SPATIAL STUDY OF INCIDENCE RATES OF OCCUPATIONAL ACCIDENTS IN BRAZIL FROM 2002 TO 2012

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- ABSTRACT: The intensive process of economic growth and job creation in Brazil in the last years is often associated an important dimension where this process is far drop satisfactory: the high incidence rates of occupational accidents. Important instruments can be constructed from the quantitative study considering possible changes caused by economic dynamics over the years. We conducted exploratory spatial data analysis (ESDA) and Local Indicators of Spatial Association (LISA) to analyze the spatial distribution of this rate in order to identify critical regions in Brazil. Data were extracted from the Brazilian Ministry of Labor and Employment (MTE) and from the Brazilian Ministry of Social Security websites for the years from 2002 to 2012. Results show that the incidence rate of occupational accidents in Brazil is distributed in a geographically non-random manner and municipalities with high rates tends to cluster.

- KEYWORDS: Spatial statistics; incidence rates of occupational accidents; Brazilian municipalities.

1 Introduction

The intensive process of economic growth and job creation that Brazil has experienced in the last years, combined with the rapid pace of technological change and the persistence of unsafe or environmentally threatening working conditions, often is associated with an important dimension in which this process is far from satisfactory: the high incidence rates of occupational accidents.

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In Brazil, country with an estimated population of 202 million inhabitants, the economic relevance of work-related accidents is a very serious and widespread public health problem. According to information from the Statistical Yearbook of Accidents at Work (AEAT) of the Ministry of Social Security (MPS), more than 700,000 cases of work-related accidents are recorded in Brazil every year excluding cases that are not officially notified. In 2012 there were registered 705,239 occupational accidents and diseases among workers covered by Social Security. Among these records, 14,755 cases of permanent disability and 2,731 deaths there were registered.

According to the National Institute of Social Security (INSS), the number of occupational accidents has decreased in Brazil in recent decades. This is not due solely to individual aspects of the workers; they are also related to workers protection policies, both in its design and organization, as in the execution of its various dimensions: technical, economic, social, cultural and political (SANTANA *et al.*, 2007). Thus, regional complexity of occupational accidents occurrence in Brazil varies and also dependent on the nature, stage and diversity of the productive processes installed in each of the 27 federation units that make up the country.

It is still incipient the number of quantitative studies that investigate the incidence of occupational accidents in Brazil. Despite this, some important research has been carried out especially in the epidemiological field. Santana *et al.* (2005) synthesized epidemiological findings about fatal and nonfatal occupational accidents in Brazilian populations, from 1994 to 2004, in order to delineate the extent of the problem in the country, the distribution's characteristics and the quality of information. Santana *et al.* (2006) show the great burden represented by work accidents among the diseases and health problems that generate temporary disability for work, in the case of workers who could receive insurance benefits in Brazil.

Considering the issue of occurrence and registration of occupational accidents, which is influenced by multiple factors, such as the scientific and technological progress, as well as local socioeconomic transformations, combined with scarce literature on occupational accidents incidence in Brazil, there is much to be studied and learned about. Therefore, important instruments can be constructed from the quantitative study of occupational accidents in Brazilian municipalities, considering possible changes caused by economic dynamics over the years. These are essential to the study of spatial distributions with application of spatial statistical techniques in order to identify patterns and risk areas – conglomerate of municipalities with the highest incidence of accidents – and also to examine if the distribution of such event is random geographically. This assessment can be useful in defining priority municipalities for the development of strategic actions of surveillance and distribution of resources, considering the various factors involved in occupational risks of municipalities and surrounding region.

The paper is organized as follows: Section 2 presents the statistical methodology used in the study and website where the necessary components can be downloaded. Section 3 analyses the evolution of spatial distribution of the incidence

rates of occupational accidents in Brazil from 2002 to 2012. Finally, Section 3 summarizes the main results from the empirical analysis and presents the closing remarks.

2 Material and methods

Exploratory spatial data analysis (ESDA) is a subset of exploratory data analysis methods that focus on the distinguishing characteristics of geographical data and, specifically, on spatial autocorrelation and spatial heterogeneity (ANSELIN *et al.*, 2007). ESDA represents a preliminary process where data and research results are viewed from many different vantage points, one of which is the display of data on maps.

In this study, spatial data are observed on polygon entities with defined boundaries – areal data; for details, see Bivand *et al.* (2013). The polygon boundaries may be administrative boundaries created for very different purposes. The observed data are aggregations within the boundaries and then the areal entities constitute the units of observation. By and large, areal entities are aggregates used to tally measurements, like the incidence rates of occupational accidents in Brazilian municipalities.

We conducted ESDA to quantify the spatial dependence between events in order to analyze the spatial spread of the incidence rates of occupational accidents in different years. Here, exploratory techniques examine the null hypothesis that there is no spatial dimension to the distribution of incidence rates of occupational accidents across Brazil's municipalities. Stated otherwise, ESDA examines whether the distribution of incidence rates is spatially random. It also helps in visualizing patterns in the data and identifying spatial clusters.

Spatial autocorrelation is an important tool in ESDA. This statistic ranges from -1 to 1 indicating negative and positive spatial autocorrelation, respectively. First, the existence of spatial autocorrelation of the incidence rates was examined using the well-known Moran's I index. Consider a region divided in m spatial units indexed by i and j $(i, j = 1, 2, \ldots, m)$ and let n_i and x_i be the number of cases and the risk population in spatial unit i, respectively. The observed rate in unit i is defined as $p_i = n_i/x_i$. Moran's I is given by

$$I = \frac{m}{\sum\limits_{ij} w_{ij}} \frac{\sum\limits_{ij} w_{ij}(p_i - \bar{p})(p_j - \bar{p})}{\sum\limits_{i}(p_i - \bar{p})^2},$$

where the value w_{ij} is the weight assigned to spatial units i and j, and $\bar{p} = \sum\limits_{i} p_i/m$. Here, w_{ij} was defined as $w_{ij} = 1$ if $i \neq j$ and the spatial units are adjacent, and by $w_{ij} = 0$, otherwise. However, incidence rates and the estimated Moran's I index may be affected when the size of the risk populations is very unequal and/or the numbers of observed occupational accidents are very small. In such cases, the

variance may not be constant in the study area. Hence, we use the empirical Bayes index (EBI) proposed by Assunção and Reis (1999) to produce more satisfactory estimates using a deviation of the estimated marginal mean standardized by an estimate of its standard deviation:

$$z_i = \frac{p_i - b}{\sqrt{v_i}},$$

where b and v_i stand for the marginal expectation and the variance of the relative risk p_i, respectively. The EBI is estimated on the basis of the proposed z_i scores rather than the original risks p_i,

$$\text{EBI} = \frac{m}{\sum\limits_{ij} w_{ij}} \frac{\sum\limits_{ij} w_{ij} z_i z_j}{\sum\limits_{i} (z_i - \bar{z})^2}.$$

The statistical significance of Moran's I and EBI is tested on the basis of the standardized normal distribution using 1,000 permutations.

The Local Indicators of Spatial Association (LISA) was applied to measure the degree of local spatial association for each observation in the data set. In turn, LISA statistic provides information on the correlation of an outcome of interest among a focal unit i and the units to which i is connected, j (e.g., i's neighbors, j), whether the association is positive (i.e., similar values) or negative (i.e., dissimilar values), and whether the association is statistically significant. Thus, the LISA statistic serves to identify local clusters or spatial patterns of an outcome of interest. To be clear, while the global Moran's I may suggest, in general, that there is little spatial autocorrelation in the data, LISA values can identify smaller geographic areas where positive or negative clustering occurs.

The LISA is calculated for each area based on the spatial weights object used. The values returned include a Z-value, and may be used as a diagnostic tool. The statistic is:

$$I_i = \frac{(p_i - \bar{p})}{\sum\limits_{i} (p_i - \bar{p})^2 / (m-1)} \sum_{j} w_{ij} (p_j - \bar{p}),$$

and its expectation and variance are given in Anselin (1995).

The cartographic bases and digital networks used in the georeferencing were obtained from the Brazilian Institute of Geography and Statistics (IBGE) website.[1] IBGE provides maps of the Brazilian territorial space divided into 5,566 municipalities according to the digital municipal mesh of 2007. There are shapefiles for Brazil and its 27 Federation Units divided by municipalities and maps of each municipality divided by census tracts. In our study of spatial aggregates, the spatial unit of analysis is the municipality; Figure 1.

Exploratory spatial analysis, maps and estimations were carried out in R (R CORE TEAM, 2018), using the rgdal (BIVAND *et al.*, 2015) and spdep (BIVAND and PIRAS, 2015) packages.

[1]IBGE is the Brazilian official institution for census and socioeconomic data.

Figure 1 - Map of the Brazilian territorial space divided into 5,566 municipalities; IBGE.

2.1 Data

The incidence rate is defined as the number of occupational accidents per 1,000 persons in employment (CHAGAS *et al.*, 2011). The use of incidence rates instead of the total number of accidents at work allows abstracting from the evolution of total employment. To assist in calculating incidence rates, information about the annual number of new cases of occupational accidents registered and the annual average number of employment ties during the calendar year are required. These data were extracted from the Brazilian Ministry of Labor and Employment (MTE) and from the Brazilian Ministry of Social Security websites.[2] Then the incidence

[2]Data available in `http://bi.mte.gov.br/` and `http://www3.dataprev.gov.br/aeat/`. Access in December 2015.

rate is obtained by the ratio:

$$\frac{\text{Annual number of new cases of occupational accidents registered}}{\text{Annual average number of employment ties}} \times 1{,}000.$$

The analysis used in this study is univariate and our key variable is the incidence rate of occupational accidents given in equation above.

3 Results

We analyse the evolution of the spatial distribution of workplace accidents in Brazil drop from 2002 to 2012. We do not present results for the absolute number of cases of occupational accidents recorded in Brazilian municipalities.

Table 1 shows the distribution of the number of municipalities by incidence rate ranges from occupational accidents in Brazil. It should be stressed the range. Called attention to the range which includes municipalities with an incidence rate equal to zero. In this range ('Equal to 0'), there is a downward trend in the number of municipalities without accident records over the years; there were 1,767 municipalities in 2002 and 988 in 2012. In the incidence range greater than 100 by 1,000 employment ties ('Greater than 100'), the number of municipalities also decreases; were computed 91 in 2002 and only 18 in 2012.

Table 1 - Number of municipalities by incidence rate ranges from occupational accidents in Brazil, 2002 to 2012

	Year										
Incidence rate	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Greater than 100	91	79	92	68	47	34	37	37	25	17	18
(50,100]	114	129	156	150	132	137	159	123	105	89	80
(20,50]	653	665	807	811	770	832	965	886	781	729	711
(10,20]	1,073	1,117	1,196	1,240	1,295	1,149	1,104	1,119	1,190	1,199	1,263
(5,10]	891	959	941	1,004	1,019	1,017	932	977	1,042	1,053	1,161
(0,5]	977	949	867	842	909	946	926	986	1,050	1,094	1,345
Equal to 0	1,767	1,668	1,507	1,451	1,394	1,451	1,442	1,438	1,373	1,385	988

The existence of spatial autocorrelation in incidence rates of occupational accidents was analyzed using Moran's global (I) index and empirical Bayes index (EBI). Positive and negative values indicate the presence of positive and negative spatial autocorrelation, respectively, and null values indicates global independence. For testing the statistical significance of these indexes, the null hypothesis is the spatial independence.

The Moran's I and EBI statistics results are summarized in Table 2. The second column gives the observed Moran's I value and the third column gives the EBI; associated p-value in parentheses. This p-value is determined on the basis of the standardized normal distribution using 1,000 permutations of the observed rates. Note the positive spatial autocorrelation (tend to be clustered together in space) for all years considered. All values are statistically significant at the 1% level. These results indicate that the incidence of accidents in a Brazilian municipality

is positively correlated with the average incidence of accidents in neighboring municipalities. This indicates that the incidence of occupational accidents are not occurring randomly in the Brazilian municipalities.

Table 2 - Moran's global (I) index and empirical Bayes index (EBI) for incidence rates of occupational accidents in Brazil, 2002 to 2012, and associated p-value

Year	**Moran's I**	**EBI**
2002	0.1714 (<0.001)	0.2927 (<0.001)
2003	0.2377 (<0.001)	0.3129 (<0.001)
2004	0.2171 (<0.001)	0.2224 (<0.001)
2005	0.2318 (<0.001)	0.2109 (<0.001)
2006	0.2538 (<0.001)	0.2211 (<0.001)
2007	0.2296 (<0.001)	0.1666 (<0.001)
2008	0.1869 (<0.001)	0.1259 (<0.001)
2009	0.1468 (<0.001)	0.0897 (<0.001)
2010	0.1555 (<0.001)	0.0963 (<0.001)
2011	0.1535 (<0.001)	0.0944 (<0.001)
2012	0.1704 (<0.001)	0.1158 (<0.001)

The spatial distribution of the incidence rate of occupational accidents across Brazil's 5,566 municipalities and the corresponding LISA cluster maps from 2002 to 2012 are shown in Figures 2 and 3, respectively.

The incidence rate of occupational accidents among the different municipalities over the eleven years investigated shows diverse pattern. It can be noticed the presence of some isolated municipalities with incidence rates that surpass 100 accidents per 1,000 employment ties (darkest areas) and there is indication of agglomeration of municipalities with relatively high incidence rates of accidents, especially in the Southeast and South regions of the country. In contrast, there are areas in Brazil that are lightly colored, i.e., have low incidence rates of occupational accidents. These results suggest the use of LISA, in order to identify the spatial dependence and quantify the degree of spatial association in each locality of the sample group.

LISA was then applied in order to map which of the municipalities has a statistically significant relationship with its neighbors and reveal the location where each group tends to agglomerate. LISA *cluster maps* were constructed to visualize the distribution of statistically significant clusters and are shown in Figure 3. Blank areas are regions of spatial randomness in the distribution of incidence rates of occupational accidents, while colored areas are non-random spatial clusters. All cluster associations are significant at least at the 10% level ($\alpha = 0.1$). Municipalities colored for significance constitute the core of spatial clusters. That is, the colored municipalities have a statistically significant relationship with the municipalities that border them, including those that are clear. Thus, the outer boundary of the cluster extends into the blank municipalities bordering the colored one, and the true size of the spatial cluster is larger than the colored cores; see Anselin (2005).

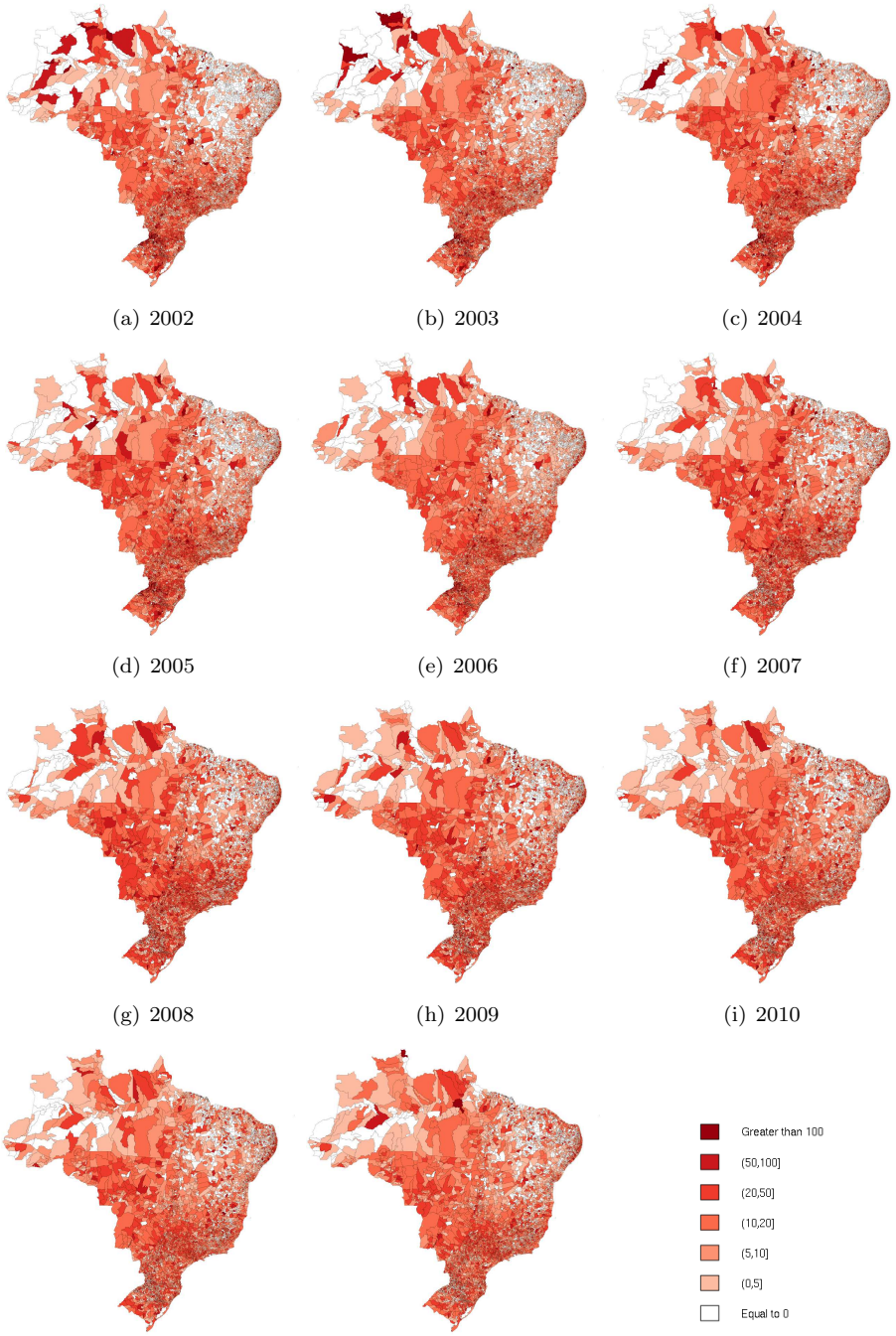
The interpretation of LISA *cluster map* is straightforward. Red identifies

those municipalities with high incidence rates of occupational accidents that are surrounded by municipalities with similarly high incidence rates (indicated on the map as "high-high"). Dark blue identifies units with low incidence rates surrounded by units with similarly low rates ("low-low"). Light blue identifies those units with low incidence rates surrounded by units with high rates ("low-high"), while the pink identifies those with high incidence rates of occupational accidents surround by units with low rates ("high-low"). The strongly colored regions are therefore those that contribute significantly to a positive global spatial autocorrelation outcome, while paler colors contribute significantly to a negative autocorrelation outcome. When a particular municipality has a high incidence rate and it is near other municipalities in the same situation, it was considered as critical region for the event studied.

The LISA *cluster map* in Figure 3 suggest some significant critical regions ("high-high") for incidence rates of occupational accidents across Brazilian space, i.e., municipalities with high incidence rates are considered to agglomerate and form clusters in specific areas of the country. For example, there is a clear cluster in the North region of Brazil in 2002. This cluster consists of 7 municipalities of the state of Roraima added the 3 municipalities of the Pará state. In the Southeast, São Paulo has 106 municipalities located in "high-high" regions and Minas Gerais has 20. In more serious situation, the South region has 296 municipalities in critical regions in 2002; 145 in Rio Grande do Sul, 121 in Santa Catarina and 30 in Paraná.

In some years, the critical regions represent spatial regimes that cross boundaries of states. The broadest critical region in South region of Brazil, from 2002 to 2006, includes municipalities of Paraná, Santa Catarina and Rio Grande do Sul, simultaneously. Notably, there are still some small clusters of municipalities in other specific areas of the country. This spatial regime tends to repeat itself until 2006, despite the lower participation of municipalities in the state of Roraima in critical regions. The state of São Paulo and the South region continues to present groups of municipalities in "high-high" areas. From 2002 to 2006, a group of municipalities of the Rio Grande do Sul remains in this area and Santa Catarina appears almost as a single large critical region.

Similar to 2007, a pattern change in the spatial distribution of the incidence rates of occupational accidents in Brazil is checked. In order to reduce the under-registration of occupational accidents in Brazil through the Occupational Accident Communication (CAT), in 2007 was introduced the new system of concession of social security benefits. With this system, the INSS is responsible for indicating if the worker's disability is due to occupational accident, impacting the way the work accident statistics are compiled by the Ministry of Social Security. This should be the main reason for the changing pattern of distribution of the incidence rates evidenced on maps from 2007, when the South region of the country is no longer the region with the highest participation of municipalities in critical regions, condition now assumed by the Southeast. It was also this year that São Paulo became the state with a higher proportion of municipalities in critical regions; are observed 210 municipalities in 2007 and 205 in 2008, remaining at that level until 2012. In addition, after 2007 there is a significant increase of municipalities from Central-



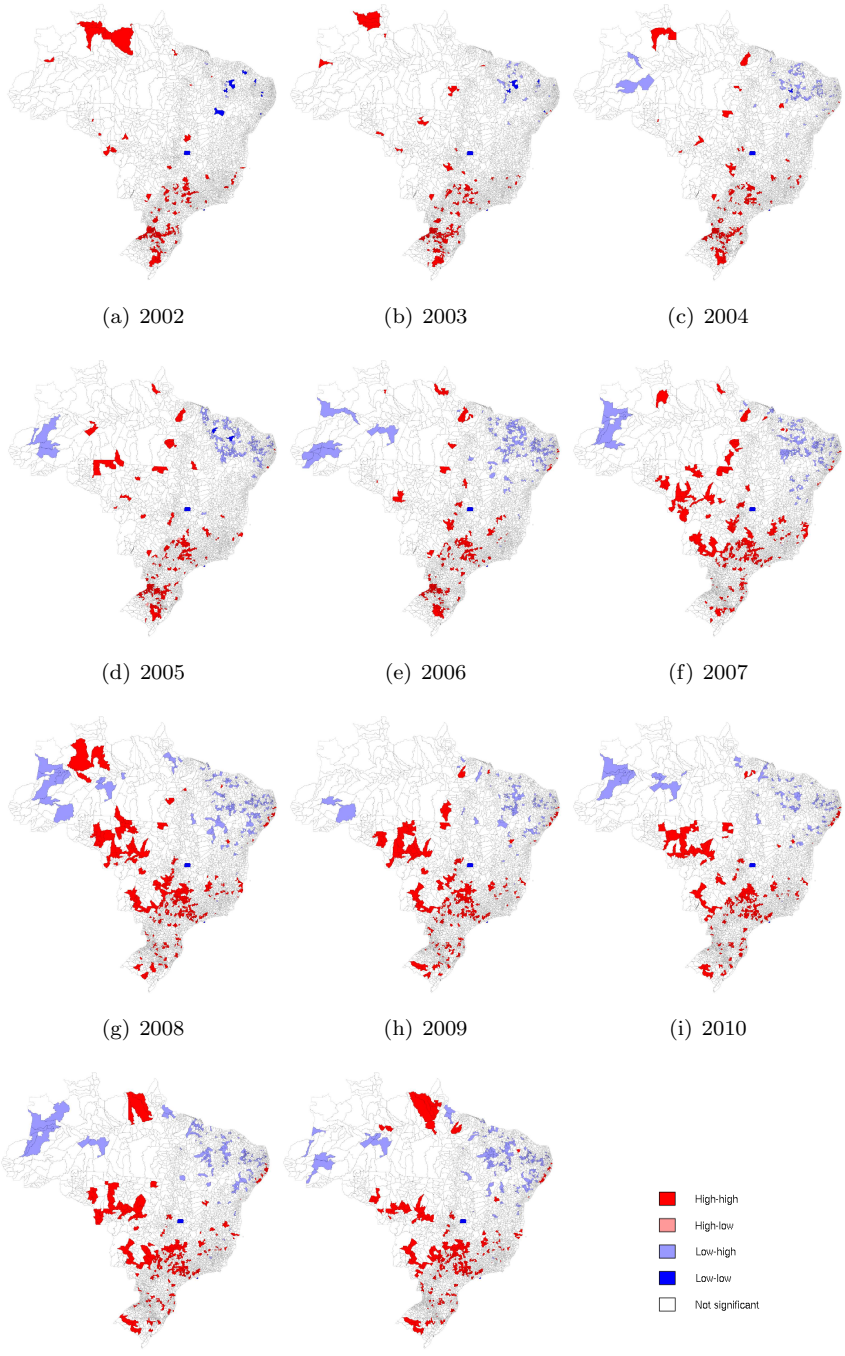
(a) 2002 (b) 2003 (c) 2004

(d) 2005 (e) 2006 (f) 2007

(g) 2008 (h) 2009 (i) 2010

(j) 2011 (k) 2012

Figure 2 - Spatial distribution of incidence rates of occupational accidents, 2002–2012.



(a) 2002 (b) 2003 (c) 2004

(d) 2005 (e) 2006 (f) 2007

(g) 2008 (h) 2009 (i) 2010

(j) 2011 (k) 2012

Figure 3 - LISA cluster map of incidence rates of occupational accidents, 2002–2012.

West in critical regions and formation of spatial clusters of municipalities with high incidence rates that cross boundaries of the states of São Paulo, Minas Gerais, Mato Grosso do Sul and sometimes reach the state of Goiás.

Distrito Federal – the administrative division where the country's seat of government, Brasília, is located – remains, from 2002 to 2012, as an area of low incidence rate surrounded by municipalities with similarly low rates, therefore in the "low-low" region (dark blue area).

Table 3 - Percentage of municipalities with high incidence rates of occupational accidents that are surrounded by municipalities with similarly high incidence rates ("high-high")

		Year										
	Federation Unit	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
North	Amazonas	1.6	1.6	–	3.2	–	–	4.8	–	–	–	4.8
	Acre	–	–	–	–	–	–	–	–	–	–	–
	Amapá	–	–	–	6.3	18.8	6.3	–	–	–	6.3	37.5
	Pará	2.1	2.8	3.5	4.9	4.2	5.6	1.4	2.8	1.4	1.4	4.2
	Rondônia	3.8	3.8	1.9	1.9	1.9	9.6	15.4	15.4	5.8	9.6	7.7
	Roraima	46.7	33.3	20.0	–	6.7	6.7	13.3	–	–	–	–
	Tocantins	–	–	–	1.4	1.4	2.2	–	–	–	–	–
Northeast	Alagoas	–	2.9	3.9	3.9	7.8	9.8	17.6	15.7	20.6	15.7	14.7
	Bahia	0.2	–	–	–	–	1.2	1.0	1.2	0.7	1.7	1.9
	Ceará	–	–	–	–	–	–	–	–	–	–	0.5
	Maranhão	0.9	0.5	–	–	–	0.9	0.9	0.9	–	–	–
	Paraíba	–	–	–	0.4	0.4	0.4	0.4	–	–	–	–
	Pernambuco	–	–	0.5	0.5	2.7	2.7	8.1	7.0	9.2	10.3	5.9
	Piauí	–	–	0.9	–	–	0.4	0.4	–	–	–	–
	Rio Grande do Norte	–	–	–	–	–	–	–	–	–	–	–
	Sergipe	–	–	–	–	–	–	–	–	–	2.7	1.3
C.-West	Distrito Federal	–	–	–	–	–	–	–	–	–	–	–
	Goiás	2.4	2.4	4.9	4.1	8.1	11.4	13.0	13.4	7.3	5.7	7.3
	Mato Grosso	5.0	4.3	3.5	7.8	2.8	18.4	21.3	17.0	17.0	17.7	11.3
	Mato Grosso do Sul	2.6	1.3	1.3	1.3	3.8	19.2	23.1	19.2	16.7	24.4	24.4
Southeast	Espírito Santo	9.0	6.4	9.0	5.1	–	12.8	7.7	5.1	6.4	1.3	–
	Minas Gerais	2.3	2.1	2.9	2.8	3.5	5.9	6.4	5.2	5.4	5.9	7.7
	Rio de Janeiro	–	–	–	–	–	3.3	1.1	–	–	–	–
	São Paulo	16.4	16.3	15.0	19.7	22.0	32.6	31.8	27.4	29.6	31.9	31.9
South	Paraná	7.5	7.0	5.8	6.5	7.5	11.5	8.8	7.3	5.3	6.0	8.0
	Rio Grande do Sul	29.2	29.8	26.6	30.8	26.0	6.5	7.5	5.6	4.8	6.5	4.8
	Santa Catarina	41.3	39.2	38.2	34.5	29.4	12.3	13.3	15.0	14.0	14.0	11.9

Values are in percentages (%); '–' indicates absence of municipalities in critical regions.

In complement to visual analysis of Figures 2 and 3, the proportions of municipalities by federation unit that are in critical regions ("high-high") were obtained. Values in percentages are shown in Table 3. Schematically, the analysis is done as follows: in 2002, for example, Amazonas registered 1.6% of its municipalities in critical region.

As can be seen in Table 3, the states of Rio Grande do Sul and Santa Catarina are those with higher proportions of their municipalities in critical regions from 2002 to 2006. From 2007, both states have substantial decreases in percentages. In contrast, from 2007, in Rondônia, Alagoas, Pernambuco, Goiás, Mato Grosso, Mato

Grosso do Sul, Minas Gerais and São Paulo there was an increase in the percentages of their municipalities in critical regions of occupational accidents.

Some states of Northern region of Brazil assume serious proportions in certain years, e.g., Amapá registered 18.8% in 2006 and 37.5% in 2012 and, especially Roraima registered 46.7%, 33.3% and 20.0% in 2002, 2003 and 2004, respectively. In the Northeast region there are no states with high proportions of municipalities in critical regions, except the state of Alagoas. In Central-West region, the states of Mato Grosso (21.3% in 2008) and, especially Mato Grosso do Sul (24.4% in 2011 and 2012) have important numbers. São Paulo is a state of the Southeast region with important participation of municipalities in critical regions in all the years considered here.

Another relevant observation that can be made from the Table 3 is the opposite movement that can be perceived in the proportions obtained for the states of São Paulo and Santa Catarina. When looking at the high proportions of 41.3% (2002), 39.2% (2003) and 38.2% (2004) in Santa Catarina, in the state of São Paulo values were the lowest: 16.4%, 16.3% and 15.0%, respectively. The values went down in São Paulo and the values went up in Santa Catarina in 2008 and 2009 and the proportions went in the opposite direction persistently until 2012.

The reasons for such trends in each of the 27 federation units (UF) are complex, and understanding them requires a consideration of the macroeconomic, social, and political determinants conducive to biological, chemical, physical and ergonomic risks, as well as the presence of psychosocial stressors in the workplace. It is necessary to identify the nature, stage and diversity of the productive processes installed in each UF that make up the country.

Conclusions

A study of spatial aggregates was conducted to identify patterns in the spatial distribution of incidence rate of occupational accidents and risk areas across Brazilian municipalities, 2002 to 2012. Visual inspection of thematic maps is commonly used by health programs and services to identify epidemiologically important areas and to select priority municipalities for intervention.

The incidence rate of occupational accidents in Brazil is distributed in a geographically non-random manner, which may indicate that geographic units are linked together, and occupational accidents in any one Brazilian municipality are influenced by occupational accidents in nearby municipalities. In other words, the likelihood or risk of occupational accidents in any one municipality cannot be explained without reference to the likelihood of occupational accidents in nearby municipality. Thus, policies should not treat municipalities individually or as isolated from each other, since incidence of accidents in one municipality affects incidence of accidents in nearby municipalities.

Clearly there are areas in Brazil where high levels of occupational accidents tends to cluster. These clusters were called critical regions of high incidence. In some situations these critical regions straddle the borders of two or more states of

the country, suggesting the need for implementation of worker protection policies covering these states together. This kind of joint effort may be especially difficult in Brazil where state or municipal authorities have different policy priorities. However, this collaboration must be adopted in order to promote the prevention and reduction of this indicator.

In order to reduce the under-registration of occupational accidents in Brazil through the Occupational Accident Communication (CAT), in 2007 was introduced the new system of concession of social security benefits. With this system, the National Institute of Social Security (INSS) is responsible for indicating if the worker's disability is due to occupational accident, impacting the way the work accident statistics are compiled by the Ministry of Social Security. This should be the main reason for the changing pattern of distribution of the incidence rates evidenced on maps from 2007, when the South region of the country is no longer the region with the highest participation of municipalities in critical regions, condition now assumed by the Southeast. It was also this year that São Paulo became the state with a higher proportion of municipalities in critical regions.

The purpose of this study was exploratory and have not been investigated other covariates that may be related to the incidence of occupational accidents in Brazil. It is suggested to evaluate the Human Development Index (HDI), Gross Domestic Product (GDP), population education level, the predominant industry sectors, the presence of Reference Centers for Workers' Health (CEREST), among others. In addition, it is necessary to identify the nature, stage and diversity of the productive processes installed in each of the 27 federation units that make up the country in order to implement appropriate strategies to the predominant sector of activity in each Brazilian municipality and surrounding region.

According to information from the Ministry of Social Security, the municipality to which the data of occupational accident is assigned is the municipality where the accident occurred. Thus, the published statistics may differ from local surveys, if used the concept of municipality where the employer establishment is located or municipality of residence of the injured.

Population-based studies on workers' health have the advantage that they represent an existing epidemiological profile of the workforce, which allows the identification of occupational groups that can be studied in more detail with other methodologies (SANTANA and LOOMIS, 2004). According to Park (2002), by enhancing exposure assessment through a focus on case series, epidemiologic research can expand its contribution to preventing workplace injuries. National databases and information systems of employers and insurers could contribute case series for injury hazard identification (PARK, 2002).

Finally, the study stresses the importance of conducting further studies to explore socioeconomic, demographic, environmental and cultural aspects of the country in order to orient the use of specific strategies as the most-effective intervention to improve prevention-oriented practices of occupational accidents in Brazil. However, as should be adopted throughout government program focusing on collectivity, any strategy of worker protection should not be directed at individual

municipalities, treating them as if it were isolated or independent of each other.

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- *RESUMO: O processo intenso de crescimento econômico e geração de empregos no Brasil nos últimos anos está frequentemente associado a uma importante dimensão onde esse processo está longe de ser satisfatório: as altas taxas de incidência de acidentes ocupacionais. Importantes instrumentos podem ser construídos a partir do estudo quantitativo, considerando possíveis mudanças causadas pela dinâmica econômica ao longo dos anos. Aplicamos análises exploratórias de dados espaciais e Indicadores Locais de Associação Espacial (LISA) para e espacialmente a distribuição dessa taxa, a fim de identificar regiões críticas no Brasil. Os dados foram extraídos do Ministério do Trabalho e Emprego e do Ministério da Previdência Social para os anos de 2002 a 2012. Os resultados mostram que a taxa de incidência de acidentes ocupacionais ocorre de forma geograficamente não-aleatória e que municípios com altas taxas tendem a se agrupar.*

- *PALAVRAS-CHAVE: Estatística espacial; taxa de incidência de acidentes ocupacionais; municípios brasileiros.*

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