Advances in Science and Technologies, Vol 15, No 1 & 2, September / October 2021, pp 21-32

Retrospective Study on Human *Cryptosporidium* and Other Enteric Protozoan Parasites Commonly Associated With Human Diarrhea in Owerri, Imo State, Nigeria

Vitalis I. Njoku[1], A. J. Njoku[1], Alex D.W. Acholonu[2] and C.N. Ukaga[1]
[1]Department of Animal and Environmental Biology, Faculty of Sciences, Imo State University, Owerri, Nigeria
[2]Department of Biological Sciences, Alcorn State University, Alcorn State, Mississippi, 39096, USA
Submitted: July 31, 2021; Accepted: September 30, 2021

Abstract

Parasitological and epidemiological studies to determine the association of *Cryptosporidium* and other enteric protozoan parasites with diarrhea in Owerri and its environs of Imo state, Nigeria were carried out between September 2002 and May 2005. The relationship among these enteric parasites, especially *Cryptosporidium* with HIV/AIDS and the environmental factors that affect their distribution were also determined. A total of 3054 stool samples from patients attending various health institutions in the study area was examined. Of these, 1204 (39.4%) were diarrheic while 1850 (60.6%) were non-diarrheic. Enteric parasites were detected in 572 (47.5%) of the diarrheic stool samples while non-diarrheic stool samples were in 320 (17.3%). Enteric parasites identified in diarrheic stool samples include protozoans (28.7%), helminths (4.9%), and mixed infections (1.8%). The enteric protozoans identified include *E. histolytica* (10.1%), *Giardia lamblia* (7.9%), *Cryptosporidium* species (4.9%) and *E.coli* (5.8%). *E.histolytica* showed the highest prevalence. Age related *Cryptosporidium* infection was higher in children aged <1-5 years and higher in those of 21-60. Of the 3054 stool samples examined, 356 were from HIV positive patients. 52 (14.6%) had Cryptosporidiosis had a high pathogenicity and was found in association with diarrhea and only rarely in non-diarrhea samples. From this study *Cryptosporidium* is associated with diarrhea as much as *Giardia lamblia* and *E.histolytica* especially in HIV positive patients and children.

Keywords: *Cryptosporidium,* protozoan parasites, diarrhea, HIV/AIDS, *Giardia lamblia, E.histolytica.*

1.0 Introduction

Human intestinal parasitism is a common phenomenon in many countries, especially in the developing countries where about a third of the population live in slums and shanty towns and thus are predisposed to infection. Human enteric parasites have continued to cause significant morbidity and mortality globally, especially in developing countries due to poor hygiene, ignorance, poverty, and environmental conditions.

Certain additional populations of people are at a risk of contracting a parasitic infection. A dramatic increase in parasitic infection incidence occurred initially in the homosexual population and is now becoming more prevalent in the heterosexual population as well. Individuals with acquired immune deficiency syndrome (AIDS) and children in some day-care centers are also among those at risk (Zeibeig, 1997).

Although most parasitic infections are often asymptomatic, it may be dangerous to assume that they are innocuous (Ozeretskorskanyo, 1982). Many parasitic organisms that infect humans are worldwide in their distribution and

occur with some frequency in the temperate zones (Sydney, *et al.*., 1978).

Parasitic infections affect millions of people worldwide afflicting considerable human suffering and economic hardship. In first world countries, protozoan infections are relatively uncommon. However, outbreak of cryptosporidiosis and giardiasis associated with drinking water supplies and cryptosporidiosis associated with imported fresh produce are of major concern even in North America. Generally, in immunocompetent people, protozoan parasitism is rare and not a serious problem. In the very young and very old, protozoan parasitism while still uncommon, is of concern in people who are immunocompromised by HIV/AIDS, or anti-transplant rejection drugs. In these situations, infections are often fatal or life threatening.

Many medically important protozoa require invasion, resulting in damage, illness or even death, of a suitable host to complete all or part of their life cycle. Geographical limitations, i.e., distribution range of the protozoan, its area of evolutionary origin and current area of greatest density of infection are becoming meaningless in the modern world. Travel is easy and fast. Visitors and immigrants bring in diseases and parasites that are then introduced into health systems, sewage systems, and the environment. New cultural behaviors, diets, and practices may encourage the survival and spread of these pathogens in new habitats.

Numerous protozoa inhabit the gastrointestinal track of humans. A majority of them are non-pathogenic commensals, or only result in mild disease. Under certain circumstances, some of those organisms can cause severe disease. For examples, *Giardia lamblia* can cause severe acute diarrhea, which may lead to chronic diarrhea and nutritional disorders; *Entamoeba histolytica* can become a highly virulent and invasive organism that causes a potentially lethal systemic disease. Apicomplexa (*Cryptosporidium, Isopora* and *Cyclospora*) and *Microspora* species, which do not normally evoke severe disease, can cause severe and life-threatening diarrhea in AIDS patients and other immunocompromised individuals. The protozoan, *Giardia lamblia* and *Entamoeba histolytica* had been known for a long time as agents of enteric infections and also have been looked for. However, the presence of *Cryptosporidium* and other coccidian protozoan parasites are not often pursued in our environment. Cooke and Moody (1983) evaluated protozoal enteric pathogens and found that intestinal coccidial infections, in man, caused by *Cryptosporidum parvum*, *Isospora belli* and *Microsporidia* species (which are environmental parasites and usually water-borne) have gained prominence since their implications in diarrhea of the immunocompromised patients.

Intestinal protozoa and helminths rank among the 10 most serious infections of man in the world (Edungbola and Obi, 1992). They constitute enormous environmental, medical, public health and socio-economic problems, which may lead to high morbidity, mortality and/or high medical care costs.

Since protozoa cysts survive for considerably long periods outside the body if not desiccated, it is obvious that if they get into drinking water or moist foods, such as raw vegetables, they are in an advantageous position to "thumb a ride" into a human alimentary canal. Polluted water is undoubtedly one of the most important means of transmission. Chlorination of water in most cities prevents sewage-tainted supplies from causing typhoid or other bacterial infections, but it has no effect on protozoan cysts. Studies have shown that *Cryptosporidium* oocysts are 240,000 times more resistant to chlorination than ***Giardia*** cysts (Jakubowski, 1995).

Objectives

To determine the association of *Cryptosporidium* and other enteric protozoan parasites with diarrhea in Owerri and its environs in Imo State, Nigeria.

To determine the relationship between these enteric parasites, especially *Cryptosporidium*, and HIV/AIDS.

1. To identify enteric (intestinal) parasites that may be seen in human diarrhea stool samples.
2. To determine the prevalence of Cryptosporidium associated with human diarrhea.
3. To determine the prevalence of protozoan parasites commonly associated with human diarrhea in the study area.
4. To determine whether HIV/AIDS positive subjects are more predisposed to intestinal protozoan infections in the study area than non – positive ones.
5. To compare the prevalence of *Entamoeba histolytica*, *Giardia lamblia* and other enteric protozoan parasites associated with human diarrhea in the study.
6. To determine the possible seasonality of protozoan infections in the study area.
7. To determine the environmental factors that favor the prevalence/distribution of intestinal protozoa causing diarrhea in man.

2.0 Materials and Methods

2.1 The Study Area

The study area for this investigation is Owerri and environs in Imo State, Nigeria. Owerri Municipal was carved out of the former Owerri Local Government Are of Imo State by 1996 as the only Municipal council in Imo State. It serves as Imo State Capital and the seat of the Imo State Government is located there-in. It also accommodates some Federal Government offices.

Owerri is located at approximately between latitude 5"34" and 15' N. longitude 7^0 30'. Owerri has a population of about 693,039 at the time of the study and is not too developed, with rural areas surrounding it.

Sewage disposal is poor and the environment dirty. Sources of drinking water include surface water (flowing [lotic] water), underground water (boreholes, which include hand pumps), and packaged water ("pure water"), bottled water and tap water. Education is a thriving industry in the area and farming is part of the occupation of the inhabitants. A good number of the people are

teachers and civil servants. Raw food and cooked food are also taken, and animal to person contact takes place, as a lot of residents have pets like dogs, cats, goats, etc.

There are government-owned hospitals, but the Federal Medical Centre, owned by the Federal Government provides basic health facilities and serves as a referral center.

Owerri Municipality shares borders in the Northeast and South with Owerri North Local Government Area and Owerri West Local Government Area in the West. In the Eastern and Northern fringes of the borders are two big mechanic villages namely, Nekede and Orji mechanic villages where repairs and panel beating of all kinds of vehicles are done.

Figure 1: Map of Nigeria showing study area, Imo State

Figure 2: Map of Imo State

2.2 Materials

The samples investigated were those collected from patients who reported diarrhea and/or abdominal pain after attending health institutions in the Owerri Municipal and environs. Federal Medical Centre was the major source of samples, as it serves as a referral center especially for those diarrheic patients with AIDS. The subjects included both males and females of all ages attending hospitals/clinics/laboratories etc. Such subjects presenting with or without frequent stooling are included. Patients suffering from the Human Immuno deficiency Virus/Acquired Immune Deficiency Syndrome were also investigated. This study was carried out between September 2002 and May 2005.

2.3 Collection of Fecal Specimens

Fresh fecal specimens, whether formed, soft, semi-solid or watery were obtained uncontaminated with urine. The specimens were collected into suitable size, clean, dry, leak proof sterile plastic containers. About a large teaspoon amount of feces or about 10ml of fluid specimens were collected. Emphasis was laid on diarrheic (watery) specimens to reach the laboratory as soon as possible after being passed (at most within 15 minutes). This is to preserve parasites such as *Entamoeba histolytica* and *Giardia lamblia* trophozoites.

2.4 Methods Used For Examination of Fecal Specimens Collected

Various methods were adopted for examination of each fecal specimen in searching for oocysts of *Cryptosporidium, Isopora belli, Cyclospora cayetanensis, Micropsoridum* and cysts of *Giardia lamblia*, *Entamoeba histolytica* and *Balanitidium coli* and of their trophozoites. Such methods include macroscopic examination, microscopic examinations of saline wet and iodine wet mounts, and concentration methods of sedimentation and flotation and staining of smears by the modified Ziehl-Neelson and 1% Sefranin/methylnene blue techniques.

3.0 Results

Of the 3054 samples examined, 1204 (39.4%) were diarrheic while 1850 (60.6%) were non-diarrheic. The prevalence of enteric pathogens identified in human diarrheic and non-diarrheic stool samples in the study population is indicated in Table 1 and Figure 3. The enteric protozoans identified include *Entamoeba histolytica* (10.1%), *Giardia lamblia/duodenalis* (7.9%), E. coli (5.8%) and *Cryptosporidium* species (4.9%) (See Table 5).

Macroscopic observation of stool consistency of the stool samples collected in the study area is indicated in Table 3. Soft/loose and watery stool samples were regarded as diarrheic samples as this was based on the number of stooling per day.

Observation on the presence of blood and mucous in the examined diarrheic stool samples was carried out and indicated in Table 4. In most amoebic dysentery the stools consisted of almost pure blood and mucous, while in some *Cryptosporidium* and *Giardia* infections, diarrheic stool samples consisted more of mucous. Table 1 shows prevalence of enteric pathogenic parasites. Table 2 shows prevalence of cryptosporidium and related species in diarrheic and non-diarrheic stool samples from the study area. Table 5 summarizes the prevalence of enteric protozoan parasites commonly associated with human diarrhea in the study area.

Sex related prevalence of enteric protozoan parasites commonly identified in the study population was shown in Table 6. Of the 3054

stool samples collected, 1640 and 1414 were from males and females respectively.

Of the 1204 diarrheic stool samples examined, 590 (49.0%) were from males while 614 (51.0%) were from females.

The prevalence of enteric protozoan parasites commonly identified in the study population according to age was carried out. The results are shown in Table 7. The least prevalent rate for Cryptosporidium species of 0.9% and 1.3% as shown in Table 7 were in age-groups 11 – 20 years and 60 and above respectively.

Table 8 shows the result of whether HIV/AIDS diarrhea patients are more predisposed to enteric protozoans in the study population. Of 1204 diarrheic stool samples, 252 (21.0%) of the diarrheic stool samples were from HIV/AIDS patients. 179 (71.0%) of the diarrheic samples showed protozoan parasites in them, while of the 952 non-diarrheic samples, 167 (17.5%) were positive for enteric protozoans. See Table 8 for other relevant information.

The determination of the possible seasonality of enteric protozoan infections in the study population was carried out (Table 9). The highest prevalence rates of 25.2% and 21.4% were identified in the months of May marking the beginning of rainy season and April marking the end of dry season. The least prevalence rate of 11.8% was in the month of October.

Poor sanitation which is the general situation in the study area may have affected every other source of infection in the environment as the major cause of enteric protozoan infections leading to diarrhea.

Table 1: Prevalence of enteric pathogens identified in human diarrheic and non-diarrheic stool samples in study population.

Pathogens	**Diarrheic stool samples examined n = 1204 n (%)**	**Non – diarrheic stool sample examined n = 1850 n (%)**	**Total number of stool samples examined n = 3504 n (%)**
Protozoans	346 (28.7)	161 (8.7)	507 (14.5)
Helminthes	59 (4.9)	159 (8.6)	218 (6.2)
Mixed Infections	145 (12.0)	0 (0.0)	145 (4.1)

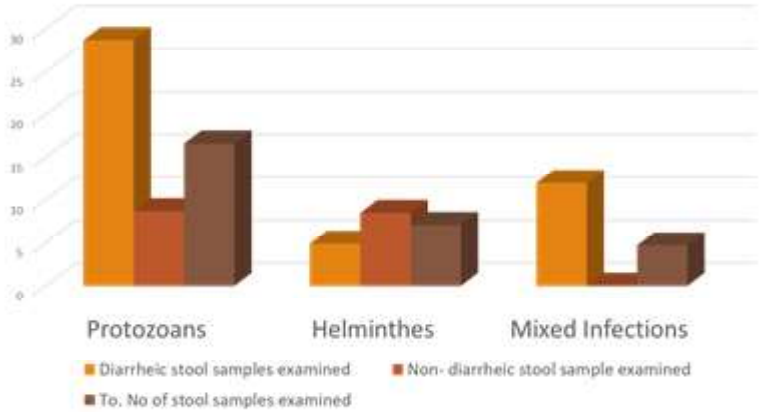

Figure 3: Prevalence of enteric pathogens identified in human diarrheic and non-diarrheic stool samples in study population

Table 2: Prevalence of cryptospordium, isospora, cyclospora, and microspordium in diarrheic and non- diarrheic stool samples from the study population

	Number Examined	Cryptosporidium species N (%)	Isospora belli N (%)	Cryclospora cayetenensis N (%)	Microsporidium N (%)
Diarrheic Stool Samples	1204	59 (4.9)	0 (0.0)	0 (0.0)	0 (0.0)
Non – Diarrheic Stool Samples	1850	7 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)

Table 3: Macroscopic observation of stool consistency of the stool samples collected in the study area

Consistency	No	%
Formed stool	871	28.52
Semi formed stool	979	32.06
Soft / Loose stool	715	23.41
Watery stool	489	16.01
Total	3054	100.00

Table 4: Observation on the presence of blood and/or mucous in the examined diarrheic stool samples examined.

Observation	Number	%
Blood	159	13.2
Blood and Mucous	331	27.5
Mucous	105	8.7
No Blood and Mucous	609	50.6
Total	1204	100.00

Table 5: Prevalence of enteric protozoan parasites commonly associated with human diarrhea in the study population

	Diarrheic Stool Samples		Non-Diarrheic Stool Samples		Total	
	Protozoans found	% Infected	Number Infected	% Infected	Infected	% Infected
E. histolytics	122	10.1	66	3.6	188	6.7
G. lamblia	95	7.9	45	2.4	140	4.6
Cryptosporidum species	59	4.9	7	0.3	66	2.2
Entameba coil	70	5.8	43	2.3	113	3.7
Number Positive	346	28.7	161	8.7	507	16.6
Number Examined	1204		1850			

Table 6: Prevalence of enteric protozoan parasites commonly associated with human diarrhea in the study population according to sex

Sex	No. Examined	No. Infected	% Infected	Cryptos-poridium parvum N (%)	Entameba-histolytica N (%)	Giardia lamblia N (%)	Entameba coil N (%)
Male	590	174	29.5	28 (4.7)	63 (10.7)	51 (8.6)	32 (5.4)
Female	614	172	28.0	31 (5.0)	59 (9.6)	44 (7.2)	38 (6.2)
	1204	346 (28.7)					

Table 7: Prevalence of enteric protozoan parasites commonly associated with human diarrhea in the study population according to age

Age	No. Examined	No. Infected	Cryptospo-ridum parvum	Entameba-hystolytica N (%)	Giardia lamblia N (%)	Entameba coil N (%)
< 1 – 10 yrs	916	166 (18.1)	28 (3.0)	39 (4.3)	72 (7.9)(10.7)	27 (2.9)
11 – 20 yrs	874	154 (17.6)	8 (0.9)	75 (8.6)	30 (3.4)	41 (4.7)
21 – 40 yrs	664	108 (16.2)	18 (2.7)	43 (6.4)	20 (3.0)	27 (4.0)
41 – 60 yrs	380	56 (14.7)	9 (2.4)	23 (6.4)	11 (2.8)	13 (3.4)
60 yrs & above	220	23 (10.4)	3 (1.3)	8 (3.6)	7 (3.1)	5 (2.3)

Table 8: Determination of whether HIV/AIDS diarrhea patients are more predisposed to enteric protozoans in the study population

Stool Samples	No. Examined	No. Infected	Cryptospori-dum parvum N (%)	Entameba-hystolytica N (%)	Giardia lamblia N (%)	Entameba coil N (%)
HIV positive diarrheic stool samples	252	179 (71.0)	45 (17.8)	49 (19.4)	53 (21.0)	32 (12.7)
HIV negative diarrheic stool samples	952	167 (17.5)	14 (1.4)	73 (7.7)	42 (4.4)	38 (4.0)
	1204	346	59	122	95	70

4.0 Discussion and Conclusion

This study on the prevalence of Cryptosporidium and other enteric protozoans associated with human diarrhea in Owerri and environs, Imo state Southeast Nigeria showed that enteric protozoan parasites could constitute part of the opportunistic infections in diarrhea subjects. The prevalence of protozoan parasites associated with human diarrhea was 28.7% as against a prevalence rate of 8.7% from non-diarrhea subjects.

The sex related prevalence of protozoan infections associated with human diarrhea was also determined. Both sexes seem to be equally susceptible. Prevalence rates of 29.5% and 28.0% were recorded for males and females respectively. This may be a result of equal exposure to the poor sanitary conditions existing

Table 9: Determination of possible seasonality of enteric protozoans identified in the study population

Months	Total no Examined	Total no Infected N (%)	Cryptos-poridum Parvum found N (%)	Entameba-hystoly-tica N (%)	Giardia lamblia N (%)	Entameba coil N (%)
Feb	321	57(17.8)	2(0.6)	18(5.6)	10(3.1)	27(8.4)
March	409	55(13.4)	4(1.0)	18(4.4)	11(2.7)	22(5.4)
April	364	78(21.4)	10(2.7)	43(11.8)	13(3.6)	12(3.5)
May	376	95(25.2)	8(2.1)	56(14.9)	19(5.0)	12(3.2)
June	305	37(12.1)	7(2.3)	14(4.6)	12(3.9)	4(1.3)
July	277	30(10.8)	7(2.5)	4(1.4)	14(5.0)	5(1.8)
Aug.	291	42(14.4)	9(3.1)	13(4.5)	15(5.2)	5(1.7)
Sept.	337	69(20.4)	8(2.3)	18(5.3)	24(7.1)	19(5.6)
Oct.	374	44(11.8)	11(2.9)	4(1.1)	22(5.9)	7(1.9)
	3054	507(16.6)	66(2.2)	188(6.2)	140(4.6)	113(3.7)

in the study area.

Age related prevalence of protozoan infections associated with human diarrhea showed that children <1-5 years had a higher rate of 40.0% age-group 6-20 years, 20.9% and 61 years and above, 15.2%. Subjects in the age group <1-20 years probably spend more time in the environment and getting more contaminated than the other age groups. The prevalence of protozoan infection was found to be decreased in subjects above 20 years. This may be because subjects of this age are becoming conscious of their personal hygiene (Smith and Bartlett, 1991). Luka *et al.*., (2000) observed a similar trend in Kaduna.

The predisposition of HIV/AIDS diarrhea subjects to protozoan infections was determined. The HIV diarrhea patients had a prevalence rate of 71.0%. This may be a result of immunodeficiency experienced in HIV positive diarrhea patients. The enteric protozoan parasites identified in this study associated with human diarrhea include *Entamoeba histolytica* (10.1%), *Giardia lamblia* (7.9%), *Entamoeba coli* (5.8) and *Cryptosporidium* species (4.9%). Kogi *et al.* (1991) in Samaru, Zaria in their study identified *Entamoeba histolytica* (3.8%), *Giardia lamblia* (2.6%) and *Entamoeba coli (*9.2%). The difference in result may be in the number of studies and difference in environmental factors. *Cryptosporidium*, in this study had a lower prevalence rate of 4.9% in this study when compared with other enteric protozoans identified. Non-diarrheic stool samples had a prevalence rate of 0.4%. Fayer and Ungar (1986) reported that the prevalence rate of cryptosporidial infection in patients with gastroenteritis were variable. They reported rates ranging from 0.6-7.3% in developed countries to 3-12% for developing countries. While our results agree with the reports of Fayer and Ungar (1986) to some extent, it disagrees with the report of Onyerinde et al. (1989) which did not find any Cryptosporidium in any of the gastroenteritis patients they studied in Lagos. Onah *et al.* (1998) reported that the incidence of Cryptosporidium in Nigeria is very low.

The sex related prevalence of *Cryptosporidium* infection in human diarrhea showed that both sexes seem to be equally susceptible. Prevalence rates of 4.7% and 5.0% were recorded for males and females respectively. This may be as a result of equal exposure to poor environmental sanitation and other sources of transmission.

The rate of *Cryptosporidium* infection in patients with diarrhea according to age showed that children between ages <1-20 years had a prevalence rate of 4.2% while adults aged 31 years and above had 5.8%. Kwaga *et al.* (1998) in Zaria in their study stated that the rate of detection was higher in adults (29.0%) than in children (8.0%). The difference in the prevalence rates between their study and this study may be because in Zaria association with farm animals is higher and is the major mode of transmission. Furthermore, the authors stated that the children that were positive for *Cryptosporidium* were aged 1-2 years while in this study children aged <1-5 years have a prevalence rate of 6.7% and those aged 21-60 years, 8.4%.

Cryptosporidium species involvement in HIV/AIDS diarrhea patients were determined. A prevalence rate of 17.8% was recorded in HIV positive with diarrhea while HIV negative patients with diarrhea had a prevalence rate of 1.4%. In other studies, observing HIV positive patients with diarrhea, Diengtol *et al.* (1996) reported an infection rate of 6.8% among the HIV positive diarrhea patients. Anosike *et al.* (2004) recorded a 1.1% prevalence rate in HIV-seropositive diarrhea patients and 0% in non-HIV diarrhea patients. The difference here may be due to the number of patient samples studied. Keptcheu *et al.* (2000) also recorded 4.5% prevalence rate in HIV positive diarrhea patients studied in Jos, Plateau State, and 0% in non-diarrhea HIV negative subjects.

Entamoeba histolytica was the most frequently isolated protozoan in this study. It has an overall prevalence rate of 16.2% in the study area. In the diarrheic stool samples, a prevalence rate of 10.1% was recorded against 3.6% in non-diarrheic stool samples. This agrees with the 11.0% observed by World Health Organization Scientific Working Group (1980) where Kogi *et al.* (1991) recorded 3.8%. Environmental factors and number of samples examined may account for these differences. Like *Cryptosporidium* infection, both sexes had equal exposure to sources of infection by *Entamoeba histolytica.* In this study a prevalence rate of 10.7% and 9.6% was recorded for males and females respectively. *Entamoeba histolytica* was recorded to have prevalence rates of 12.4% in the age group <1-20 years and 6.9% in the age group 21 and above. The age group 6-20 years had the highest prevalent rate of 16.2%, followed by the <1-5 years (8.9%) with the infection decreasing from the age 21 and above. Arafat *et al.* (1978) recorded a prevalence rate of 16% in age group 11-20 in Egypt while this study recorded same prevalence rate in ages 6-20 years.

Entamoeba histolytica infection rate of 17.8% was recorded among HIV positive diarrhea patients. Anosike *et al.* (2004) recorded 17.8% among HIV-seropositive patients studied in Owerri, 36.2% was recorded by Keptcheu *et al.* (2000), in Jos. It was believed from this study, and that of Anosike *et al.* (2004) that *Entamoeba histolytica* is more prevalent in HIV positive diarrhea patients.

The prevalence rate of *Giardia lamblia* in this study was recorded as 7.9% for diarrheic stool samples and 2.4% for non-diarrheic stool samples. Kogi *et al.* (1991) recorded a prevalence rate of 2.7% in Rwanda, Central Africa. The result of this study agrees with the report of Myer and Jarroll (1980) which states that giardiasis is the commonest cause of diarrhea in the United States with an overall prevalence estimated at 7.4%, which is about the same as its average world-wide prevalence (Mahmoud and Nikitas, 1975). Prevalence in Great Britain varied from 2% to 10% (Felman and Nikitas, 1985). Different rates of exposure to sources of infection may be responsible for these differences observed.

Sex related *Giardia lamblia* association with human diarrhea in the study population was determined. A prevalence rate of 8.6% and 7.2%

was recorded for males and females respectively. The difference is minimal. The males and females seem equally exposed to the sources of transmission of *Giardia lamblia.*

Age prevalence distribution of *Giardia lamblia* association with human diarrhea in the study population showed a rate of 12.0% in children aged <1-20 years and 2.2% in adults aged 21 and above. Bogaert *et al.* (1984) reported a prevalence rate of 3.6% in children and 1.0% in adults. It has been reported that *Giardia* infections are very common in children in developing countries (Farthin, 1994) and its prevalence with diarrhea is about 20% (5-43%) (Islam, 1990). These agree with the result of this study. The highest infection rate of 18.3% in this study was recorded among the age group <1-5 years. Nadham *et al.* (1995) reported a rate of 12.9% among children <1-5 years in Iraq. Higher prevalence rates in children of 51% in Northern Nigerian was reported (Tornkis 1981). Joyce (1996) reported 31% in children within 10 years in Kenya. Okorie *et al.* recorded in Aba a prevalence rate of 6% among children studied. The difference in percentage distribution observed in these various studies could be attributed to environmental factors and ability to identify organism in stool samples. This study also revealed that *Giardia* infection also decreases with age with little increase at the group 61 and above. Tornkis, (1981) recorded 18% in adults 40 years and above. This difference in children and adults could be explained thus: apparently some people are more sensitive to the presence of *G. lamblia* than are others, and considerable evidence suggests that some protective immunity can be acquired. (Larry and Janovy, 1996). Also, Rajeshvar (1996) attributed the high infection rate of *Giardia lamblia* among children to the fact that they probably lack protective immunity. The Bad Bug Book (2001) observing that giardiasis is more prevalent in children than adults, suggesting that many individuals seem to have a lasting immunity after infection.

Among the HIV positive diarrhea patients studied, *Giardia lamblia* had the highest prevalence rate of 21.0% followed by *Entamoeba histolytica* 19.4%, and *Cryptosporidium* 17.8%. Anosike *et al.* (2004) in Owerri reported a prevalence rate of 7.8% among HIV seropositive patients, while Keptclheu *et al.* (2000) reported no *Giardia lamblia* in HIV positive patients studied in Jos. Bonilla *et al.* (1994) recorded infection rates of 20% of *Giardia lamblia* in Venezuela. These are obvious differences not easy to explain.

Entamoeba histolytica and *Giardia lamblia* are intestinal parasites of global distribution. The high level of these protozoan parasites recorded in this study are consistent with previous works in some parts of Nigeria (Ogunba, 1997).

Protozoan infections, from this study, appear to be non-seasonal. Infections can occur at any time of the year. *Cryptosporidium* infection showed the highest prevalence rate in the months of October (2.9%) marking the end of rainy season and April, 2.7% marking the end of dry season. *Entamoeba histolytica* showed its peak in the months of April (11.8%), end of dry season and May (14.9%), beginning of rainy season. The least rates of 1.1% and 1.4% were observed in October and July. *Giardia lamblia* recorded higher prevalence rates of 7.1% and 5.0% in the months of September, May, and July, with least prevalence rates of 3.1% and 2.7% in the months of February and March. The non-seasonality of infection was observed, though different peaks were seen for each protozoa identified, and may be a result of the fact that people in the study area drink unfiltered surface water or mixed unfiltered surface water and ground water supplies. These surface waters may be contaminated by human feces and animal feces especially cattle feces, as the nomads move towards this area for want of water to feed their cattle, plus other related factors pertaining to unsanitary living conditions. For the ground water, bore-holes are sunk at random without meeting the specifications recommended by WHO/UNICEF. These improperly sited boreholes may be responsible for the high frequency of the parasitic infections as contamination of ground water by human excreta

may result from boreholes sited less than 21 meters from soak-away pits, thus allowing the possibility of contamination of drinking water sources. Even when a purified water system prevails, accidents may lead to widespread infections. One hazard is in defective plumbing. Chlorination of water in most cities prevents sewage-tainted supplies from causing typhoid or other bacterial infections but it has no effect on protozoan (oo)cysts.

Since a majority of the diarrhea patients had no contact with animals, but had exposure to other sources of transmission, this study therefore suggests that people, food, water and other sources may play a role in transmission of (oo)cysts. Obviously, further epidemiological and longitudinal clinical studies are needed to further determine the seasonal distribution and the exact mode of transmission.

It is also associated with diarrhea as *Giardia lamblia* and *E. histolytica* especially in HIV patients and children. Since diagnosis of *Cryptosporidium* species is possible with simple staining techniques, it is suggested that routine examination for *Cryptosporidium* be part of the parasitological routine tests or methods used with AIDS patients. The predisposition of HIV/AIDS diarrhea subjects to protozoan infections was determined and ascertained. The HIV positive diarrhea patients had a prevalence rate of 71.0 % as against 17.5% of HIV negative patients. This significant infection rate may be as a result of immunodeficiency experienced in HIV positive patients.

Acknowledgement

I am grateful to Dr. Robert Sizemore, professor of biology, Alcorn State University, for reading over this manuscript and making useful suggestions. I appreciate the technical assistance provided by Jinad Sawdiq, Alcorn State University student from Nigeria.

References

Anosike, J.C. Dozie, I.N.S, Ukaga, C.N. Nwoke, B.E.B. and Nwabeze. E.U. (2004): Prevalence of gastrointestinal parasites in HIV-Seropositive patients in Owerri, Imo State. Nigeria. Abstract from the 28th Annual Conference of the Nigerian Society for Parasitology. (Unpublished document)

Arafat, M.S, El- Ridi, A.M.S. Ezzat, H.O.A. and Makhlouf, L.M. (1978) Sero parasitological study of Entamoeba histolytica in Egypt. Journal of Egyptian Society of Parasitology, 8: 329-332.

Bogaerts, I., Lepage, P., Rouvroy, D., and Vandepitte, J., (1984): Cryptosporidium species a frequent cause of diarrhea in Central Africa. *Journal of Clinical Microbiology*, 20: 874 – 876.

Bonilla, L.C., Guanipa, N., Cano, G., Raleigh, X., and Quuada, L., (1994): Cryptosporidiosis among patients with AIDS in Zulia state, Venezuela. *American Journal of Tropical Medicine and Hygiene*, 47: 582 – 585.

Bray, R.G. and Harris, N.G., (1977): The epidemiology infection with Entamoeba histolytica in Gambia, West Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 71: 401 – 407.

Cooks, A.M. and Moody, A.H. (1983): Diarrhea due to coccidian and other protozoan of gastrointestinal tract. Diasu Africa xii

Dada, B.J.o and Bellingo, E.D. (1979): Prevalence and Public Health Significance of helminth Ova in dogs feces deposited on the streets of Zaria, Nigeria *Annals of Tropical Medicine and parasitology,* 73:89-90

Diegatol, T., Nalir, O., Diallo, S., Coll, S.A.M., and Dieng, Y. (1996): Prevalence of Cryptosporidium species and *Isospora belli* in patients with HIV in Dakar Senegal. Dakar Medical journal, 39: 121 – 124

Eduagbola, L.D. and Obi, A.A (1992): A review of human intestinal parasites in Nigeria: Challenges and prospects for integrated control. Journal on Nigerian Society of Parasitology, 13: 27-37.

Farthing, M.J. (1994): Giardiasis as a disease. *In Giarda*: from molecules to disease. Thompson, R.C.A., Reynoldson, J.A, Lymbery, A.J. eds. Wallinford, England, CAB International: 15-37.

Fashuyi, S.A. (1983): The prevalence of helminth eggs in human feces deposited on the streets of

Lagos. West African Medical Journal, 2 135 - 138.

Fayer, R. and Ungar, P.L.B. (1990): Cryptosporidium spp. and cryptosporidiosis. *Microbiiology Review.* 50: 458 – 83.

Felman, J.M. and Nikitas, J.A. (1985): Giardeasis. *Curtis,* 305-306.

Hogiyn, N.K., Molback, K. and Japsens, P. (1986): Cryptosporidium species – a frequent cause of diarrhea in Liberian children. *Journal of Clinical Microbiology, I23: 1109 – 1113.*

Hutty, R., and Sharon, A. (1990): The impact of inadequate sanitary conditions on health in developing countries. *World Health Statistics,* Quaterly, 43-45.

Islam, A. (1990): Giardiasis in developing ccountries. In: Giardiasis ed. Meyer, E.A., Elservier, Amsterdam, 235 – 66.

Jakubowski, W. (1995): Giardia and Cryptosporidum: The Details: 1995 safe drinking water seminar, US Environmental protection Agency. (Unpublished Document).

Joyce, T., McGuigan, K.G., El. more-Meegan, M., Convoy, R.M. (1996): Prevalence of enteropathogens in stool of rural Maasai children under five years of age in the Maasiland region of the Kenya Rift valley. *East African Medical Journal*, 73: 59 – 62.

Keptcheu, D.L., Elekwa, D., and Ikeh, E.I. (2000): Prevalence of intestinal Parasites in Human Immunodeficiency Virus (HIV) Patients in Jos, Nigeria. *Journal of Medical Laboratory Sciences,* 9: 26 – 29.

Kogi, E. Umoh, J.U., and Vajimer, C.G. (1991): Intestinal parasites and gastroenteritis among patients attending the university clinic, Samaru, Zaria, Nigeria. *The Nigerian Journal of Parasitology,* 12: 77-80.

Kwaga, J.P.K., Uno, J.U. and Odoba, M.B. (1988): Crypptosporidium infections in humans with gastroenteritis in Zari, Nigeria. *Epidemiology and Infection,* 101: 93-97

Larry, S.R. and Janovy, J. Jr. (1996): Amoebas. Foundation of parasitology, 5th ed. The Megrow.Hill Companies, Inc. WMC-Brown Publishers, New York, 99-112

Luka, S.A., Ajogi, I., and Umoh, J.U (2000): Helminthiasis among primary school children in Lere Local Government Area, Kaduna State, Nigeria. *The Nigerian Journal of Parasitology,* 21: 109 – 116.

Mata, L. Bolanos, Pezarro. H., and Vives, N. (1984): Cryptosporidiosis in children from some highland Costa Rican rural and urban areas. *American Journal of Tropical Medicine and Hygine,* 33: 24 – 29.

Meyers, J.D.; Kuharic, H.L. and Holmes, K.K. (1977): Giardia lamblia infection in homosexual men. *British Journal of Venereology*, 53 :54-55

Nedham, K., Mahdi, Imad, A., Al-Sadoon, and Adel, T., Mohamed. (1995): First report of cryptosporidiosis among Iraqi children. http// www.emro.who.int. Publications.EMHJ/0201/ tables/21-16t01.gif.

Ogungba, E.O., (1977): The prevalence on intestinal Protozoa in Ibadan, Nigeria. Annals of the Journal of Tropical Medicine and Hygiene, 15: 180 – 182

Onah, J.A., Idiong, D.U. Bello, C.S.C. Ujah, I.A.O. and Mawak, J.D. (1998): Cryptosporidiosis in Jos, Nigeria. *Nigerian Journal of Parasitology*, 19: 45-50

Onyerinde, J.P.O., Odugbemi, T., Benson, R.I, Alonge, A.A., and Roberts, J.I.K. (1989): Investigations of Cryptosporidium in relation to other intestinal parasites of Lagos university Teaching Hospital Lagos. *West African Journal of Medicine,* 8: 24 – 269.

Ozeretskorskanyo, N.N. (1922): Intestinal parasitic infections, Scandanavian *Journal of* Infections Disease 86: 46 -51

Smith, J and Bartlett, M. (1991): Diagnostic parasitology, introduction and methods. In: Manual of Clinical Microbilogy, eds. Balows, A; Hausler, J. and Hermann K.L. 701 – 705

Sydney, M.F. William, J.M., Elvgn, G.S. (1978): Diagnostic microbiology 5th C.V. Mosby Company. pp. 352 – 370

Tomkis, A. (1981): The significance of intestinal parasites in malnourished population. *Parasitology,* 82: 38 – 40.

Zeiberg, A.E. (1977): Clinical parasitology. A practical approach inn W.S. Saunders.