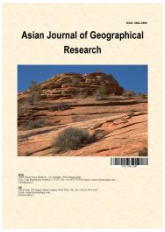

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Evaluation of Water Contamination and Its Health Implications on the Residents of Ayamelum Local Government Area, Anambra State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This research detailed on the Evaluation of Water contamination and its Health Implications on the Residents of Ayamelum Local Government Area, Anambra State, Nigeria. The recorded health implications caused by contaminated water enlightened the importance to discuss the measures to improve accessibility to safe drinking water, by employing outstanding measures to ensure proper sanitation service within the environ and personal hygiene behavior, which are significant to preventing infections. A total of 200 water samples collected from the inhabitants were examined

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for Cryptosporidiosis. Data obtained were analyzed using SPSS (statistical package for social Science) Version 20.0 based on significance contamination level (P ≥ 0.05). Out of the total respondents 10.00% were below 10 yrs, 21.00% were between 11 to 20 yrs, 16.00% were between 21-30 yrs, 17.00% were between 31-40 yrs, 10.00% were between 41-50yrs, 20.00% were between 51-60 yrs while 6.00% were between 61-70yrs. 66.00% were male while 34.00% were female. About 29.00% of the respondents depend on borehole, 25.00% on Lake/river/stream, and 16.00% on rainwater while 29.00% depends on table/sachet water. The result showed a Prevalence of 56(14.00%) for Salmonellosis and 36 (8.00%) for Crystosporidiosis with a 12 (3.0%) co-infection rate of Salmonellosis and Crystosporidiosis from water. In terms of distribution with regard to towns, Umueje had the most prevalence of 6 (30.00%) for Salmonellosis and 6 (50.00%) for Cryptosporidiosis while Umumbo, Igbakwu and Ifite had the least 2 (10.00 %) for Salmonellosis and 0.00% for Cryptosporidiosis. Age specific prevalence showed that *Cryptosporidium* parasite was highest in 11-20 yrs 6 (14.28 %) while Salmonellosis infection was highest in age group of 21-30 years 8 (25.00%). People with diarrhea 12 (46.15%) are household who depends on Well water 6 (50.00%), lake/river/stream 16 (32.00 %) and borehole for drinking water 10 (17.24%). The study recommends that water from various sources should be investigated and treated before use and all sources of water should be improved to prevent Salmonellosis and Crystosporidiosis infections.

Keywords: Rainwater; lake water; river water; stream water; water samples; economic activities and water pollution.

1. INTRODUCTION

Water contamination is the pollution of water bodies, mostly by human activities. Water bodies include lakes, Rivers, oceans, aquifers and ground water. Water is polluted, when contaminants are introduced into the natural water bodies. It can lead to degradation and destruction of aquatic ecosystem [1-3]. Again, this can lead to public health problems for those living downstream, as they may use the same polluted river water for bathing or drinking or irrigation [2-6]. Water is said to be polluted when there is serious presence of high level pollutants in such a way that it is no longer suitable for drinking, bathing, cooking and other uses (Olaniran, 1995) and which predisposes man, animals and ecosystem to ailments, stress and death. Water pollution is now considered not only in terms of public health problem, but also in terms of conservation, aesthetics and preservation of natural beauty and resources [7-12].

However, it is toxic water that cannot be used for essential human purposes like cooking, drinking, and agriculture. This can also cause cholera, diarrhea, dysentery, poliomyelitis and typhoid (World Health Organization, 2010). Water is vital to the existence of all living organisms, but this valued resource is increasingly being threatened as human populations grow and demand more water of high quality for domestic purposes and economic activities, (Onwuzurike et al., 2019). The significance of water to human and other biological systems cannot be over emphasized, and there are numerous scientific and economic facts that, water storage or its pollution can cause severe decrease in productivity and deaths of living species (Garden et al., 2010). Clean and sufficient quantum of water provide the foundation for prosperous communities. We rely on clean water to survive, yet right now we are heading towards water crisis [13-17]. Over the last years, in many African countries, a considerable population growth has taken place, accompanied by a steep, increase in urbanization, industrial and agricultural land use [18-21]. This entails an increase in discharge of a wide diversity of pollutants to receiving natural water bodies and has resulted to undesirable negative effects on different components of the aquatic environment (Saad et al., 1984). As a result, there is need for improved management and utilization of natural resources, so as to reduce the amount of waste and pollution generated by human activities [22-25]. The quality of any surface or ground water is a function of either or both human activities and natural influences, (Stark et al., 2001). It is now generally accepted that aquatic environment cannot be perceived simply as holding tanks that supply water for human activities, rather, these environments are complex matrices that requires careful use to ensure sustainable ecosystem functioning.

1.1 The Study Area

1.1.1 Location of the study

The study covered the following towns. Anaku, Omor, Umueje, Omasi, Igbakwu, Umumbo,

Umerum and Ifite-Ogwuari. Anaku in Ayamelum Local Government Area of Anambra State, Nigeria. Ayamelum Local Government Area lies, in Anambra North Senatorial Zone, within the Latitude 6^0 59' 12.98"E and Longitude 6^0 33' 12.78"N (Fig. 1).

The study area is bordered by "Omabala River, which is a tributary of the River Niger (North), Aguleri, Ezu River (South), Omor and Umuerum communities (East). Although the towns in the area share common boundary with Kogi by appellation "Ogbe", which is derived from its linkage with the Benin Empire (1440-1897) of the defunct Bendel State (now Edo State) and Igala Kingdom of Kogi State in Nigeria, this originated Anaku as the land of warriors. Kogi is easily accessible from Umueje about (25 km). Anaku is easily accessible from Onitsha (about 50 km) and Otuocha Aguleri (about 20 km). Umumbo is easily accessible from Enugu about (7 km) and has abundant natural resources. Fishing, farming (mainly known for rice farming) and Hunting are the predominant occupations in the study area. Ayamelum soil is mostly clay, it is of forest zone.

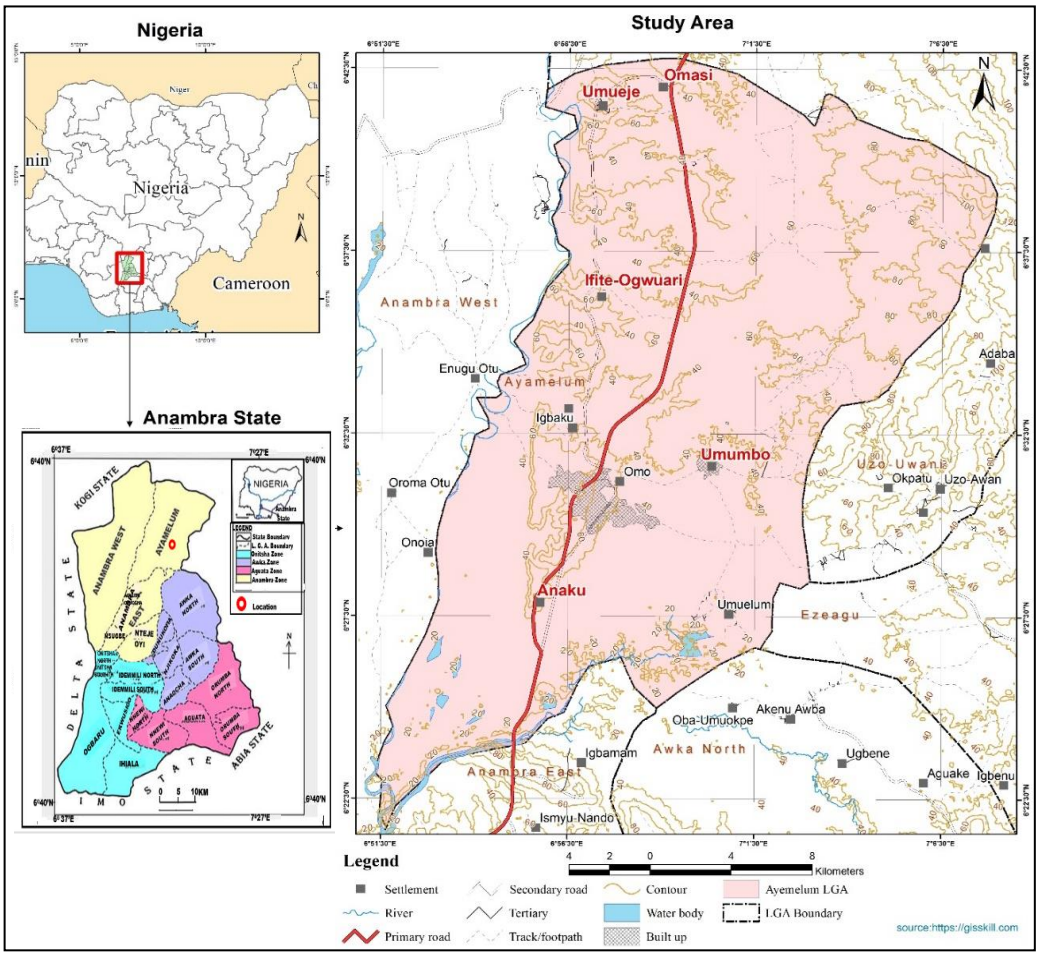

Fig. 1. Map of Ayamelum Local Government Area, showing the study Area

2. METHODOLOGY

2.1 Sample Collection

A total of 200 water samples were collected between Augusts to September 2022 from eight different towns which make up the Local Government Area. Simple Random sampling technique was applied to collect water samples; the participant Age range was between 10 to 70 years old. The representative towns under study were considered randomly to reflect even geographical spread. This helped ascertain the health risk associated with pathogenic protozoan and the town with the highest prevalence.

2.2 Water Sample Collection

Water samples were collected from venation streams, rivers, ponds, rain water, lake and other sources of water were collected from the various towns in the Local Government for examination using random measure.

2.3 Water Sample Analysis

2.3.1 Sedimentation method

About 15ml from each water sample collected was transferred into a conical test tube and centrifuged at 1500rpm for 5mins, the supernatant were discarded and 10ml of normal saline was added into the sediment and stirred for 5min, then the solution was centrifuged at 1500 rmp for 5 min, (Demen, et al. 2007), and the supernatant was discarded. Then the sediment was mixed and a drop was added on the centre of a clean grease free slide and a drop of luguus-iodine was added using pasture pipette, a clean cover slip was placed gently to examine bubble and over flowing. Then the preparation was examined under microscope for parasite cyst and ova using x10 and x40 objective lens.

2.4 Ethical Consideration and Consent

Institutional approval was obtained from Anambra State Ministry of Health Research Ethics Committee. Also, informed verbal consent was obtained from all the participants before administering the questionnaire. The participants were informed about the research, its objectives and participation was voluntary. Participants were assured that every data collected would be handled confidentially and would be used for research purposes.

2.5 Statistical Analysis

Data obtained were analyzed using SPSS (statistical package for social Science) Version 20.0. The data were analyzed and interpreted using analysis of variance (ANOVA), to determine the significant difference between the mean of *Cryptosporidium* parasites and *Salmonella spp* examined based on the geographical location of the water and stool samples. The analysis was based on significance contamination level ($P \geq 0.05$). Also by assigning a numerical number to the number of parasite cysts, oval, and trophozoite seen during the analysis such as positive (+) for present and negative (-) for absent.

3. RESULTS AND DISCUSSION

3.1 Prevalence of *Cryptosporidium* and Salmonellosis Infection among People Living in Ayamelum Local Govt. Area

Table 1 indicate the prevalence of Salmonellosis and Cryptosporidiosis among inhabitants of Ayamelum Local Government Area, Anambra State. The result showed that out of 200 water samples examined, 36(18.00%) were positive for Salmonellosis and 24(12.00%) positive for Cryptosporidiosis.

3.2 Prevalence of Salmonellosis and Cryptosporidiosis with Respect to Towns within the Local Government Area

Table 2 and Fig. 2 showed the distribution of participants with respect to towns, the participants were drawn from 8 different villages in Anyamelum LGA. Omasi contributed 4(20.00%) for Salmonellosis and 0.00% for Cryptosporidiosis while Umumbo contributing 2(10.00%) for Salmonellosis and 0.00% for Cryptosporidiosis, Igbakwu contributed 2(10.00%) for Salmonellosis and 0.00% for Cryptosporidiosis, Umerum contributed 0.00% for Salmonellosis and 2(16.67%) for Cryptosporidiosis. Others included 2(10.00%) for Salmonellosis and 4(33.33%) for Crytosporidiosis in Ifite, 2(10.00%) for Salmonellosis and 0.00 % for Cryptosporidiosis in Omor, 2(10.00 %) for Salmonellosis and 0.00 % for Cryptosporidiosis in Anaku while Umueje had the most contribution of 6(30.00%) for Salmonellosis and 6(50.00%) for Crytosporidiosis. There was significant difference in terms of distribution of participants and prevalence $P > 0.001$.

Table 1. Prevalence of Salmonellosis and Cryptosporidiosis among inhabitants of Ayamelum Local Government Area, Anambra State (n=200)

Infection	No of positive result (%) in water
Salmonellosis	36 (18.00 %)
Cryptosporidiosis	24 (12.00 %)

Table 2. Prevalence of Salmonellosis and Cryptosporidiosis with respect to towns in Ayamelum Local Government Area, Anambra State

S/N	Name of villages	No of samples	No infected with Salmonellosis (%)	No infected with Cryptosporidiosis (%)
1	OMASI	14	4 (20.00)	0.00
2	UMUMBO	24	2 (10.00)	0.00
3	IGBAKWU	26	2(10.00)	0.00
4	UMERUM	20	0.00	2 (16.67)
5	IFITE	28	2(10.00)	4 (33.33)
6	OMOR	40	2(10.00)	0.00
7	ANAKU	22	2(10.00)	0.00
8	UMUEJE	26	6(30.00)	6 (50.00)
	TOTAL	200	20 (100.00)	12 (100.00

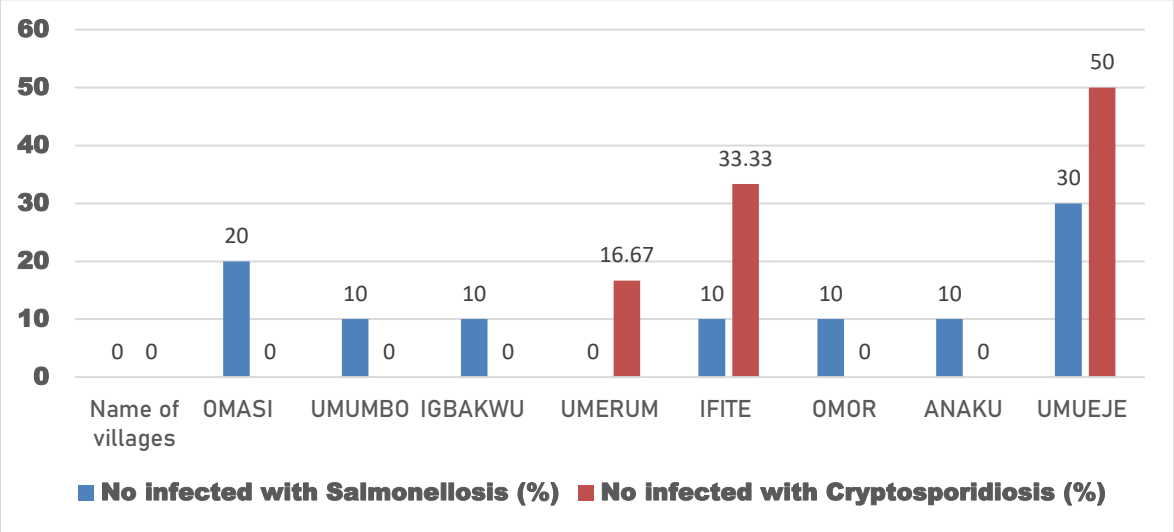

Fig. 2. Prevalence of Salmonellosis and Cryptosporidiosis with respect to towns in Ayamelum Local Government Area, Anambra State

3.3 Relationship between *Cryptosporidium* and Salmonellosis Infection among People Living in Ayameluim Local Govt Area

Table 3 show the co-infection of Salmonellosis and Cryptosporidiosis in water samples from Ayamelum Local Government Area, Anambra State. From the result, 10(2.50%) of the water samples showed co-infection of Salmonellosis *and* Cryptosporidiosis.

3.4 Predisposing Factors and Indicators for *Cryptosporidium* Infection among People Living in Ayameluim Local Govt Area

Table 4 revealed that prevalence of *Cryptosporidium* source of drinking water. In terms of sources of drinking water, household with lake/river/stream as their only source of drinking water have a high prevalence of *Cryptosporidium* infection 12(24.00%) out of 50 samples, household with borehole 6(10.30%) out of 58 samples, well water 6(50.00%) out of 12 samples. Spring water, table/sachet water showed no positive results.

3.5 Factors and Indicators Responsible for Salmonellosis

Table 5 and Fig. 3 show the predisposing factors for Salmonellosis among inhabitants of Ayamelum Local Government Area such as Household that makes use of borehole as source of drinking water showed 10(17.24%) out of 58 samples, spring 2(8.33%) out of 24 samples, well water 6(50.00%) out of 12 samples, table/sachet 2(8.30%) out of 24, lake/river/stream 6(50.00%) out of 50 samples and rain water showed no positive results out of 32 samples.

Table 3. Co-infection of Salmonellosis and Cryptosporidiosis in both stool and water samples from Ayamelum Local Government Area, Anambra State

Samples	No of sample examined	No of positive result (%) for Salmonellosis	No of positive result (%) for Cryptosporidiosis	No of positive result for both infection
Water sample	200	36 (18.00%)	24 (12.00%)	10 (2.50%)

Table 4. Relationship of *Cryptosporidium* among Inhabitants of Ayamelum Local Government Area, Anambra with Respect to water sources

Variable	No. of samples for each categories	No positive samples based on categories	Prevalence for each categories	*P- value*
Source of drinking water				
Borehole	58	6 (10.30%)	6 (3.00%)	0.367
Spring	24	0 (0.00%)	0 (0.00%)	
Well	12	6 (50.00%)	6 (3.00%)	
Lake/river/stream	50	12 (24.00%)	12 (6.00%)	
Table/satchet water	24	0 (0.00%)	0 (0.00%)	
Rain water	32	0 (0.00%)	0 (0.00%)	

Table 5. Relationship of Salmonellosis among inhabitants of Ayamelum Local Government Area, Anambra State with respect to water sources

Variable	No. of samples for each categories	No.(100%) positive samples based on categories	Prevalence for each categories	*P- value*
Source of drinking water				
Borehole	58	10(17.24%)	10(5.00%)	0.367
Spring	24	2 (8.33%)	2 (1.00%)	
Well	12	6 (50.00%)	6 (3.00%)	
Lake/river/stream	50	16 (32.00%)	16 (8.00%)	
Table/sachet water	24	2 (8.30%)	2 (1.00%)	
Rain water	32	0 (0.00%)	0 (0.00%)	

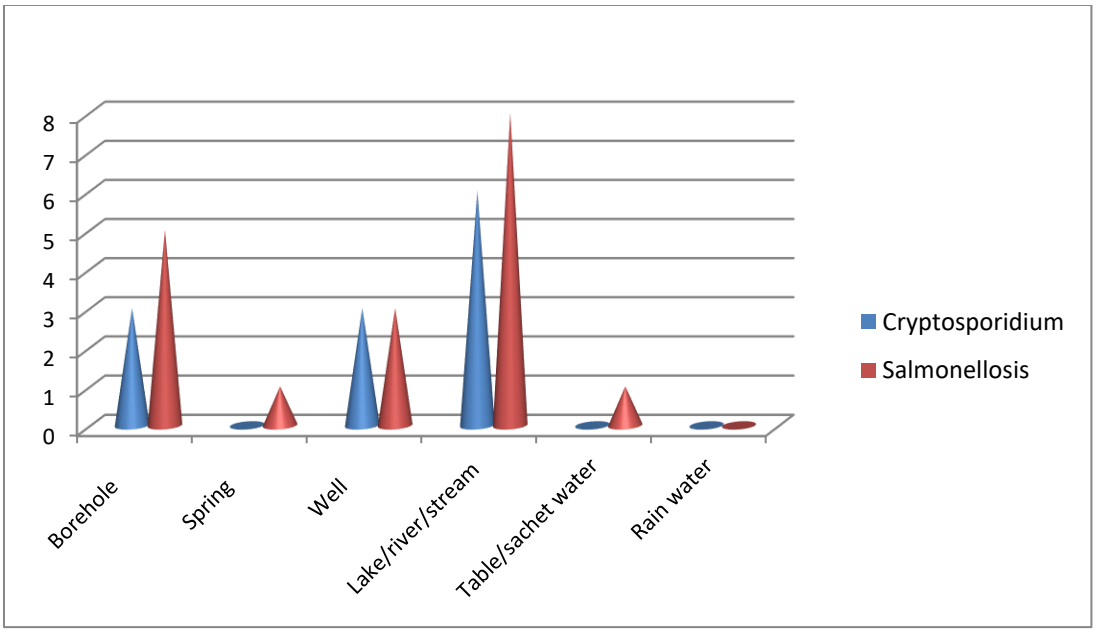

Fig. 3. Prevalence of *Cryptosporidium* and Salmonellosis infection with respect to sources of drinking water among people living in Ayamelum local Govt Area

4. CONCLUSION AND RECOMMENDATIONS

Even though, *Cryptosporidium* spp oocysts are resistant to many disinfectants, but it can be inactivated by heating water up-to 62 °C. Likewise, the WHO guidelines for drinking water quality also suggest that *Cryptosporidium* spp oocysts are non-viable and can be inactivated at 60°C. There was a very low risk of infection to those who usually use boiled water for drinking. In addition, present study also revealed that individuals who were consuming un-boiled surface water were at greater risk (p = 0.007) for *Cryptosporidium* infection, while those who used boiled water for consumption were found protective against infection. The drinking water is rarely disinfected and is often contaminated by untreated infectious human excreta, which puts the local residents at great risk of intestinal parasitic infections. Safer drinking water is an urgent need in the rural regions of Ayamelum LGA. During present study, the human feces were often found near surface water and houses and in some towns the sewage and toilets waste water were freely flowing to the surface water sources which is a concern for possible water-borne transmission of *Cryptosporidium* infection. These findings also suggest that individuals consuming surface water (for drinking or bathing purposes) are at risk of infection. Most of the participants were from villages and rural areas where birds, cats and dogs are commonly wandering freely, which may be a route for subsequent zoonotic spreading of oocysts, contaminating the soil and water with their feces. Cows, buffalos and other domestic animals are also seen drinking and bathing in the surface water (rivers, streams and canals) along with children. A study from eight villages in Anyamelum LGA showed that *Cryptosporidium* and salmonella infection were prevalent in Lake/river/stream (6 positive out of 25 samples), followed by household with Borehole and Well (3 positive each out of 29 and 6 samples).

DATA AVAILABILITY STATEMENT

The authors are grateful to the Alpha Research Laboratory, Ezeudu Street off Zik Avenue Awka. Anambra State, for assisting in the laboratory analysis in this research.

CONFLICT OF INTEREST

I Onyenweife Geraldine Ifesinachi, the corresponding author of the manuscript entitled **"**Evaluation of Water contamination and its Health Implications on the Residents of Ayamelum Local Government Area, Anambra State, Nigeria", hereby declare that there is no conflict of interest in this manuscript.

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