doi: 10.5216/rpt.v51i1.70826

REVIEW

DISEASES CAUSED BY PATHOGENS IN THE URBAN WATER SYSTEM IN THE METROPOLITAN REGION OF BELÉM, PARA, BRAZIL, AND THEIR RELATIONSHIP WITH THE SOCIO-ECONOMIC CONTEXT OF THE POPULATION

Ana Paula de Sousa Coelho[1,2], Yasmim Stephane Lima Tavares[1,3] and Henrique Fonseca Sousa do Nascimento[1]

ABSTRACT

The metropolitan region of Belém-PA suffers human fecal pollution in the local water supply system favoring the increase in cases of water circulating diseases in the population, especially the most socioeconomically vulnerable. Therefore, it is necessary to compile information on cases of these diseases over the years in this region, in order to better define public health policies. Thus, this work aims to contribute to the gathering of this information through a literature review selecting articles found in the SciELO, Pubmed and Google Academic databases with publications between 2005 and 2021 in Portuguese and English. The neighborhoods most affected by water circulation diseases proved were Guamá, Marco, Jurunas, Tapanã, Telegrafo and Terra Firme, located close to hydrographic basins, rivers and canals and are subject to flooding due to high tides and overflowing canals. In addition, the population in these neighborhoods is considered underprivileged. The most cited diseases and symptoms were leptospirosis, worms and diarrhea, which are easily prevented. Total and thermotolerant coliforms were also widely described, being the main indicators of fecal water contamination. The importance of sanitary measures is evidenced, as these reduce cases of water supply diseases in urban centers and improve population health. The quality of the water in the supply network is also important to mitigate the prevalence of these diseases.

KEY WORDS: Pathogens; sanitation; water resources; Belém, PA.

1. Faculdade Cosmopolita, Belém, Pará, Brazil.
2. Universidade do Estado do Pará (UEPA), Belém, Pará, Brazil.
3. Instituto Federal de Ciências e Tecnologia do Pará (IFPA), Belém, Pará, Brazil.

Ana Paula de Sousa Coelho: orcid.org/0000-0001-8214-6473; Yasmim Stephane Lima Tavares: orcid.org/0000-0001-9581-1428; Henrique Fonseca Sousa do Nascimento: orcid.org/ 0000-0001-8919-9068

Corresponding author: Ana Paula de Sousa Coelho. Faculdade Cosmopolita, Av. Tavares Bastos, 1313, CEP 66615-005 Marambaia, Belém, PA, Brasil. E-mail: paulasc.012@gmail.com

Received for publication: 16/11/2021. Reviewed: 17/1/2022. Accepted: 28/2/2022.

INTRODUCTION

Water is essential for human survival, used in a number of ways such as crop irrigation, as an electric power source and even for leisure. However, this natural resource has been degraded through human action by disorderly occupation in inappropriate areas with precarious sanitary infrastructure (Wu et al., 2018; Boyd, 2019).

According to the Universal Declaration of the Rights to Water, drafted by the United Nations (UN), access to clean water is a fundamental human right. The scarcity of drinking water, as a consequence of the anthropic influence on water resources, can lead to negative effects on human life, even making this unfeasible (Daniel & Cabral, 2011; dos Santos Junior et al, 2018).

Urban centers have always been the main cause of water pollution, since large populations generate a greater amount of human waste. However, most of this waste does not undergo treatment before being released into the environment and eventually returns to the population in the form of floods and diseases (dos Santos et al., 2017).

Many infectious and parasitic diseases that affect emerging countries are transmitted through water used for direct or indirect consumption in food intake and personal hygiene. Poor basic sanitation, river pollution and flooding, which are considerably common factors in Brazil, contribute to the contamination of water resources (Liu et al., 2018).

Basic sanitation is seen as the whole set of factors related to human health, such as the quality of life mediated by the individual's environmental, physical, biological and psychosocial conditions. In view of this, infectious and parasitic diseases existing in the environment, related to inadequate basic and environmental sanitation, are a potential determinant for the health of the population (Rose et al., 2019). Among these diseases are diarrhea caused by intestinal parasites, leptospirosis, hepatitis A, as well as others, which are potentially preventable through adequate basic and environmental sanitary actions (Siqueira et al., 2017).

According to the ABES Ranking of Universal Sanitation (ABES, 2020), 40,000 hospitalizations resulting from infections caused by inadequate environmental sanitation were registered in Brazil in the first quarter of 2020 alone. The north and northeast regions presented the highest bed occupancy rate in the public health system (SUS), respectively 7.3% and 6.9%. In the capital Belém do Pará, an average of 217 hospitalizations were registered and the expenses with these reached R$ 260,137.00.

Sá and collaborators (Sá et al., 2005) state that the North region suffers the most from diseases related to water quality due to deficient basic sanitation, and according to the Brazilian Association of Environmental and Sanitary

Engineering (ABES, 2019) the North region, when compared to other regions, still presents the lowest levels of basic sanitation in the country.

The municipality of Belém undergoes disorderly urbanization where a large part of the population is located close to rivers and canals in which household waste and garbage are dumped due to non-existent selective collection and poor basic sanitation, favoring the transmission of diseases through contaminated water (de Araujo et al., 2010).

Floods occur in a large part of the metropolitan region of Belém when the rainfall index increases. This signifies risk of contamination by pathogens (de Cabral et al., 2014) since the poor population habitually uses the canals for leisure, such as fishing and bathing. In addition, due to the precarious drainage system, many streets and houses are flooded, a fact that can increase the morbidity rate in the population (Uhr et al., 2016; Silva, 2016).

In this scenario, it is necessary to carry out data and information compilation regarding waterborne diseases in the metropolitan region of Belém, PA over the years, so that better public health policies can be defined. The purpose of this work is, therefore, to contribute in gathering this information.

METHOD

This study is an integrative literature review in which articles were selected with a focus on waterborne pathogens in the city of Belém-PA, as well as on the socioeconomic characteristics of the population, using the SciELO, Google Scholar and PubMed databases as research sources. The review was performed by all authors present in the study to better verify the data.

As a search strategy, the descriptors "Pathogens", "Sanitation", "Water Resources" and "Belém-PA" were used. Articles that were published between 2005 and 2021 in English and Portuguese were included. On the other hand, articles that were published in years prior to the period established, and in other languages were excluded. Articles that did not refer to the metropolitan region of Belém, PA or did not address the socioeconomic profile of the population and waterborne pathogens were also excluded.

RESULTS AND DISCUSSION

Thirty-nine studies were found in the SciElo, Google Scholar and PubMed databases within the inclusion and exclusion criteria, and after analyzing the full texts, 14 studies were selected and searched in the SciELO and Google Scholar databases, with publications between 2005 and 2021 in Portuguese for the discussion in this article as shown in Figure. However, no studies were found from 2006 to 2009, 2011, 2012, 2017 and 2019, as detailed in Table.

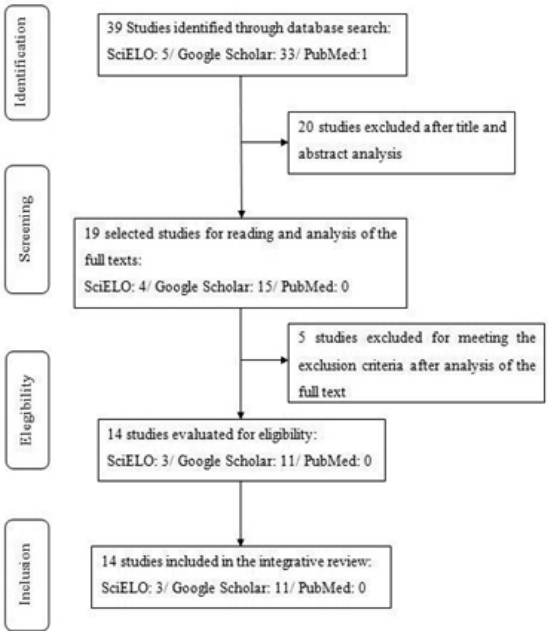

Figure. Flowchart referring to the selection of articles for the integrative review.

Table. Selected articles with the main neighborhoods, pathogens and associated diseases according to authors and their exclusive tools.

N°	AUTHOR/YEAR	NEIGHBORHOODS	PATHOGENS AND ASSOCIATED DISEASES	CONCLUSION
1	Sá et al., 2005.	Barreiro and Maracangalha.	Total and thermotolerant coliforms.	Popular customs related to water care remained even after the government sanitation project in Belém.
2	Carmona et al., 2010.	Parque Verde, Pratinha, São Clemente and Tapanã.	Fecal coliforms and Diarrhea.	Not all the population in the study area has a water supply service and those that have the service deal with poor quality.

3	Mancabú, 2013.	Guamá and Terra Firme.	Schistosomiasis and Leptospirosis.	The poorest population is most affected as the government overlooks their basic human rights, and they do not have the necessary means to satisfy their basic needs.
4	Melo, 2014.	Águas Negras and Paracurí.	Amebiasis, Ascariasis, Dysentery, Hepatitis A, Leptospirosis and Skin mycosis	The water supply in these neighborhoods is precarious with total lack of environmental sanitation. Streets and rivers are used for waste disposal, thus causing flooding due to overflowing canals making waterborne diseases a long-term problem.
5	da Silva et al., 2015.	Tenoné.	Total coliforms and *Escherichia coli.*	The water supplied for population consumption must be of good quality, which is a measure to protect public health and must be the main objective of the water supply networks.
6	Neto et al., 2015.	Jurunas.	Diarrhea, Cholera, Hepatitis A and Verminosis.	Providing good quality water is a preventive health policy generating many benefits such as improving the health of individuals and saving government costs with treatment. However, not all populations have access to these services and when they do these are of inferior quality.
7	Neves et al., 2015.	Telégrafo	Fecal coliforms.	The population disposes of their garbage and sanitary sewage directly in the Guajará Bay without any prior treatment.

8	Gonçalves et al., 2016.	Condor, Guamá and Jurunas.	Leptospirosis.	Transmission is due to the association between risk factors related to the environment, geography and socioeconomic conditions, and this allowed for differences in the occurrence of the disease in each neighborhood.
9	Brito et al., 2018.	Castanheira e Marco.	Diarrhea, Dysentery, Schistosomiasis, Giardiasis, Leptospirosis and *Salmonella* sp.	The Castanheira neighborhood presented the biggest infrastructure problem and quality of the sanitary services provided, which can directly affect the presence of diseases in the population.
10	da Silva Rebêlo et al., 2018.	Canudos, Guamá, parte do Marco, Terra Firme and Universitário.	Gastrointestinal diseases, schistosomiasis and leptospirosis.	The lack of a public sewage system, efficient water system and solids management, coupled with lack of knowledge regarding environmental education, directly affect the physical, mental and social well-being of the population.
11	Trindade, 2018.	Comércio, Guamá, Jurunas and Telégrafo.	Thermotolerant coliforms, *Escherichia coli* and *Vibriocholerae*.	Despite the findings in water and their virulence factors, there was no significant relationship between contamination and diarrheal cases during the study period.

12	Dergan et al., 2020.	Guamá, Marambaia, Marco, Pedreira and Tapanã.	Leptospirosis.	The spread of this disease is mainly due to constant flooding and lack of basic sanitation, in addition to the population not being instructed regarding adequate waste management.
13	Baia et al., 2021.	Marco.	Amebiasis, Ascariasis, Acute diarrhea and Leptospirosis.	Residents of canal areas are more susceptible to some pathologies due to precarious basic sanitation, which is linked to their social level.
14	Nogueira et al., 2021.	Val-de-Cans.	Fecal and thermotolerant coliforms.	The water analyzed in the study is of uncertain quality, which may be causing health problems to residents.

All the studies evaluated showed that some neighborhoods in the metropolitan region of Belém are more affected by water circulation diseases than others are. Among the most cited stands out the neighborhood of Guamá, located in the peripheral area, then Marco, located between the outskirts and center of Belém. Jurunas, Pratinha, Tapanã, Telégrafo and Terra Firme also appear as peripheral neighborhoods frequently cited among the selected articles. Cardoso and collaborators (Cardoso et al., 2008) point out that neighborhoods closer to the center of the capital have greater economic development and, consequently, greater infrastructure in relation to basic sanitation when compared to neighborhoods further away from the city center.

One of the possible reasons why these neighborhoods are the most cited is because they are located in areas close to rivers and canals in the city, an important factor for disease transmission (Neves et al., 2015; Baia et al., 2021). Several canals flow, without any kind of treatment, into the Guajará Bay and the Guamá River, which in turn receive most of the city's sewage, which is why during high tide and when it rains the canals overflow risking population health, as this inadequate disposal favors the proliferation of pathogens (Melo, 2014; Dergan et al., 2020).

Another factor that contributes to the overflowing canals is the inadequate management of waste by the population itself, even with selective collection in the neighborhoods, residents throw waste in the canals or around them (Melo, 2014; Neves et al., 2015; da Silva Rebêlo et al., 2018; Dergan et al., 2020). However, despite public collection of residential waste, it is

not properly handled. Data from the Statistical Yearbook of the Municipal Sanitation Plan (Prefeitura municipal de Belém, 2014), show that of the residential garbage destined for the dump, 1.4% is burned and 0.04% is buried.

This inadequate disposal of waste and rising water levels on public roads are determining factors for the spread of leptospirosis, as shown in Table. Here 7 authors (Mancabú, 2013; Melo, 2014; Gonçalves et al., 2016; Brito et al., 2018; da Silva Rebêlo et al., 2018; Dergan et al., 2020; Baia et al., 2021) cite the incidence of this disease, associated with peripheral neighborhoods and local environmental problems.

Other water circulation diseases are evidenced in the articles analyzed, such as schistosomiasis and other verminosis (Mancabú, 2013; Melo, 2014; Neto et al, 2015; Brito et al., 2018; da Silva Rebêlo et al., 2018). In addition, there are fecal and thermotolerant coliforms in drinking water (Sá et al., 2005; Carmona et al., 2010; Neves et al., 2015; Trindade, 2018; Nogueira et al., 2021), which cause diarrhea, the main symptom found in the research (Carmona et al., 2010; Neto et al, 2015; Brito et al., 2018).

Another factor that contributes to the transmission of diseases is the consumption of contaminated water. According to the *Instituto Trata Brasil* (2020), Belém, capital of Pará, comes 95th in the basic sanitation ranking with 70.3% total water supply, 13.6% total sewage collection service, however only 2.3% of this sewage is treated, evidencing a drop in comparison with the 2019 ranking when the city came 90th (*Instituto Trata Brasil*, 2019).

FINAL CONSIDERATIONS

In view of the information obtained from the researched bibliographies, the underprivileged population is the most affected by waterborne pathogens. Located mostly in the peripheral neighborhoods of the Metropolitan Region of Belém, suffering precarious sanitation.

Diseases caused by water supply pathogens are easy to prevent, for this reason a quality water supply system, sewage treatment, drainage system and other sanitary measures are extremely important for the well-being of the population. Investments in these actions would mitigate government costs regarding treatment of these diseases, which are considerable due to the number of people affected.

In addition, better treatment of the water supplied by the General Network to the population is paramount, since most homes depend on this network. Increasing resident awareness regarding the importance of these measures and of waterborne diseases also contributes to reduce the number of cases of these infections.

CONFLICTS OF INTEREST

There were no conflicts of interest; all authors are in accordance with this article.

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