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Social Vulnerability and Rainfall: Impacts on Collective Health

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Abstract**—***Objective: To analyze the relationship between the prevalence of waterborne infectious diseases in the city of Limoeiro do Ajuru and the risk of flooding. Method: To obtain the data, data from the Brazilian Unified Health System (DATASUS), cases of acute diarrhea and respiratory infections in the rainy period 2007 to 2017 were analyzed in the database of the Brazilian Institute of Geography and Statistics (IBGE). To obtain the rainfall data for the Joana Coeli Station from 2007 to 2017, a consultation was carried out on the website of the National Water Agency (ANA).Results: The supply of treated water in the flood risk area is mostly improvised; there is also a lack of septic tanks, problems that contribute to soil and water contamination in the rainiest season, factors that lead to the emergence of waterborne diseases and respiratory problems. Conclusion: The study indicates that, in the research site, the areas of risk of flooding, combined with social and environmental vulnerability associated with high rainfall, cause the appearance of acute diarrheal diseases and acute respiratory infections in individuals in the locality.*

Keywords**—Floods. Acute diarrhea. Respiratory problem. Rainy season.**

I. INTRODUCTION

In Brazil, climate changes such as rainfall variation are the result of natural and social processes that can generate natural disasters, problems to human health due to floods, floods and floods, modifying the ecosystem and biological cycles that can increase the incidence of infectious diseases and non-transmissible(1).

It is very frequent in Brazil situations of vulnerability of the population to risks, on a daily basis, due to the lack of urban planning, poverty and environmental problems, characteristics that were detected in the city of Limoeiro do Ajuru, Pará, region of integration of Tocantins, where the social and health determinants are aggravated, mainly with population growth in areas without urban structure(2).

In 2010, the city of Limoeiro do Ajuru had a low human development index of 0.493 and more than 54.62% of the population had an income of less than one minimum wage; the main economic activity was concentrated in public administration, in the fish trade and agriculture(3). In the municipality there is a predominance of floodplains close to the Tocantins River, favorable to flooding in periods of rainier weather. The rainy season, associated with social and infrastructure factors, causes flooding, which in turn causes economic, social and environmental damage, causing diseases to people in vulnerable situations(4, 5).

In addition to unwanted social conditions, the municipality is also deficient in terms of environmental sanitation. There is precariousness or absence of rainwater

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drainage, inadequate management of solid urban waste and sewage is responsible for social problems caused by rains that cause flooding[6].

According to the epidemiological data of the municipality of Limoeiro do Ajuru in 2016, waterborne diseases prevailed, as well as there was a predominance of care in the local health system, particularly when there is a higher incidence of rainfall. In the period between the years 2007 to 2017, the prevalence of acute diarrheal diseases and respiratory infections was notorious, which affected the population of the studied locations.

In this context, the present study aimed to analyze the relationship between the prevalence of waterborne infectious diseases in the city of Limoeiro do Ajuru with the flooding risks and the health impacts of the community.

II. METHOD

This was a study with a descriptive quantitative approach, comprised of four stages, namely: 1 - Identification of the research site; 2 - Fieldwork; 3 - Data collection; 4 - Document analysis.

The research site was based in the municipality of Limoeiro de Ajuru, which has considerable rainfall as well as diseases that prevail during the rainy season. As a reference we have the vulnerable population in areas at risk of flooding; the demand for care for acute diarrhea and respiratory infections in the urgency and emergency of the municipal hospital, thus outlining the profile and characteristics of the vulnerable population in the municipality.

Epidemiological data were extracted from the system of acute diarrheal diseases (SIVEP-DDA) provided by that of the 13th regional health department of the Secretary of Health of the State of Pará (SESPA) and in the database of the Brazilian Institute of Geography and Statistics (IBGE). Electronic means were also consulted on the website of the National Water Agency (ANA) to obtain the rainfall data for the Joana Coeli station in Limoeiro do Ajuru, from 2007 to 2017.

The mapping of the points with the highest incidence of flooding in rainy periods was carried out by evaluating the addresses of the records of the system of acute diarrheal diseases (SIVEP-DDA) and acute respiratory infections (Figure 1).

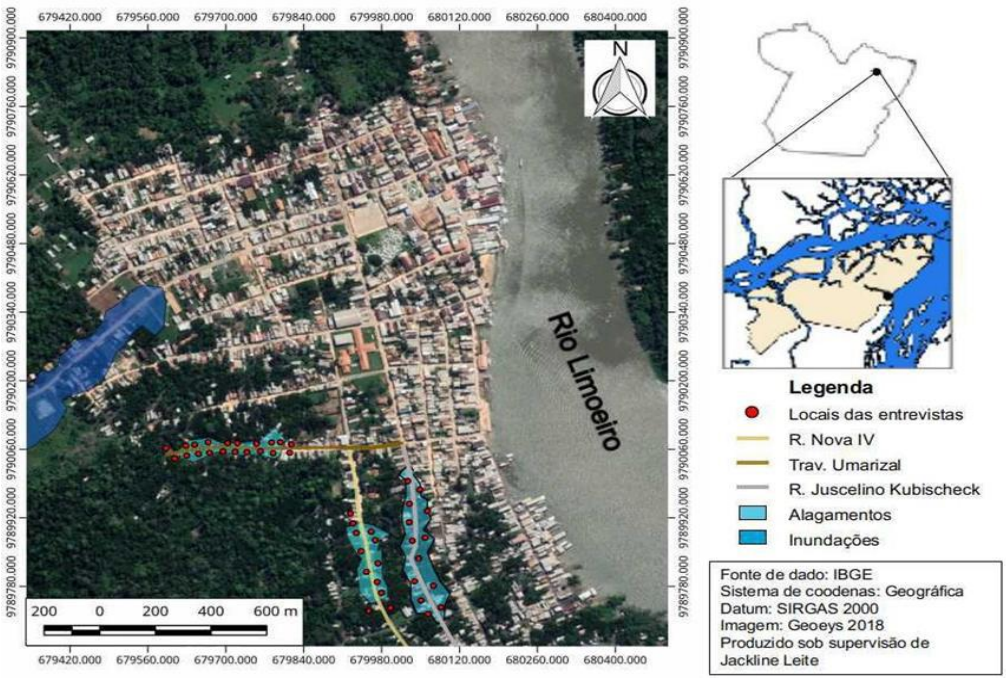

Fig.1: Location map of flood and flood areas.

Source: Oliveira JL, 2018. IBGE cartographic base.

The data obtained were verified and entered in the Libre Office Calc software, which constituted a database. Descriptive statistics of the study were prepared in tables and graphs, based on the calculation of frequencies (categorical variables) and measures of central tendency

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and dispersion (means and standard deviations of quantitative variables).

The rainfall data were analyzed using the Time Series method, to verify the correlation between the cases of acute diarrheal disease and the volume of rainfall over the period from 2007 to 2017.

III. RESULTS AND DISCUSSION

According to the survey on rainfall at the Joana Coeli station in Limoeiro do Ajuru from 2007 to 2017, there was a slight downward trend from 2014 to 2017. This significant rainfall variability results in notable annual deviations. During the 10 years, the highest rate of precipitation in Limoeiro do Ajuru occurred in 2009, with a total of 3,822 mm, resulting in a positive variation from the normal of 47%. On the other hand, in 2016, it was the year that presented the lowest index: 949.5 mm, with a negative deviation of 44% in relation to the average. Table 1 shows the rainfall distribution, and highlights that in March 2009 there was the highest rainfall and the lowest precipitation in November 2015.

Table 1: Monthly pluviometric series, per year, in the municipality of Limoeiro do Ajuru, measured by rain gauge from Joana Coeli station, from 2007 to 2017.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	210,4	638,7	491,3	187,3	458,5	266,6	323,6	200,6	113,9	163,7	135,4
Feb	469,9	252,3	558,8	282,1	507,9	357,9	402,9	179,8	250,5	75,6	235,7
Mar	653,4	565,9	793,2	384,4	381,4	448,1	446,1	148,4	293,4	146,5	171,5
Apr	371,7	335,9	406,3	252,6	566,7	371,2	557,2	303,9	360,5	250	169,8
May	254,2	237,2	467,7	462,6	393,7	247,1	337,7	69,4	299,6	51,5	92,5
Jun	165,5	301,4	404,3	183	140,7	121,9	160,8	63,7	176,3	53,8	67,4
Jul	158,7	56,9	255,2	133,2	212,2	101,4	216,7	158,8	61,5	70,5	33,9
Aug	105,5	104,5	42,1	42,4	145,8	106,6	146	29,2	12,2	11,5	11,6
Sep	46,8	82,0	48,4	65,7	33,8	43,2	48,3	46,6	7,6	4,8	7,4
Oct	118,1	10,8	86,8	8,6	130,1	95,9	8,7	37,1	10,6	5,1	30,1
Nov	84,4	146,5	9,5	102,1	261,7	16,3	143,5	87,2	1,3	11,5	23,4
Dec	244	162,7	258,4	248,8	127,3	255	108,8	28,3	3,1	105,0	78,8
Total Annual	2882,6	2894,8	3822	2352,8	3359,8	2431,2	2900,3	1353	1590,5	949,5	1057,5

Source: Oliveira JL, 2018; data extracted from the National Water Agency - ANA, 2017.

However, despite climatic conditions influencing the geographic distribution of prevalent diseases, it is relevant to analyze other factors to explain the number of cases of acute diarrhea and respiratory infections in a given region. In addition to assessing hydro climatic conditions, it is also necessary to assess the socio-economic conditions involved in the issue[7].

The occurrence of constant flooding in areas where there is a lack of infrastructure, sanitation and others responsible for the health and well-being of the population, make people vulnerable to diseases, because with the waters overflowing with garbage and debris that cause the proliferation of insects and other undesirable species[8].

Fieldwork in the affected areas reveals that the treated water supply in the flood risk area in Limoeiro do Ajuru is improvised with unprotected plumbing in most homes; it also reveals the lack of septic tanks in approximately 40% of this affected population, problems that contribute to soil and water contamination, which with increasing rainfall invades homes.

Thus, the absence or deficiency in the protection of water resources, mainly in relation to human or animal excreta, is capable of developing a series of pathogenic organisms such as viruses, bacteria, protozoa or intestinal helminths. The most frequent causes of contamination in the field of population groups concern open or poorly

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closed water tanks and a lack of personal and environmental hygiene habits[9].

To promote public health, drinking water is provided through collective water supply that aims to capture water from the source, treat it and distribute it through a distribution network to the buildings. However, in Limoeiro do Ajuru, individual systems such as wells in rural areas and on the outskirts are still common and not always safe and adequate from the sanitary point of view[6].

Although precarious, the public water supply system is relevant in promoting public health, but to meet the characteristics of drinking water quality, it must have characteristics suitable for consumption, such as the absence of: taste and odor, toxic substances, pathogenic microorganisms and still present concentrations of residual chlorine within the quality standards[10].

In this perception of exposure and propensity, the deficiency of basic sanitation in Limoeiro do Ajuru stands out as an environmental and social vulnerability, associated with the low income of the resident population, highlighting the potability of water that is essential for human life as a risk factor[11].

These results contribute to the Municipal Human Development Index (MHDI) being the 134th place among the 143 municipalities in the State of Pará, thus, it is among the lowest index (0.493 according to the IDESP-2016 report). The MHDI represents an adaptation of the global HDI methodology for application in the comparison between Brazilian municipalities, it is an indicator of the inhabitants' ability to guarantee a standard of living that ensures their basic needs[12].

The survey data (table 2) reveal that the annual average of cases of acute diarrhea and acute respiratory diseases recorded at the hospital of Limoeiro do Ajuru were 790 cases of respiratory diseases and 1,025 cases of diarrheal diseases, from 2007 to 2017. Such data are worrisome from the point of view of health, the environment and the social situation of the population, since most of these citizens have incomplete elementary education and live without instructions related to public health, which allows greater health problems. This analysis remains current on the previous one carried out by the Ministry of Health between environmental sanitation and the health impacts of Brazilian citizens assessed in general terms[13].

Table 2: Measures of position and variability in the number of cases of diarrhea, respiratory diseases and rainfall in the municipality of Limoeiro do Ajuru, from 2007 to 2017.

Variable	Mean	DesvPad	Minimum	Maximum
Diarrhea Cases	1024,5	188,2	669,0	1333,0
Cases ofAcuteRespiratoryDiseases	789,9	232,9	460,0	1133,0
Total PRP (mm)	2.327	963	950	3.822

Source: National Water Agency (ANA), 2017.

On a ten-year time scale (2007-2017) (Table 3), there are records of acute diarrhea and respiratory infections in urgent and emergency care at the Ajuru lemon hospital. Such data show evidence between the correlation of the total rainfall with the higher number of diarrhea cases in relation to the cases of respiratory infections, and that the rains have great influence in determining the period of occurrence of the diseases. In this case, the prevalence of diarrhea and respiratory infections confirms that its prevalence is associated with social, environmental and urban regulation[13].

Table 3: Distribution of Acute Diarrheal Disease Cases, total and average rainfall in the municipality of Limoeiro do Ajuru, from 2007 to 2017.

Year	Diarrhea Cases	RespiratoryDisease Cases	Total PRP (mm)	Mean PRP (mm)
2007	813	783	2882.6	240.2

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Year	Diarrhea Cases	RespiratoryDisease Cases	Total PRP (mm)	Mean PRP (mm)
2008	1116	826	2894.8	241.2
2009	1333	1117	3822	318.5
2010	1220	595	2352.8	196
2011	968	1133	3359.8	279.9
2012	1143	599	2431.2	202.6
2013	1115	1073	2900.3	241.6
2014	1020	460	1353	112.7
2015	669	678	1590.5	132.5
2016	946	593	949.5	79.1
2017	926	832	1057.5	88.1

*PRP = Precipitação pluviométrica.

Source: Limoeiro do Ajuru Municipal Hospital (2018); ANA (2018).

The number of cases of Acute Diarrheal Disease was higher in the period from 2008 to 2014, decreasing from 2015 to 2017; with respect to respiratory diseases, there was a decrease in 2016 and 2017. It is worth mentioning the year of 2009, which experienced greater rainfall and a greater number of cases of acute diarrhea and acute respiratory infections (table 3). Note that the average rainfall volume in the municipality, coincides with the last two years.

It is also noted that over the years between 2007 and 2017 the total precipitation per year has decreased in the region over the years. In this same period, a downward trend is observed in cases of diarrhea and respiratory diseases that may be related to the decrease in precipitation, in the relation of the lower the precipitation, the lower the probability of problems related to rain diseases.

Since flooding is also the result of inadequate public management and basic sanitation and other elements, they become factors of great risks to the precarious living conditions of the population with a low Municipal Human Development Index (MHDI), it is necessary to improve the capacity to care for the population problem and enable the basic needs of citizens to be ensured such as health, housing, education, among others[(3)].

Economic factors and social inequality are some of the most relevant causes that lead to poor health conditions, as poverty can result in malnutrition, poor living conditions, poor levels of education, construction of houses or work located in areas with environmental risks[(4)].

The assessment of environmental risk in Limoeiro do Ajuru is essential, given that the city is undergoing a disorderly expansion phase, with no structure in unplanned areas, which leaves the population vulnerable[(14)]. Thus, social vulnerability considers insecurity and exposure to risk and disturbances caused by events or economic changes, has its direct effects on the living conditions of less favored social groups, at the same time that the availability of resources and strategies of families are important elements for facing impacts on collective health[(15)].

IV. CONCLUSION

The study revealed that the social vulnerabilities associated with flooding in the rainy periods at the research site showed significant impacts on the population's health, with emphasis on acute diarrheal diseases and acute respiratory infections.

The rainfall analysis between the years 2007 to 2017 in Limoeiro do Ajuru highlighted the month of March 2009 with the highest index associated with the number of sick people, obtained through the health records of the local hospital and official data. But, despite the fact that the volume of rainfall has been decreasing over the years, as well as the number of cases of diseases related to water transmission and respiratory problems, health problems in rainy seasons, maintain the correlation between the high volume of rain and the increase in acute diarrhea and respiratory infections in the municipality.

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In our view, minimizing the amount of infectious diseases mentioned can occur if there are mechanisms to prevent social and health determinants, such as: improving environmental conditions, educational, economic actions and minimizing risk factors in order to reduce vulnerability of the population.

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