ORIGINAL ARTICLE

Community knowledge and attitudes toward waterborne intestinal diseases in a municipality of the Central Maranhão Mesoregion, Brazil

Conhecimentos e atitudes da comunidade sobre doenças intestinais de veiculação hídrica em um município da Mesorregião do Centro Maranhense, Brasil

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Abstract

Objective: this study aimed to analyze the community's level of knowledge and attitudes regarding Waterborne Intestinal Diseases (WIDs) in the municipality of Lago dos Rodrigues, Maranhão. **Methods**: this was an observational and cross-sectional study conducted to obtain information on the level of knowledge of the community regarding WIDs. Data were collected through the administration of a questionnaire between February and March 2022. **Results**: the study included 394 participants who reported or did not report WIDs. Among the respondents, 82.4% reported having heard about intestinal diseases; 55.0% stated that they knew how an intestinal disease is transmitted; 90.1% believed that intestinal diseases can be transmitted through drinking water; 67.7% reported not knowing what protozoa, viruses, and bacteria are; 74.6% knew that protozoa, viruses, and bacteria may be present in untreated water intended for consumption; 73.6% knew that protozoa, viruses, and bacteria can act as parasites in the human body and cause diseases, including intestinal diseases; and 79.9% reported knowing how to prevent intestinal diseases caused by waterborne parasites. **Conclusion**: the results showed satisfactory levels of knowledge and preventive attitudes toward WIDs, but further studies are needed due to limited data in the state of Maranhão.

Keywords: intestinal diseases; waterborne diseases; health knowledge; Brazil.

Resumo

Objetivo: analisar o nível de conhecimento e as atitudes da comunidade em relação às Doenças Intestinais de Veiculação Hídrica (DIVHs) no município de Lago dos Rodrigues, Maranhão. **Métodos**: trata-se de um estudo observacional e transversal para a busca de informações sobre o nível de conhecimento da comunidade sobre as DIVHs. Para a coleta de dados foi realizada a aplicação de um questionário no período de fevereiro a março de 2022. **Resultados**: o estudo incluiu 394 participantes que relataram ou não relataram as DIVHs. Entre os entrevistados, 82,4% afirmaram já ter ouvido falar em doenças intestinais; 55,0% relataram saber como ocorre a transmissão de uma doença intestinal; 90,1% acreditavam que doenças intestinais podem ser transmitidas pela água ingerida; 67,7% relataram não saber o que são protozoários, vírus e bactérias; 74,6% sabiam que protozoários, vírus e bactérias podem estar presentes em água não tratada para consumo; 73,6% sabiam que protozoário, vírus e bactérias podem atuar como parasitos no organismo humano e causar doenças, inclusive doenças intestinais; e 79,9% relataram saber como se prevenir de doenças intestinais causadas por parasitos transmitidos pela água. **Conclusão:** os resultados demonstraram níveis satisfatórios de conhecimento e atitudes preventivas da população em relação às DIVHs, contudo, faz-se necessária a realização de mais estudos, devido à limitação de dados disponíveis no estado do Maranhão.

Palavras chave: doenças intestinais; doenças de veiculação hídrica; conhecimento em saúde; Brasil.

INTRODUCTION

Waterborne Intestinal Diseases (WIDs) are common worldwide, especially in underdeveloped countries. Their dissemination is directly associated with poor water quality, inadequate basic sanitation, and limited knowledge regarding preventive measures[1,2,3]. Transmission occurs through the ingestion of water contaminated with a variety of pathogenic microorganisms of fecal origin, among which certain species of protozoa, viruses, and bacteria are notable[4,5]. These diseases may present in acute or chronic forms and can manifest with mild, moderate, or severe intensity, depending on several factors such as the type of etiological agent, its virulence, the infectious dose, the host's susceptibility, and the interval between the onset of signs and symptoms and the provision of appropriate healthcare intervention[6].

In Brazil, the incidence of WIDs has increased annually and continues to be relevant to the population's morbidity and mortality profile, despite being mostly preventable or even

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eradicable[7]. However, most cases are not reported because many pathogens cause diseases with mild symptoms, which discourages individuals from seeking professional care, thereby preventing the identification of outbreaks[8].

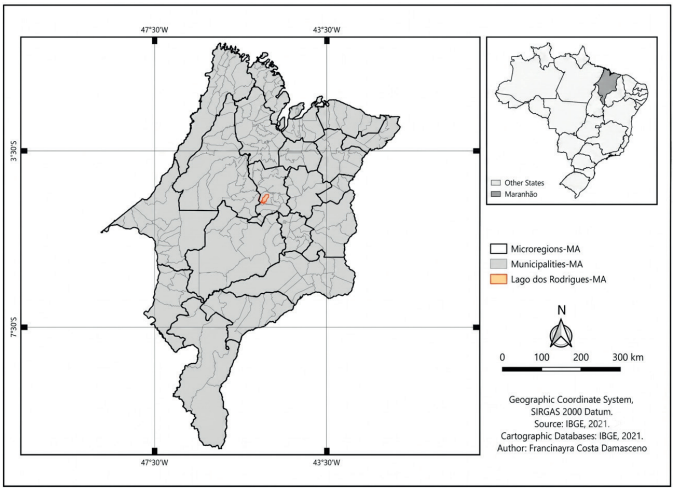
The state of Maranhão ranked last in Brazil's Human Development Index (HDI) in 2021 and also had the lowest monthly per capita household income in 2023[9]. These indicators reflect conditions of social vulnerability and low living standards, which may facilitate the transmission of WIDs. The municipality of Lago dos Rodrigues, located in the Centro Maranhense Mesoregion, presents characteristics that favor a high occurrence of WIDs, as it is one of the least populated cities in the state, with demographic, economic, and social features similar to those of other municipalities in Maranhão and a predominantly low-income population. Accessing community perceptions and popular conceptions about diseases is essential for the development of effective control strategies[10]. Therefore, the present study aimed to analyze the community's level of knowledge and attitudes regarding WIDs in the municipality of Lago dos Rodrigues, state of Maranhão.

MATERIAL AND METHODS

Study area

The research was conducted in the municipality of Lago dos Rodrigues, state of Maranhão, located in the Central Maranhão Mesoregion and the Médio Mearim Microregion, with the following geographic coordinates: latitude 4° 36′ 9″ South, longitude 44° 59′ 2″ West (Figure 1). The municipality covers a territorial area of 220.776 km² and had an estimated population of 8,857 inhabitants in 2021, resulting in a population density of approximately 43.21 inhabitants/km². In 2021, the region's Gross Domestic Product (GDP) per capita was R$ 9,500.91, and the *Índice de Desenvolvimento da Educação Básica* (IDEB) for 2023 was 5.7 for early years and 4.3 for final years in public schools[11].

Figure 1. Location map of the municipality of Lago dos Rodrigues, state of Maranhão.



Source: SOUSA, F. C. D. (2022).

Sampling

The minimum sample size was calculated considering a 5% significance level, a hypothetical frequency of 50% (community knowledge about WIDs), and a 5% confidence limit. The total population of 8,857 inhabitants estimated by IBGE (2021)[12] was also considered. Based on these parameters, the minimum required sample size of 394 individuals was obtained. The software OpenEpi version 3.01 28 (Georgia, United States of America) was used for determining the minimum sample size. For the study, individuals aged 18 years or older were randomly selected in each of the 37 registered streets.

Type and Design of the Study

This is an observational and cross-sectional study conducted in two stages. First, a pilot questionnaire was administered to 10 randomly selected residents of the municipality in order to test the data collection instrument. Subsequently, the community's level of knowledge about WIDs was assessed using the same questionnaire, which had already been tested and validated.

Questionnaire administration

The questionnaire was administered between February and March 2022. It consisted of 14 multiple-choice questions addressing key aspects of the main WIDs, including transmission and risk behaviors reported by the community. Sociodemographic variables such as sex, age, education level, race, income, and household environment were also collected. Due to the COVID-19 pandemic at the time of data collection, preventive health measures were adopted, including maintaining a minimum distance of one meter between the participant and the researcher and requiring both the interviewer and participant to wear face masks covering the nose and mouth to avoid the spread of SARS-CoV-2.

Inclusion and Exclusion Criteria

Participants originating from and residing in the municipality of Lago dos Rodrigues, of both sexes, aged 18 years or older, who, after a prior explanation of the study and signing the *Termo de Consentimento Livre e Esclarecido* (TCLE) in two copies (one kept by the participant and the other by the research team), agreed to participate in the study were included.

Descriptive statistical analysis of the data

Microsoft Office Excel 2013 (Washington, United States of America) and GraphPad Prism 5 (San Diego, United States of America) software were used to prepare tables, charts, and graphs. This analysis included calculations of absolute and relative frequencies for the following categorical variables: sociodemographic (sex, age, education level, race, income, and household environment), as well as for aspects related to the main WIDs, including transmission and risk behaviors for infections reported by the community.

Ethical Aspects

The present study was submitted to and approved by the *Comitê de Ética em Pesquisa* of the Universidade Estadual do Maranhão (UEMA), under *Certificado de Apresentação de Apreciação Ética* (CAAE) number 53830321.1.0000.5554. The study was conducted based on the participants' responses, without any nominal identification or residential address, in accordance with the *Resolução do Conselho Nacional de Saúde* (CNS) number 466/2012, dated December 12, 2012[13].

Statistical Analysis

Contingency tables were used to assess the association between categorical variables through Pearson's chi-square test ($\chi 2$). In the tables, the dependent variable (responses regarding whether or not the interviewed population had presented any WID) was cross-tabulated with the independent sociodemographic variables (sex, age group, education level, race, income, and family arrangement), with hygiene-related variables (handwashing after using the bathroom and before meals; washing fruits and vegetables before consumption; source of drinking water; place of defecation; fecal disposal; waste destination; and the presence of domestic animals), as well as variables related to the community's level of knowledge about WIDs (whether they had heard about them, mode of transmission, transmission through water, knowledge about different causative pathogens, and whether they knew how to prevent WIDs). Statistical analyses were performed using the OpenEpi software, version 3.01[14], adopting a significance level of $p \leq 0.05$.

RESULTS

Of the 394 interviewees who reported or did not report WIDs, most were female (261; 66.2%), aged 18 to 49 years (238; 60.4%), had no schooling or had completed primary education (231; 58.6%), self-identified as brown (249; 63.2%), had an income less than or equal to one minimum wage (294; 74.6%), and lived in households with 1 to 3 individuals (223; 56.6%). There was an association with the absence of WID among interviewees aged 18 to 49 years ($\chi 2 = 5.82$; df = 1; p = 0.01), those with no schooling or only primary education ($\chi 2 = 3.94$; df = 1; p = 0.04), and those who self-identified as brown ($\chi 2 = 3.63$; df = 1; p = 0.05) (Table 1).

Table 1. Sociodemographic variables of the interviewed population from the municipality of Lago dos Rodrigues, Maranhão, in relation to the presence or absence of Waterborne Intestinal Diseases (WIDs).

Variables	Presented any WID n (%)	Did not present any WID n (%)	Statistical analysis
Sex			
Male	58 (14.7)	75 (19.0)	$\chi 2 = 0.41$ df = 1 p = 0.51
Female	105 (26.6)	156 (39.7)	
Age range (in years)			
18 to 49	110 (27.9)	128 (32.6)*	$\chi 2 = 5.82$ df = 1 p = 0.01
50 to 89	53 (13.4)	103 (26.1)	
Education level			
No schooling or primary education	86 (21.8)	145 (36.9)*	$\chi 2 = 3.94$ df = 1 p = 0.04
High school or higher education	77 (19.5)	86 (21.8)	
Race			
Brown	112 (28.4)	137 (34.9)*	$\chi 2 = 3.63$ df = 1 p = 0.05
Others	51 (12.9)	94 (23.8)	
Household income			
≤ 1 minimum wage	115 (29.1)	179 (45.7)	$\chi 2 = 2.42$ df = 1 p = 0.11
>1 minimum wage	48 (12.1)	52 (13.1)	
Family arrangement			
1 to 3 individuals	86 (21.8)	137 (34.9)	$\chi 2 = 1.66$ df = 1 p = 0.19
≥ 4 individuals	77 (19.5)	94 (23.8)	

WID = Waterborne Intestinal Diseases; n = number of interviewees; % = percentage of interviewees; $\chi 2$ = chi-square value; df = degrees of freedom; p = p-value; *Category with significant frequency.

Regarding the habits adopted by the community, 353 (89.6%) reported washing their hands after using the bathroom; 367 (93.1%) stated that they washed fruits and vegetables before consumption; 289 (73.3%) consumed filtered, bottled, or purified water; 391 (99.2%) reported defecating in a bathroom located inside the house or in the backyard; 378 (95.9%) stated that household feces were disposed of in a septic tank; 385 (97.7%) had their household waste collected by the public service; and 266 (67.5%) reported having animals at home. There was an association with the absence of WIDs among respondents who reported washing their hands after using the bathroom ($\chi2 = 12.04$; df = 2; p = 0.002), who stated that they washed fruits and vegetables before consumption ($\chi2 = 8.26$; df = 2; p = 0.01), and those who had animals in the household environment ($\chi2 = 5.72$; df = 1; p = 0.01) (Table 2).

Table 2. Variables related to the habits of the interviewed population from the municipality of Lago dos Rodrigues, Maranhão, in relation to the presence or absence of Waterborne Intestinal Diseases (WIDs).

Variables	Presented any WID n (%)	Did not present any WID n (%)	Statistical analysis
Washes hands after using the bathroom and before meals			
Yes	136 (34.5)	217 (55.4)*	$\chi2 = 12.04$ df = 2 p = 0.002
No	3 (0.7)	3 (0.7)	
Sometimes	24 (6.0)	11 (2.7)	
Washes fruits and vegetables before consumption			
Yes	145 (36.8)	222 (56.6)*	$\chi2 = 8.26$ df = 2 p = 0.01
No	9 (2.2)	3 (0.7)	
Sometimes	9 (2.2)	6 (1.5)	
Source of drinking water			
Filtered, bottled, or purified water	116 (29.4)	173 (44.0)	$\chi2 = 0.67$ df = 1 p = 0.41
Tap water or well water	47 (11.9)	58 (14.7)	
Place of defecation			
Indoor or backyard bathroom	161 (40.8)	230 (58.5)	$\chi2 = 1.86$ df = 1 p = 0.17
Open defecation	2 (0.5)	1 (0.2)	
Feces disposal			
Septic tank	153 (38.8)	225 (57.2)	$\chi2 = 3.07$ df = 1 p = 0.07
Others	10 (2.5)	6 (1.5)	
Waste destination			
Collected by sanitation service	158 (40.1)	227 (57.7)	$\chi2 = 0.76$ df = 1 p = 0.38
Incinerated or other	5 (1.2)	4 (1.0)	
Has animals			
Yes	121 (30.7)	145 (36.9)*	$\chi2 = 5.72$ df = 1 p = 0.01
No	42 (10.6)	86 (21.8)	

WID = Waterborne Intestinal Diseases; n = number of interviewees; % = percentage of interviewees; $\chi2$ = chi-square value; df = degrees of freedom; p = p-value; *Category with significant frequency.

Most study participants reported having heard about intestinal diseases (325; 82.5%); knowing how an intestinal disease is transmitted (217; 55.1%); believing that intestinal diseases can be transmitted through drinking water (355; 90.1%); not knowing what protozoa, viruses, and bacteria are (267; 67.8%); knowing that protozoa, viruses, and bacteria may be present in untreated water intended for consumption (294; 74.6%); knowing that protozoa, viruses, and bacteria can act

as parasites in the human body and cause diseases, including intestinal diseases (290; 73.6%); and knowing how to prevent intestinal diseases caused by parasites transmitted through water (315; 79.9%). There was an association with the absence of WIDs among interviewees who reported having heard about intestinal diseases ($\chi2 = 17.51$; df = 1; $p < 0,001$); those who did not know how an intestinal disease is transmitted ($\chi2 = 14.05$; df = 1; $p < 0,001$); those who did not know what protozoa, viruses, and bacteria are ($\chi2 = 12.98$; df = 1; $p < 0,001$); those who knew that protozoa, viruses, and bacteria may be present in untreated drinking water ($\chi2 = 30.18$; df = 1; $p < 0,001$); those who knew that protozoa, viruses, and bacteria can act as parasites in the human body and cause diseases, including intestinal diseases ($\chi2 = 31.09$; df = 1; $p < 0,001$); and those who said they knew how to prevent intestinal diseases caused by waterborne parasites ($\chi2 = 6.12$; df = 1; $p = 0.01$) (Table 3).

Table 3. Variables related to knowledge about Waterborne Intestinal Diseases (WIDs) among the interviewed population from the municipality of Lago dos Rodrigues, Maranhão, according to the presence or absence of these diseases.

Variables	Presented any WID n (%)	Did not present any WID n (%)	Statistical analysis
Do you know or have you heard about intestinal diseases?			
Yes	150 (38.0)	175 (44.6)*	$\chi2 = 17.51$ df = 1 p <0,001
No	13 (3.2)	56 (14.2)	
Do you know how an intestinal disease is transmitted?			
Yes	108 (27.4)	109 (27.6)	$\chi2 = 14.05$ df = 1 p < 0,001
No	55 (13.9)	122 (30.9)*	
Do you think intestinal diseases can be transmitted through drinking water?			
Yes	152 (38.5)	203 (51.8)	$\chi2 = 3.50$ df = 2 p = 0.17
No	8 (2.0)	17 (4.3)	
I don't know	3 (0.7)	11 (2.7)	
Do you know what protozoa, viruses, and bacteria are?			
Yes	69 (17.5)	58 (14.7)	$\chi2 = 12.98$ df = 1 p < 0,001
No	94 (23.8)	173 (44.0)*	
Did you know that protozoa, viruses, and bacteria may be present in untreated drinking water?			
Yes	145 (36.8)	149 (37.9)*	$\chi2 = 30.18$ df = 1 p < 0,001
No	18 (4.5)	82 (20.8)	
Did you know that protozoa, viruses, and bacteria can act as parasites in the human body and cause diseases, including intestinal diseases?			
Yes	144 (36.5)	146 (37.2)*	$\chi2 = 31.09$ df = 1 p < 0,001
No	19 (4.8)	85 (21.5)	
To prevent intestinal diseases caused by parasites transmitted through water, do you know what should be done?			
Yes	140 (35.5)	175 (44.5)*	$\chi2 = 6.12$ df = 1 p = 0,1
No	23 (5.8)	56 (14.2)	

WID = Waterborne Intestinal Diseases; n = number of interviewees; % = percentage of interviewees; $\chi2$ = chi-square value; df = degrees of freedom; p = p-value; *Category with significant frequency.

DISCUSSION

Understanding the population's behavior, as well as its knowledge, perceptions, and attitudes regarding diseases, together with the regional context in which the study area is inserted, is essential for the development of effective control strategies[15]. The present study characterized the local reality and living conditions of the population of the municipality of Lago dos Rodrigues, state of Maranhão, and assessed the community's perception regarding the occurrence of WIDs. The analysis of the results revealed satisfactory levels of knowledge among the population about these diseases, as well as preventive attitudes practiced by the community. To the best of our knowledge, this is the first comprehensive assessment addressing this topic in the municipality, and no previously published data are available for comparison with the findings of this research.

A low educational level has been identified as one of the main risk factors for acquiring intestinal parasitic infections[16], considering that access to education enables individuals to develop better knowledge, attitudes, and practices regarding their health status and disease prevention[17]. In contrast, although uncommon in studies of this type, the present research revealed a direct association between low educational attainment and the absence of reported WIDs ($\chi2 = 3.94$; df = 1; p = 0.04), indicating that the lack of formal schooling did not influence disease outcomes within the community. This discrepancy may be explained by the fact that access to health education does not depend on schooling level[18], since health education constitutes a public health approach whose aim is to promote behavioral change in the population in response to sanitary problems[19]. Moreover, it is important to highlight that health and environmental education serve as facilitators for improving individuals' quality of life, fostering good hygiene practices, and strengthening critical awareness of the context in which they live[20].

Although this was not the focus of the research, during the recent COVID-19 pandemic, educational actions gained greater visibility in the fight against the disease, employing strategies aimed at preventing the population from becoming ill[21]. Therefore, considering the transmission routes of respiratory and intestinal diseases, this result was already expected, certainly due to the preventive measures implemented by the World Health Organization (WHO) to limit the spread of COVID-19[22,23,24].

A study conducted in two general municipal hospitals in Changsha, the capital of Hunan Province in the People's Republic of China, evaluated the long-term impact of COVID-19 protective measures on the incidence of 39 notifiable diseases throughout the year 2020[24]. The analyses revealed that the epidemic had a particularly significant impact on respiratory and intestinal infectious diseases, whose numbers dropped sharply between February and June 2020 compared with the average levels for the same period from 2017 to 2019. According to the authors, COVID-19 protective measures prevented the spread of respiratory and intestinal infectious diseases, but not sexually transmitted or bloodborne infections[24].

In this study, personal hygiene practices for the control of WIDs were frequently reported, such as washing fruits and vegetables before consumption and washing hands after using the bathroom and before meals. These practices influenced the absence of WIDs among most respondents who stated that they adopted such habits [($\chi2 = 12.04$; df = 2; p = 0.002) and ($\chi2 = 8.26$; df = 2; p = 0.01), respectively]. It is well established in several studies that population behavior directly affects the positivity of intestinal parasitosis; therefore, communities that possess knowledge and adopt proper practices regarding food and environmental hygiene are less likely to acquire intestinal parasites[25].

A problem observed in Lago dos Rodrigues was the presence of WIDs among participants who reported adopting the same preventive habits (34.5% and 36.8%, respectively), indicating a possible inadequate method of handwashing and food washing, and or the use of water from questionable sources, thereby maintaining the prevalence of WIDs in the region[26]. A study was conducted to determine the prevalence and risk factors associated with intestinal parasitic infections among elementary and secondary school students from a school located in the city of João Pessoa, capital of the state of Paraíba. Similar results to those found in the present study were observed, in which most parasitized students (46.3%) washed fruits and vegetables using water only[27]. According to the authors, the likelihood of intestinal parasite positivity among students who did not adequately wash fruits and vegetables was 2.0 times higher than among those who washed them properly, leading to the conclusion that washing with water only was considered a risk factor[27].

An issue raised in this study, contrary to what has been observed in most other investigations[28,29,30,31], was the coexistence between domestic animal ownership and the absence of WIDs in the community ($\chi2 = 5.72$; df = 1; p = 0.01). The sampled population did not appear to be affected by these diseases, which is uncommon in environments with close contact with domestic animals, as such animals are important vehicles for the transmission of intestinal pathogens to humans[32,33]. This finding is consistent with results reported in studies conducted in Osasco, São Paulo[34] and Porto Alegre, Rio Grande do Sul[35], in which the authors indicated that the presence of animals in poorer households tended to be associated with a lower risk of parasitosis. Care for both animal and human health includes the control of parasitic infections[34,35].

A study conducted with parents of preschool students from two schools located in the Metropolitan Region of Recife, state of Pernambuco, showed that there was concern among respondents about keeping animals healthy, including rabies

vaccination (92.2%), veterinary consultation (82.8%), and the administration of anthelmintic drugs (76.6%). In addition, respondents demonstrated knowledge about the existence of diseases that can be transmitted by animals, the ways of acquiring them, and prophylactic measures to prevent diseases such as helminth infections[36]. According to the authors, this may explain the fact that prophylactic information on parasitic diseases within underprivileged communities reduces their prevalence, thereby improving population health and quality of life[36].

Based on the reports obtained during the interviews, a satisfactory level of knowledge was observed among the surveyed population. Such knowledge influences quality of life and health promotion within the community, since, despite the participants' low level of formal education, there was an association with the absence of WIDs among interviewees who demonstrated a notable understanding of intestinal diseases, pathogens, modes of transmission, and disease prevention. In this study, WIDs did not affect participants who reported having heard about these diseases ($\chi2 = 17.51$; df = 1; $p < 0,001$), nor those who reported not knowing their mode of transmission ($\chi2 = 14.05$; df = 1; $p < 0,001$), as well as those who did not know what protozoa, viruses, and bacteria are ($\chi2 = 12.98$; df = 1; $p < 0,001$). This apparent inconsistency between knowing what an intestinal disease is and being unaware of its mode of transmission, as well as of the parasites responsible for causing such diseases, may be associated with the influence that a low level of schooling exerts on the population's lack of knowledge regarding the definition of transmission chains and parasitic agents. Therefore, it is essential that this topic be addressed in schools and within community groups[15].

Despite this observed inconsistency, it was noted that the vast majority of the sampled population knew that protozoa, viruses, and bacteria may be present in untreated water intended for consumption (n = 294; 74.6%) and that these same microorganisms can act as parasites in the human body and cause diseases, including intestinal diseases (n = 290; 73.6%). These results showed an association with the absence of WIDs among interviewees who reported having such knowledge ($\chi2 = 30.18$; df = 1; $p < 0,001$; $\chi2 = 31.09$; df = 1; $p < 0,001$, respectively). Expressive data such as these indicate that the population is aware of the existence of organisms that may be harmful to health, even though they cannot be seen with the naked eye, and that there is also concern regarding the risk of disease transmission through water[37].

The incidence of waterborne diseases is related to the lack of treatment of water intended for ingestion, which in turn is associated with users' perceptions of water quality[38]. Accordingly, the present study indicates that participants rely on their perceptions of water quality and potability as a means of disease prevention within the community, since an association was also observed with the absence of WIDs among interviewees who reported knowing how to prevent intestinal diseases caused by waterborne parasites ($\chi2 = 6.12$; df = 1; $p = 0.01$). Several studies emphasize the need for water treatment to make it suitable for human consumption and to prevent disease. In agreement with the findings of this research, an association between the presence of certain intestinal parasites and the consumption of treated water was observed in a study conducted in the municipality of Bias Fortes, state of Minas Gerais, in which the highest frequency of polyparasitism occurred among individuals who consumed untreated water, and lower frequencies were observed when the water consumed had been strained, filtered, or boiled[39].

The main limitations of the present study include the difficulty in contacting participants due to the COVID-19 pandemic and the acceptability of participation among the residents of the municipality, since they are not accustomed to this type of research routine. Nevertheless, despite the limitations mentioned, the results of this study indicate the importance of advancing knowledge about WIDs in the region, highlighting the need for further studies on this topic due to the lack of epidemiological research records in the municipality.

Based on the information obtained in this study, municipal financial support is recommended for the implementation of educational projects through community-based health actions, with the purpose of promoting access to information and, consequently, increasing the population's level of knowledge. Educational actions provide learning opportunities for the community on health promotion topics[15].

CONCLUSIONS

The low level of formal education among the interviewees from the municipality of Lago dos Rodrigues, state of Maranhão, did not affect the outcomes regarding the occurrence of WIDs in the region, even though low educational attainment is considered one of the main factors associated with the acquisition of these diseases. It was observed that most of the interviewed population adopts good preventive practices related to WIDs, indicating that health education actions implemented by public authorities, whether at the municipal or global level in the prevention and control of diseases, have a strong influence on changes in population behavior, preventing illness and contributing to improvements in community quality of life. However, it is important to emphasize that preventive measures aimed at controlling WIDs are only capable of eradicating them in a given region if the entire population has access to treated water sources for consumption. Thus, planning efforts and public policies that result in improvements in basic sanitation conditions within the community are recommended. In addition, the results of the study revealed satisfactory levels of knowledge about these diseases among most of the population. Nevertheless, due to the low level of schooling of the majority of participants, this knowledge appears to result primarily from daily experiences and observations and is transmitted from generation to generation. In the municipality, a gap remains

in the exploration of this topic, and although the substantial sample collected contributed to understanding popular knowledge and attitudes regarding community diseases, studies on WIDs still require further investigation due to the lack of records concerning the distribution and or occurrence of these diseases in Maranhão.

REFERENCES

1. Guedes AF, Tavares LN, Marques MN, Moura SP, Sousa MN. Tratamento da água na prevenção de doenças de veiculação hídrica. J Med Helth Promo. 2017 Jan; 2(1): 452-461, 2017.

2. Bragagnollo GR, Godoy PC, Santos TS, Ribeiro VS, Moreno JA, Ferreira BR. Intervenção educacional sobre enteroparasitoses: um estudo quase experimental. Revista Cuidarte. 2018 Jan- Abr; 9(1): 2030-2044. doi: https://doi.org/10.15649/cuidarte.v9i1.486 .

3.Organização Mundial da Saúde. Água mais segura, melhor saúde [Internet]. Genebra: OMS; 2019 [cited 2023 Jun 21]. Available from: https://apps.who.int/iris/handle/10665/329905.

4. Stolf DF, Molz S. Avaliação microbiológica da água utilizada para consumo humano em uma propriedade rural de Taió–SC. Saúde e meio ambiente: rev. inter. 2017 Jul; 6(1): 96-106. doi: 10.24302/sma.v6i1.1104.

5. Marcelino RL, Santos AL, Nunes BL, Dias SR. Parasitoses de veiculação hídrica em águas urbanas [Internet]. ANALECTA. 2018 [cited 2022 Set 11]; 4(4): 179-194. Available from: https://seer.uniacademia.edu.br/index.php/ANL/article/view/1769/1114.

6. Ministério da Saúde (BR). Diretriz para atuação em situações de surtos de doenças e agravos de veiculação hídrica [Internet]. Brasília: Ministério da Saúde; 2018 [cited 2022 Set 11]. Available from: https://bvsms.saude.gov.br/bvs/publicacoes/diretrizes_agravos_veiculacao_hidrica.pdf.

7. Moura L, Landau EC, Ferreira AM. Doenças relacionadas ao saneamento ambiental inadequado no Brasil. In: Landau EC, Moura L (ed). Variação geográfica do saneamento básico no Brasil em 2010: domicílios urbanos e rurais. Brasília: EMBRAPA; 2016. p. 189-210.

8. Ministério da Saúde (BR). Doenças tropicais negligenciadas 30 de janeiro – dia mundial de combate às doenças tropicais negligenciadas. Bol Epidemiol. 2021 Mar; (Esp).

9. Instituto Brasileiro de Geografia e Estatística. Cidades e Estados. Dados do Censo de 2021 e 2023 [Internet]. Rio de Janeiro: IBGE; 2023 [cited 2022 Set 11]. Available from: https://cidades.ibge.gov.br/.

10. Claro LB, Tomassini HC, Rosa ML. Prevenção e controle do dengue: uma revisão de estudos sobre conhecimentos, crenças e práticas da população. Cad Saúde Pública. 2004 Dez; 20(6): 1447-1457. doi: https://doi.org/10.1590/S0102-311X2004000600002.

11. Instituto Brasileiro de Geografia e Estatística. Cidades e Estados [Internet]. Rio de Janeiro: IBGE; 2025 [cited 2025 Fev 20]. Available from: https://cidades.ibge.gov.br/.

12. Instituto Brasileiro de Geografia e Estatística. Estimativas da População 2021 Internet]. Rio de Janeiro: IBGE; 2025 [cited 2025 Fev 20]. Available from: https://www.ibge.gov.br/estatisticas/sociais/populacao/9103-estimativas-de-populacao.html?edicao=31451.

13. Conselho Nacional de Saúde (BR). Resolução nº 466, de 12 de dezembro de 2012. Aprovar diretrizes e normas regulamentadoras de pesquisas envolvendo seres humanos [Internet]. 2012 [cited 2021 Maio 14]. Available from: https://www.gov.br/conselho-nacional-de-saude/pt-br/atos-normativos/resolucoes/2012/resolucao-no-466.pdf/view.

14. Dean AG, Sullivan KM, Soe MM. OpenEpi: open source epidemiologic statistics for public health [Internet]. 2013 [cited 2025 Fev 27]. Available from: https://www.openepi.com/Menu/OE_Menu.htm.

15. Busato MA, Dondoni DZ, Rinaldi AL, Ferraz L. Parasitoses intestinais: o que a comunidade sabe sobre este tema?. Rev Bras Med Fam Comunidade. 2015 Mar; 10(34): 1-6. doi: https://doi.org/10.5712/rbmfc10(34)922.

16. Siqueira MP, Azevedo EP, Almeida EM, Matos JS, Rodrigues AR, Scarabell SC, et al. Conhecimentos de escolares e funcionários da Rede Pública de Ensino sobre as parasitoses intestinais. Rev Inst Adolfo Lutz. 2016; 75: 01-12.

17. Chaves DC, Miranda TA, Silva GA, Dias BA. Conhecimentos, atitudes e práticas quanto a parasitoses intestinais de Quilombola–Bragança–Pará. Rev. CPA Quali Vida. 2022; 14(2): 1-8.

18. Rocha CM, Rodrigues LS, Costa CC, Oliveira PR, Silva IJ, et al.. Avaliação da qualidade da água e percepção higiênico-sanitária na área rural de Lavras, Minas Gerais, Brasil, 1999-2000. Cad Saúde Pública, v. 22, p. 1967-1978, 2006.

19. Falkenberg MB, Mendes TP, Moraes EP, Souza EM. Educação em saúde e educação na saúde: conceitos e implicações para a saúde coletiva. Ciênc saúde coletiva. 2014; 19(3): 847-852. doi: https://doi.org/10.1590/1413-81232014193.01572013.

20. Luciano JM. Enteroparasitoses e a relação com a situação socioeconômica e sanitária no Brasil: a educação em saúde e ambiental como ferramenta preventiva [TCC]. São Paulo (SP): Universidade Estadual Paulista; 2022.

21. Morel, APM. Negacionismo da Covid-19 e educação popular em saúde: para além da necropolítica. Trab. educ. saúde. 2021. doi: https://doi.org/10.1590/1981-7746-sol00315.

22. Oliveira AC, Lucas TC, Iquiapaza RA. What has the covid-19 pandemic taught us about adopting preventive measures?. Texto contexto – enferm. 2020; 29. doi: https://doi.org/10.1590/1980-265X-TCE-2020-0106.

23. Organização Mundial da Saúde. Ações críticas de preparação, prontidão e resposta para o COVID-19 [Internet]. Genebra: OMS; 2021 [cited 2023 Abr 3]. Available from: https://www.who.int/publications/i/item/critical-preparedness-readiness-and-responseactions-for-covid-19.

24. Chen S, Zhang X, Zhou Y, Yang K, Lu X. COVID-19 protective measures prevent the spread of respiratory and intestinal infectious diseases but not sexually transmitted and bloodborne diseases. J Infect. 2021 Apr; 83(1): e37-e39. doi: 10.1016/j.jinf.2021.04.018.

25. Maciel LS, Souza RM, Mattos NV, Araújo PT, Pádua CO, Fraga MO, et al Ocorrência de protozoários intestinais em crianças do Ensino Fundamental de Sete Lagoas, Minas Gerais: um enfoque sobre a prevenção de enteroparasitoses. RBAC. 2017; 49(1): 95-9. doi: 10.21877/2448-3877.201500122.

26. Silva JC, Furtado LF, Ferro TC, Bezerra KC, Borges EP. Melo AC. Parasitismo por Ascaris lumbricoides e seus aspectos epidemiológicos em crianças do Estado do Maranhão. Rev. Soc. Bras. Med. Trop. 2011 Fev; 44(1): 100-102. doi: https://doi.org/10.1590/S0037-86822011000100022.

27. Monteiro AC, Soares DA, Diniz SC, Cavalcante UM, Silva AB, Viana RP, et al. Intestinal parasitism and related risk factors for primary school students in João Pessoa, northeast Brazil. Biosci. J, 2018 Jul-Ago; 34(4): 1062-1072. doi: https://doi.org/10.14393/BJ-v34n1a2018-39899.

28. Batista T Trevisol FS, Trevisol DJ. Parasitoses intestinais em pré-escolares matriculados em creche filantrópica no sul de Santa Catarina. Arq catarin med, 2009; 38(3): 39-45, 2009.

29. Furtado LF, Melo AC. Prevalência e aspectos epidemiológicos de enteroparasitoses na população geronte de Parnaíba, Estado do Piauí. Rev. Soc. Bras. Med. Trop. 2011Ago; 44(4): 513-515. doi: https://doi.org/10.1590/S0037-86822011000400023.

30. Assis EM, Oliveira RC, Moreira LE, Pena JL, Rodrigues LC, Machado-Coelho GL. Prevalência de parasitos intestinais na comunidade indígena Maxakali, Minas Gerais, Brasil, 2009. Cad Saúde Pública. 2013 Abr; 29(4): 681-690. doi: https://doi.org/10.1590/S0102-311X2013000400006.

31. Santos AA, Gurgel-Gonçalves R, Machado ER. Factors associated with the occurrence of intestinal parasites in children living in the Federal District of Brazil. Rev. Patol Trop. 2014 Jan-Mar; 43(1): 89-97. doi: 10.5216/rpt.v43i1.29374.

32. Serra CM, Uchôa CM, Coimbra RA Exame parasitológico de fezes de gatos (Felis catus domesticus) domiciliados e errantes da Região Metropolitana do Rio de Janeiro, Brasil. Rev. Soc. Bras. Med. Trop. 2003 Jun; 36(3): 331-334. doi: https://doi.org/10.1590/S0037-86822003000300003.

33. Katagiri S, Oliveira-Sequeira TC. Zoonoses causadas por parasitas intestinais de cães e o problema do diagnóstico. Arq. Inst. Biol. 2007 Apr-Jun; 74(2): 175-184. doi: https://doi.org/10.1590/1808-1657v74p1752007.

34. Araújo HB Filho, Carmo-Rodrigues MS, Mello CS, Melli LC, Tahan S, Morais MB. Parasitoses intestinais se associam a menores índices de peso e estatura em escolares de baixo estrato socioeconômico. Rev. paul. Pediatr. 2011 Dez; 29(4): 521-528. doi: https://doi.org/10.1590/S0103-05822011000400009.

35. Ely LS, Engroff P, Lopes GT, Werlang M, Gomes I, Carli GA. Prevalência de enteroparasitos em idosos. Rev. bras. geriatra. Gerontol. 2011; 14(4): 637-646.

36. Lima AM, Alvez LC, Faustino MA, Lira NM.. Percepção sobre o conhecimento e profilaxia das zoonoses e posse responsável em pais de alunos do pré-escolar de escolas situadas na comunidade localizada no bairro de Dois Irmãos na cidade do Recife (PE). Ciênc saúde coletiva. 2010 Jun; 15(suppl 1): 1457-1464.

37. Silva SR, Heller L, Valadares JC, Cairncross. O cuidado domiciliar com a água de consumo humano e suas implicações na saúde: percepções de moradores em Vitória (ES). Eng. Sanit. Ambient. 2009 Dez; 14(4): 521-532. doi: https://doi.org/10.1590/S1413-41522009000400012.

38. Sousa RS, Menezes LG, Felizzola JF, Figueiredo RO, Sá TD, Guerra GA. Água e saúde no município de Igarapé-Açu, Pará. Saúde Soc, 2016 Out-Dez; 25(4): 1095-1107. doi: https://doi.org/10.1590/S0104-12902016157497.

39. Andrade EC, Leite IC, Vieira MT, Abramo C, Tibiriçá SH, Silva PL. Prevalência de parasitoses intestinais em comunidade quilombola no Município de Bias Fortes, Estado de Minas Gerais, Brasil, 2008. Epidemiol Serv. Saúde. 2011 Set; 20(3): 337-344. doi: http://dx.doi.org/10.5123/S1679-49742011000300008 .

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