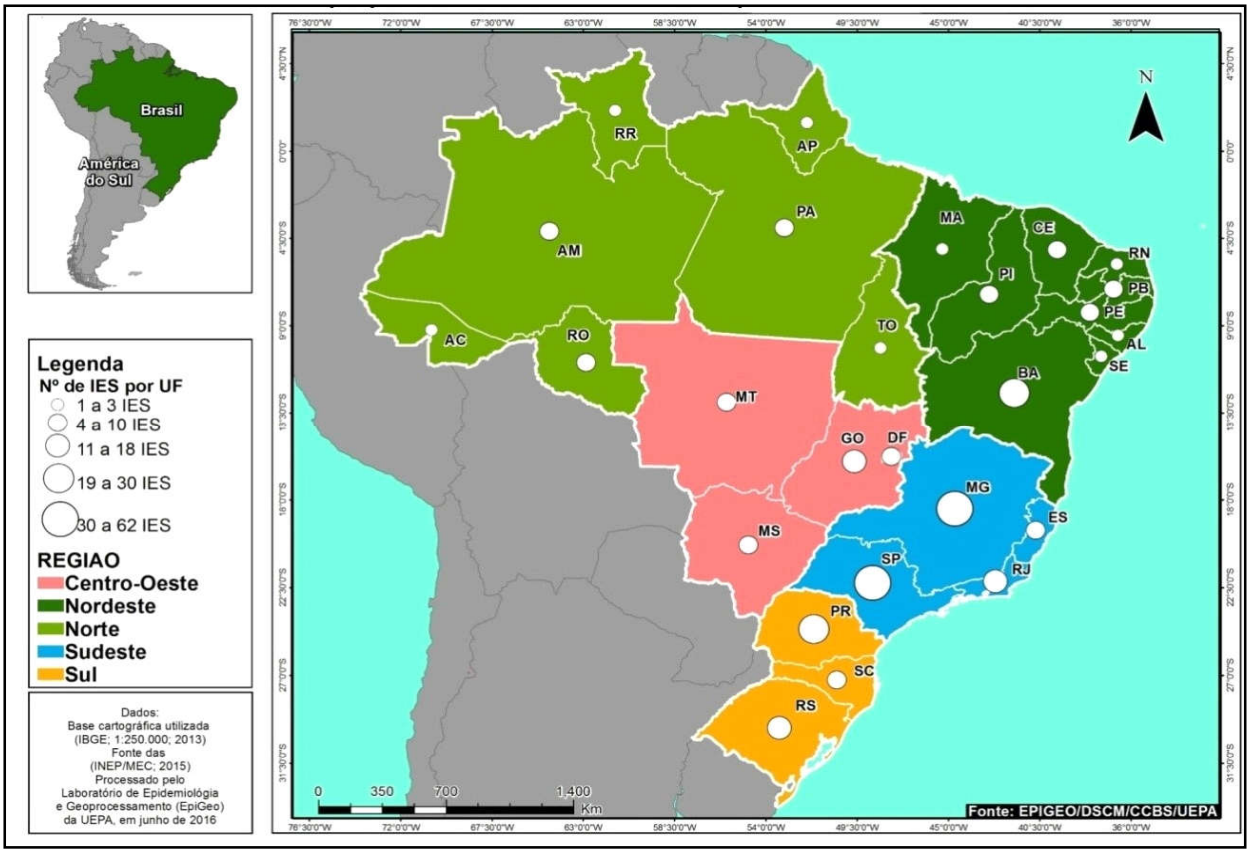
The following data were collected from the E-MEC portal: name of the institution; name of the maintainer; administrative category of HEIs; academic organization of HEIs; Address; ZIP CODE; neighborhood; telephone; county, state. An Excel spreadsheet was thus obtained. Subsequently, a Geographic Database (BDGEO) was generated by indexing geographic coordinates in HEIs that have Biomedicine courses in Brazil, which resulted in the spatial distribution of the same through thematic maps. The spatial distribution of HEIs was represented by thematic maps grouped by regions and states. Some information could not be considered because of the lack of information available on the portal. The information was collected between April and May 2016. Because it was documentary data there was no need for submission to the Ethics and Research Committee on Human Beings.

### Statistical analysis

Data were organized in spreadsheet in Excel 2013, and descriptive and inferential statistics were performed. Spatial analyzes were performed using georeferencing from the BDGEO, with the production of thematic maps using ARCGIS 10.5 software.

## RESULTS

By the year 2016, 333 Higher Education Institutions (IES) were identified in the 5 regions of Brazil registered in the website of the E-MEC - Ministry of Education that offer for the graduation the bachelor's degree in biomedicine in the face-to-face modality (Brazil, 2015) (Figure 1). Figure 1 shows the total of 333 HEIs distributed in Federative Units in Brazil. Thus, in the Center-West there are 35 registered IES, of which 6 are in the Federal District - DF, 13 in Goiás - GO, 6 in Mato Grosso do Sul - MS, and 10 in Mato Grosso.




Source: Research data, 2016.
* Note:IES - Institution of Higher Education, UF - Federative Unit.

**Figure 1. Number of HEIs that have Biomedicine courses per Brazilian Federative Unit**

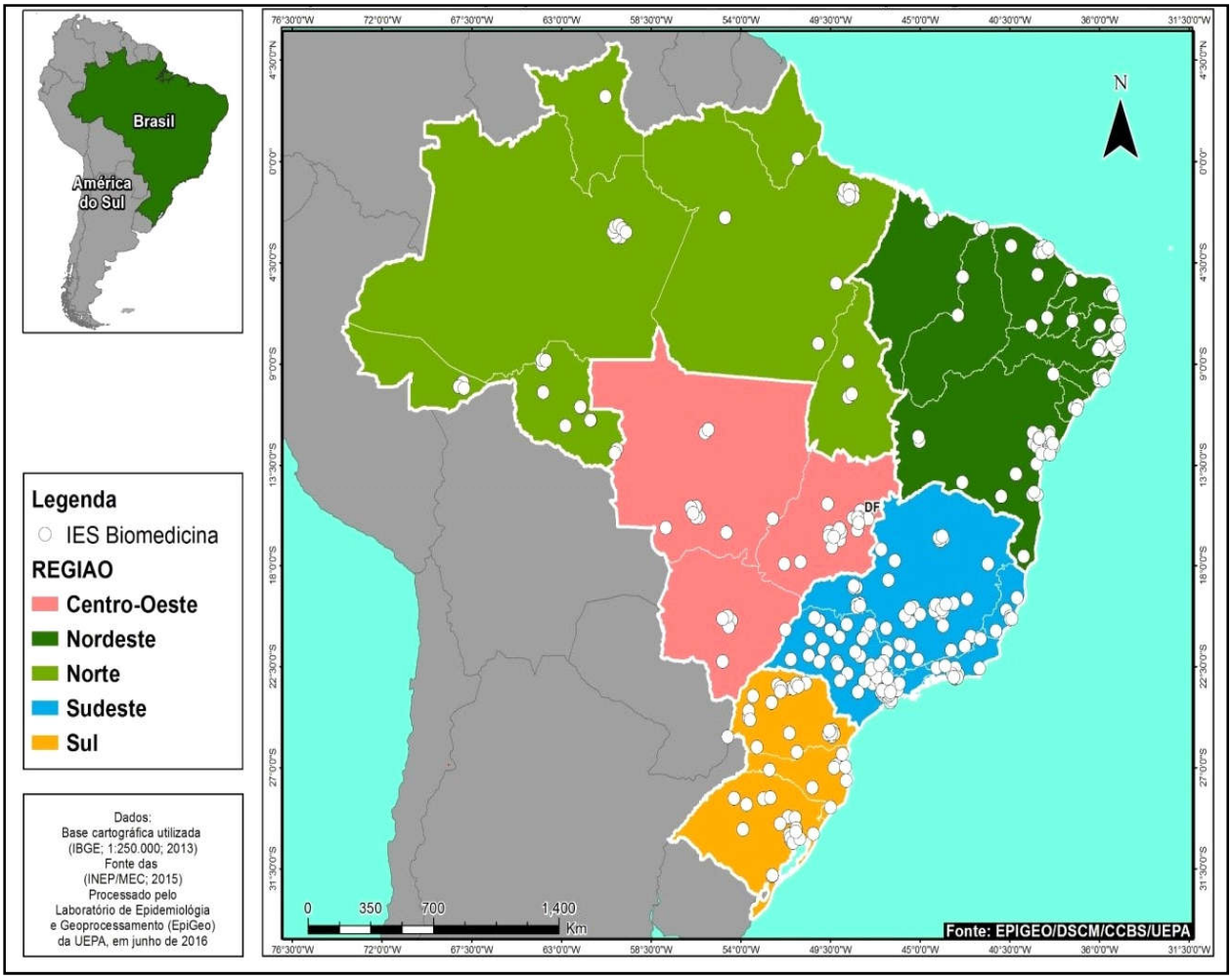
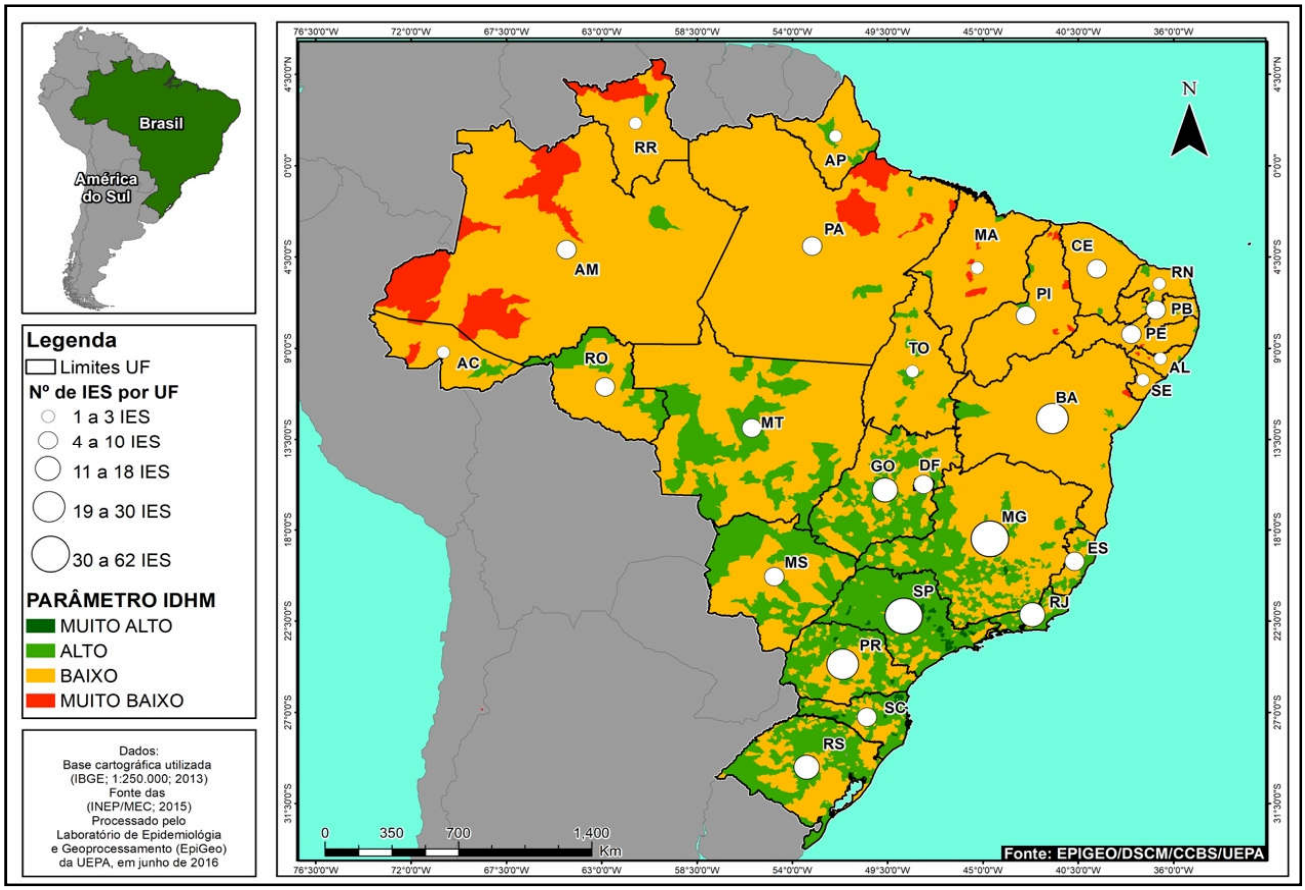



**Figure 2. Distribution of HEIs with Biomedicine courses by regions in Brazil**




Source: Research data, 2016.
* Note: IES- Institution of Higher Education.

**Figure 3. Punctual spatial distribution of Higher Education Institutions, which have Biomedicine courses, in relation to the Municipal Human Development Index, in Brazil**

In the North region, 37 HEIs were identified, among which 3 were present in Acre - AC, 7 in Amazonas - AM, only 1 in Amapá - AP, 11 in Pará - PA, 11 in Rondônia - RO, 1 in Roraima - RR, and finally 3 in Tocantins - TO. In the South, 54 IES were registered in the E-MEC, where 26 IES were located in Paraná - PR, 9 in Santa Catarina - SC, and 19 in Rio Grande do Sul - RS. In the Northeast region according to the E-MEC site there were 77 IES enrolled. There were 4 IES in Alagoas - AL, 30 in Bahia - BA, 8 in Ceará - CE, 4 in Maranhão - MA, 7 in Paraíba - PB, 10 in Pernambuco - PE, 7 in Piauí - PI, 4 in Rio Grande do Norte - RN, and 3 in Sergipe - SE. The Southeast region consisted of 130 HEIs that provided the biomedicine course for undergraduate studies, and were distributed unevenly in each locality. In Espirito Santo there were 6 IES, 46 in Minas Gerais - MG, 16 in Rio de Janeiro - RJ, and 62 in São Paulo - SP, being the state with the highest IES concentration in the Southeast region. Figure 2 shows the spatial distribution of higher education institutions offering Biomedicine courses in the Brazilian regions: center-west, north-east, north, southeast and south and their relations with the HDI. According to the spatial distribution of HEIs, which have Biomedicine courses, related to the HDI, a non homogeneous distribution of HEIs was observed, with a greater centralization of HEIs in the South and Southeast, regions where the highest HDI are located, with parameters mostly very tall and tall. On the other hand, the North and Northeast regions have a lower concentration of HEI and, in turn, contain the lowest HDI. Since the small concentrations of HEIs in these regions are mostly located in the states' capitals (Figure 3).

## DISCUSSION

The present research showed that up to the year 2013 333 HEIs were identified with a bachelor's degree in biomedicine. However, this distribution was not homogeneous, with the highest concentration of HEI in the southeast region followed by the northeast and south regions, respectively. Then, in relation to this distribution with the HDI, it was observed that the regions with the highest HDI (South and Southeast) were also the ones that concentrated the largest number of HEIs, leaving only the Northeast region that revealed a low HDI, although it occupied the third place in amount of HEI. These findings can be justified by the population density and the investment of government resources differentiated in each region characteristic of a country with a large territorial extension, but with differentiated policies in each region or state. Thus, the southeast region is the one with the highest number of inhabitants per square kilometer, according to the Brazilian Institute of Geography and Statistics (Jakobi, 2008). This increase in population generates an increase in the demand for work of the biomedical professional, which is not the case in the central-west and north regions. Among the objectives of the IDHM is to create possibilities for use by managers, decision makers and policy makers to improve the articulation of initiatives aimed at human development in the public and private sectors (UNDP, 2016). In addition, according to the Ministry of Education (MEC), in 2014, there were 7.3 million students enrolled in higher education in Brazil, and the vast majority of these students were in the southeast region, according to these data, that the distribution

of higher education institutions is uneven. Another important issue that must be considered in this process of poor distribution of HEIs in Brazil is the lack of necessary investments (financial, structural and human resources) in regions with a lower number of higher education students. As a result, a large number of biomedical professionals are observed in the Southeast region. In the specific case of the Central-West region, one of the possible reasons for the lower amount of HEI with the Biomedicine course is shortage of work offer for the biomedical professional. In this part of the country agribusiness prevails, with emphasis on the important Brazilian biomes, Amazonia, Cerrado and Pantanal (Student's Guide, 2016). Therefore, the decrease in the demands of work opportunities reflects the low investment in the training of biomedical professionals. With regard to the North region, the low HEI register with the biomedicine course can be explained by the lower demographic density when compared to the other Brazilian regions, in which HEIs that offer courses at a distance stand out (Student's Guide, 2016). Even in the face of this disparity, the Biomedicine course has been gaining prominence in the North region, probably due to the increase of scientific research on local diseases and diseases and the need for an early and immediate diagnosis of the various pathologies. In the State of Pará, the Evandro Chagas Institute, because it is a respected research center worldwide known to the Ministry of Health, may also be responsible for the growing interest of young people in biomedical research and tropical medicine. According to the Federal Council of Biomedicine, biomedicine in the South is on the rise. They associate this fact, the great demand for qualified professionals of this area by industries and hospitals, which even generated the need for the creation of a new regional council (CRBM, 2018).

In the Northeast, the presence of industries that invest in the biomedical area seems to be one of the reasons for the large number of HEIs with the course. It is also in this region where the program of expansion of Higher Education, made available by the federal government, works, which has resulted in important advances in research and postgraduate areas (Student's Guide, 2016). Finally, the higher concentration of HEI with the course of Biomedicine in the Southeast region can be explained by its greater population density when purchased from other regions of the country. In addition, it includes food industry complexes, among others, and centers for dissemination and scientific research (IBGE, 2014). This fact boosts the great demand of biomedical professionals, who analyze the quality of the food and guarantee the quality in its production process, besides actively participating in the scientific investigations. It is noteworthy that due to the fact that the Southeast region was the pioneer in offering Biomedicine courses, it has the highest number of graduates in this profession. In a study by Silva and Bacha (2014), the correlation between the supply of health services with the Gross Domestic Product (GDP) and the Human Development Index (HDI) was evidenced. It was noted that as the region's GDP increases, health spending also rises. Probably a higher level of income demands a demand for prevention services and treatments at a higher level of complexity. In regions with high HDI, economic growth is reflected in the improvement in the population's quality of life. The study by Marães *et al*. (2015) corroborates the results of this research, observing that in regions where there is a lower concentration of HEIs there is also the lowest GDP and the lowest economic activity in the country. These data allow us to infer that the distribution of the courses is related to the economic development of the regions (Marães *et al*., 2015). Through the use of the spatial distribution, expressed through thematic maps, it was possible to describe and facilitate the visualization of the studied scenario, allowing to show associations between the distribution of the HEIs that have the biomedicine courses and to associate to the development of the regions with the highest concentrations of the courses. Finally, Biomedicine in Brazil, since its inception, has presented many curricular changes, developing qualified professionals, and expanding its areas of qualifications to accompany the population's need in health, where the profession grows according to the expansion in the labor market, making possible and essential to the opening of new undergraduate courses by the Brazilian regions.

**Conclusion**

The present research showed that, in Brazil, the increase in the supply of Biomedicine courses by Higher Education Institutions has been notable, but this expansion has not been uniform. An example of this disparity can be verified in the analysis by regions, which evidenced the Southeast region as the leader in IES registration with the Biomedicine course, unlike the central and western regions, which recorded the lowest numbers of HEIs with the course. Nevertheless, it is possible to emphasize that biomedicine in Brazil has achieved great acceptance and notoriety in the large study centers, which has favored its implantation in many universities spread throughout the country, being one of the courses that tends to progress due to the increase in the incidence of epidemics that affect Brazil and the world. Finally, it is expected that this distribution of Higher Education Institutions with the Biomedicine Course may serve as an incentive to conduct research on the professional training of biomedical and its importance for public health, thematic still under-researched in Brazil. This lack of scientific studies has limited further research on the subject and reveals the need for biomedical research.

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