PARASITOLOGICAL EVALUATION OF DOMESTIC WATER SOURCES IN A RURAL COMMUNITY IN NIGERIA

Chollom, Solomon Chuwang[1]; Iduh, Micheal Unata[2]; Bitrus, Joseph Gyang[3]; Abbah, Idoko Micheal[4]; Ujah Aloysius[5], Agada, Godwin Ojonugwa[6]; Peter, Joan[7]; Akele, Yomi Richard[3]

1. Viral Research Department, National Veterinary Research Institute, Vom, Nigeria
2. Department of Medical Microbiology, Usmanu Dan Fodio University, Sokoto, Nigeria.
3. Bacteriology Department, Federal College of Veterinary and Medical Laboratory Technology, Vom, Nigeria
4. Haematology and Blood Group Serology Department, National Veterinary Research Institute, Vom, Nigeria
5. Chemical Pathology Department, National Veterinary Research Institute, Vom, Nigeria
6. Central Diagnostics Department, National Veterinary Research Institute, Vom, Nigeria
7. Parasitology Division, National Veterinary Research Institute, Vom, Nigeria

Corresponding author: Chollom Solomon Chuwang, Viral Research Department, National Veterinary Research Institute, PMB 01, Vom, Nigeria. Email- cholloms_12@yahoo.com

Abstract

Aim: To evaluate the level of safety of water sources in a rural settlement in Nigeria with reference to parasitic infections and to make appropriate recommendations to the government and the community dwellers.

Study Design: Investigative study

Place and duration of study: Samples were collected in Heipang, Barkin Ladi Local Government Area of Plateau State, Nigeria between October-December, 2012. They were processed at the General Laboratory of National Veterinary Research Institute, Vom, Nigeria.

Methodology: 100 water samples were collected from domestic water sources. 10 of the samples were from streams, 60 from ponds, 20 from wells and 10 were from bore holes. Samples were investigated for presence of parasites using standard World Health Organisation approved laboratory techniques. Each sample was subjected to macroscopy, filtration, centrifugation and microscopy.

Results: It revealed that 59 out of 100 water sources investigated had parasitic infestation. Ponds had the highest degree of parasitic contamination (78.3%), streams followed closely with 50%, while wells and bore holes had 35% and 0% in that order. Helminths were the leading parasitic genera encountered with

Ascaris species accounting for 33.9% of the parasites. Hookworm was the second most common helminth with the prevalence of 20.3%. *Strongyloides* species accounted for a paltry prevalence of 3.4%. Protozoan cysts of *Balanditium coli* and *Entamoeba histolytica* accounted for 18.6% of parasites each.

Conclusion: These findings clearly show that most water sources in the study area constitute grave epidemiological threat to public health. Inhabitants of such communities should boil or treat their water before consumption while government authorities should provide safe drinking water to the rural dwellers.

Keywords: Water, helminths, protozoa, prevalence, Nigeria

1. Introduction

Quality water should be free from chemical and biological contamination and must be acceptable in terms of colour, taste and odour in accordance with the World Health Organisation guidelines on the quality of drinking water (1).

Wells, bore holes, ponds and streams need a great deal of protection from pollution and contamination by potential parasites, micro-organisms and harmful chemical substances. Unfortunately, these water sources have become sites for breeding and harbouring of many disease - causing agents, (2).

Water-borne diseases are usually acquired by the consumption of polluted water containing human and animal faecal matter from patients or healthy carriers (3).

Human excreta are important sources of pathogenic organisms, especially intestinal parasites which are causes of a high morbidity in the general population primarily due to inadequate disposal of excreta and lack of personal hygiene. Most urban and rural communities in the developing countries do not have adequate disposal system for human waste, and many inhabitants defecate indiscriminately in places not far from their dwelling places, including directly on the soil and rocks, by the sides of the streams, home ponds, wells, and in some cases into the streams (4). Furthermore, excreta from children and free roaming animals are particularly hazardous and a potential source of health problems in both urban and rural communities (5).

Excreta-related communicable diseases have become a major problem in areas where untreated human faeces are used as manure. These together with the human faecal wastes that are indiscriminately deposited in the environment are regularly washed into the communities' water bodies, and water pollution becomes a major public health problem with the result that fresh vegetables and water sources become highly contaminated with pathogenic parasites. Consequently, the faecal-oral route of infection becomes very important and intestinal parasitism assumes enormous proportion especially amongst undisciplined populations who usually suffer from inadequate personal and environmental sanitation (6).

Efficient refrigeration and commercial canning have been very useful in combating the problem of parasitic infection in the developed countries, but these developments are outside the reach of most areas in the underdeveloped countries. Fresh food items therefore come straight from the farms and gardens and water is taken directly from streams and ponds for consumption without pretreatment to kill parasites that may be present (7).

Parasitic infections cause various physiological disturbances in the host body. In nematodes, species such as *Strongyloides stercoralis* and *Necator americanus,* the third stage larva is responsible for infection of a new host. The infection of man and animal with these parasites is either by oral route or by active penetration of unbroken skin, and this constitutes one of the public health hazards in tropical Africa and the world in general (8).

Parasitic infections affect work and productivity as they are usually associated with a diminished capacity to carry out physical work. This is of great significance because in many countries, hard physical work is the means by which families grow their food (9). WHO (10) 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. This study was therefore designed to evaluate the parasitic hygiene of water sources in Nigerian communities using the Heipang community as a case study. The outcome of the study is expected to provide a fair idea of water safety in remote Nigerian settings.

2. Materials and Methods

2.1. Study Area

Heipang is a growing community in Barkin Ladi Local Government Area of Plateau State, Nigeria. Over ninety percent of the people are peasants involved in crop and animal production. According to the 2006 population census figures, the population of Heipang is about 42,174. Major water sources are wells, streams, ponds and in isolated cases boreholes. In spite of the location of the state airport, Polytechnic and the proposed in-land container port in the area, government presence in terms of good roads, electricity, pipe-borne water amongst others are only being enjoyed by less than one-quarter of the community. As such, it serves as a template for a typical rural settlement in Nigeria. For political convenience, Heipang is a district under Barkin-Ladi local government area of the state. The district comprises of 10 villages namely: Larwin, Ban, Pwomol, Chik, Rayogot, Laroh, Kabong, Tatu, Kpang and Yelwa.

2.2. Sample Collection

100 water samples were collected all together in the entire length and breadth of the community. Each of the 10 villages mentioned above accounted for 10 water samples: 6 were from ponds, 1 from streams, 2 from wells and 1 from boreholes. Cumulatively, 10 of the samples were from bore holes, 20 from wells, 60 from ponds while 10 were from streams. Samples were collected randomly.

Clean glass specimen bottles were used to collect samples from streams, boreholes and ponds. A public fetcher was used to draw water from wells into a clean sample container. All the water samples were well labeled and transported immediately to the laboratory for examination.

2.3. Sample Processing

Collected samples were examined both macroscopically for colour and presence of adult parasites. For purpose of microscopy, concentration by centrifugation as described by WHO (11) was adopted. Briefly:

A gauze filter was placed into a funnel and then placed on top of a centrifuge tube; the water samples in each container were shaken and passed through the filter into separate tubes to reach the 10ml mark. The filter was then removed and particulate materials present discarded as of bore holes water sample no particles were found. The tubes were then transferred to the centrifuge tubes and centrifuged for 5 minutes at a pre-determined speed of 100 × g (300rpm). After the period of centrifugation, the supernatant was discarded by gently inverting the tubes leaving the deposits in the tube. The tubes were placed on a rack and the fluid on the sides allowed to drain down the sediments in tubes. Sediments were then re-suspended. A drop of the deposits was placed on a clean slide for examination under a cover slip.

2.4. Direct Wet Preparation

Using a Pasteur pipette, the deposit was placed on a clean grease-free glass slide and was covered with cover slip to avoid air bubbles and over floating. The smear was viewed microscopically using x10 and x40 objective for focusing and identification of parasites, respectively.

2.5. Iodine Preparation:

A drop of Lugol's iodine was placed at the edge of the slide. The smear was examined systematically under the microscope using x10 and x40 objectives for focusing and identification of parasites, respectively.

2.6. Identification of Parasites

Parasites were identified by the morphological structures of their cysts, ova or larvae when focused under the microscope as documented by Cheesbrough (12).

3.0. Results

All the samples collected from boreholes in the locality were free from parasitic infestation. However, samples from streams, ponds and wells had various degrees of parasitic contamination. Out of one hundred (100) water samples collected and examined, 59 of them had parasites giving an overall prevalence of 59% in the study site (Table 1).

Water from ponds was the most contaminated with 78.3% positivity for parasites, 35% of well water sources had parasites just as 50% of stream water sources had parasites (Table 1).

On the whole, seven different parasites were encountered in this study. They include ova of *Ascaris* species which accounted for 33.9% of all the parasites, hookworm ova (20.3%), larvae of *Strongyloides spp* (3.4%), larvae of *Giardia intestinalis* (1.7%), cysts of *Balantidium coli* (18.6%), cysts of *Entamoeba coli* (3.4%) and cysts of *Entamoeba histolytica* (18.6%). *Ascaris.* spp were the most widely distributed as they were found in all but one location, accounting for 90% spread in the locality. Hookworms followed closely with 70% spread while *Balantidium coli* and *Entamoeba histolytica* had 60% and 50% spread, each. The least distributed parasites were *Giardia intestinalis*, *Strongyloides spp* and *Entamoeba coli.*

Helminths were the most prevalent genera accounting for 57.6% of all the parasites recovered, with protozoan parasites making up the remaining 42.4%.

Table I: Rate of Contamination of Water Sources by Parasites

Water Source	No Positive	Percentage
Stream *(n=10)*	5	50.0
Pond *(n=60)*	47	78.3
Well *(n=20)*	7	35.0
Borehole *(n=10)*	0	0.0
Total *n=100*	**59**	**59.0**

Table II: Spread of parasites in all the locations investigated

Name of parasite	Locations	Percentage
Ascaris species	9	90%
Strongyloides spp	1	10%
Giardia intestinalis	1	10%
Hookworm	7	70%
Balantidium coli	6	60%
Entamoeba coli	1	10%
Entamoeba histolytica	5	50%

4.0. Discussion

The outcome of this work indicates clearly parasitic contamination of water sources in rural communities in Nigeria. The prevalence of contamination varies between stagnant and flowing water. The ponds in the study area included the deep ponds that lasted throughout the year. Shallow ponds last for up to about 6 months and dry up. Others were just water filling an existing depression for few weeks or days. However, since the ponds served as reservoirs that collect run-off water from different routes, they therefore stand a greater risk of contamination. Hence, they recorded the highest number of pathogenic parasites. The public health significance of these results is that the pathogenic parasites may pose serious hazard to human health, especially on the community dwellers, such as farmers due to occupation and children due to poor sanitary habits. Another challenge is on people who use water for washing purposes and children who walk around barefooted as the mode of transmission of some helminths is by the penetration of the unbroken skin (13).

Exactly half the number of streams investigated had parasitic infestation. This is attributed to the fact that streams are regularly being contaminated with faecal materials and sewage due to indiscriminate defecation and rain water. In the course of this work, human faecal wastes were found around some streams, ponds and wells visited.

35% of wells were infested with parasites. This is due to lack of toilet facilities in most of the communities. Also, most wells in these communities are usually left opened.

Water samples from boreholes were found to be free from parasites. This is largely attributed to their make-up. Unlike other sources that are open to external contamination, boreholes operate a water system that is closed. This observation supports that parasitic infestation of water sources is contaminative in nature. It has been previously explained that human parasites do not directly use water bodies for life cycle development. Instead, their vectors inhabit water bodies thereby associating their transmission to water bodies and certain water foods (14). Government authorities can therefore improve the quality of life in these communities by making available more borehole and pipe-borne water facilities.

Primarily, the risk of intestinal parasitic infections is assumed to be from hookworm and *Ascaris* species, but the prevalence of helminths in this study ranked higher than those of other parasites. This is in agreement with the observation made by Okonkwo, (15). The 18.6% prevalence of *B. coli* in this study can be explained by the fact that a high percentage of the inhabitants of the study area are involved in swine production and since the protozoa in question are of worldwide distribution and commonly infects pigs, the contamination observed in the present study probably arose from water contaminated with faecal material from swine which are mostly raised in semi-intensive or extensive system in this community.

Ascaris species with prevalence of 33.9% ranked highest amongst helminths. It was closely followed by *Hookworms (*20.3%) and *Strogyloides spp* (3%). The outcome is not different from that of Griffin and Krishnas (16). They also concluded that the occurrence of intestinal parasites in water sources is prevalent among poor people in remote rural communities who lack proper toilet facilities, adequate supply of portable drinking water and poor sewage and waste disposal systems.

The implications of these findings therefore suggest that parasitic organisms are maintained by a viable ecosystem in remote settlements in Nigeria where toilet facilities, pipe borne water, poor sewage disposal, and illiteracy thrive the most. The combined effect of these factors exposes the inhabitants, their children and animals to a cycle of endless parasitism resulting in low productivity and high morbidity and mortality rates in most cases (2).

We were however unable to identify most parasites to specie level due to non-sensitive diagnostic tools in our research facility. Also, we were unable to determine if the hookworms encountered in this study were of animal or human origin due to the same reason.

REFERENCES

1. WHO: World Health Organisation; Catalogue on health indicators 1996. Geneva-htt://www.Northampton.ac.uk/ner/who/indicators/wbd.s.html.
2. Adams J: Managing water supply and sanitation in emergencies, Oxfam, Oxford: 1999.
3. Cairncross S and Feachem R: Environmental Health Engineering in the Tropics: An Introductory Text, 2nd edition john Wiliey, Chischester. 1993: 120.
4. Adegoke A: The Challenges of Environmental Management in Africa. The Nigeria Experience. *An* International Journal of Medical Science. 2000;(2):13.
5. Ukoli FAM: Sanitation in Africa: Nigeria. An International Journal of Medical Science 2000;(2):25-28.
6. Fitzerpatrick M and Kappos A: Environment Health Services in Thailand. Desire, Bangkok. 1999: 211.

7. Petters W: Comments and discussions II on medical aspects in the relevance of parasitology of human welfare today. Eds. A.E.R., Taylor and R. Muller 1b Symp. British Soc. Parait.1986:25-40

8. Hassan SI: Parasitic infection in primary and secondary schools in Giza government. Orutes Egypt. Journal of Egyptian Society of Parasitology. 1994;24(3): 597-601.

9. Chance MML and Evans DA: The agent in Gillers H.M., (Ed): The agent in Gillers H.M., (Ed): Protozoal Disease Arnold, London.1999: 420.

10. WHO: "World Health Organization. Safe Water and Global Health" Who. Int. 2008-06-25. Retrieved 2010-07-025.

11. WHO: World Health Organization. Guidelines for drinking water quality. Health criteria and other supporting information.1991; 39-45.

12. Cheesbrough M. District laboratory practice in tropical countries. Part 2. Cambridge University Press, London, United Kingdom 2000.

13. Arora DR and Arora B: Textbook of Medical Parasitology, 3rd edition 2000: 185 and 210. Published by: Satish K. Jain and Produced by Vinod K. Jain.

14. Chollom SC, Chollom RS, Gbise SD, Kaigama AJ, Dyek YD, Gideon BA, Ajayi OT, Nimbut LB, Maxwell IK, Dauda PK and Nwankiti OO. Prevalence and speciation of hookworm in Plateau State, Nigeria. Journal of Parasitology and Vector Biology Vol. 2012;4(2): 14 –19
15. Okonkwo PO, Akpala CO, Okafor HU,Mbah AU,Nwaniwu O. Compliance to dose of chloroquine in uncomplicated malaria correlates with improvement in the condition of rural Nigerian children. Transactions of the Royal Society of Tropical Medicine and Hygiene 2001;95(3): 320-324
16. Griffin G and Krishnas N. CME. Infectious disease, Journal of the Royal College of Physicians, London 1998;32(3-4).