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Research Article

Parasitic Contamination of Drinking Water Sources in Nunkuchu Village of Akwanga Local Government Area of Nasarawas State, Nigeria

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A B S T R A C T

Water is critical for survival of any life form and plays a huge role in domestic, industrial and agricultural purposes. However, water contamination is a major public health concern world over. This study ascertained the level of contamination of water sources and surrounding environments in selected communities of Akwanga Local Government Area, Nasarawa State. A total of 20 water and soil samples respectively, were collected from 4 locations in the study area. Overall, prevalence of parasite infestation of 47.50% was encountered in the study. Parasites encountered include hookworm spp. (15.00%), Ascaris lumbricoides (12.50%), Strongyloides spp. (7.50%), Entamoeba histolytica (5.00%), Trichuris trichiura (5%) and Girdia lamblia (2.50%) ($p < 0.05$). Parasite infestation did not differ significantly ($p>0.05$) across communities; however, higher prevalence was encountered in Nunkuchu sarki (57.14%) and Nunkuchu hayi (44.44%). All six (6) parasites encountered in the study were endemic in Nunkuchu sarki while Nunkuchu hayi and Nunkuchu titi had 5 and 3 recorded parasites respectively. Stream had the highest number of parasites 4 (80.00%), followed by well 2, with no record of parasites in boreholes ($p>0.05$). Analysis of the soil samples around the sampled water sources revealed a high prevalence of parasites around the borehole 3 (60.00%) and pond area 3 (60.00%) with the least records the well area 2 (37.50%) ($p>0.05$). This study has indicated a high contamination of water sources and the surrounding environment in Akwanga Local Government Area, Nasarawa State. This is a threat to public health and therefore requires urgent attention.

Keywords: Parasites, Contamination, Drinking water sources, Soil, Public health, Sanitation and Hygiene, Nasarawa State

1. Introduction

Water is a natural resource upon which every form of life depends. As a result, access to clean and portable water is key to healthy living. About 71% of the earth surface is covered by water, of which approximately 97% is saline, with only about 3%

as fresh water[1]. The importance of water to the survival of living organism cannot be over emphasized. It is used in every aspect of human metabolism and also very essential to plants. Apart from aiding in the survival of both plants and animals, water is also used in carrying out various life activities which include recreational, agricultural and domestic activities. It is important therefore, that water used in carrying out these activities is kept in a good state and free from contamination[2,3].

Drinking water could be gotten from sources such as borehole, tap, rivers, streams, lakes and rain. Every community of humans, animals or plants have one or more of these as their sources of water. According to a report by the World Bank Group[4], the number of people lacking safe drinking water and basic sanitation in the past 20 years has increased by 197 million and 211 million, respectively. Currently, over two billion people still lack access to safe drinking water and 3.5 billion are deprived of safely managed sanitation facilities.

Safe drinking water for human consumption should be free from pathogenic organisms, meet the standard guidelines for taste, odour, appearance and chemical concentrations and must be available in adequate quantities for domestic purposes[5,6]. However, inadequate sanitation and persistent faecal contamination of water sources is responsible for a large percentage of people in both developed and developing countries not having access to safe drinking water and suffering from various parasitic diseases[5,6]. Drinking water can be contaminated with soil transmitted helminth. Contamination may be direct by defecating or urinating into water bodies or by run-off from contaminated soil into the various sources of drinking water. Many infectious diseases are associated with faecally contaminated water and are a major cause of morbidity and mortality worldwide[7]. Waterborne diseases are caused by enteric pathogens such as bacteria, viruses and parasites that are transmitted by the faecal-oral route[8] and are the major cause of diarrhea resulting to the deaths of over 2,000 children in Africa daily. Diarrhea kills more children than HIV, tuberculosis and malaria combined and its main cause is food and water contaminated with human waste[9].

Waterborne parasitic infections have become an area of concern all around the world due to contamination of the different sources of drinking water[10]. Epidemics associated with water borne diseases are a common scenario in most developing countries of the world where access to basic amenities especially clean and safe drinking water is lacking. Water related diseases trap millions in cycle of poverty and poor health, often rendering them unable to work or go to school[11]. Contaminants in water are defined by the Safe Drinking Water Act as being anything other than water molecules and some drinking water contamination may reasonably be harmful if consumed at certain levels. Water is said to be of good quality if and when it is free from contamination, has no taste or smell and the pH is between 7.0 and 9.5 indicating a healthy level of alkaline mineral[12]. According to Pam, et al.[13] in most developing countries like Nigeria where dangerous and very toxic industrial and domestic wastes are disposed carelessly by dumping in rivers and streams with total disregard for aquatic lives and rural dwellers, water has become an important medium for the transmission of water-borne diseases in most communities, posing major public health challenges around the globe. Although Nigeria is known to be endowed with abundant water resources, the availability of potable water is a problem in many parts of the country[14].

To reduce the rate of transmission of water borne diseases there is an urgent need to update standard information on the status of drinking water safety so as to improve public health in local communities in Nunkuchu village of Akwanga Local Government Area in particular and Nasarawa State at large. Thus, this study aimed at evaluating the parasitic contamination of potable water sources in Nunkuchu village of Akwanga Local Government Area of Nasarawa State in relation to composition of parasites in water sources across seasons in order to improve the health standard of the people in the community, thereby meeting up with WHO (2015) assurance of drinking water safety which is foundational to control and prevention of water-borne diseases.

2. Materials and Methods

2.1. Study area

Nunkuchu Village, located in Nasarawa State **(Figure 1)** in North Central Nigeria and administered by Akwanga Local Government, is the study site for the research. With a land area of 996 square kilometers, Nunkuchu village had a total population of 513,930 as of the 2006 census. The primary means of subsistence in Nunkuchu village is agriculture, although residents also engage in trading, farming, fishing, hunting and crafts. The primary language spoken by the inhabitants of Nunkuchu is Mada.

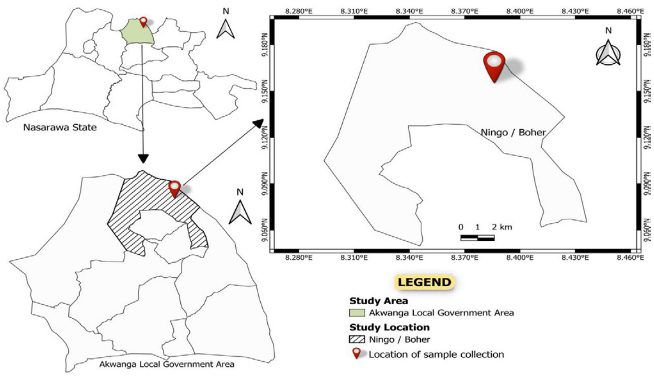

Figure 1: Map of Nasarawa State showing the location of sample collection.

2.2. Consent for the study

An advocacy visit was paid to the head of the communities where the study was conducted prior to the commencement of the study. The essence of the study was explained to them. In addition, consent was sought from the heads of every household from where the samples were collected. Samples were taken from households and communities where informed consent was given for the study.

2.3. Study design

This study employed a cross-sectional random sampling design. Communities and households were selected at random for the study. The study was designed to last for only a month (September 2023). At each point, water and soil samples were collected and analyzed for the study.

2.4. Sample collection

Four water sources (boreholes, ponds, wells and streams) were sampled for this study. Water samples were collected directly from the various sources of drinking water within the communities into 1liter containers and labeled.

For soil samples, about 200 g of soil sample was collected using a hand trowel at a depth of 3 cm around each water source. At each site, samples were collected from three (3) spots and pooled together as a single sample to make up the 200g in a clean and well-labelled polythene bag. Samples were collected between 09:00hrs and 12:00hrs[15]. The samples were transported to the laboratory and analyzed within 48 hours of sample collection. In all, two visits were made to the communities, of which a total of 20 water and soil samples were collected.

2.5. Analysis of water samples

The parasitological analysis of collected Water samples was done based on the earlier method described by Iyagi[16]. Samples were filtered through a 0.5µ mesh sized sieve. After carefully rinsing the residue in a beaker containing 20ml of 5% formal saline (5% formalin in 0.85% of NaCl). The filtrate was poured into a centrifuge tube and centrifuged at 4000 rpm for 6 minutes and allowed to stand for 3 minutes in a rack. The supernatant was discarded, leaving a little amount of suspended sediment. A drop of the suspended sediment was placed on a clean glass slide and covered with a cover slip. The preparation was then stained using iodine solution and examined under a microscope using x10 and x40 objectives.

2.6. Analysis of soil samples

Collected soil samples were analyzed using the flotation technique with Sodium chloride solution (1.18 specific gravity). 50 g of soil sample was weighed in a plastic container and mixed thoroughly with 200 ml of distilled water. The suspension was then strained using a sieve of 150 mm mesh size to remove large particles and the solution allowed to stand for 2 hours. Thereafter, the supernatant was discarded and the sediment re-suspended in 50 mL of distilled and centrifuged at 1500 rpm for 5 minutes. The resulting sediment was again suspended in 15 mL of NaCl solution in a test tube and filled to the brim using the same NaCl solution allowing it to form a convex meniscus. A clean slide was then placed on the test tube for 3 minutes to collect floating eggs present in the solution[17]. The slide was carefully observed using a compound microscope at ×10 and ×40 objectives for the presence of parasite ova and compared with standard identification keys[11].

3. Data Analysis

The data collected from the study were entered into Excel and cleaned. R Console Software (Version 3.3.2) was used for data analysis. Pearson's Chi-Square test was used to examine the proportions of parasite incidence in water between research locations, the number of parasites and the sources of the water. A P value of 0.05 or less was deemed statistically significant.

4. Results

A total of 40 samples (consisting of 20 water and soil samples respectively) were collected from 4 locations in the study area. Of these, 19 were infected giving a prevalence of 47.50% as shown in **(Table 1)**. The following parasites were encountered in this study: hookworm spp had the highest abundance (15.00%) followed by Ascaris lumbricoides (12.50%), Strongyloides spp (7.50%), Entamoeba histolytica (5.00%) and Trichuris trichiura (5%). G. lamblia was the least prevalent (2.50%) parasite encountered. Statistical analysis reveals that there was a significant difference ($p < 0.05$) in the abundance of parasites encountered in the study.

Although, across locations sampled, there was no significant difference ($p>0.05$) in the prevalence of parasites encountered **(Table 2)**, the result revealed that Nunkuchu sarki had the highest burden of infection (57.14%) followed by Nunkuchu hayi (44.44%) and Nunkuchu titi (37.50%). All six (6) parasites encountered in the study were endemic in Nunkuchu sarki while Nunkuchu hayi and Nunkuchu titi had 5 and 3 recorded parasites, respectively.

The number of parasites in relation to water sources **(Table 3)** showed that stream had the highest number of parasites 4 (80.00%), followed by well 2 (40.00%) and ponds 1 (20.00%) with no record of parasites in the borehole. However, Chi square test reveal that parasite prevalence is irrespective of water source ($p>0.05$).

Analysis of the soil samples around the sampled water sources revealed a high prevalence of parasites around the borehole 3 (60.00%) and pond area 3 (60.00%) with the least records around the stream 2 (40.00%) and well area 2 (37.50%) respectively. Even though, this was not statistically significant ($p>0.05$) **(Table 4)**.

Table 1: Checklist of parasites obtained in Nunkuchu Village of Akwanga Local Government Area.

Parasites types	Parasites species (40)	No. Positive	% Positive
Protozoans	E. histolytica	2	5.00
	G. lamblia	1	2.50
Nematodes	Ascaris lumbricoides	5	12.50
	Hookworm spp.	6	15.00
	T. trichiura	2	5.00
	Strongyloides spp.	3	7.50
	Total (%)	19	47.50

($\chi^2 = 14.868$, df = 5, p-value = 0.011)

Table 2: Prevalence of parasites encountered in relation to the selected sites of study.

Selected sites				
Parasites	**Nunkuchu hayi (n=18) (%)**	**Nunkuchu sarki (n=14) (%)**	**Nunkuchu titi (n=8) (%)**	**Total (N=40) (%)**
E. histolytica	1 (5.56)	1 (7.14)	0 (0.00)	2 (5.00)
G. lamblia	0 (0.00)	1 (7.14)	0 (0.00)	1 (2.50)
Ascaris lumbricoides	2 (11.11)	2 (14.29)	1 (12.50)	5 (12.50)
Hookworm spp.	3 (16.67)	2 (14.29)	1 (12.50)	6 (15.00)
T. trichiura	1 (5.56)	1 (7.14)	0 (0.00)	2 (5.00)
Strongyloides spp.	1 (5.56)	1 (7.14)	1 (12.50)	3 (7.50)
Total N (%)	8 (44.44)	8 (57.14)	3 (37.50)	19 (47.50)

($\chi^2 = 4.27716$, df = 2, p-value = 0.118)

N= total number of samples; n= number of samples per site

5. Discussion

This study has documented a high rate of parasitic contamination of drinking water sources and the surrounding soil in Akwanga Local Government Area of Nasarawa State, Nigeria. Previous studies in the country have also reported high rates of parasitic contamination[18-20]. Among the parasites encountered in this study, the nematode group were predominant. This agrees with the earlier work by Pam, et al.[18] who also reported similar findings. Hookworms were the most dominant (15.00%) parasites encountered in this study and could be due to their ability to persist in regions with hot atmospheric conditions[18]. A similar report was also made by Pam, et al.[18] who observed that hookworm was more prevalent in their study. However, Gyang, et al.[19] recorded hookworm (13.9%) as the least prevalent nematode in their study. Contrary to our finding, Chollom, et al.[21] reported the highest prevalence in their study from A. lumbricoides (33.9%) and Strongyloides spp. (20.15%). In another work, Tula, et al.[22] found Ascaris lumbricoides (21.9%) as the dominant parasite species, while, Gyang, et al.[19] had the highest prevalence from T. trichiura (22.2%).

Table 3: Prevalence of parasites encountered in relation to different water sources.

	Water bodies		
Parasites	**Well (n=5) (%)**	**Stream (n=5) (%)**	**Total (N=20) (%)**
E. histolytica	1 (20.00)	1 (20.00)	1 (5.00)
Ascaris lumbricoides	0 (0.00)	2 (40.00)	2 (10.00)
Hookworm spp.	1 (20.00)	1 (20.00)	2 (10.00)
T. trichiura	0 (0.00)	0 (0.00)	1 (5.00)
G. lamblia	0 (0.00)	1 (20.00)	3 (15.00)
Total N (%)	2 (40.00)	4 (80.00)	9 (45.00)

($\chi^2 = 5$, df = 3, p-value = 0.172)

N= total number of samples; n= number of samples per site

Table 4: Prevalence of Parasites in soil collected around the different water sources.

Water bodies					
Parasites	**Borehole (n=5) (%)**	**Pond (n=5) (%)**	**Well (n=5) (%)**	**Stream (n=5) (%)**	**Total (N=20) (%)**
E. histolytica	0 (0.00)	0 (0.00)	1 (20.00)	0 (0.00)	1 (5.00)
Ascaris lumbricoides	1 (20.00)	0 (0.00)	0 (0.00)	1 (20.00)	2 (10.00)
Hookworm spp.	0 (0.00)	2 (40.00)	1 (20.00)	0 (0.00)	3 (15.00)
T. trichiura	0 (0.00)	0 (0.00)	0 (0.00)	1 (20.00)	1 (5.00)
Strongyloides spp.	2 (40.00)	1 (20.00)	0 (0.00)	0 (0.00)	3 (15.00)
Total N (%)	3 (60.00)	3 (60.00)	2 (37.50)	2 (40.00)	10 (50.00)

($\chi^2 = 0.4$, df = 3, p-value = 0.940)

N= total number of samples; n= number of samples per site

Two protozoan parasites were encountered in this study, with E. histolytica (5.00%) occurring as the predominant parasite followed by G. lamblia (2.50). The reverse was however reported by Gyang et al. (2017) who found that G. lamblia (33.3%) was the most prevalent followed by E. histolytica (30.6%). They attributed their findings to the contamination of water with feacal matters and indiscriminate defecation in the environment by the inhabitant of the study-area. Similarly, Odikamnoro, et al.[23] recorded the highest prevalence from G. lamblia (50.00%) in their study. It is likely that, the presence of protozoan parasites and the parasitic nematode in this study is closely associated with activities of grazing cattle that harbour and defecate these parasites. Also, the use of animal droppings as local fertilizers in farmlands which eventually drains into water sources, as well as the unsanitary attitude of people who defecate near the water sources could have contributed to the prevalence of giardiasis and amoebiasis as observed in the study.

Despite the prevalence of parasites encountered across the locations sampled, there was no significant difference (p>0.05) across the different locations. However, Nunkuchu sarki had the highest burden of infection (57.14%). This entails that the chances of the water sources and the area around these water sources being contaminated is the same across the locations. However, the high prevalence of parasites in Nunkuchu sarki could be attributed to contamination of water with feacal matters and indiscriminate defecation in the environment by the inhabitant of the location as was previously observed[24,18].

Among the surveyed water sources, streams recorded highest number of parasites (80.00%). This is similar to the result obtained by Simon-Oke, et al.[25] in Ondo state, where they also encountered high parasite contamination in streams. This could be attributed to the open and flowing nature of the spring which expose it to contamination with faecal materials and sewage due to indiscriminate defecation and dumping of refuse close to the streams. Contrary to this finding however, Gyang, et al.[19] recorded high occurrence of parasites in well sources (56.8%), although the prevalence recorded was lower compared to what was detected in the streams in our study. While 40% of the well water sampled in this study were contaminated with parasites, it is assumed that the proximity of pit toilets or improperly situated pit toilets to the wells could have contributed to their contamination. In addition, most of the wells have no covers and are left open, as a result, contaminated materials and dirts may get into the wells. The case of poorly constructed wells is another factor to be considered, as through openings by the side, the influx of runoff could carry with it contaminated particles thus contaminating the well water.

In this study, none of the boreholes sampled was contaminated. Suggesting that the design of the borehole such that it is completely closed and prevented it from external contamination and could have excluded the chances of the water being infected[18]. This finding disagrees with the earlier report by Ani and Itibia[20] who reported 9.4% prevalence of parasites in borehole sources in their findings. However, our finding is in agreement with the work carried out by Pam, et al.[18] and Gyang, et al.[19] who also recorded no parasites in borehole sources in their findings and also attributed the finding to the make-up of the boreholes.

About 20.0% of the water sampled from ponds were infected with parasites in this study. This agrees with the work of Gyang, et al.[19] who, noted that due to their standing position, ponds could serve as reservoirs where run-offs from rains coming from various locations are collected, thus serving as a potential harbour of infection. Contrary to the prevalence of parasites encountered in the water sources, boreholes and pond areas accounted for the highest number of parasites encountered from the areas around the water sources. This observation could be explained in terms of the high demand of water which leads to a corresponding high activity around these water bodies[18]. While there could also be a surge of activities around the wells and streams, however, some of these do dry up particularly during the dry season, thus reducing the level of activities in those areas and making the environment less suitable for the survival of these pathogenic organisms[18]. It is likely also that considering the fact that the boreholes are considered more safe than other open water sources such as wells and streams, there is high activity of children around these areas which could also be a cause for the high rate of contamination in the area.

6. Conclusion

A good number of the drinking water sources and their surrounding soils sampled harbored some parasitic contaminants in this study. This implies that the people of Akwanga Local Government Area are at risk of water-borne diseases and soil-transmitted infections due to high rate of parasitic infection of water sources in their surroundings.

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