10.18605/2175-7275/cereus.v15n2p264-276

<< Recebido em: 19/04/2023 Aceito em: 13/06/2023. >>

ARTIGO ORIGINAL

REVISTA CEREUS ISSN: 2175-7275

Association between garbage burning and respiratory diseases on indigenous in Mato Grosso do Sul, Brazil.

Associação entre queima de lixo e doenças respiratórias em indígenas do Mato Grosso do Sul, Brasil.

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ABSTRACT

Background: Solid waste incineration of solid waste releases chemical particles and harmful gases, generating smoke that can increase respiratory diseases (RD). Objective: To investigate the correlation between the number of indigenous, rates of garbage burning, and numbers of respiratory diseases in Mato Grosso do Sul. Method: Secondary data from IBGE and DATASUS. We used Pearson's correlation statistical analysis. Results: There was a significant relationship between indigenous and the number of residences that burn garbage ($p<0.0001$). There was also a correlation between the number of fires and indigenous with RD ($p=0.0144$) and the number of residences that burn garbage by demographic density ($p=0.0072$). Pneumonia and asthma accounted for 61.66% of indigenous hospitalizations for RD. Conclusion: Unspecified pneumonia makes up 59% of pneumonia hospitalizations among indigenous. Reinforce the assumption that burning garbage can contribute to increased hospitalization among the indigenous population.

Keywords: Hospitalizations. Human exposure. Pneumonia. Solid waste.

RESUMO

Introdução: A incineração de resíduos sólidos libera partículas químicas e gases nocivos, gerando fumaça que pode aumentar as doenças respiratórias (DR). Objetivo: Investigar a correlação entre o número de indígenas, as taxas de queima de lixo e o número de doenças respiratórias em Mato Grosso do Sul. Método: Dados secundários do IBGE e DATASUS. Usamos a análise estatística de correlação de Pearson. Resultados: Houve relação significativa entre povos indígenas e número de domicílios que queimam lixo ($p<0,0001$). Também houve correlação entre o número de queimadas e indígenas com DR ($p=0,0144$) e o número de residências que queimam lixo por densidade demográfica ($p=0,0072$). Pneumonia e asma representaram 61,66% das internações indígenas por DR. Conclusão: A pneumonia não especificada representa 59% das internações por pneumonia entre povos indígenas, reforçando a hipótese de que a queima do lixo pode contribuir para o aumento das internações da população indígena.

Palavras-chave: Hospitalizações. Exposição humana. Pneumonia. Resíduos Sólidos.

1. INTRODUCTION

Following IBGE, self-declared indigenous constitute 0.47%. The Midwest region occupies third place in the proportion of indigenous to the total population, and the state of Mato Grosso do Sul has the largest this segment of the population in the region of the country (IBGE, 2010). Many studies work on comparisons between whites, blacks, and brown people. yellow and indigenous are excluded or grouped into other groups. In addition, the issue of ethnic-racial inequality has received increasing attention in Brazil's demography and public health sectors (RAUPP *et al.*, 2017).

Human exposure to landfills can cause adverse health risks. Chemical particulates and toxic gases discharge into solid waste incineration. Smoke can travel great distances when carried by the wind (CASTRO, HERMANO ALBUQUERQUE DE *et al.*, 2007; RODRIGUES; FEITOSA; SILVA, 2015; US EPA, 2002).

The use of fire exposes the population, making it vulnerable. Studies point to the effects of exposure to air pollutants, such as nitrogen dioxide particles, sulfur dioxide, ozone, and carbon monoxide, which influence pneumonia and other respiratory diseases and lead people to be hospitalized (CASTRO, ANTÔNIO HERMESON; SILVA; ARAÚJO, 2013; CASTRO, HERMANO ALBUQUERQUE DE *et al.*, 2007; NASCIMENTO *et al.*, 2016).

This research presents an overview based on the last Brazilian Census, focusing on the indigenous population of Mato Grosso do Sul. This study aims to verify if the burning of garbage at home influences the increase of respiratory diseases (RD) in indigenous populations. We assume that such analyzes are potentially relevant for understanding health issues and targeting specific public policies for population segmentation.

2. MATERIALS AND METHODS

This work focuses on the indigenous population, emphasizing Mato Grosso do Sul and using the data from Census obtained from IBGE. The Census is fundamental and serves as a basis for formulating public policies in the areas of health, social security, and education for the population in general and assistance to specific groups, such as women, children, adolescents, and the elderly.

Usually, the Census takes place every ten years, but the last edition did not occur due to the covid-19 pandemic. The next Census will collect data until the end of 2022.

The study site is the state of Mato Grosso do Sul, located in the Center-West Region of Brazil (The third region in terms of the indigenous population to the country's total

population). It has 79 municipalities and borders five Brazilian states and two countries (Paraguay and Bolivia). Mato Grosso do Sul is composed of three biomes: Cerrado, Atlantic Forest and Pantanal. The Pantanal is to the west, and the state is home to two-thirds of this biome.

The data used come from secondary sources. To calculate the total population and number of residences that declared that they use garbage burning, the results of the 2010 Census (IBGE, 2010). The indigenous population is the sum of self-declared indigenous counted in the census result. The other groups are the sum of self-declared white, black, yellow, and brown people. The anonymized data is publicly available at (*censo2010.ibge.gov.br/resultados.html/*). We searched the DATASUS database for hospitalization records related to the ICD-10 chapter, referring to 2010, where the significant diseases are: nasopharyngitis, sinusitis, influenza, pneumonia, and laryngitis, among others(DATASUS, 2022).

A total of 1359 records of hospitalizations of indigenous were recorded, which we used for our calculation base. We checked admissions by place of residence. About 80% of indigenous reside in their area of birth. The anonymized data is publicly available at (*datasus.saude.gov.br/transferencia-de-arquivos/*).

For the construction of the heat map (Figure 1), we used the Qgis 3.16.14 tool (qgis.org/en/site). We used data from cities and the total indigenous population from the Census as a weight for the whole indigenous by the municipality in the kernel form. The heat map shows the levels of concentration of indigenous, divided into three categories (low, medium, and high) with its mesoregions. The categories were defined, with intervals based on the total number of indigenous per municipality. For the low variety, the values ranged from 0 to 74 indigenous, the medium category comprised 75 to 148 indigenous, and the high class included more significant than 148 indigenous.

For statistical analysis, we applied Pearson's correlation test between the percentages of indigenous, households that burn garbage, hospitalizations for RD, and population density. Pearson's correlation test to verify whether two variables are associated with each other (FOLCH AYORA *et al.*, 2018). We divided the data into two groups: a) 78 municipalities that have a declared indigenous population and b) municipalities that have indigenous communities (29 municipalities).

3. RESULTS

According to the Census, the Brazilian indigenous population is composed of 817,963 people, which constitutes 0.43% of the total population of Brazil (IBGE, 2010, 2012).

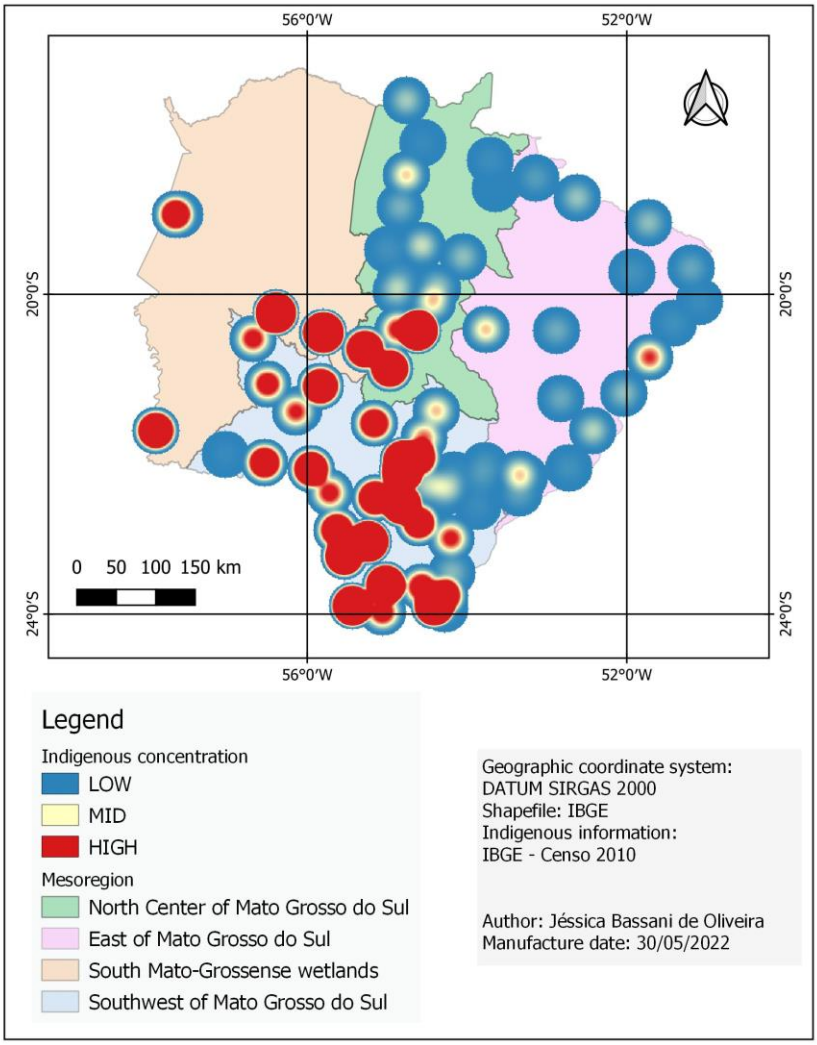

Figure 1. Concentration of indigenous in Mato Grosso do Sul in the mesoregions at low, medium, and high intensities.

Fonts: Elaborated by the authors.

Brazil has the largest population of indigenous in the northern region, with 0.16% of the country's total population. Then the Northeast region with 0.11% of the country's total population. In third place is the Central-West region, with 0.07% of indigenous in the

country's total population. The Southeast and South regions occupy the fourth and fifth places (IBGE, 2010, 2012).

We developed a heat map representing the concentration of people in MS, demonstrating the distribution of indigenous populations among the mesoregions in the three categories: low, mid, and high (Figure 1). The Southwest mesoregion of Mato Grosso do Sul has the highest concentration of indigenous in the state, with 63.72%. In second place is the South Mato-Grossense Wetlands mesoregion (23.41%), followed by the North Center of Mato Grosso do Sul (11.62%) and East of Mato Grosso do Sul (1.24%) (Figure 1).

We evaluated the correlation between the indigenous population and the garbage burning in residences in the municipalities of the Mato Grosso do Sul (Table 1). The percentage of indigenous is the total population of the municipality. The column Inhab per km² is the total number of inhabitants per square kilometer (demographic density). We divided the data into two groups: the first contains all the state municipalities with a declared indigenous population, and the second includes only the cities with indigenous communities (Table 1).

Table 1. Percentage of indigenous to other groups in Mato Grosso do Sul, percentage of residences with garbage burning and rate of indigenous with RD, population density, and distance from indigenous communities.

Mesoregion	Municipalities	Indigenous (percentage)	Residence with burning garbage to total residence (percentage)	Indigenous with respiratory diseases (percentage)	Inhab per km²	Distance from indigenous communities (km)
North Center of Mato Grosso do Sul	**Sidrolândia***	4.68	27.52	1.88	7.97	0 a 10
	Jaraguari	1.34	50.70	0.00	2.18	*NA*
	Terenos	1.15	43.50	0.51	6.03	*NA*
	Rochedo*	**0.85**	**37.74**	**0.00**	**3.16**	**0 a 10**
	Campo Grande*	**0.75**	**0.88**	**0.05**	**97.22**	**0 a 10**
	Bandeirantes	0.62	24.65	0.00	2.12	*NA*
	Corguinho	0.35	34.18	0.00	1.84	*NA*
	Sonora	0.29	6.20	0.00	3.64	*NA*
	Coxim	0.28	9.14	0.00	5.02	*NA*
	Camapuã	0.26	11.89	0.00	2.19	*NA*
	São Gabriel do Oeste	0.25	8.29	0.00	5.75	*NA*
	Rio Negro	0.16	23.96	0.00	2.79	*NA*
	Rio Verde de Mato Grosso	0.14	9.80	0.00	2.32	*NA*
	Alcinópolis	0.13	20.92	0.00	1.04	*NA*
	Pedro Gomes	0.05	19.44	0.00	2.18	*NA*
	Figueirão	0.00	25.84	0.00	0.60	*NA*
East of Mato Grosso do Sul	**Brasilândia***	**0.73**	**20.74**	**10.47**	**2.04**	**0 a 10**
	Taquarussu	0.54	19.76	0.00	3.38	*NA*
	Ribas do Rio Pardo	0.45	23.05	0.00	1.21	*NA*
	Santa Rita do Pardo	0.30	44.13	0.00	1.18	*NA*
	Bataguassu	0.25	12.41	0.00	8.21	*NA*

	Chapadão do Sul	0.20	8.32	0.00	5.10	*NA*
	Nova Andradina	0.18	10.84	0.00	9.54	*NA*
	Cassilândia	0.17	6.15	0.00	5.74	*NA*
	Água Clara	0.17	21.14	0.00	1.31	*NA*
	Três Lagoas	0.15	3.93	0.00	9.97	*NA*
	Inocência	0.12	26.50	0.00	1.33	*NA*
	Selvíria	0.11	22.22	0.00	12.93	*NA*
	Batayporã	0.11	17.46	0.00	5.98	*NA*
	Anaurilândia	0.09	29.32	0.00	2.50	*NA*
	Costa Rica	0.08	6.66	0.00	3.67	*NA*
	Paranaíba (MS)	0.05	9.52	0.00	7.44	*NA*
	Aparecida do Taboado	0.02	6.79	0.00	8.12	*NA*
Wetlands Sul Mato-grossense	**Miranda***	**25.30**	**26.42**	**1.20**	**4.67**	**0 a 10**
	Dois Irmãos do Buriti*	**17.91**	**36.85**	**0.75**	**4.42**	**11 a 30**
	Aquidauana*	**12.53**	**16.75**	**0.53**	**2.69**	**11 a 30**
	Porto Murtinho*	**8.91**	**30.78**	**1.02**	**0.87**	**Above 50**
	Anastácio*	**5.52**	**15.07**	**0.61**	**8.08**	**0 a 10**
	Corumbá*	**0.38**	**10.43**	**0.00**	**1.60**	**Above 50**
	Ladário	0.17	9.31	0.00	57.57	*NA*
Southwest of Mato Grosso do Sul	**Japorã***	**49.44**	**65.72**	**5.83**	**18.43**	**11 a 30**
	Paranhos*	**35.66**	**38.27**	**1.73**	**9.43**	**0 a 10**
	Tacuru*	**35.60**	**47.94**	**1.26**	**5.72**	**0 a 10**
	Itaporã	24.42	27.27	0.00	15.79	*NA*
	Amambai*	**20.80**	**23.85**	**2.53**	**8.26**	**0 a 10**
	Coronel Sapucaia*	**18.40**	**19.68**	**1.04**	**13.72**	**0 a 10**
	Caarapó*	**16.96**	**20.40**	**2.61**	**12.33**	**0 a 10**
	Douradina*	**16.07**	**24.63**	**0.35**	**19.10**	**0 a 10**
	Laguna Carapã*	**13.99**	**45.88**	**7.27**	**3.74**	**0 a 10**
	Antônio João*	**12.31**	**16.78**	**2.28**	**7.17**	**0 a 10**
	Juti*	**10.61**	**31.09**	**1.28**	**3.72**	**0 a 10**
	Nioaque*	**8.85**	**41.45**	**0.00**	**3.67**	**0 a 10**
	Aral Moreira*	**6.97**	**27.25**	**1.12**	**6.19**	**0 a 10**
	Eldorado*	**5.11**	**12.69**	**1.00**	**11.49**	**0 a 10**
	Dourados*	**3.48**	**6.12**	**4.85**	**47.97**	**0 a 10**
	Bodoquena	2.55	22.86	0.98	3.18	*NA*
	Bela Vista*	**2.34**	**18.01**	**2.77**	**4.74**	**31 a 50**
	Sete Quedas*	**2.24**	**20.50**	**1.24**	**1.93**	**11 a 30**
	Iguatemi*	**2.13**	**14.31**	**4.42**	**5.05**	**11 a 30**
	Bonito	1.30	12.54	0.39	3.97	*NA*
	Maracaju*	**1.17**	**9.60**	**2.05**	**7.06**	**0 a 10**
	Jardim	0.61	5.63	0.00	11.06	*NA*
	Nova Alvorada do Sul	0.61	20.32	0.00	4.09	*NA*
	Glória de Dourados	0.45	16.72	0.00	20.19	*NA*
	Jateí	0.45	27.31	0.00	2.08	*NA*
	Vicentina	0.44	23.10	0.00	19.03	*NA*
	Rio Brilhante	0.43	15.21	1.50	7.69	*NA*
	Naviraí	0.38	4.41	0.00	14.54	*NA*
	Ponta Porã*	**0.26**	**15.90**	**1.51**	**14.61**	**0 a 10**
	Guia Lopes da Laguna	0.22	15.40	0.00	8.56	*NA*
	Itaquiraí	0.17	39.59	6.25	9.02	*NA*
	Fátima do Sul	0.14	9.35	0.00	60.40	*NA*
	Angélica	0.12	18.92	0.00	7.21	*NA*
	Novo Horizonte do Sul	0.10	38.60	0.00	5.82	*NA*
	Mundo Novo	0.09	8.69	0.00	35.67	*NA*
	Caracol	0.07	25.94	0.00	1.84	*NA*
	Deodápolis	0.05	19.81	0.00	14.60	*NA*
	Ivinhema	0.04	18.61	0.00	11.11	*NA*

* Municipalities that have indigenous communities
NA: not applicable

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We applied a Pearson correlation test from the data presented in Table 2, with the values of indigenous, percentage of houses with garbage burning, percentage of indigenous with the total population with respiratory diseases, and the population density.

There is a significant correlation between the percentage of the number of indigenous and the rate of the number of residences that burn garbage on the property, with a value of $p<0.001$. This significant happens in municipalities with indigenous communities and towns where the Indigenous population is reported (Table 2).

There is a significant correlation between the number of residences and the percentage of indigenous hospitalized with RD, in the scope of all municipalities in the state, with a value of $p=0.0144$. There is also a significant correlation between the percentage of the number of residences and the demographic density (inhab/km²), in the scope of municipalities with indigenous communities, with a value of $p=0.0072$ (Table 2).

Table 2. Results of Pearson's correlation to the number of indigenous, number of houses burning garbage, and total population and indigenous population with respiratory diseases.

Line	*Pearson's Correlation*	Coefficient	All municipalities in MS	Municipalities with indigenous communities
1	% Number of indigenous (per) % Number of houses with garbage burning	r	0.5299	0.6958
		(p)	**<0.0001**	**<0.0001**
2	% Number of houses with garbage burning (per) % Indigenous with respiratory diseases	r	0.2759	0.1947
		(p)	**0.0144**	0.3114
3	% Number of houses with garbage burning (per) % Total population with respiratory diseases	r	-0.0229	0.3278
		(p)	0.8422	0.0824
4	% Number of houses with garbage burning (per) inhab/km²	r	-0.3020	0.3278
		(p)	**0.0072**	0.0824
5	% Indigenous with respiratory diseases (per) inhab/km²	r	0.0013	0.3393
		(p)	0.9907	0.0717

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Regarding the number of residences located on indigenous lands with burning garbage on the property, 13,310 places contain at least one indigenous resident. Of this number, 89.07% of homes declared the waste destination is burning on the property.

We found 1359 hospitalizations of indigenous with RD. The leading causes of hospitalizations among indigenous are pneumonia, bronchopneumonia, and asthma. NE pneumonia was responsible for 33.04% of hospitalizations. Then 12.21% of bronchopneumonia caused and asthma caused 8.24% of hospitalizations of the indigenous population.

In percentages, the municipalities with the highest values for the number of hospitalizations of indigenous with the total indigenous population of the city were:

Brasilândia (10.47%), Laguna Carapã (7.27%), Itaquiraí (6.25%), Japorã (5.83%) and Dourados (4.85%).

Table 3 presents the number of hospitalizations of indigenous by mesoregion. The East of Mato Grosso do Sul had the highest number of hospitalizations among the indigenous population of the mesoregion (0.0975%) for indigenous men and (0.0122%) for indigenous women. The Pantanal Sul Mato Grosso obtained the second highest percentage, followed by the North Center of Mato Grosso do Sul and Southwest of Mato Grosso do Sul, respectively. Despite having the lowest concentration of indigenous, the East region of Mato Grosso do Sul had most of its indigenous population affected by respiratory disease.

The age groups most affected by respiratory diseases in all mesoregions were children from 0 to 5 years old (0.0090%), children from 6 to 10 years old (0.0031%), and older adults over 60 (0.0023%). In most regions, males had respiratory diseases, except in the Southwest mesoregion of Mato Grosso do Sul, where most hospitalizations occurred in women (Table 3).

Table 3. Demographic data related to hospitalizations for respiratory diseases in indigenous by sex and age group and the total number of indigenous in the mesoregion.

Mesoregion	**Indigenous with respiratory diseases (percentage among indigenous)**		**Hospitalizations by age group (percentage among indigenous)**	
North Center of Mato Grosso do Sul	**Male**	**Female**	**Age**	**(percentage)**
	0.0029	0.0019	0-5	0.0014
			6-10	0.0011
			11-20	0.0001
			21-30	0.0002
			31-40	0.0001
			41-50	0.0000
			51-60	0.0002
			Above 60	0.0016
East of Mato Grosso do Sul	**Male**	**Female**	**Age**	**(percentage)**
	0.0975	0.0122	0-5	0.0000
			6-10	0.0000
			11-20	0.0000
			21-30	0.0365
			31-40	0.0365
			41-50	0.0000
			51-60	0.0000
			Above 60	0.0366
Wetlands Sul Mato-grossense	**Male**	**Female**	**Age**	**(percentage)**
	0.0049	0.0035	0-5	0.0028
			6-10	0.0012
			11-20	0.0003
			21-30	0.0002

			31-40	0.0003
			41-50	0.0006
			51-60	0.0009
			Above 60	0.0020
Southwest of Mato Grosso do Sul	**Male**	**Female**	**Age**	**(percentage)**
	0.0011	0.0012	0-5	0,0011
			6-10	0.0004
			11-20	0.0002
			21-30	0.0001
			31-40	0.0001
			41-50	0.0001
			51-60	0.0001
			Above 60	0.0002

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Pneumonia and asthma were responsible for 61.66% of hospitalizations of indigenous with RD hospitalizations. In municipalities with indigenous communities located between zero and ten kilometers from the urban area, 50.45% of the diseases are pneumonia, and 10.04% are asthma. Dourados, Laguna Carapã, and Sete Quedas have many hospitalizations for bronchopneumonia, 36.56%, 21.21%, and 14.81% with the other hospitalizations, respectively. Specifications of hospitalizations for pneumonia, 13% as bacterial pneumonia, 10.25% as other bacterial pneumonia, and 59% of hospitalizations are recorded only as unspecified pneumonia.

Concerning the percentage of hospitalizations by sex for indigenous, 49.52% were among men and 50.48% among women. Regarding the age group, the highest hospitalizations occurred among children from zero to five years old (53.46%), followed by children between six and ten years old (13.48%) and aged over 60 years old (12.17%).

4. DISCUSSION

Mato Grosso do Sul has 73295 indigenous and 20 communities between zero and ten kilometers away from urban areas. Most indigenous residences declared that they burn garbage on their properties.

A form of intoxication is the inhalation of substances by burning solid waste, producing large amounts of particles with heavy metals, organic compounds, and hydrocarbons that directly affect several inhabitants (WHO, 2007). Depending on the source, lead or mercury emit polychlorinated dibenzo dioxins and polychlorinated dibenzofurans or polychlorinated

biphenyls (US EPA, 2002). A systematic review carried out in Europe involving children showed an increase in the risk of pneumonia by up to 30% associated with exposure to pollutants (JACQUEMIN *et al.*, 2015).

There are reports of a strong association between air pollution and respiratory disease, asthma, bronchitis symptoms, lung function, and lung cancer (ALMETWALLY; BIN-JUMAH; ALLAM, 2020). There is a disadvantage among indigenous communities, as evidenced by the lack of basic sanitation, despite the regions having access to communities facilitated by roads and located near urban centers (COIMBRA *et al.*, 2013; COIMBRA JR., 2014).

Research has found that solid waste represents a problem in indigenous lands, and a lack of studies shows the possible causes (CORNÉLIO *et al.*, 2019; GIATTI *et al.*, 2007; LIMA, 2015). There is a profile of precarious primary infrastructure conditions in indigenous residences, especially in urban areas, revealing their vulnerability compared to the rest of the population. This fact shows the lack of basic sanitation, even in regions where access to communities is facilitated by roads or located close to urban centers (RAUPP *et al.*, 2017)

The RD in the indigenous population contains the highest rates (1.20 times higher) compared to the total population (FERREIRA; MATSUO; SOUZA, 2011). Solid waste represents a problem in the indigenous lands, and studies related to the topic are essential to support adequate public policies (CORNÉLIO *et al.*, 2019). There are reports that acute respiratory infections are the leading causes of care, hospitalization, and death of indigenous children under five years old.

A study related to RD among indigenous children presents a result that contributes to understanding the values shown in our research. The authors report the existence of a disparity between indigenous and non-indigenous health (SOUZA *et al.*, 2018). The structure of the indigenous age pyramid has a broad base and a narrow apex, reflecting the high birth and mortality rates in the first years of life, revealing a delay in the demographic transition of the indigenous population compared to other people in Mato Grosso do Sul (FERREIRA; MATSUO; SOUZA, 2011).

5. FINAL CONSIDERATIONS

This study showed for indigenous a significant correlation between the burning of residential waste, the number of indigenous hospitalized with RD, and the number of households that burn garbage by population density in the group in all municipalities.

Pneumonia and asthma accounted for 61.66% of indigenous with RD hospitalizations. In cities where indigenous communities are close to urban areas, 50.45% of pneumonia cases and 10.04% of asthma cases occurred. The records of registered hospitalizations do not know the causative agent of pneumonia increases our hypothesis that garbage burning can contribute to increased hospitalizations.

When the data from the next Census is released, we will perform a new analysis to assess whether there have been any changes in this situation. The study had limitations regarding its population because its definition occurs through open data. The methodology used in the Census was based on the assumption of people's self-declaration and not on a supporting document.

6. ACKNOWLEDGMENT

In support of Fundação de Apoio ao Desenvolvimento do Ensino, Ciência e Tecnologia do Estado de Mato Grosso do Sul (FUNDECT) (concession number 71/700.139/2018; 036/2018 and SIAFEM 028991), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for CALC (concession number 312671/2021-0).

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