Adriana Guerra Campos[a]

Aline do Monte Gurgel[b]

[a] Universidade de Pernambuco, Faculdade de Ciências Médicas. Recife, PE, Brazil.

[b] Fundação Oswaldo Cruz (Fiocruz). Fortaleza, CE, Brazil.

Contato:
Adriana Guerra Campos

E-mail:
ftadrianaguerra@gmail.com

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Severe occupational accidents and productive activities in health administrative regions in Pernambuco: an analysis based on the identification of local productive clusters

Acidentes de trabalho graves e atividades produtivas nas regiões administrativas de saúde em Pernambuco: uma análise a partir da identificação de aglomerados produtivos locais

Abstract

Introduction: *the state of Pernambuco, in Brazil, has been undergoing transformations that attract businesses and workforce.* Objective: *to analyze how the productive concentration established in the health administrative regions of Pernambuco interfered in the profile and distribution of the severe occupational accidents from 2011 to 2013.* Method: *the Locational Quotient was used to identify the formation of specialized productive clusters in the Health Administrative Regions and to compare them with the occurrence of severe accidents.* Results: *the most injured workers were men (89.7%) aged between 30 and 44 years. Six health administrative regions were identified as specialized in a particular productive activity, but the occupations with more accidents recorded were: agricultural workers (15.4%), bricklayers (8.7%) and unskilled construction workers (4.0%), even in regions where agricultural and construction activities were not the main productive sector.* Conclusion: *the identification of productive clusters enabled the understanding of the productive organization pattern in the state, as well as of the profile of injured workers in each location, allowing the identification of productive sectors and priority occupations for structuring of workers' health surveillance.*

Keywords: workers' health; occupations; occupational accidents; productive clusters.

Introduction

Since the 2000s, Brazil began to experience an accelerated economic growth. From 2007 on, with the increase of economic growth rates, the developmental ideology reemerged with improvements, due to the rise of a new model of government named "neo-developmentalism"[1,2]. The main "neo-developmentalism" strategies favor, through foreign direct investments, commodity exports and the business with large transnational and financial capital companies[1,3].

However, this model of growth is marked by environmental injustice, i.e., investments and businesses that use resources of the territories and concentrate income and power while the burden of development falls on the most vulnerable population groups, affecting the health and integrity of ecosystems, inhabitants and workers, who are often subject to accidents[4].

Occupational accidents are predictable and avoidable events. Work has been a frequent scenario of accidents that involve spending on health services, compensation and pension, in addition to all the social consequences to the injured worker[5]. According to the International Labour Organization (ILO), annually 2.34 million deaths occur worldwide due to work-related accidents and diseases, causing losses of 2.8 billion dollars per year[6]. Although there are security measures to prevent the occurrence of accidents, they are not enough, since their requirements are often not complied with[7].

The recent installation of various industries in Pernambuco (an oil refinery; a coke processing unit; a petrochemical pole; shipyards; several national and multinational food, automobile and pharmaceutical companies; and other enterprises with high polluter potential) indicates the migration of "dirty" industries to the state, also representing new risks and new forms of falling ill and dying in the territory, particularly for workers[8].

Considering that the occurrence of occupational accidents is a public health problem, there is the need to monitor its occurrence and implement preventive measures. Since 2004, the notification of severe occupational accidents in the Notifiable Diseases Information System (Sinan) is mandatory, and comprises accidents that caused death or maiming of individuals in any age group, as well as accidents with persons under legal age (18 years old), regardless of the seriousness of the injury[9].

Although the information present in the Sinan are important to understand the characteristics of accidents related to work, it is necessary to include other analyses that consider aspects associated with the socioeconomic development that has occurred in the territory over the years. Encompassing varied and complex situations, the accident phenomenon can be understood in its various dimensions, enabling a more complete interpretation and limiting the occurrence of out of context and mistaken analyses[10].

In this sense, the identification of local productive clusters is an important analytical tool, because it allows us to identify local concentrations of industrial production systems and indicates if a particular territory has expertise in a particular productive activity[11,12]. These concentrations are determined by the calculation of the Locational Quotient (LQ)[11,12], which enables the identification of local clusters specialized in a particular productive activity, and can assist in understanding the changes and differences in the morbidity and mortality profile of workers in different territories. This identification of local productive arrangements is essential to build a health network geared to workers, providing services in accordance with the economic profile of the region.

In this perspective, this study aimed to analyze the occurrence of severe occupational accidents according to the productive clusters established in the Health Administrative Regions, from 2011 to 2013, to verify how productive concentration interferes in the profile and distribution of these accidents in the state.

Method

A descriptive, cross-sectional study was carried out. Data were collected from severe occupational accidents recorded in Sinan, the main health information system to record diseases and injuries of mandatory notification. Data on employment in the

formal sector were collected by the Annual Relation of Social Information (Rais), of the Brazilian Ministry of Labor and Employment (MTE). For the collection of data, we considered the records from the period between 2011 and 2013.

To characterize the population of workers who have suffered several occupational accidents, variables for the identification of the following characteristics were selected: a) sociodemographic (age, education, gender, race); b) regarding work (occupation, labor market situation); and c) regarding accident (type of accident, parts of the body affected, outcomes of the case, and emission of work accident communication – CAT). The occupations were classified according to the Brazilian Classification of Occupations (CBO)[13].

The analysis of the productive sectors concentration and the identification of local productive activities agglomeration was carried out by determining the Locational Quotient (LQ)[14,15]. LQ enables to measure the concentration of a certain economic activity in a given area, taking as reference the distribution of this activity in a wider geographical area, comparing two sector-spatial structures. In this study, the geographical reference used to calculate the LQ was based on the 12 state Health Administrative Regions defined by the Director Plan for Regionalization (PDR) in activity in Pernambuco[16]. Such criterion was chosen to identify the productive clusters in neighboring cities aiming at integrating the organization, planning, and execution of health actions and services directed to workers.

From the calculation of LQ, it is possible to highlight the specialization of a region at a particular productive activity when the result is greater than 1 (one), pointing out that, in this territory, a particular production sector is more important than in the regional context of all sectors. The calculation to obtain LQ is described below:

$$QL_{ij} = \frac{\dfrac{E_j^i}{E_j}}{\dfrac{E_{PE}^i}{E_{PE}}}$$

Where:

E_j^i = employment in the productive activity i in region j;

E_j = total employment in region j;

E_{PE}^i = employment in productive activity i in Pernambuco;

E_{PE} = total employment in Pernambuco.

The calculation of LQ is based on the number of workers in each sector as base variable, due to its greater information availability and the degree of uniformity to measure and compare the distribution of sectors or activities in the territory, as well as due to its representativeness to measure economic growth[17]. Quantitative data of workers were obtained according to the existing eight productive sectors (mineral extraction; processing industry; public utility industrial services; construction; commerce; services; public administration; agriculture and livestock, vegetal extraction, hunting and fishing). For locational analysis of productive sectors it was used the division of economic activity subsectors defined by the Instituto Brasileiro de Geografia e Estatística – IBGE [Brazilian Institute of Geography and Statistics], totaling 25 areas.

Although it is possible to identify the specialization of a given region in a productive sector when the LQ is above 1, it is necessary to consider regional disparities when a high number of subsectors is above this value in different regions. Given the regional inequality of distribution of the productive structure, the cut-off value assumed by LQ should be significantly above this number[11,12]. To ensure the grouping of cities with high specialization and high productive concentration indexes, thus conforming a local production system, this study adopted LQ≥4 as cut-off point [11].

In the end, the main occupations in the regions with records of severe occupational accidents were compared with the regions with productive specialization (LQ≥4).

The data were organized with the aid of Microsoft Excel worksheets (version 2010), allowing us to identify productive clusters and to analyze them from the notifications of the severe occupational accidents in the territory, according to the city that notified them.

This study was approved by the Research with Human Beings Ethics Committee of the Hospital Complex HUOC/PROCAPE under CAAE 41093415.8.0000.5192.

Results

In the analyzed period, in Pernambuco 64.3% of the severe occupational accident notifications were related to the so-called typical accidents, i.e., accident that occur at workplace during work activity. Of these, 39.7% happened with workers officially registered as employees, followed by 12.3% self-employed professionals. However, in 18.9% of the forms this variable was filled out as

"not known". The same applies to the CAT emission – the corresponding field was filled as "not known" in 39.9% of the forms. In 37.1% of cases, CAT was not emitted.

Table 1 shows the sociodemographic characteristics of the workers seriously injured in Pernambuco during the 2011-2013 period. According to Sinan registers, there were a total of 3,444 records: 29.3% in 2011; 33.7% in 2012; and 37.0% in 2013. For all the periods analyzed, most of the injured workers were in the age group of 30 to 44 years, followed by young adults (18-29 years). In 1.13% of the notified cases, birth and notification date were the same, evidencing a mistake in notifying the information. These cases were not used for

Table 1 Sociodemographic characteristics of workers involved in severe occupational accidents. Pernambuco (2011-2013)

Variables	2011 n (%)	2012 n (%)	Year 2013 n (%)	Total n (%)
Age				
Minor (<18)	35 (3.5)	38 (3.3)	27 (2.1)	100 (2.9)
Young adult (18 to 29)	358 (35.5)	383 (33.0)	478 (37.5)	1.219 (35.4)
Maturity (30 to 44)	371 (36.8)	465 (40.1)	500 (39.2)	1.336 (38.8)
Transition age (45 to 59)	173 (17.1)	218 (18.8)	210 (16.5)	601 (17.5)
Older adult (≥60)	64 (6.3)	39 (3.4)	46 (3.6)	149 (4.3)
Excluded by mistake	8 (0.8)	16 (1.4)	15 (1.2)	39 (1.1)
Gender				
Male	919 (91.1)	1.031 (89.0)	1.138 (89.2)	3.088 (89.7)
Female	90 (8.9)	128 (11.0)	138 (10.8)	356 (10.3)
Color/race				
White	124 (12.3)	80 (6.9)	102 (8.0)	306 (8.9)
Black	49 (4.9)	38 (3.3)	67 (5.2)	154 (4.5)
Yellow	3 (0.3)	12 (1.0)	7 (0.5)	22 (0.6)
Mixed race	504 (49.9)	670 (57.8)	923 (72.3)	2.097 (60.9)
Indigenous	2 (0.2)	3 (0.3)	6 (0.5)	11 (0.3)
Not known*	262 (26.0)	253 (21.8)	158 (12.4)	673 (19.5)
Not filled**	65 (6.4)	103 (8.9)	13 (1.0)	181 (5.3)
Education Level				
Illiterate	23 (2.3)	21 (1.8)	33 (2.6)	77 (2.2)
Some elementary school	211 (20.9)	129 (11.1)	232 (18.2)	572 (16.6)
Elementary school	20 (2.0)	22 (1.9)	18 (1.4)	60 (1.7)
Some high school	27 (2.7)	21 (1.8)	24 (1.9)	72 (2.1)
High school	64 (6.3)	60 (5.2)	120 (9.4)	244 (7.1)
Some higher education	6 (0.6)	4 (0.3)	6 (0.5)	16 (0.5)
Higher education	13 (1.3)	9 (0.8)	12 (0.9)	34 (1.0)
Not known*	389 (38.5)	635 (54.8)	695 (54.5)	1.719 (49.9)
Does not apply***	12 (1.2)	17 (1.5)	15 (1.2)	44 (1.3)
Not filled**	244 (24.2)	241 (20.8)	121 (9.5)	606 (17.6)
Total per year(s)	1.009 (100.0)	1.159 (100.0)	1.276 (100.0)	3.444 (100.0)

Source: Notifiable Diseases Information System (Sinan-PE).

* Not know: Option chosen during filling of the form when the information could not be obtained.

** Not filled: No option was chosen – blank.

*** Does not apply: indicates possible mistake when filling the form.

the age group analysis, but were considered in the other variables analysis. Regarding gender, men accounted for 89.7% of workers who have suffered severe occupational accidents. Most notifications happened to the mixed race individuals in the years analyzed, but there was a high rate of "not known" registrations in the formulary – 19.5% of total notifications in the studied period, reaching 26% in 2011. As for schooling, we observed a predominance of elementary school. For this variable, we observed incomplete information in over 60% of the cases.

Table 2 presents the main occupations that had notification of severe occupational accidents in the studied period, according to case evolution. We observed a predominance of agriculture and construction workers in all three years. When considering the sum of those years, the occupation that showed higher number of notifications was agricultural workers (15.4%), followed by bricklayers (8.7%) and unskilled construction workers (4.0%). Considering the total cases of accidents recorded in the studied period, most evolved into temporary incapacity (46.9%) or cure (26.5%). Deaths corresponded to 2.6% of the total cases, with significant participation of temporary agriculture workers (8.9% of deaths).

Considering the total cases in the three years (data not presented in table), the main body parts affected in the notified severe occupational accidents were: hand (24.7%), upper limb (22.0%), lower limb and head (both with 20.7%).

Over the studied years, the Health Administrative Region I, which covers the cities of the metropolitan area, had 3,491,690 workers registered in Rais, representing 68.4% of all the workforce employed in the formal sector in Pernambuco. This region is the one that offers most jobs in the state, and has great productive diversification, showing LQ above 1 in over half of the productive sectors.

The analysis of the geographical distribution of the economic activities showed that the productive sectors are not evenly distributed in Pernambuco. As **Table 3** shows, there is a large regional concentration (LQ≥4) in the subsectors of mineral extraction, non-metallic mineral production, agriculture, shoe, textile, food and beverage industry. **Table 3** also presents the Health Administrative Regions where these sectors are inserted and the three occupations with the highest number of accidents in those regions. The production concentration of the other sectors was below the cut-off point adopted for this study (LQ<4), when considering the distribution per Health Administrative Region.

Table 3 highlights that the only Health Administrative Region where the occupations that had most accidents were compatible with the identified productive activity specialized in the territory was the Health Administrative Region VIII, which is mainly agricultural. In the other regions, the main productive activity locally developed and the group of workers affected by severe accidents were divergent.

Table 2 Outcomes of severe occupational accidents in the occupations in which there were more notifications of this type of accident. Pernambuco (2011-2013)

| Occupation (CBO) | | Outcome of the accident | | | | Accident n (%) |
	Cure n (%)	Temporary incapacitation n (%)	Permanent incapacitation n (%)	Death due to the accident n (%)	Other outcomes* n (%)	
2011 (n=1.009)						
Agriculture and livestock worker in general	154 (70.6)	51 (23.4)	5 (2.3)	2 (0.9)	6 (2.7)	218 (100.0)
Bricklayer	23 (31.9)	38 (52.8)	3 (4.2)	2 (2.8)	6 (8.3)	72 (100.0)
Unskilled construction worker	7 (26.9)	12 (46.1)	-	1 (3.8)	6 (23.1)	26 (100.0)
Cook	1 (5.3)	14 (73.7)	1 (5.3)	-	3 (15.8)	19 (100.0)
General assistant of conservation of permanent roads	1 (5.3)	12 (63.2)	-	1 (5.3)	5 (26.3)	19 (100.0)
Mechanic for maintenance of cars, motorcycles and similar vehicles	5 (27.8)	12 (66.7)	-	-	1 (5.6)	18 (100.0)

(Continua)

Tabela 2 Continuação...

Occupation (CBO)	Outcome of the accident					Accident n (%)
	Cure n (%)	Temporary incapacitation n (%)	Permanent incapacitation n (%)	Death due to the accident n (%)	Other outcomes* n (%)	
Temporary agriculture worker	2 (11.8)	6 (35.3)	-	4 (23.5)	5 (29.4)	17 (100.0)
Electrician	1 (7.1)	10 (71.4)	1 (7.1)	1 (7.1)	1 (7.1)	14 (100.0)
Driver	2 (16.7)	9 (75.0)	-	1 (8.3)	-	12 (100.0)
Sugarcane crop worker	3 (42.9)	4 (57.1)	-	-	-	7 (100.0)
Street vendor	1 (20.0)	2 (40.0)	1 (20.0)	-	1 (20.0)	5 (100.0)
Messenger	-	-	-	-	-	-
Other occupations	171 (29.4)	284 (48.8)	36 (6.2)	22 (3.8)	69 (11.8)	582 (100.0)
Total	371 (36.8)	454 (45.0)	47 (4.7)	34 (3.4)	103 (10.2)	1.009 (100.0)
2012 (n=1.159)						
Agriculture and livestock worker in general	73 (46.8)	44 (28.2)	1 (0.6)	-	38 (24.4)	156 (100.0)
Bricklayer	18 (17.5)	38 (36.9)	7 (6.8)	2 (1.9)	38 (36.9)	103 (100.0)
Unskilled construction worker	6 (13.0)	19 (41.3)	1 (2.2)	2 (4.3)	18 (39.1)	46 (100.0)
Street vendor	1 (2.3)	5 (11.4)	1 (2.3)	1 (2.3)	36 (81.8)	44 (100.0)
Temporary agriculture worker	4 (9.3)	14 (32.6)	1 (2.3)	-	24 (55.8)	43 (100.0)
General cook	5 (14.3)	26 (74.3)	-	-	4 (11.4)	35 (100.0)
Sugarcane crop worker	16 (80.0)	4 (20.0)	-	-	-	20 (100.0)
Electrician	3 (15.8)	6 (31.6)	1 (5.3)	4 (21.0)	5 (26.3)	19 (100.0)
Driver	-	4 (22.2)	1 (5.5)	-	13 (72.2)	18 (100.0)
Mechanic for maintenance of cars, motorcycles and similar vehicles	4 (36.4)	7 (63.6)	-	-	-	11 (100.0)
General assistant of conservation of permanent roads	2 (28.6)	5 (71.4)	-	-	-	7 (100.0)
Messenger	-	1 (25.0)	-	-	3 (75.0)	4 (100.0)
Other occupations	131 (20.1)	309 (47.3)	37 (5.7)	14 (2.1)	162 (24.8)	653 (100.0)
Total	263 (22.7)	482 (41.6)	50 (4.3)	23 (2.0)	341 (29.4)	1.159 (100.0)
2013 (n=1.276)						
Agriculture and livestock worker in general	45 (28.5)	72 (45.6)	11 (7.0)	1 (0.6)	29 (18.3)	158 (100.0)
Bricklayer	28 (22.4)	70 (56.0)	2 (1.6)	2 (1.6)	23 (18.4)	125 (100.0)
Unskilled construction worker	14 (21.5)	43 (66.1)	1 (1.5)	-	7 (10.8)	65 (100.0)
Temporary agriculture worker	3 (7.1)	32 (76.2)	-	4 (9.5)	3 (7.1)	42 (100.0)
Cook	3 (7.3)	34 (82.9)	-	-	4 (9.7)	41 (100.0)
Street vendor	2 (7.1)	12 (42.9)	-	3 (10.7)	11 (39.3)	28 (100.0)
Messenger	-	13 (52.0)	-	-	12 (48.0)	25 (100.0)

(Continua)

Tabela 2 Continuação...

Occupation (CBO)	Outcome of the accident					Accident n (%)
	Cure n (%)	Temporary incapacitation n (%)	Permanent incapacitation n (%)	Death due to the accident n (%)	Other outcomes* n (%)	
Electrician	6 (25.0)	10 (41.7)	1 (4.2)	1 (4.2)	6 (25.0)	24 (100.0)
Driver	4 (16.7)	11 (45.8)	2 (8.3)	-	7 (29.2)	24 (100.0)
Sugarcane crop worker	14 (73.7)	3 (15.8)	1 (5.3)	1 (5.3)	-	19 (100.0)
Mechanic for maintenance of cars, motorcycles and similar vehicles	8 (50.0)	8 (50.0)	-	-	-	16 (100.0)
General assistant of conservation of permanent roads	1 (16.7)	2 (33.3)	1 (16.7)	-	2 (33.3)	6 (100.0)
Other occupations	151 (21.5)	371 (52.8)	22 (3.1)	21 (3.0)	138 (19.6)	703 (100.0)
Total	279 (21.9)	681 (53.4)	41 (3.2)	33 (2.6)	242 (19.0)	1.276 (100.0)
2011-2013 (n = 3.444)						
Agriculture and livestock worker in general	272 (51.1)	167 (31.4)	17 (3.2)	3 (0.6)	73 (13.7)	532 (100.0)
Bricklayer	69 (23.0)	146 (48.6)	12 (4.0)	6 (2.0)	67 (22.3)	300 (100.0)
Unskilled construction worker	27 (19.7)	74 (54.0)	2 (1.5)	3 (2.2)	31 (22.6)	137 (100.0)
Temporary agriculture worker	9 (8.8)	52 (51.0)	1 (1.0)	8 (7.8)	32 (31.4)	102 (100.0)
Cook	9 (9.5)	74 (77.9)	1 (1.0)	-	11 (11.6)	95 (100.0)
Street vendor	4 (5.2)	19 (24.7)	2 (2.6)	4 (5.2)	48 (62.3)	77 (100.0)
Electrician	10 (17.5)	26 (45.6)	3 (5.3)	6 (10.5)	12 (21.0)	57 (100.0)
Driver	6 (11.1)	24 (44.4)	3 (5.5)	-	21 (38.9)	54 (100.0)
Sugar cane crop worker	33 (71.7)	11 (23.9)	1 (2.2)	1 (2.2)	-	46 (100.0)
Mechanic for maintenance of cars, motorcycles and similar vehicles	17 (37.8)	27 (60.0)	-	-	1 (2.2)	45 (100.0)
General assistant of conservation of permanent roads	5 (15.6)	19 (59.4)	1 (3.1)	1 (3.1)	6 (18.7)	32 (100.0)
Messenger	-	14 (48.3)	-	-	15 (51.7)	29 (100.0)
Other occupations	452 (23.3)	964 (49.7)	95 (4.9)	58 (3.0)	369 (19.0)	1.938 (100.0)
Total	913 (26.5)	1.617 (46.9)	138 (4.0)	90 (2.6)	686 (19.9)	3.444 (100.0)

Source: Notifiable Diseases Information System (Sinan-PE).

* Includes deaths for other reasons, ignored and left blank.

Table 3 Productive specialization by subsector, according to Health Administrative Region, Locational Quotient (LQ)* and occupations with most notifications of severe occupational accidents. Pernambuco (2011-2013)

Subsector	Health Administrative Region	LQ	Severe occupational accident	
			Occupation	n (%)**
Mineral extraction	IX	19.32	Agriculture and livestock worker in general	128 (44%)
			Bricklayer	17 (5.8%)
			Drivers	4 (1.4%)
Non-metallic minerals production industry	IX	12.57	Agriculture and livestock worker in general	128 (44%)
			Bricklayer	17 (5.8%)
			Drivers	4 (1.4%)
Shoe industry	II	12.48	Temporary agriculture worker	3 (15%)
			Bricklayer	2 (10%)
			Cook	1 (5%)
Agriculture	VIII	6.71	Agriculture and livestock worker in general	5 (7.3%)
			Bricklayer	5 (7.3%)
			Temporary agriculture worker	4 (5.9%)
Textile industry	IV	6.18	Agriculture and livestock worker in general	83 (25.7%)
			Bricklayer	27 (8.4%)
			Construction worker	6 (1.9%)
Food and beverage industry	III	5.35	Sugar cane crop worker	5 (16.1%)
			Bricklayer	3 (9.7%)
			Agriculture and livestock worker in general	2 (6.4%)
	XII	4.92	Bricklayer	22 (8%)
			Construction worker	18 (6.5%)
			Sugar cane crop worker	16 (5.8%)

Sources: Notifiable Diseases Information System (Sinan-PE) and Annual Relation of Social Information (RAIS).

* LQ: Location Quotient – productive concentration calculated based on the number of workers in each activity.

** We considered the sum of severe occupational accidents in the mentioned occupations, regarding the total severe occupational accidents that occurred in the health administrative regions.

Discussion

Pernambuco has been the destination of large industrial enterprises over the past few years. The creation of industrial complexes and the implantation of large factories have attracted a lot of workforce, resulting in a diversification of productive activities in several regions of the state, what influences the behavior and distribution of work-related health problems.

Concerning the accident vicitms' profile, we observed in this study that severe occupational accidents happened predominately with male workers, particularly among adults and young adults, in accordance with the results found in other studies[18,19]. Leigh[20] highlights that accidents that happened with young individuals involve higher indirect financial costs from the social perspective (loss of earnings, benefits and restrictions on household chores), leading to a cost as high as that of cancer. Similarly, we observed that over 50% of the accidents analyzed in this study evolved into some kind of disability, either temporary or permanent (partial or total), which evinces the high social and economic cost of these accidents.

We also observed in this research that the parts of the body mostly affected in accidents were the

hands and upper and lower limbs, as identified in other studies[19,21]. The most affected parts of the body are the most exposed ones during workers tasks, as rural workers' hands and legs, bricklayers' heads and hands, carpenters' hands and cooks' upper limb.

In a study developed in Bahia, Brazil, 78% of the deaths resulting from occupational accidents related to urban violence occurred with individuals who were the family's main livelihood provider[22]. This ratifies the great impact a severe occupational accident can causes, affecting public health and family structures, where people who are closer to the worker bear the main consequences of the accident[23].

It is necessary to consider that the severe occupational accident is an extreme event, producing visibility and impact, but several minor accidents or "near-accidents" that do not have the same visibility may be happening. Furthermore, it is important to point out that work-related diseases and injuries are mostly chronic events with difficult diagnosis due to the fact that there is a gap between the exposure and the emergence of the first symptoms[24]. In some work activities, chronic diseases, like RSI/MSD, are notified significantly more often than acute events, such as severe occupational accidents[21].

Although commuting accidents has been increasing considerably, in general, most of the occupational accidents records refer to typical accidents, an aspect observed in this and in other studies[22,25]. We can conjecture that the characterization of a traffic accident as an occupational accident (commuting accident) is less common than those accidents that happen during the labor activity (typical accident), what would lead to a greater under-notification[19].

The expectation of a higher incidence of occupational accidents within productive activities assembling great number of workers was not confirmed by our findings in the present study. In Pernambuco, the main occupations with severe occupational accidents notifications are not directly related to the main specialized activities developed in the Health Administrative Regions. The study showed that the highest incidence of severe occupational accidents took place among the occupations "agriculture and livestock workers in general" and "temporary agricultural workers" for 75% of the Health Administrative Regions of Pernambuco, regardless of their productive concentration being or not being on the agriculture subsector. An exception was observed in the Health Administrative Region VIII, where the agriculture subsector is dominant and where we found the highest concentration of several occupational accidents notifications for rural workers (temporary

agricultural workers, and agriculture and livestock workers). The injured worker's profile in this subsector is composed of individuals with low schooling and informally linked to their jobs – corroborating the results of other studies[26,27]. Therefore, this group should be a priority for health interventions in that territory, emphasizing preventive actions.

Differently, when considering the production activity concentration by local/municipal administractive region, it is possible to observe that within the same Health Region there are ones that are more engaged than others in certain activities. These evidences that the productive activities are not evenly distributed in the analyzed health administrative regions. This might happened because the analysis of severe occupational accident notifications was carried out according to the notifying unit place (where the worker was treated), as they produced better filled out Sinan data. The cases tend to converge to the Regional Health Centers where treatments of higher technological complexity can be offered and where the severest acute events, such as occupational accidents, are forwarded.

From these results it is possible to formulate some hypotheses about the incompatibility of severe occupational accident notifications and the main productive activities in the territories: a) as determining production concentration involves only the formal sector, it is not possible to correlate it with severe occupational accident notifications of informal workers; b) the productive sector that stands out in the region may not be related to the occurrence of severe occupational accidents but with other acute and/or chronic events; c) workers involved in the accidents may have declared they were rural workers even though this activity did not cause the accident, or they were not even engaged in rural activities; and/or d) agricultural work is, in fact, very dangerous, and workers of this productive sector are often involved by severe accidents either by pesticides exposure or by making use of dangerous working tools.

Regarding accidents reported in agricultural occupations, there are some indications that injured workers do not always performed activities related to the agricultural sector. Although there are no published studies supporting this hypothesis, reports from health care professionals working at the Occupational Health Reference Centers (Cerest), located in the backlands of Pernambuco, point out that this situation is often evidenced in health services in the state, what would disguise the actual occupations where the occurrence of severe occupational accidents stands out. Moreover, there are some records in the observations of the

notification form that corroborate to this hypothesis by presenting data of rural workers accidents related to another activity, such as "lacerations in ice cream machine", for example.

We still have to consider that, although the state of Pernambuco has developed other productive activities, with the opening of several industries that have diversified the workforce of the region over the past three decades[30], the historical economic heritage of agriculture, especially in the production of sugarcane, is still present among the productive activities carried out in some of the Pernambuco regions.

In this study, unskilled construction workers and bricklayers also stood out among the main categories that suffered accidents, a reality also found in several studies carried out in different places and periods[22,25,32,31]. Gürcanli and Müngen[33] state that construction workers run 3 to 6 times more risks to be involved in an accident when compared with other occupations. The findings from this study corroborate these arguments, suggesting that civil construction has high risks and high rates of accidents, although the formation of productive clusters in this sector is not evident.

In other activities that are admittedly highlights in national production, such as those developed at the textile industry centers of the backlands, the main occupations with notification of severe occupational accidents are not also related to the specialized activity of the region. The clothing activities are closely related to chronic musculoskeletal diseases resulting from repetitive movements, and respiratory diseases caused by the inhalation of cotton particulates (byssinosis), chronic events that may be more frequent in these health administrative regions when compared to severe occupational accidents. On the other hand, according to a report submitted by Universidade Federal de Pernambuco (UFPE) to Sebrae [Brazilian support service for micro and small enterprises], in 2003, in Caruaru, Toritama and Santa Cruz do Capibaribe – cities that are part of the textile center of the Health Administrative Region IV −, 83.2% of companies did not have trained employees[34]. Therefore, there was higher risk of accidents involving these non-trained workers, considering the use of stamping and fabric cutting machines that can cause serious injury, what may reveal under-notification of accidents.

Similarly, workers from the plaster stone industry, specialized in mineral extraction, did not stand out among the cases of severe occupational accidents that occurred in the Health Administrative Region IX, even this center being responsible for 90% of the country gypsum production., The plaster

production process results in respiratory diseases (like pneumoconiosis), and accidents such as burns, mutilations, falls of plates etc.[35,36] The findings from this study can also lead to assumptions regarding under-notification of serious cases and/or to the predominance of chronic diseases in this sector.

The identification of clusters, as proposed here, contributes to the understanding of the nature and development pattern of this productive organization form, as well as of its eminently spatial dimension. From the point of view of the planning of economic and regional development policies, the proposed methodology opens up a new path for selection of productive sectors to be supported with implementation of structures and public policies for health promotion and workers' protection, among others. The spatial aspect of agglomerations imposes a very special dynamics in relation to traditional management tools, and can assist in the proposition, development and consolidation of public policies in different spheres of Government[12]. Nevertheless, as the primary productive sector of a territory not always concentrates the severe occupational accidents, we must consider that to plan Occupational Health actions it is important to ponder the socio-institutional vulnerabilities related to the production processes, especially in historically dangerous industries.

Whenever there is the formation of productive clusters showing the specialization of a particular region, we expected changes in the diseases work-related epidemiological profile in that region. As accidents are events of high complexity, consequence of the interaction among worker's individual aspects, environmental and working process, social context, and productive activity developed, it is necessary to consider and intervene on the key factors that can lead to workers' death and illness. Studies that explore the territorialization of productive activities can serve as a tool to plan surveillance actions and to structure health networks suited to the profile of the productive activities in those territories. In addition, it is important to consider higher-risk activities, such as agriculture and civil construction, due to the frequency and severity of accidents associated to them. In addition, it is also important to prioritize production activities that may have to lead to major accidents, i.e., with great potential to bring consequences not only for workers, but also to neighboring communities, industries and environments[37,38].

This study presented some analysis limitations that need to be considered. Rais data comprise only the formal sector, making it difficult to highlight the clusters in activities where there are other forms of insertion in the job market. On the other hand, formal

work has a great ability to represent the existence of spatial concentration, since informal sector activities are also linked to economic trends represented by the formal sector. Besides, the indicator presents limitations related to its use in small regions, with little diversified production structure, what may result in a quotient that over-value the weight of a given sector to the region. The quotient also tends to underestimate the importance of certain sectors in regions with a diversified production structure, even if this sector has significant weight in the regional context, as is the case of the Health Region I. Moreover, the study used a descriptive methodology, and therefore cannot make analytic inferences that would show statistically significant differences among the administrative health regions.

Although severe occupational accidents have high visibility as a result of their magnitude and impact, the high rate of under-notification of information related to this event, coupled to the low quality of the records, is a great limitation to analyze the real situation of injured workers. In addition, there are the limitations of the information system used, which made impossible for us to discern the injuries according to their occurrences and limited

the analysis regarding the productive profile of the regions. In this way, the information about the affected occupations had little prominence when considering the most representative sectors in a given territory, and different regions have tended to present the same profile of injured workers, even having different production characteristics. The recent productive transformation in the state can make the economic activities historically developed in those territories (although in decline or stable) gain a relative weight, similar to those sectors that are now structured in the regions when we consider the occurrence of severe occupational accidents.

Studies like this one can encourage the creation of specialized health services, trained to receive accidents cases according to the productive profile of each health region. It is essential to stimulate analyses that deem the impacts of large productive structures on the morbidity and mortality profile of the working population, to anticipate predictable and preventable events in the workplaces and in the production processes, and also to promote improvements in working conditions and in workers quality of life.

Authors' contributions

The authors contributed equally to design the research, to gather and analyze the data, and to compose and draft the final version.

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