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Socio-environmental aspects and diseases related to contaminated water in vulnerable communities in the Northeast of Brazil

Aspectos socioambientais e doenças relacionadas à água contaminada em comunidades vulneráveis no Nordeste do Brasil

Aspectos sociales y ambientales y enfermedades relacionadas con el agua contaminada em comunidades vulnerables del Nordeste de Brasil

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Abstract
The aim of this investigation was to analyse the perception of waterborne diseases and socioeconomic and environmental aspects of Quilombolas in vulnerable communities in Northeast Brazil, as the research was conducted in three vulnerable communities located in this area. The study was sectional regarding quantitative approach and was carried out from September 2018–August 2019 through interviews with 164 individuals and the analysis of drinking water quality. The highest prevalence was intestinal parasitic diseases (57%), primarily Schistosoma mansoni (20%). The interviews revealed that 27% of individuals used drinking water from the general distribution network and 26% from a well/spring outside the residence. Of these, 39% did not undergo any treatment before ingestion. Of the 10 water samples collected for microbiological analysis, there was growth of heterotrophic bacteria (53%), faecal coliforms (50%) and thermotolerant bacteria (7%). Study participants were subject to environmental characteristics that made them vulnerable to health issues. The promotion of health actions and the implementation of measures related to the treatment and storage of drinking water are tools that can combat the occurrence of diseases.
Keywords: Public health; Rural population; Waterborne diseases; Water quality.

Resumo
O objetivo deste artigo foi analisar a percepção das doenças de veiculação hídrica e os aspectos socioeconômicos e ambientais dos quilombolas em comunidades vulneráveis do Nordeste do Brasil, visto que a pesquisa foi realizada em três comunidades vulneráveis localizadas nesta área. O estudo foi do tipo seccional com abordagem quantitativa, realizado no período de setembro de 2018 a agosto de 2019 por meio de entrevistas com 164 indivíduos e análise da

qualidade da água potável na região. A maior prevalência foi de doenças parasitárias intestinais (57%), principalmente Schistosoma mansoni (20%). As entrevistas revelaram que 27% dos indivíduos utilizavam água potável da rede geral de distribuição e 26% de poço / nascente fora da residência. Destes, 39% não realizaram nenhum tratamento antes da ingestão. Das 10 amostras de água coletadas para análise microbiológica, houve crescimento de bactérias heterotróficas (53%), coliformes fecais (50%) e bactérias termotolerantes (7%). Os participantes do estudo estavam sujeitos a características ambientais que os tornavam vulneráveis a problemas de saúde. A promoção de ações de saúde e a implementação de medidas relacionadas ao tratamento e armazenamento de água potável são ferramentas que podem combater a ocorrência de doenças.
Palavras-chave: Saúde pública; População rural; Doenças de veiculação hídrica; Qualidade da água.

Resumen
El objetivo de esta investigación fue analizar la percepción de las enfermedades transmitidas por el agua y los aspectos socioeconómicos y ambientales de los quilombolas en comunidades vulnerables del noreste de Brasil, ya que la investigación se realizó en tres comunidades vulnerables ubicadas en esta zona. El estudio fue seccional en cuanto al enfoque cuantitativo y se llevó a cabo de septiembre de 2018 a agosto de 2019 a través de entrevistas a 164 personas y el análisis de la calidad del agua potable. La mayor prevalencia fueron las enfermedades parasitarias intestinales (57%), principalmente Schistosoma mansoni (20%). Las entrevistas revelaron que el 27% de las personas usaban agua potable de la red de distribución general y el 26% de un pozo / manantial fuera de la residencia. De estos, el 39% no se sometió a ningún tratamiento antes de la ingestión. De las 10 muestras de agua recolectadas para análisis microbiológico, hubo crecimiento de bacterias heterótrofas (53%), coliformes fecales (50%) y bacterias termotolerantes (7%). Los participantes del estudio estaban sujetos a características ambientales que los hacían vulnerables a problemas de salud. La promoción de acciones de salud y la implementación de medidas relacionadas con el tratamiento y almacenamiento de agua potable son herramientas que pueden combatir la ocurrencia de enfermedades.
Palabras clave: Salud pública; Población rural; Enfermedades de transmisión por agua; Calidad del agua.

1. Introduction

In many countries, socially disadvantaged groups have limited access to health resources; they get sick and die earlier than those in more privileged social classes (Irwin et al., 2006). Individuals and families in social vulnerability do not only have a low income, as is the case of Brazilian Quilombola families. There are other unfavorable indicators restricting access to information and the difficulty of accessing basic services, such as water supply and sewage (Bezerra et al., 2015). The lack or inadequacy of these services contribute to low indices in health indicators, resulting in injuries or parasitic infectious diseases (Thomas et al., 2011; Karanis et al., 2006).

It is estimated that that 8–10 people living in rural areas do not have access to safe drinking water and sewage, and are therefore, disproportionately underserved. In 2017, 785 million people around the world still required basic services, with 2.2 billion lacking access to safe and sustainable water supplies, 4.2 billion lacking access to safe sanitation services, and 3 billion without facilities for basic hygiene habits (ONU, 2019).

The main health risk is consumption of water with faeces, including pathogens that cause infectious and parasitic diseases, which may vary according to the environment most prevalent in low-income populations, such as those in rural communities (Null et al., 2018). However, access to clean drinking water is a basic human right recognised by the United Nations General Assembly explicitly through Resolution 64/292 of 28 July 2010. The recognition of this right contributes to the survival of human beings and prevention of disease (United Nations General Assembly, 2010).

Lack of access to treated water supplies proves the existence of social inequalities. Diseases related to drinking water contamination represent a major public health challenge, especially in developing countries (Aleixo et al., 2019). Among populations that live in areas with difficulty of access to public services, such as clean water supply and sanitary sewage, are the Quilombola communities formed by ethnic-racial groups, with their own historical trajectories. These individuals are socially vulnerable within the context of rural and economically disadvantaged populations (Freitas Júnior et al., 2018).

Over the years, these Quilombola communities have presented issues that have progressed from vulnerability to a struggle for ethnic-cultural and historical identification. In the midst of several existing complications, it is highlighted that

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most of the health problems presented in traditional populations are due to the situation of exclusion, and their stigma in relation to access to goods and quality of life (food, clothing, and housing) and services (water supply, basic sanitation, and access to health) (Ferreira et al., 2014; Pimentel; Ribeiro, 2016).

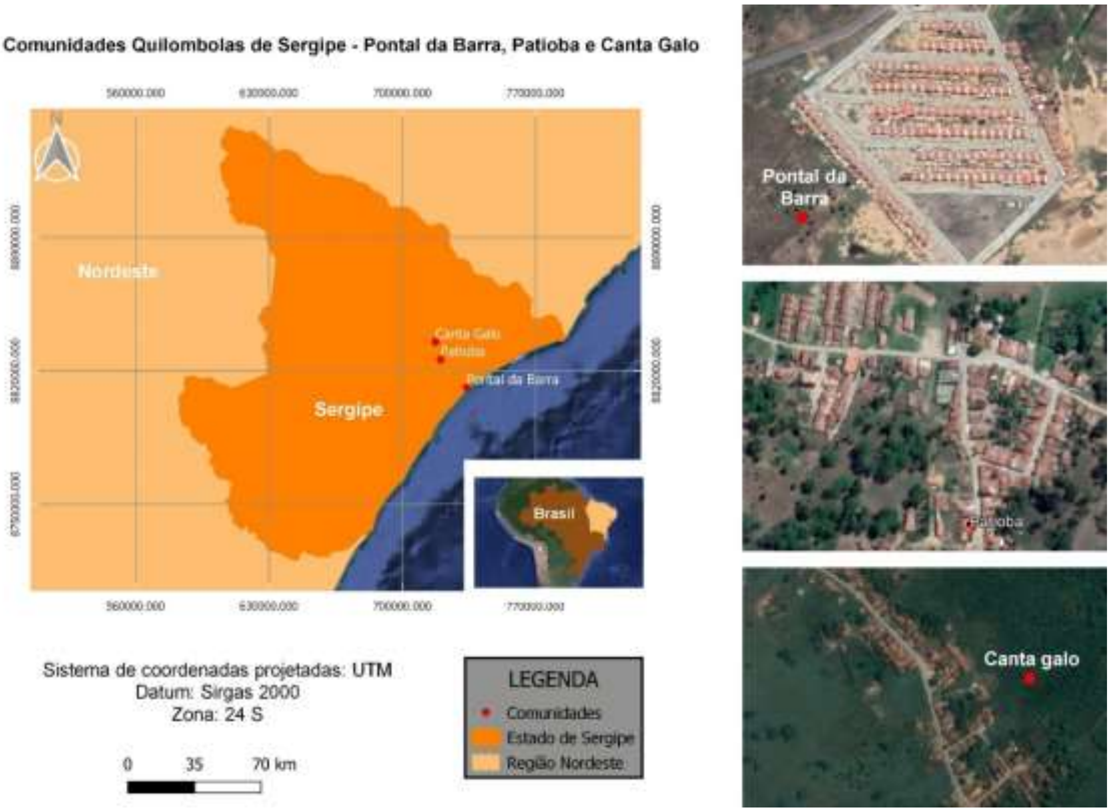
According to Bezerra et al. (2015), individuals and families in situations of social vulnerability do not only have low level of incomes, as in the case of Quilombola families, but are also similar in terms of other unfavorable indicators (i.e., low level of education and professional qualification), restricted access to information, difficulty in accessing basic services, and poor housing and sanitation conditions.

Similar to other rural communities, when compared to the urban population, these communities are in poor health or insufficient health condition (Silva et al., 2017). Data from the Unified Registry of Social Programs in 2013 state that only 46% of Quilombolas have adequate sanitation, and 55% do not have piped water (Brazil, 2013a). Thus, these people live in vulnerable situations, especially in North and Northeast Brazil, due to socioenvironmental indicators related to poverty, sanitation and neglected diseases (Magalhães Filho & Paulo, 2017). The aim of this paper was to analyse the perception of waterborne diseases and socioeconomic and environmental aspects of Quilombolas in vulnerable communities in Northeast Brazil.

2. Methodology

We conducted a sectional study with a quantitative approach, analysing diseases related to contamination and transmission, and socioeconomic and environmental conditions. Cross-sectional or cross-sectional studies that determine “snapshots” of the health status of a population or community based on the individual assessment of the health status of each member of the group, and also determine global health indicators for the investigated group (Rouquayrol & Filho, 2003). This analysis was based on interviews conducted from September 2018–August 2019, direct observation of peridomiciliary environments and physicochemical and microbiological analysis of consumption water in dry and rainy seasons (2018–2019). The study was conducted in the rural Quilombola communities of Patioba, Pontal da Barra and Canta Galo, located in the state of Sergipe in Northeast Brazil (Figure 1).

Figure 1. Location of Quilombola Communities studied in the State of Sergipe, 2020.



Source: Authors.

This research is part of the Unified Health Research Program (PPSUS), which aims to identify issues that are needed to strengthen the efforts and organisational actions of the scientific community to encourage policy change and compliance with Brazilian public health standards (Souza & Calabró, 2017). It was submitted for evaluation by the Research Ethics Committee of Tiradentes University, and was approved under number 1685357. The requirements presented were carried out in Resolution 466/12 of the National Health Council, which deals with research conducted involving human beings in Brazil.

In the sample calculation, the number of families registered as Quilombolas in each community was used, which was calculated using the formula proposed by Barbetta (2010), based on the communities of the Guarda-Chuva project (Table 1) and number of families (Table 2). This was based on data obtained from the National Institute of Colonization and Agrarian Reform (INCRA), and an error of 0.05 and confidence level of 95% were considered. The minimum sample for carrying out the umbrella project was 274 families and 20% were added, considering the possible losses that could compromise the representativeness of this sample. Therefore, the total sample was 329 families (Table 2) (Brazil, 2018b).

Table 1. Identification, classification and location of georeferenced coordinates of water collection points in quilombola communities of Pontal Barra, Canta Galo, Patioba.

Communities	Points	Description	Classification	Coordinates
Pontal da Barra	PB1T	Distribution	Potable water	X = 0733787 Y = 8811120
	PB2B	Water truck[1]	Potable water	X = 0733787 Y = 8811120
	PB3	Artesian well	Subterranean water	X = 0733827 Y = 8811152
	PB4	Distribution	Potable water	X = 0733827 Y = 8811041
Canta Galo	CG1	Water truck[1]	Potable water	X = 0715973 Y = 8836814
	CG2	Distribution	Potable water	X = 0717441 Y = 8835022
	CG3	Distribution	Potable water	X = 0717250 Y = 8835112
Patioba	PA1	Distribution	Potable water	X = 0720112 Y = 8826019
	PA2	Distribution	Potable water	X = 0719712 Y = 8826073
	PA3	Water source	Raw water	X = 0720265 Y = 8827404

Note: [1] Water collection performed in plastic container distributed by water truck. Source: Authors.

Table 2. Descriptive analysis of physicochemical parameters of drinking water samples collected in the quilombola communities of Pontal Barra, Canta Galo, Patioba.

ESSAY	Ordinance No. 2914	UNITY	MINIMUM	MAXIMUM	AVERAGE	STANDARD DEVIATION
Free chlorine	0.2 to 2.00	mg / L	**0.02**	**0.12**	0.04	0.023
Total chlorine		mg / L	0.03	3.8	0.30	0.934
Nitrite	1	mg / L	0	0.34	0.02	0.085
Nitrate	10	mg / L	1.5	**15.6**	5.40	4,594
Sulfate	250	mg / L	0	85	26.06	28.40
Ammonia	1.5	mg / L	0	0.71	0.09	0.222
turbidity	5	NTU	0.49	2.71	1.27	0.753
pH	6.0 to 9.5	—	**4.72**	7.55	6.54	0.675
Temperature		ºC	23.37	32.24	28.28	3,206
Dissolved oxygen		mg / L	0	9.9	6.05	2,510
Conductivity		S / cm	87	791	399.56	222.5
STD		mg / L	44	396	183.44	109.8
Salinity		mg / L	40	380	173.13	107.75
true Color	15	PtCo	1	**27**	8.67	7.55

Note: [1] values shown in bold represent those that exceed the limit values according to the standards previously established in the legislation related to drinking water quality. 2 PB - Pontal da Barra, CG - Canta Galo, PA - Patioba. Source: Authors.

This study covered two communities located in eastern Sergipe and one in the Greater Aracaju region, and these communities were selected for the presentation of vulnerability in health and environment from other researches (Torales et al. 2013; Passos et al., 2017). The total number of the minimum sample of the communities selected for the present study was 131 participants, with 20% added, considering the possible losses that could compromise the representativeness of this sample. In total, 164 people were interviewed, selected proportionally by population size.

For the interview, one person per family, over 18 years of age, was selected per household. Minors and individuals with mental impairment conditions registered in medical records were excluded. The final number of participants in the sample was 164, with losses expected and valid for 37 people (18%). The interviews were conducted using a single, standardised form validated by the Brazilian Institute of Geography and Statistics, and based on the National Policy for Sample Households (2018) (IBGE, 2018).

To perform the analysis of water potability, 10 water collection points were selected in strategic locations. The choice of these locations was justified by easy access and use by the community for personal hygiene and other uses (Table 3). The samples were stored and preserved according to the Standard Methods for the Examination of Water and Wastewater (SMEWW) 1060. The physical-chemical analyses were performed in the field with the aid of a HANNA HI 9828/93414 multiparametre probe, and a Hach DR 5000 Spectrophotometer and Micro20/Akso photometer, in which the following were measured: free chlorine, total chlorine, nitrite, nitrate, sulfate and ammonia. The turbidity and color parametres were obtained using the HANNA HI 93414 Turbidity and Chlorine and Hach DR 5000 equipment, respectively.

Table 3.

Communities	Points	Description	Classification	Coordinates
Pontal da Barra	PBT1	Distribution	Potable water	X = 0733787 Y = 8811120
	PBB2	Water truck[1]	Potable water	X = 0733787 Y = 8811120
	PB3	Artesian well	Subterranean water	X = 0733827 Y = 8811152
	PB4	Distribution	Potable water	X = 0733827 Y = 8811041
Canta Galo	CG1	Water truck[1]	Potable water	X = 0715973 Y = 8836814
	CG2	Distribution	Potable water	X = 0717441 Y = 8835022
	CG3	Distribution	Potable water	X = 0717250 Y = 8835112
Patioba	PA1	Distribution	Potable water	X = 0720112 Y = 8826019
	PA2	Distribution	Potable water	X = 0719712 Y = 8826073
	PA3	Water source	Raw water	X = 0720265 Y = 8827404

Note: [1]water collection performed in plastic containers distributed by water truck.
Abbreviations: PBT = Pontal da Barra (treated); PBB2 = Pontal da Barra (plastic container); PB = Pontal da Barra; CG = Canta Galo; PA = Patioba
Source: Authors.

For the performance of the microbiological analyses, the methodologies adopted from the SMEWW were used for each microbiological assay, as well as their respective units (APHA, 1998).

Analysis of the information collected during the interviews were constituted in a database and analysed by SPSS 11.0 software. For quantitative analysis, relative and absolute frequency analyses were performed. The categorical variables were written using absolute and frequency and relative percentage, and the continuous variables were described using means, standard deviation, and minimum and maximum. The level of statistical significance was 5%.

3. Results and Discussion

Quantitative analysis of responses to interviews and social, health and environmental characterization

The respondents of the household interviews (n = 164) were characterised by the predominance of females (77.4%) aged between 18–24 years (32.9%), married (67.7%), self-declared black (57.3%) and unemployed (79.3%). The level of education that prevailed was incomplete elementary I (36.5%), in which 17.6% reported not being capable of reading or writing. In the economic context, the majority (81.0%) were between the classes D and E.

Regarding the social and environmental conditions and sanitary facilities, it was possible to observe that houses of the population analysed existed on paved streets (81.7%), with domestic water supply coming from the general distribution network (78.0%) through water pipes (89.6%), the supply for which 68.2% of the individuals do not pay.

The use of the general distribution network (27.4%) was the main source of drinking water, followed by water from the well or spring outside the residence (26.8%). Most individuals stored water in a water tank (39.0%) or did not perform any treatment for drinking water at home (39.0%). The sanitary sewage and garbage collection were performed by means of rudimentary sump (82.3%) and bucket cleaning three times a week (54.8%).

Regarding the hygiene habits of the population studied, observed was that 76.2% stated they did not have the habit of eating fruits and vegetables without washing them, 62.8% reported not walking barefoot in the street (often in extra-domestic space), and 73.7 % have or have had contact with water from the river, stream or pond at some point in life.

Among the diseases that may be related to water contamination or transmission, the most significant was intestinal parasitic diseases (57.9%), especially Schistosoma mansoni (20.7%). From the results obtained from the parasitological exams of verified faeces, Entamoeba histolytica showed a higher prevalence rate (1.8%), followed by S. mansoni (1.2%). Of these, 95.7% of the Quilombola population evaluated had no parasitological stool at the time of interview. Of the interviewees, 61.5% had already presented with diarrhea at some point in their lives, with 18.9% with mucus and 15.8% with blood in the stool.

Physicochemical and microbiological quality of water

The water quality analysis evaluated the changes in the physicochemical and microbiological parametres of the water used by the communities. Fifteen samples of water used for consumption from the three studied Quilombola communities were collected during two dry and rainy (Feb–Mar 2019) and wet (Jul–Aug 2019) periods. Of these, 10 samples were treated by the public supply (66.67%), two samples were collected from plastic bottles used to store water (13.33%), two samples were from well water (13.33%) and one sample was from the source (6.67%) used by the Patioba community as an alternative source of drinking water.

In relation to the values of free residual chlorine obtained during the collection period, it was observed that none of the samples showed chlorine within the standard recommended by the ordinance (0.2 mg/l –2 mg/L), in which the maximum value was 0.12 mg/L and the minimum 0.02 mg/L, an average of 0.04 mg/L and a standard deviation of 0.023 (Table 4).

Table 4. Descriptive analysis of physicochemical parametres of drinking water samples collected in the Quilombola communities of Pontal da Barra, Canta Galo, and Patioba.

ASSAY	DRINKING WATER BRAZIL	UNITY	MINIMUM	MAXIMUM	AVERAGE	STANDARD DEVIATION
Free chlorine	0.2–2.00	mg/L	**0.02**	**0.12**	0.04	0.023
Total chlorine		mg/L	0.03	3.8	0.30	0.934
Nitrite	1	mg/L	0	0.34	0.02	0.085
Nitrate	10	mg/L	1.5	**15.6**	5.40	4,594
Sulfate	250	mg/L	0	85	26.06	28.40
Ammonia	1.5	mg/L	0	0.71	0.09	0.222
turbidity	5	NTU	0.49	2.71	1.27	0.753
pH	6.0–9.5	—	**4.72**	7.55	6.54	0.675
Temperature		ºC	23.37	32.24	28.28	3,206
Dissolved oxygen		mg/L	0	9.9	6.05	2.510
Conductivity		S/cm	87	791	399.56	222.5
STD		mg/L	44	396	183.44	109.8
Salinity		mg/L	40	380	173.13	107.75
True Color	15	PtCo	1	**27**	8.67	7.55

Note: values shown in bold represent those that exceed the limit values according to the standards previously established in the legislation related to drinking water quality.
Abbreviations: STD =; NTU =
Source: Authors.

According to the Ministry of Health nº2914 / 2011, the pH value should be between 6.0–9.5; however, the samples had a variation of 4.72–7.55. It was observed that the minimum value was below the minimum value allowed by the ordinance

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in the sample belonging to point PA2 Feb 2019, which belongs to the Patioba community school. The average pH was 6.54 ± 0.67. The PA1 point sample from Jul 2019 showed nitrate concentration (15.90 mg/L), which was above the maximum allowed value (VMP). The mean of the values obtained for this parametre was 5.40 ± 4.59 mg/L and the average nitrite was 0.02 ± 0.09 mg / L.

The average of turbidity was 1.27 ± 0.75 NTU. The color of the sample presented a minimum value of Ptco 1 and maximum of 27 PtCo units at point PB3; water with a yellowish color exceeded the value of 15 PtCo.

According to the results obtained from the microbiological analysis, it was possible to detect that 15 (53%) analysed samples exhibited growth of heterotrophic bacteria. The points CG1 (Mar–Aug 2019), CG3 (Mar 2019), PA2 (Feb 2019) and PA3 (Feb 2019) showed unit values of colony formation higher than those allowable by law (500 [colony forming units] CFU/100 ml) (Table 5).

Table 5. Microbiological parametres of the water samples collected during the dry and rainy periods from Quilombola communities of Pontal da Barra, Canta Galo, and Patioba.

POINTS	DATES	Thermotolerant coliforms (MPN/100 ml)	Total coliforms (MPN/100ml)	Heterotrophic Bacteria (CFU/ml)
Ordinance No. 2914/2011	**maximum values**	absent in 100 ml		< 500
PBT1	**Feb 2019**	**7.3**	**62**	NHC
PBB1	**Jul 2019**	NR	NR	NR
PB2	**Feb 2019**	**7.2**	**9**	100
	Jul 2019	< 1	14	100
PB3	**Feb 2019**	**22**	**22**	NHC
	Jul 2019	< 1	NHC	NHC
CG1	**sea 2019**	**1.8**	**170**	**1,000**
	Aug 2019	< 1	NHC	**1,000**
CG2	**sea 2019**	< 1	NHC	NHC
	Aug 2019	< 1	NHC	NHC
CG3	**sea 2019**	< 1	NHC	**1000**
	Aug 2019	< 1	NHC	NHC
PA1	**Feb 2019**	< 1	**23**	100
	Jul 2019	< 1	NHC	NHC
PA2	**Feb 2019**	< 1	**4**	**10,000**
	Jul 2019	NR	NR	NR
PA3	**Feb 2019**	< 1	**4.5**	**1,000**
	Jul 2019	NR	NR	NR

Note: Maximum allowed value (VMP): according to decree No. 2914/2011
Abbreviations: CFU = colony formation unit; MPN/100 ml = most probable number in 100 ml; NHC = no colony; NR = not done; PBT = Pontal da Barra (Treated); PBB2 = Pontal da Barra (plastic Bombona); CG = Canta Galo; PA = Patioba.
Source: Authors.

At the point PA2 (Feb 2019), there was a growth of heterotrophic bacteria 20 times above the VMP (10,000 CFU/100 mL). The PBB1 points (Feb 2019), PB2 (Feb–Jul 2019) and PA1 (Feb 2019) also showed growth of heterotrophic bacteria; however, they did not exceed the value of 500 CFU, representing 25% of the samples.

As for total coliform, it should also be absent in water samples, according to the potability ordinance. In eight of the 15 analysed samples, coliform growth was found, presenting 50% in the points PBT1, PB2, PB3, CG1, PA1, PA2 and PA3, and the highest point on CG1 (170 MPN/100 ml), where distributed water was stored in pails, in open containers and without protection.

The analyses performed in PBT1 (7.3 MPN/100mL), PB2 (7.2 MPN/100mL), and PB3 (22 MPN/100 ml) (Feb 2019) (community of Ponta da Barra) showed growth of thermotolerant coliforms. At point CG1 (1.8 MPN/100mL) (Mar 2019), there was also growth of coliform, representing a risk to the health of the residents. The percentage of thermotolerant growth in the dry season of the samples collected in February–March 2019 was 7.2%.

Health aspects, socio-demographic and environmental

In all housing and sanitation options, indicators analysing the situation of the Quilombola population was found to be unfavorable to their health and well-being (Naman & Gibson, 2015). In Brazil, this results from the association between housing, poverty, and overrepresentation indicators of black or mulatto people of the poor population (Souza & Calabró, 2017). Similar to this, other studies (VanDerslice, 2011; Naman & Gibson, 2015; Stillo & MacDonald, 2017) related the disparities of access to water and sewage services in South America with historical and present acts of racism.

Consequently, as an implication on the social determinants of health (i.e., health inequalities and environmental injustice), there has been a contribution to the politicisation of illness processes. This has resulted in the denouncement of the unjust, avoidable, unacceptable and inhumane character that affects the health conditions of some social segments located in spatial contexts of socioeconomic, environmental and cultural inequalities (Jesus, 2020).

As a result, the lack of access to decent housing and sanitation emerges as determinants of the health-illness process in the country (Brazil, 2010) and, consequently produces epidemiological conditions whose predominant profiles are groups without power and property. In this sense, the black population that constitutes one of these vulnerable groups stands out. The scarcity of performed studies, or when they are performed, do not bring the historical context or place it in the theoretical and political discussion of racism (structural, institutional, or environmental). In fact, the discussion about environmental racism in Brazil is still very incipient, and only recently has the discussion about institutional racism gained strength (Cunha, 2012).

In addition, it should not be forgotten that the broader racial variable and discussion of racism and racial inequality in epidemiology and public health, as well as the dialogue with the environmental interface, remain neglected in the hegemonic research agendas of social sciences in health. This exists in that they place demands, such as promoting research on the epidemiological picture of the black population, approaching, identifying and combating forms of institutional racism and identifying the health needs of the black population in rural areas (Werneck, 2016).

Thus, it can be seen from the data presented in this article that the studied Quilombola communities are the result of socioeconomic disparities, similar to other rural communities when compared to the urban population, and these Quilombola communities are in precarious or insufficient health conditions (Santos & Silva, 2014). Certain situations can occur due to geographic isolation, limited access and lack of quality in public services (basic sanitation, access to drinking water) at the time they are offered.

In the three studied communities, low socioeconomic and education level stood out as relevant factors. The interviews indicated that residents of the communities mostly belonged to a low socioeconomic level, mostly class D–E, which corresponds to an average household income of R $708.19 (considered low class in Brazil). Similar to previous studies linking socioeconomic status to the limited political power, these results indicate that race and socioeconomic status may serve as important potential factors influencing disparities in access to water supply and sanitary sewage (Cutter, 1995; Heaney et al., 2011).

Despite the emphasis of access to water and sanitation on health effects in previous studies (Bain et al. 2014; Naman & Gibson, 2015), an apparent lack of awareness of these risks in the three communities was noted. As for disposal of solid and liquid waste, although some respondents reported that their homes had septic tanks, the use of the rudimentary septic tanks and bathrooms in the backyard exists in the Quilombola communities studied in Sergipe. The inconsistency of information concerning the sewage, which can be seen as a weakness regarding the knowledge of people about the sanitation services offered in their community, was also noted.

Unfortunately, significant health risk situations have been described in the three communities, including overflows of tanks in streets, which may increase the risk of transmission of infectious diseases (Sorensen et al., 2015).

Access to drinking water is mostly from artesian/spring well sources inside or outside the homes. Studies concerning the quality of drinking water collected from wells have been developed around the world, with important relevance (Nalbantcilar & Pinarkara, 2016; Kayembe et al., 2018). Kayembe et al. (2018) described that some less-favoured regions and those without many water options for consumption end up using alternative sources susceptible to contamination.

The storage of water at home was incorrectly performed inside a water tank, plastic bottles or barrel of clay and may be exposed to biotic agents that could aggravate the final quality of water for consumption. Moreover, most of the respondents had not treated the drinking water at home. According to Betancourt et al., traditional methods of treatment drinking water, when applied to raw water sources, may contribute to reducing microorganisms that cause public health concerns (Betancourt, 2004; Filho & Paulo, 2017).

Similar to this study, it was observed in Quilombola communities that individuals did not carry out any kind of water treatment, and much of the water was consumed from wells. Thus, waterborne diseases in this study may also be related to water storage and supply (Cavalcante, 2014).

The intestinal parasites found in this study were similar when compared to other studies conducted in Brazilian rural communities (Rocha et al., 2006; Nounou et al., 2013; Sousa et al., 2016). The higher prevalence of the schistosomiasis among the parasitic diseases reported by respondents may be due to the presence of the intermediate host in water collections in the peridomiciliary regions of the studied communities. Several studies have shown that although the number of infected people in Brazil is declining, there is also a continuous transmission of parasitic diseases, which reflects the little investment in health and sanitation (Nounou et al., 2013).

In this sense, the health problems of the Quilombola population are a major challenge to faced when referring to the provision of public services, considering the socio-economic disparities, disadvantaged geographical locations, invisibility conditions and ethnic inequalities to which these communities are subjected (Betancourt & Rose, 2004).

Regarding the quality of drinking water, the parametres analysed were important for understanding the microbiological and physicochemical quality of the water used by the communities, which may also be affected by the form of storage. When performed incorrectly, the presence of pathogens damaging its quality may be shown. When these parametres exceeded the VMP (according to the potability ordinance No. 2914/2011 in force in Brazil), the health of the individual who consumes is endangered, due to the risk for waterborne diseases (Nounou et al., 2013). The presence of coliforms in water indicates pollution with a potential risk of presence of pathogenic organisms, and their absence is evidence of a microbiologically potable water, since coliforms are more water-resistant in water than pathogenic bacteria of intestinal origin (Betancourt & Rose, 2004).

The results of this study reveal that the average bacterial density in drinking water was relatively high, especially due to improperly stored water sources compared to protected sources. The presence of thermotolerant coliforms found in the water samples was worrying, since this classification includes bacteria of the genus Escherichia coli (Bain et al., 2014).

These findings may be related to possible health risks of the studied Quilombola communities. The VMP found in unprotected water sources suggests that, although not conclusive, there may be a relationship to the lack of water protection and poor sanitation conditions and practices as potential reasons for the high presence of microbiological contaminants.

The increase in microbial counts of water samples distributed by the overall network may also be associated with the hygiene behaviours of different families, which was a finding similar to other studies (Nounou et al., 2013). Some families used alternative sources for domestic activities, while others used dirty or inappropriate containers to collect and store drinking water. This may also be linked to some cases, for which there were decreases in the number of total coliforms and thermotolerant coliforms that had unusual access to the distribution network.

Water contamination was also potentially linked to groundwater contamination by human waste, which created a diffuse source of faecal contamination for water sources, poor hygiene and sanitation practice. These practices included laundry activities close to water sources by families and contaminated water sources (Kayembe et al., 2018). Faecal contamination appears to be primarily responsible for water contamination supply wells in rural areas (Rocha et al., 2006), with another study confirming a a greater danger for infectious disease in people using water treated by wells in their homes (Nounou et al., 2013). Both surveys indicated that the use of municipal sanitation systems can reduce these risks. However, inappropriate drinking water supply, poor sanitation and lack of protection of water sources are especially highlighted as risks for most rural communities in developing countries that rely on raw drinking water (Betancourt & Rose, 2004).

4. Conclusion

Unequal access to water and sanitation services can have considerable health effects and is disproportionate to politically vulnerability. Understanding the main factors affecting basic services can be useful to address health disparities. This research suggests measures related to water treatment, storage and distribution, which may be associated with waterborne diseases. In addition, there exists a need to create education and health promotion actions on food hygiene and sanitation adequacy to reduce the number of cases of these diseases.

The community is an important and manageable social system that can directly influence its relationship with the health status of its population. Therefore, it is necessary to understand the structure of communities before the implementation of health programs, since the promotion of equity in health services should be the element most considered for planning assistance in this population.

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References

Aleixo, B., Pena, J. L., Heller, L. & Rezende, S. (2019) Infrastructure is a necessary but insufficient condition to eliminate inequalities in access to water: Research of a rural community intervention in Northeast Brazil. *Science of The Total Environment* 652, 1445. 10.1016/j.scitotenv.2018.10.202.

Standard Methods for the Examination of Water and Wastewater (1998) (20th ed.), American Public Health Association/American Water Works Association/Water Environment Federation, Washington DC, USA.

Bain, R., Cronk, R., Wright, J., Yang, H., Slaymaker, T. & Bartram, J0 (2014) Fecal contamination of drinking-water in low-and middle-income countries: a systematic review and meta-analysis. *PLoS Medicine* 11 (5), 100–1644. 10.1371/journal.pmed.1001644.

Betancourt, W. Q., & Rose, J. B. (2004) Drinking water treatment processes for removal of Cryptosporidium and Giardia. *Veterinary Parasitology* 126, 219–234. 10.1016/j.vetpar.2004.09.002.

Bezerra, V. M., Andrade, A. C. S., Cesar, C. C., & Caiaffa, W. T. (2015) Domains of physical activity in slave-descendant communities in Southwest Bahia State, Brazil: a population-based study. *Cad. Saúde Pública* 31 (06), 1213–1224. 10.1590/0102-311X00056414.

Brazil. 2013a Secretaria de Políticas de Promoção da Igualdade Racial. Secretaria de Políticas Para Comunidades Tradicionais. Guia de Políticas Públicas para Comunidades Quilombolas: Brasília: Secretaria de Políticas de Promoção da Igualdade Racial.; 62p.

Brazil. 2018b Síntese de indicadores sociais: uma análise das condições de vida da população brasileira: 2018 / IBGE. Rio de Janeiro, Brazil: Instituto Brasileiro de Geografia e Estatística - IBGE. Coordenação de População e Indicadores Sociais.

Cavalcante, R. B. L. (2014) Ocorrência de Escherichia coli em fontes de água e pontos de consumo em uma comunidade rural. *Rev. Ambient. Água* 9 (03), 550–558. 10.4136/ambi-agua.1301.

Cunha, E. M. G. P. (2012) Ethnic-racial approach: paths taken and new challenges. In: *Health of the black population*, L.E. Batista, J. Werneck, J., F. Lopes (org.), Petropolis-RJ: Editora D&P Alii, Brasília, pp. 37–48.

Cutter, S. L. (1995) Race, class and environmental justice. *Progress in Human Geography* 19 (1), 111–122. https://doi.org/10.1177/030913259501900111.

Filho, F. J. C. M., & Paulo, P. L. (2017) Water supply, sanitation and health aspects in Quilombola communities in the State of Mato Grosso do Sul. *Interações* (Campo Grande) 18 (02), 103–116.

Freitas Júnior, R. A. D. O., Santos, C. A. D., Lisboa, L. L., Freitas, A. K. M. S. D., Garcia, V. L., & Azevedo, G. D. D. (2018) Incorporating Cultural Competence for Maternal Healthcare in the Quilombola Population into Health Profession Training. *Revista Brasileira de Educação Médica* 42 (2), 100–109. http://dx.doi.org/10.1590/1981-52712015v42n2rb20170086.

Heaney, C., Wilson, S., Wilson, O., Cooper, J., Bumpass, N., & Snipes, M. (2011) Use of community-owned and-managed research to assess the vulnerability of water and sewer services in marginalized and underserved environmental justice communities. *Journal of Environmental Health* 74 (1), 8–17.

Hennessy, T. W., Ritter, T. L., Holman, R. C., Bruden, D. Christensen, K. L. Y., Bullkow, L. R., Cheek, J. E., Singleton, R., & Smith, J. (2008) The Relationship Between In-Home Water Service and the Risk of Respiratory Tract, Skin, and Gastrointestinal Tract Infections Among Rural Alaska Natives. *American Journal of Public Health* 98 (11), 2072–2078. 10.2105/AJPH.2007.115618.

Synthesis of social indicators: an analysis of the living conditions of the Brazilian population 2018 Brazilian Institute of Geography and Statistics – IBGE, Rio de Janeiro, Brazil.

Irwin, A., Valentine, N., Brown, C., Loewenson, R., Solar, O., Brown, H., Koller, T., & Vega, J. (2006) The Commission on Social Determinants of Health: Tackling the Social Roots of Health Inequities. *PLoS Med* 3 (6), e106. 10.1371/journal.pmed.0030106.

Jesus, V. D. (2020). Racializing the (sociological) view on environmental health in the sanitation of the black population: A colonial continuum called environmental racism. Saúde e Sociedade, 29(2).

Karanis, P., Kourenti, C., & Smith, H. (2007) Waterborne transmission of protozoan parasites: a worldwide review of outbreaks and lessons learnt. *Journal of Water and Health* 5 (1), 1–38.

Kayembe, J. M., Thevenon, F., Laffite, A., Sivalingam, P., Ngelinkoto, P., Mulaji, C. K., & Poté, J. (2018) High levels of faecal contamination in drinking groundwater and recreational water due to poor sanitation, in the sub-rural neighbourhoods of Kinshasa, Democratic Republic of the Congo. *International Journal of Hygiene and Environmental Health* 221 (3), 400–408. https://doi.org/10.1016/j.ijheh.2018.01.003.

Magalhães Filho, F. J. C., & Paulo, P. L. (2017) Water supply, sanitation and health aspects in Quilombola communities in the State of Mato Grosso do Sul. *Interações* (Campo Grande). 18 (2), 103–116.

Nalbantcilar, M. T., & Pinarkara, S. Y. (2016) Public health risk assessment of groundwater contamination in Batman, Turkey. *Journal of Water and Health* 14 (4), 650–661. 10.2166/wh.2016.290.

Naman, J. M., & Gibson J. M. (2015) Disparities in Water and Sewer Services in North Carolina: An Analysis of the Decision-Making Process. *American Journal of Public Health* 105 (10), 20–26. 10.2105/AJPH.2015.302731.

Nounou, H. A., Ali, S. M., Shalaby, M. A., & Asala, R. G. (2013) The threats of microbial contamination and total dissolved solids in drinking water of Riyadh's rural areas, Saudi Arabia. *Asian Biomedicine* 7 (4), 491–498. 10.5372/1905-7415.0704.203.

Null, C., Stewart, P., Pickering, A. J., Dentz, H. N., Arnold, B. F., Arnold, C. D., Benjamin-Chung, J., Clasen, T., Dewey, K. G., Fernald, L. C. H., Hubbard, A. E., Kariger, P., Lin, A., Luby, S. P., Mertens, A., Njenga, S. M., Nyambane, G., Ram, P. K., & Colford, J. M. Jr. (2018) Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Kenya: a cluster-randomised controlled trial. *Lancet Glob Health* 6 (3), e316–e329. 10.1016/S2214-109X(18)30005-6.

Passos, T. S., Hora, A. B., Paixão, A. L. S. S., Santos, J., Almeida-Santos, M. A., & Oliveira, C. C. C. (2017) Health education for prevention of sexually transmitted diseases in quilombola communities. *Journal of Nursing UFPE online* 11 (10), 3965–3970.

Rouquayrol, M. Z, & Filho, N. The Epidemiology & Health. Guanabara Koogan; 2003, 736p.

Rocha, C. M. B. M. D., Rodrigues, L. D. S., Costa, C. C., Oliveira, P. R. D., Silva, I. J. D., Jesus, É. F. M. D., & Rolim, R. G. (2006) Avaliação da qualidade da água e percepção higiênico-sanitária na área rural de Lavras, Minas Gerais, Brasil, 1999-2000. *Cadernos de Saúde Pública* 22, 1967–1978. https://www.scielosp.org/article/csp/2006.v22n9/1967-1978/.

Silva, E. K. P. D., Medeiros, D. S. D., Martins, P. C., Sousa, L. D. A, Lima, G. P., Rêgo M. A. S., Silva, T. O. D, Freire, A. S., & Silva, F. M. (2017) Food insecurity in rural communities in Northeast Brazil: does belonging to a slave-descendent community make a difference? *Cadernos de Saúde Pública* 33 (4), 1–14. 10.1590/0102-311X00005716.

Sorensen, J. P. R., Lapworth, D. J., Marchant, B. P., Nkhuwa, D. C. W., Pedley, S., Stuart, M. E., Bell, R. A., Chirwa, M., Kabika, J., Liemisa, M., & Chibesa, M. (2015) In-situ tryptophan-like fluorescence: a real-time indicator of faecal contamination in drinking water supplies. *Water Research* 81, 38–46. https://doi.org/10.1016/j.watres.2015.05.035.

Sousa, R. S. D., Menezes, L. G. C. D., Felizzola, J. F., Figueiredo, R. D. O., Sá, T. D. D. A., & Guerra, G. A. D. (2016) Água e saúde no município de Igarapé-Açu, Pará. *Saúde e Sociedade* 25, 1095–1107. https://core.ac.uk/display/80944195.

Souza, G. F., & Calabró, L. (2017) Evaluation of the degree of implementation of the Program Research for SUS: shared management in health. *Saúde em Debate* 41, 180–191. https://www.scielo.br/pdf/sdeb/v41nspe/0103-1104-sdeb-41-nspe-0180.pdf.

Stillo, F., & MacDonald, G. J. (2017) Exposure to Contaminated Drinking Water and Health Disparities in North Carolina. *American Journal of Public Health* 107 (1), 180–185. 10.2105/AJPH.2016.303482.q11

Torales, A. P. B. (2013) Quality of life and self-esteem of Quilombola communities in the state of Sergipe. [Masters dissertation]. Aracaju. Tiradentes University, p.121.

United Nations General Assembly. (2010) The Human Right to Water and Sanitation. Plenary Resolution, A/RES/64/292, Agenda Item 48, A/64/PV.108, GA/10967, 122-0-41, 1249. https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/64/292.

World Health Organization. (2019) Progress on household drinking water, sanitation and hygiene 2000-2017. Special focus on inequalities. New York: United Nations Children's Fund (UNICEF) and World Health Organization. https://www.who.int/water_sanitation_health/publications/jmp-report-2019/en/.

VanDerslice, J. (2011) Drinking Water Infrastructure and Environmental Disparities: Evidence and Methodological Considerations. *American Journal of Public Health* 101 (s1), 109–114. https://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.2011.300189.

Werneck, J. (2016) Institutional racism and health of the black population. *Saúde e Sociedade*. 25 (3), 535–549. 10.1590/S0104-129020162610.