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Parasitological Assessment and Public Health Implications of Water Used for Domestic Purposes in Ebonyi Local Government Area of Ebonyi State, Nigeria

C. V. Nwidembia[1], O. O. Odikamnoro[1], A. U. Nnachi[2*], C. C. Egwuatu[3], I. N. Aghanya[3], A. J. Nwinyimagu[1], O. I. Ezejiofor[4], I. Mbachu[5] and C. O. Ukaegbu[6]

[1]Department of Biological Science, Faculty of Science, Ebonyi State University, Abakaliki, Nigeria.
[2]Department of Immunology, Faculty of Medicine, Nnamdi Azikiwe University, Awka, Nigeria.
[3]Department of Medical Microbiology and Parasitology, Faculty of Medicine, Nnamdi Azikiwe University, Awka, Nigeria.
[4]Department of Medicine, Faculty of Medicine, Nnamdi Azikiwe University, Awka, Nigeria.
[5]Department of Obstetrics and Gynecology, Faculty of Medicine, Nnamdi Azikiwe University, Awka, Nigeria.
[6]Department of Medical Microbiology, Faculty of Medicine, University of Jos, Jos, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author CVN designed the study and served as the principal investigator. Author OOO participated in study design and served as the principal supervisor. Author AUN participated in the study design and sample processing, and drafted the manuscript for publication. Authors CCE and INA participated in sample collection and analysis. Authors AJN and OIE participated in study design and sample collection. Authors IM and COU participated in data acquisition and analysis. All authors read and approve the manuscript.

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**Corresponding author: Email: nnachiau@gmail.com;*

ABSTRACT

Aims: Water-borne diseases have been a major cause of morbidity in most developing countries including Nigeria mainly due to poor quality of water used for domestic and industrial purposes. This study was on the parasitological assessment and public health implications of water used for domestic purposes in Ebonyi Local Government Area, Ebonyi State, Nigeria.
Study Design: This was an observational study.
Place and Duration of Study: Ebonyi Local Government Area of Ebonyi State, Nigeria between September, 2014 and October, 2014.
Methodology: Samples from different water bodies in each of four communities in Ebonyi Local Government Area were collected and analyzed using standard parasitological methods.
Results: The results revealed the presence of seven (7) different parasites including *Giardia lamblia, Schistosoma haematobium, Ascaris lumbricoides, Entamoeba histolytica, Strongyloides stercoralis, Diphyllobothrium latum* and *Taenia* spp. The result showed that *Giardia lamblia* had the highest occurrence of 23.57% while *Entamoeba histolytica* recorded the least parasite presence with 7.14%. The pond water showed the highest occurrence of parasites presence with 44.29% while the least occurrence was borehole with 0.71%. Only borehole from Nkaleke community showed the presence of a parasite (*Entamoeba histolytica*).
Conclusion: This study result is of alarming concern as the water bodies sampled are the major water sources available in those areas and by this study are unsafe for domestic use because of their high parasite presence. It is therefore imperative to suggest that the government of Ebonyi state and Nigeria at large should make available infrastructures that would make the water bodies safe for domestic use. Meanwhile, the inhabitants of risk areas and the general populace are advised to boil or treat their drinking water with water guard before use. Also, indiscriminate dumping of refuse or faecal materials should become everyone's concern and be discouraged.

Keywords: Water; Giardia lamblia; Schistosoma haematobium; Ascaris lumbricoides; Entamoeba histolytica; Strongyloides stercoralis; Diphyllobothrium latum; Taenia spp.; Faecal contamination.

1. INTRODUCTION

The survival of man in any given geographical area depends on the availability and quality of water in the area. Indeed, virtually all human activities involve water usage ranging from drinking, washing, cooking, irrigation and for industrial activities [1]. However, the human race is under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of air, water and soil [2]. Due to increased human population, industrialization, use of fertilizers and man-made activities, water is highly polluted with different harmful contaminants [3]. Although the water content of the biosphere is enormous, only a small portion is available for human domestic use due to contamination [3]. Faecal matter from patients and healthy carriers of pathogenic microorganisms poses the most threatening form of water pollution [4]. The most predominant waterborne disease, diarrhoea, has an estimated annual incidence of 4.6 billion episodes and causes 2.2 million deaths every year [5]. Children are the main victims of diarrhoea and other faecal–oral disease, and also the most likely source of infection [6]. Since parasites live in the intestine of an infected host and the cyst of the parasite can be passed out as part of the faecal matters of infected persons or animals, indiscriminate defecation is seen as the culprit to the high prevalence of parasites in water bodies, which consequently cause waterborne diseases [7]. Biological contaminants such as bacteria, viruses, fungi, protozoa and helminths constitute the major cause of foodborne and water-borne diseases with varying degrees of severity, ranging from mild indisposition to chronic or life-threatening illness, or both [7]. Water borne diseases of parasitic origin are of major concern to public health globally. Majorly in developing countries, water borne diseases have been frequently associated with high mortality and morbidity especially in children [8]. The WHO has estimated that food- and water-borne infectious diseases currently infect 3.5 billion people in developing countries and cause about 160,000 deaths per year and 80% of these occur in children less than 5 years of age [9]. This study was conducted to investigate the parasitological quality of domestic water sources in Ebonyi Local Government Area of Ebonyi State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out in Ebonyi Local Government Area, one of the 13 Local Government Areas in Ebonyi State, Nigeria. Ebonyi Local Government Area is an agrarian council area. It is located between longitude 7°59 ^{1}E and 8°20 ^{1}E and latitude 6°22 ^{1}N and 6°43 ^{1}N. The area falls within the climatic region of South Eastern Nigeria where the rainy season spans from April to October and dry season from October to April [10]. The average annual rainfall of the study area is about 1500 mm with actual surface temperature (seasonal temperature) of 24-36℃ during dry season and about 18℃ during the rainy season [10]. In the local government area, four randomly selected communities, namely: Ndiabor, Mbeke, Ndiagu and Nkaleke were used for the study.

2.2 Sample Size and Source

Samples were collected from 320 sampling points. Well, stream, borehole and pond water bodies were used for the study. Samples were collected separately in clean sterilized plastic bottles in the months of September and October, 2014 from Ndiabor, Mbeke, Ndiagu and Nkaleke communities of Ebonyi Local Government Area of Ebonyi State, Nigeria.

2.3 Sample Collection

Samples were collected in one liter containers already pre-sterilized at 121℃ for 15 minutes and preserved with 10% formalin as described by Roohul-Amin et al. [11]. While sampling in the streams, the collection bottle was lowered in water at a depth of about 15cm to 30cm. The bottle was held at the base and placed against the direction of the water flow. Immediately the water was collected, the bottle was covered up to avoid spillage, carefully labelled and transported to the Department of Biological Science Laboratory, Ebonyi State University, Abakaliki for immediate processing.

2.4 Parasitological Analysis of Water Samples

The preserved one liter sample was allowed to settle for 24 hours. The supernatant was carefully removed and discarded without disturbing the sediment using a siphon. The sediment was then transferred to centrifuge tubes. The wall of the sedimentation container was washed thoroughly using a spray bottle with detergent solution and the rinsing was added to the sediments in the centrifuged tubes. All the recovered materials were centrifuged at 1000g for 15 minutes. The supernatant was removed and discarded and the sediments transferred to one tube. Flotation technique ideal for the recovery of parasite eggs/larvae/cysts was used by suspending the pellet in an equal volume of aceto-acetic buffer (pH 4.5) [12,13]. The mixture was re-centrifuged at 1000g for 15 minutes and the pellets were transferred to microscope counting cell for final examination using 10x and 40x objectives. The parasites were identified according to Ukaga et al. [14]. The number of parasites per liter of water was calculated following the equation:

$N = AX/PV$ [15]

Where:

- N = number of eggs/cysts/larvae/ova of parasite
- A = number of parasites counted on the Mac master slide
- X = volume of the final product (ml)
- P = Mac master cell capacity (0.3ml)
- V = Pellet volume

2.5 Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 19.0.

3. RESULTS

The parasitological examination of domestic water samples from four communities in Ebonyi Local Government Area of Ebonyi State, Nigeria revealed the presence of seven (7) different parasites including: *Giardia lamblia, Schistosoma haematobium, Ascaris lumbricoides, Entamoeba histolytica, Strongyloides stercoralis, Diphyllobothrium latum* and *Taenia* spp. In this study, *Giardia lamblia* had the highest prevalence rate of 8(25.81%), followed by *Schistosoma haematobium* and *Taenia* spp., each having the prevalence rate of 6(19.35%); however, *Diphyllobothrium latum* was not seen in the water samples from Ndiabor. Out of the 31 parasites seen in water samples from Ndiabor, 8(25.80%) was from well, 9(29.03%) from stream and 14(45.16%) was from pond, whereas no parasite was seen in borehole (Table 1).

The results of the analysis of water samples from Mbeke community show that both *Giardia lamblia* and *Taenia* spp. had the highest prevalence rate of 10(26.32%) each, followed by *Ascaris lumbricoides* having 8(21.05%) prevalence rate; *Entamoeba histolytica* was observed least, having the occurrence rate of 1(2.263%). Out of the 38 parasites seen in water samples from Mbeke community, 20(52.63%) was from pond, 11(28.95%) well and 7(18.42%) from stream, whereas no parasite was seen in borehole water sampled (Table 2). The analysis of water samples from Ndiagu community of Ebonyi Local Government Area showed that *Giardia lamblia* and *Taenia* spp. occurred highest at the rate of 8(25.00%) each, followed by *Schistosoma haematobium* having 6(18.75), while *Entamoeba histolytica* and *Strongyloides stercoralis* had the lowest occurrence of 2(6.25%) each. Out of the 32 parasites seen in water samples from Ndiagu community, 13(40.62%) was from well, 12(37.50%) was from pond and 7(21.88%) was from stream; no parasite was seen in borehole water samples (Table 3).

Table 1. Parasitological examination of water samples from Ndiabor

S/N	Parasite	NW*	NS*	NB*	NP*	Total
1	*Giardia lamblia*	3	1	0	4	**8**
2	*Schistosoma haematobium*	2	4	0	0	**6**
3	*Ascaris lumbricoides*	2	0	0	3	**5**
4	*Entamoeba histolytica*	0	0	0	1	**1**
5	*Strongyloides stercoralis*	0	2	0	3	**5**
6	*Diphyllobothrium latum*	0	0	0	0	**0**
7	*Taenia spp*	1	2	0	3	**6**
	Total	**8**	**9**	**0**	**14**	**31**

*NW = Ndiabor well, NS = Ndiabor stream, NB= Ndiabor bore hole, NP = Ndiabor pond, * = Number of egg/cyst/larva*

In Nkaleke community, the results showed that *Ascaris lumbricoides* had the highest occurrence of 8(20.00%) followed by *Giardia lamblia* and *Taenia* spp. having the occurrence of 7(17.50%) each; *Strongyloides stercoralis* had the least occurrence of 2(5.00%). Out of the 40 parasites seen in samples from Nkaleke community, 16(40.00%) was from pond, 13(32.50) from stream and 10(25.00%) was from well; only 1(2.50%) was from the borehole water samples in Nkaleke community. Table 5 summarizes the mean percentages by both parasites and water sources. Pond water recorded the highest (44.3%) parasites presence while borehole water recorded the least percentage (0.71%) parasite presence. Meanwhile, *Giardia lamblia* was leading with 23.6% presence while *Entamoeba histolytica* had the least percentage presence of 7.14%.

4. DISCUSSION

The result of the parasitological survey of the four domestic water sources from Ebonyi Local Government Area showed that the water samples contained varying degrees of presence of seven (7) intestinal parasites including *Giardia lamblia, Ascaris lumbricoides, Taenia* spp.*, Strongyloides stercoralis, Entamoeba histolytica, Schistosoma haematobium* and *Diphyllobothrium latum*. The most occurring parasite observed in this study was *Giardia lamblia* (23.6%), followed by *Taenia* spp. (20.7%). The cause of this could be connected to poor personal hygiene of individuals, low sanitary facilities and different human activities in and around the water bodies [12]. This result corroborates with other previous studies of Stott [16], Coelho et al. [17], Asaolu et al. [18], Valbuena [19] and Iyayi et al. [20] who showed the frequent presence and high concentration of *Giardia lamblia* and *Ascaris lumbricoides* in water and raw sewage. Similarly, Kpoda et al. [15] assessed the quality of vegetable irrigation water in Ougadougou city, Burkina-Faso parasitologically. The results showed high presence of *Ancylostoma duodenale, Giardia lamblia, Hymenolepis nana, Taenia* spp.*, Ascaris lumbricoides*, *Strongyloides stercoralis* and *Entamoeba histolytica.* However, this present study did not record any occurrences of *Ancylostoma duodenale* and *Hymenolepis nana*.

Table 2. Parasitological examination of water samples from Mbeke community

S/N	Parasite	MW*	MS*	MW*	MP*	Total
1	*Giardia lamblia*	5	2	0	3	**10**
2	*Schistosoma haematobium*	2	1	0	2	**5**
3	*Ascaris lumbricoides*	1	1	0	6	**8**
4	*Entamoeba histolytica*	0	0	0	1	**1**
5	*Strongyloides stercoralis*	0	0	0	2	**2**
6	*Diphyllobothrium latum*	0	0	0	2	**2**
7	*Taenia spp*	3	3	0	4	**10**
	Total	**11**	**7**	**0**	**20**	**38**

*MW = Mbeke well, MS = Mbeke stream, MB = Mbeke bore hole, MP = Mbeke pond, * = Number of egg/cyst/larva*

Table 3. Parasitological examination of water samples from Ndiagu community

S/N	Parasites	NDW*	NDS*	NDB*	NDP*	Total
1	*Giardia lamblia*	3	1	0	4	**8**
2	*Schistosoma haematobium*	2	2	0	2	**6**
3	*Ascaris lumbricoides*	1	1	0	1	**3**
4	*Entamoeba histolytica*	1	0	0	1	**2**
5	*Strongyloides stercoralis*	2	0	0	0	**2**
6	*Diphyllobothrium latum*	1	2	0	0	**3**
7	*Taenia spp*	3	1	0	4	**8**
	Total	**13**	**7**	**0**	**12**	**32**

*NDW = Ndiagu well, NDS = Ndiagu stream, NDB = Ndiagu bore hole, NDP = Ndiagu pond, * = Number of egg/cyst/larva*

Table 4. Parasitological examination of water samples from Nkaleke community

S/N	Parasites	NKW*	NKS*	NKB*	NKP*	Total
1	*Giardia lamblia*	3	0	0	4	**7**
2	*Schistosoma haematobium*	2	2	0	0	**4**
3	*Ascaris lumbricoides*	1	6	0	1	**8**
4	*Entamoeba histolytica*	1	2	1	2	**6**
5	*Strongyloides stercoralis*	1	1	0	0	**2**
6	*Diphyllobothrium latum*	0	1	0	5	**6**
7	*Taenia spp*	2	1	0	4	**7**
	Total	**10**	**13**	**1**	**16**	**40**

NKW = Nkaleke well, NKS = Nkaleke stream, NKB = Nkaleke bore hole
*NKP = Nkaleke pond, * = Number of egg/cyst/larva*

Table 5. Percentage parasites presence in all sampled domestic water

S/N	Parasites	Well	Stream	Borehole	Pond	Total (%)
1	*G. lamblia*	14	4	0	15	**23.6**
2	*S. haematobium*	8	9	0	4	**15.0**
3	*A.. lumbricoides*	5	8	0	11	**17.1**
4	*E. histolytica*	2	2	1	5	**7.1**
5	*S. stercoralis*	3	3	0	5	**7.9**
6	*D. latum*	2	3	0	7	**8.6**
7	*Taenia spp*	7	7	0	15	**20.7**
	Total (%)	**29.3**	**25.7**	**0.7**	**44.3**	**100**

Among the water sources, pond water recorded the highest prevalence of parasite (44.29%). This could be attributed to the fact that during the rains, ponds serve as reservoirs that collect run-off water from different routes. This conforms to previous studies of Chollom et al. [9], and Ani and Itiba [21]. The well water also recorded a high prevalence of parasites (29.29%), which agrees with CDC [22], that wells may be more vulnerable to contamination after flooding particularly if the wells are shallow or have been submerged by flooding water for a long period of time; this may also be due to lack of proper toilet facilities in these communities and the fact that wells in these communities are always open.

Water samples from borehole had low rate of parasite infestation (0.7%); this could be explained by the fact that boreholes operate a closed system and this restricts faecal contaminations and contact with parasite vectors. Chollom et al. [9] reported that infestation of water is contaminative in nature as human parasites do not directly use water bodies for life cycle development; rather their vectors inhabit water bodies thereby associating their transmission to water. However, the *E. histolytica* observed in a sample of borehole from Nkaleke community is in disparity with the report of Chollom et al. [9] that water samples from boreholes were found to be free from parasites. This variation can be as a result of closeness to septic tanks, soakaway pit, shallowness of the borehole, as well as possible contamination during sample collection.

5. CONCLUSION

Since this study showed more than one parasite per liter of water in three of the four domestic water samples examined, it means that with the exception of borehole water samples, the rest of

the water sources are not good for drinking and other domestic purposes. This study result is of alarming concern as the water bodies sampled are the major water sources available in those areas and by this study are unsafe for domestic use because of their high parasites presence. It is therefore imperative to suggest that the government of Ebonyi State and Nigeria at large should make available infrastructures that would make the water bodies safe for domestic use. Meanwhile, the inhabitants of risk areas and the general populace are advised to boil or treat their drinking water with water guard before use. Also, indiscriminate dumping of refuse or faecal materials should become everyone's concern and greatly discouraged.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The study was reviewed and approved by the Research and Ethics Committee of the Ebonyi State University, Abakaliki, Nigeria. Permission was obtained from the Head, Public Health Department of Ebonyi Local Government Area of Ebonyi State, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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