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Prevalence and Socio-environmental Predictors of Cryptosporidiosis in Kebbi State, Nigeria

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Abstract: A cross-sectional study to determine the prevalence and socio-environmental factors associated with cryptosporidiosis was carried out between January to December 2012 in two communities in Kebbi state, Nigeria. Faecal specimen was collected from each participant and structured questionnaire applied. Samples were examined for *Cryptosporidium* by formal-ether concentration and modified Ziehl-Neelsen staining technique. A total of 2100 participants were tested, 290(13.8%) were infected with *Cryptosporidium*. Logistic regression analysis indicates that, in Aliero, infection was associated with: Presence younger children (Odds Ratio=1.889, P-value <0.0001, 95% Confidence Interval= 1.568-2.274), Regular hands washing (OR=0.399, P<0.0001, 95% CI=0.283-0.535), Presence of diarrhoea (OR= 2.66, P<0.0001, 95% CI= 1.733-4.100), While in Zuru, the infection was predicted by: Younger age group (OR=1.283, P= 0.004, 95% CI=1.085-1.520), Married status (OR=2.463, P=0.028, 95%CI=1.100-5.513), Lack of formal education (OR=2.993, P<0.0001,95% CI=1.872-4.786) and Farming occupation (OR=1.392, P=0.002, 95% CI=1.135-1.703). It was concluded that unhygienic behavioral variables, certain environmental and socio-demographic factors predicted the presence of cryptosporidiosis in the area. Sustainable intervention should include basic health education, access to clean water and adequate sanitation.

Keywords: Cryptosporidiosis, Prevalence, Risk Factors, Kebbi State

1. Introduction

Cryptosporidium is a common diarrhoea-causing parasitic genus in the world. It is a significant human pathogen and its known zoonotic potential makes it a threat to global public health [1, 2]. Its transmission has been associated with contaminated drinking water and food, low socioeconomic status and overcrowding conditions [3]

Most studies on *Cryptosporidium* infections in Nigeria and other places in the tropics, have focused on the occurrence of infection in hospitals and health care settings. Few studies have paid attention to the sources of infection within a population, or suggested control measures to reduce the risk of disease in developing countries. Currently 20 valid species of *Cryptosporidium* are known of which eight have been linked to human infection. Transmission routes follow a person to person and zoonotic patterns, both directly and indirectly, through the environment. Statistical association of disease with exposure risks [4-6] have explained already established links to direct transmission [7-9]. While zoonotic and waterborne transmissions are commonly reported in industrialized nations, the situations in developing countries however, have no conclusive evidence for these transmission routes. Reported presence of *Cryptosporidium* oocysts in domesticated and wild animals, and drinking water sources suggests a zoonotic potential also in the tropics [10-13]. The present situation in developing countries is such that, only a few, molecular-based information is available describing species infecting human or non-human hosts in the environment.

Currently, known risk factors for acquiring cryptosporidiosis are mainly derived from outbreaks studies, in spite of the fact that the majority of human infection is sporadic. Our knowledge of the existence of multiple transmission routes, including consumption of water from private and public supplies, consumption of contaminated foods and drinks, contact with infected animals, person-to-person transmission in households and care settings, and exposure to recreational water in swimming pools or water parks, and travel to endemic countries were mostly derived from Outbreak investigations

[14]. Disease determinants are likely to differ for various species and in different geographical settings, due to differences in demographic, socioeconomic, environmental and behavioural variables. This underscores the importance of molecular typing in identifying species or genotype in epidemiologic studies. However, this has been possible only on a relatively few case–control studies in developing countries [15, 16].

Despite our knowledge of cryptosporidiosis transmission, often the exact mode of transmission is difficult to establish. The importance of certain risk factors for acquiring infection remains unclear. For instance the extent to which socio–economic, behavioural and environmental factors contribute to the transmission of this disease is not sufficiently established. In an effort to fill this gap the influence of these factors on the spread of the disease in two communities in North -western Nigeria were examined From January to December, 2012.

2. Materials and Methods

Zuru is located in the south Eastern part of Kebbi state, between longitude 11°24′09′′ N and latitude 5°15′07′ E. It is about two and half hours drive from BirninKebbi, the state capital. It has an estimated population of about 165,547 thousand people living in the local government area [17]. Aliero on the other hand is located in the extreme northwestern part, between latitude 12°19′06′′N and 4°30′10′′E. Based on the 2006 national census, Aliero has a population of about 123,785 people [18]. The two communities feature low socioeconomic status and poor environmental sanitation. Adequate water supply, sewage, and waste disposal systems are lacking. Garbage is burned or thrown away near houses and can be found deposited on several places. Zuru land supports the savannah kind of vegetation with pockets of woodland vegetation along the river basins. Grains, tubers, legumes, fruits are grown in the area. WhileAliero is flat and slightly undulating with compact stony and brown soil, and has northern guinea savannah vegetation. The leading economic activity in both communities is mainly agriculture. The inhabitants therefore are mostly farmers, animal rearers, blacksmiths, traders and some are civil servants. The people of Aliero are predominantly Hausa/ Fulani, but Zuru people are Dakarkari by ethnicity.

3. Study Design

3.1. Human Populations

Participantswere randomly sampled for this study from volunteered families in the two communities identified with the highest prevalence during an earlier pilot study. Ethical approval was given by the Kebbi State ministry of health Birnin-kebbi. Informed verbal consent was obtained from all family heads, adults and parents of children before participating in the study. Samples were collected and screened for the presence of *Cryptosporidium* Oocysts.

3.2. Administration of Questionnaires

Pre-tested structured questionnaires were administered both in English and Hausa languages (as preferred by the interviewee) to all members of volunteered families.

Data such as demographic, socio-economic, Knowledge, attitudes and practices relating to Cryptosporidiosis infection, e.g. Sex, age, educational level, average monthly income, regular handling of animals and their wastes around the house, sources of water supply, toilet systems, waste disposal methods, disease perception etc., were taken.

3.3. Stool Collection and Processing

Stool samples were collected from house to house using clean, grease-free, tightly capped, and labeled sterile stool plastic bottles. The field workers visited each home and a single fresh stool sample was collected from each consenting family member. Samples were then transported to the biology laboratory of Kebbi State University of Science and Technology, Aliero or the medical laboratory of the Martha Bamayi General Hospital, Zuru depending on the collection site, for immediate processing within 24 hours.

In the laboratory, stool samples were concentrated by formal-ether technic. Briefly using an applicator stick, about 1g of stool sample was placed in a clean 15 ml conical centrifuge tube containing 7 ml formalin. The sample was suspended and mixed thoroughly with applicator stick. The resulting suspension was filtered through a sieve (cotton gauze) into a beaker and the filtrate was poured back into the same tube. The debris trapped on the sieve was discarded. To this mixture, 3 ml of diethyl ether is added and hand shaken; the content is centrifuged at 2000 rpm for 3 minutes. The supernatant was poured away, living only the fine sediment at the bottom of the tube [19]. This was then used to prepare slides for the detection of *Cryptosporidium* Oocysts.

3.4. Modified Ziehl-Neelsen Acid Fast Technique

One to two drops of the sediment was smeared on the slide and air dried. This was fixed with absolute methanol for 1 minute. The slide was flooded with carbolfuchsin for 15 minutes and rinsed thoroughly with water and decolorized with 1% alcohol for 2 minutes after which it was rinsed with water. The smear was then counter stained with malachite green or methylene blue for 1minute and rinsed with water. This was finally air dried and examined under the microscope using the 40x objective. To achieve better view 10x objectives using oil immersion were used. Where present, *Cryptosporidium* oocysts are round and stain red [20].

3.5. Statistical Analysis

Statistical analysis was performed using the version 15 Statistical package for Social Sciences (SPSS Inc, Chicago, IL) on windows 10. Chi square test was used to compare prevalence by age and gender and to confirm possible association between infection and other exposure variables. Multivariate logistic-regression analyses were carried out to determine independent risk factors associated with infection in the study areas. Associations were considered significant at P ≤ 0.05.

4. Results

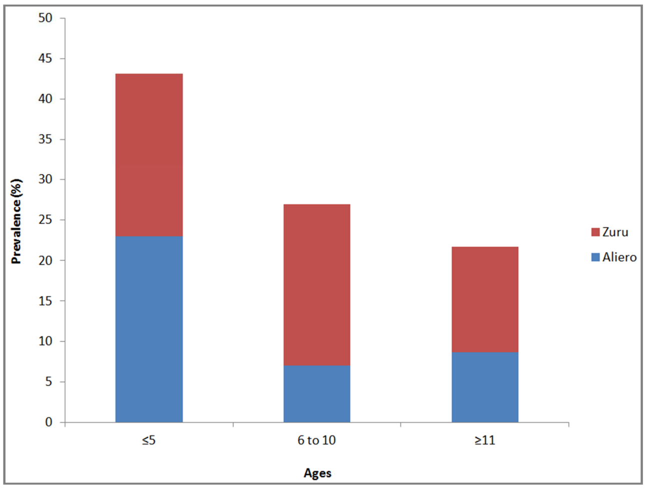

Figure 1. *Prevalence of Cryptosporidium infection stratified by age and study communities in Kebbi state.*

Table 1. *Prevalence of Cryptosporidium infection stratified by demographic factors of inhabitants in study areas.*

Variable	Infection			χ^2	P-value
	Number examined	Number infected	Percent age (%)		
Age					
≤ 5	606	128	21.1	38.606	<0.0001
6-10	339	40	11.8		
≥ 14	1155	122	10.6		
Gender					
Male	1158	175	15.1	3.681	0.055
female	942	115	12.2		
Community					
Aliero	1095	123	11.2	12.763	<0.0001
Zuru	1005	167	16.6		
Marital status					
Single	1680	268	16.0	33.152	<0.0001
married	377	21	5.6		
divorced	29	0	0		
Widow/widower	14	1	7.1		
Religion					
Islam	1861	252	13.5	1.768	0.612
Christianity	226	37	16.4		
Others	13	1	7.7		
No of persons/household					
< 8	541	87	16.1	3.160	0.075
≥ 8	1559	203	13.0		

Table 2. *Prevalence of Cryptosporidium infection by socioeconomic factors in Aliero andZuru, Kebbi State.*

Factor	Infection			χ^2	P-value
	Number examined	Number infected	Percent age (%)		
Educational level					
Can read and write	643	78	12.1	2.195	0.138
Cannot read or write	1457	212	14.6		
Occupation					
Dependants	1057	180	17.0	19.481	0.001
Farming	496	57	11.5		
Trading	259	27	10.4		
Wage earner	230	21	9.1		
Others	58	5	8.6		
Household income					
<N7,500	572	59	10.3	19.207	<0.0001
≥ N7,500	303	30	9.9		
Does not know	168	21	12.5		
None	1057	180	17.0		
Type of house					
Cement bricks	539	69	12.8	8.649	0.034
Mud	1368	181	13.2		
Grass/Others	193	40	20.0		
House floor					
Tiled	194	28	14.4	5.778	0.056
Cement Concret	791	91	11.5		
Uncemented	1115	171	15.3		
Source of light					
Electricity	1333	170	12.8	5.944	0.114
Bush lamp	753	118	15.7		
Candle/others	14	2	14.3		

Table 3. *Prevalence of Cryptosporidium infection in Zuru and Aliero by environmental factors.*

Variable	Cryptosporidium infection			χ^2	P-value
	Number examined	Number infected	Percentage (%)		
Animals kept in house					
Cow	450	53	18.4	32.887	<0.0001
Sheep/Goat	767	81	10.6		
Cat	412	46	11.2		
Domestic fowls/pegion	362	72	19.9		
Pig/Others	109	8	7.3		
Toilet facilities					
Water closet	225	30	13.3	26.461	<0.0001
Pit latrine	1493	180	12.1		
Bush/others	382	80	20.9		
Source of water supply					
Public taps/Bore holes	1127	131	11.6	23.106	<0.0001
Well/stream	973	159	16.4		
Waste disposal method					
Usually burnt	138	13	9.4	156.73	<0.0001
Common site in the house	1185	124	10.5		
No specific site/others	777	153	19.7		
Children <6 years/household					
<6	1167	184	15.8	8.455	0.004
≥6	933	106	11.4		

Table 4. *Prevalence of Cryptosporidium infection in relation to behavioural and disease perception factors in Aliero and Zuru, Kebbi State.*

Variable	*Cryptosporidium* infection Number examined	Number infected	Percent age (%)	χ^2	P-value
Hand washing					
Regularly	630	47	7.5	206.7	<0.001
Ocassionally	1080	101	9.4		
Not at all	390	142	36.4		
Rate of abdominal illness					
Very commom	411	46	11.2	3.233	0.199
Common	1492	218	14.6		
Not common	197	171	13.2		
Last experience of abdominal illness					
Less than 1 month ago	1261	180	14.3	0.790	0.852
Between 2-3 months	712	92	12.9		
Several months	127	18	14.2		
Disease perception					
Infected through swimming	490	71	14.5	1.428	0.679
Consumption of contaminated water/food	270	37	13.7		
Transmitted from animals	73	8	11.0		
Caused by evil spirits	123	20	16.3		
Don't know	1144	154	13.5		
Diarrhoeal status					
With diarrhoea	328	64	19.5	10.62	<0.001
Without diarrhoea	1772	226	12.8		
Total	2100	290	13.8		

Table 5. *Logistic regression analysis of factors associated with Cryptosporidium infection in Aliero and Zuru, Kebbi State.*

Community	Factor	Odds Ratio	P-value	95% CI
Aliero	Age	1.889	<0.0001	1.568 - 2.274
	Hands washing	0.399	<0.0001	0.283 - 0.535
	Diarrhoea Status	2.666	<0.0001	1.733 - 4.100
Zuru	Age	1.284	0.004	1.085 - 1.520
	Marital status	2.463	0.028	1.100 - 5.513
	Educational level	2.993	<0.0001	1.872 - 4.786
	Farming Occupation	1.392	0.002	1.135 - 1.703

A total of 2,100 of study population (1158 males and 942 females) submitted stools for laboratory investigation. Ages of participants' ranged from 1to 65years, with a mean (S.D) 11.5(10.3) and a median age of 6 years.

The overall prevalence of *the* infection was 13.8% (290/ 2100). Table1 shows the pattern of infection in relation to demographic variables. Distribution was age-dependent with significantly higher prevalence among younger subjects (21.1%) than the olds (10.6%). Gender wise, prevalence was higher among males (15.1%) than females (12.2%) but the effect was not significant. With respect to location, infection was significantly related to the community in question. Peak prevalence was recorded in Zuru (16.6%) than Aliero (11.2%). Prevalence was significantly higher among the singles (16.0%) than married participants (5.6%). Distribution of prevalence with respect to individual's religious affiliation ranged between 7.7% - 16.4% and was not significant. While none was recorded among divorcees. Crowding in homes shows no significant effect among subjects. In this case prevalence was higher among less crowded homes (16.1) than the crowded (13.0%).

The effect of socioeconomic variables on the prevalence of *Cryptosporidium* in subjects is presented in table 2. Level of education showed no significant influence (p=0.138) on prevalence despite higher infection rate among illiterates (14.6%,) than in those who had formal education (12.1%). A noticeable disparity was observed among various occupations, where prevalence varied from 8.6% - 17.0%. Family income played significant role in determining prevalence among various income categories. Persons from households with no certain income had higher prevalence (17.0%) than those who had some form of livelihood (9.9% - 12.5%). In terms of infection with respect to type of house, prevalence varied significantly higher among grass house owners (20.0%) and lower among owners of houses made of cement bricks (12.8). However, owners of bush lamp (as source of light) had a higher rate of infection (15.7%) than those who had electricity supply (12.9%), but the distribution was not different.

Table 3 depicts the association of environmental factors with infection. Of the reported ownership of domesticated animals, prevalence was common among those who kept domestic birds (19.9%, P<0.0001)) than other animals (5.3% - 18.4%). Dissimilarity was observed in the distribution of infection with respect to types of toilet facilities used by participants. Infection was significantly higher among those who defecated in nearby bushes (20.9%, <0.0001) than those who owned a private pit latrine or water closet. Variation in prevalence occurred with respect to Source of water supply. Consumption or use of water from wells/streams predisposed subjects to significantly higher levels of infection than those who have their supplies from Boreholes/taps (16.4%, 11.6%, <0.0001 respectively). Waste disposal methods used by participants affected distribution. Infection was significantly lower among those coming from homes where refuse is incinerated (9.4%, <0.0001) and higher in those who simply dumped them at some common place (10.5%) or at no specific place (19.7%) in their homes. Presence of young children in home was observed to be significant factor. Families with young children <6 years of age had significantly higher rates than those with older children (15.8%, 11.4%, P=0.004 respectively).

Prevalence in relation to behaviour and disease perception is shown in table 4. Hand washing before eating was significantly associated with infection (p <0.001). The highest prevalence occurred among subjects who never practiced hand washing before eating (36.4%) than in those who washed their hands regularly before eating (7.4%).

Although the reported experiences of abdominal discomforts were common among subjects (14.6%), this showed no association with *Cryptosporidium* infections (p=0.199). More than half of subjects (54.5%) had no idea of how the infection is transmitted or acquired. Among the subjects 123(5.8%) persons believed that cryptosporidiosis is caused by evil spirits and interestingly the highest prevalence (16.3%) was recorded among this group. Presence of diarrhoea featured as an important factor for occurrence of the parasite (19.5%, p = <0.001) than absence of it in subjects (12.8%).

The results of multiple regression analysis showed that several independent factors for Cryptosporidiosis are involved. Results for Aliero and Zuru are summarized in table 5. In Aliero, infection was age dependent. Presence of Young children had almost 2 times increased risk of infection than older persons (OR=1.889, P <0.0001, CI= 1.568 – 2.274). Regular hands washing before eating by residents was significantly protective than occasional or no hands washing at all (OR=0.399, P<0.0001, 0.283 – 0.535). Presence of diarrhoea was about 3 times more likely to determine an infection than its absence (OR=2.66, P< 0.0001, CI= 1.733 – 4.100) (table 5). While in Zuru, four factors were significantly predictive. Younger age increased the risks of infection (OR=1.284, P= 0.004, CI= 1.085 – 1.520), married persons were more than twice at risk of infection than the unmarried (OR=2.463, P=0.028, CI= 1.100 – 5.513), A lack of formal education heightened risks by 3times than being educated (OR= 2.993, P<0.0001, CI= 1.872 – 4.786), farming occupation had increased risks of infection than other trades (OR=1.392, CI= 1.135 -1.703).

5. Discussion

The data in this study provides evidence of the link between certain socio-environmental factors and cryptosporidiosis in North- western Nigeria. Prevalence of infection in this study is relatively high (13.8%) compared to similar studies reported from Nigeria and other tropical countries. In North-western Nigeria, [21] reported a prevalence of 1.9% among patients aged 2 months to 70-years-old, while [22] reported a prevalence rate of 4.8% among malnourished children aged 0 – 5 years. In another report, *Cryptosporidium* Oocysts were not detected in stools of 189 HIV –infected and uninfected patients [23] and 52 malnourished HIV –infected children [24].

In contrast, higher prevalence rates of 17 – 52.7% were reported in other studies from Nigeria [25, 16]. In other tropical countries, prevalence ranges from 0.1 – 32.5% [26] and the reported prevalence in children from Uganda, Kenya and Brazil was 72.7%, 4% and 31.3% respectively.

In the present study, significant difference in prevalence is observed between the two communities (P<0.0001). Subjects in Zuru had a higher infection rate (16.6%) than their counterparts in Aliero (11.2%). This is attributable to possible differences in community practices relating to infection and levels of environmental contamination ([27]. According to Zaidah *et al*. disparity in distribution may be linked to population characteristics, geographic location, and detection methods. In addition, it is also opined that prevalence may vary due to differences in infection sources and other risks of infection [25].

Prevalence was intimately associated with age. Young children were almost 2 times at risk of infection than older persons >5years of age in both communities. Similar trends have been reported in Nigeria and other countries in Africa [16, 21, 23 - 25, 28 - 34] This outcome, may also infer that infection due to presence of children is evidence of possible person-to-person (anthropogenic) transmission. This observation is similar to that of [21] in which younger age was significantly associated with *Cryptosporidium* infection.

The difference in infection between male and female gender was at a border line significance (P = 0.055). But a number of reports indicate that the infection may not always have a positive association with gender since in many communities both gender are equally exposed to similar risks of infection. Both sexes engage in same recreational activities and so are likely to be equally exposed to any environmental contamination. For example, [35] did not find any marked difference in infection between both sexes among Cuban children. In previous studies in Cuba and South Africa, [37] respectively had reported that gender did not present any differences in infection for *Cryptosporidium*. This pattern has also been confirmed in a study in Ethiopia, that cryptosporidiosis has no association with a particular sex group [38].

In this study hand washing before eating was significantly protective. Residents who washed hands regularly before eating were less likely to be infected than those who only washed occasionally or do not wash at all. It is immensely important that health care providers should at least educate and emphasize the importance of hand washing among residents. Increased handinfections and illnesses, in addition to diarrhoeal disease, could be prevented. Hand washing is an economical method of primary prevention. Additional studies are needed to evaluate the durability of this behavioural change in hand washing and the prevention of diarrhoeal illness and other illnesses in developing regions of the world. Of the study subjects, 390(18.6%) alluded that they ate with unwashed hands. More than half 1080(51.4%) admitted that they only washed hands occasionally before eating. It is imperative to state here that, while access to improved facilities and sanitation are key factors to reduction in parasitic burden, the behaviour and education of the people is an important factor. For instance [39] showed that improved water supply and sanitation without proper education and betterment of living standards does not always lead to a reduction in transmission levels of enteric parasitic diseases.

Our findings also showed an intimate association between patterns of infection and access to good water supply and sanitation. Access to boreholes/taps resulted in lower infection rate (% 11.6) than other less safe sources of water (River/streams) supply (16.4). The association of water sources to *Cryptosporidium* infection as observed in this study is comparable to that of [40], but contrasts with the findings of [34,41] in which water was shown to possess no significant relationship to this infection. Though the outcome of this study may be explained by the varying degrees of environmental contamination associated with the various facilities for water supply and sanitation, it is also possible that socio-economic characteristics of residents will play vital roles in explaining the observed trends.

The keeping of pets and rearing of domestic animals at home is a common practice in northern Nigeria. There are reports worldwide on associated risk of *Cryptosporidium* infections in people who keep domestic animals at home [42, 43, 44]. In this study, virtually all participants kept one type of animal or the other or at least lived with neighbors who kept animals at home. Perhaps, owners of pets or domestic animals may not have observed good hygiene or sanitation in their homes to prevent infection. A better assessment however should have been a comparison of genotypes detected from the stools of children with genotypes also detected from the stools of domestic animals. Usually these animals defecate on the compound soil, and sometimes dry up on the soil to contaminate the environment, which also serve as playing grounds for children. Cryptosporidiosis being a zoonotic infection, it is suspected that some level of infections of the parasites could come from infected animals kept at home. Reports from other studies indicate, on the contrary that, having one or more pets or domestic animals at home was not a risk factor for acquiring *Cryptosporidium* infections [36, 45].

Furthermore, there was correlation of educational background with infection rates. Illiterates were almost three times prone to infection than those who can read and write. The observations made are possible despite the influence of other factors such as type of occupation of residents. It is often upheld by many that the well-educated are likely to practice personal hygiene better than those who have only low level of education or are illiterate. Since level of sanitation and hygiene both affect transmission of this parasite, it is expected that the rate of infection among illiterates will be higher when compared to those with good education.

Similarly, presence of a toilet facility was protective compared to open defecation in nearby bushes. The highest prevalence of infection (22.3%) was recorded among subjects who deficated in the open bush. Comparable patterns have also been observed by earlier studies [46, 47].

Contamination of the environment has a strong relationship with enteric parasitic infections [39]. The effect is that where human or animal excreta are indiscriminately thrown around, fecal-borne pathogens will litter the environment thereby increasing the risks of infection [48]. The outcome of this study reveals a significant association ($P< 0.001$) of waste disposal method to infection. The practice of indiscriminate littering (rather than incinerating) of wastes in households tended towards an increase of infection than it was in other forms of waste disposal.

Socioeconomic inequalities has been linked to a wide range of health outcomes, including premature mortality, cardiovascular disease, and self-reported ill health (Lawlor and Sterne, 2007)49.The interaction of infection with socioeconomic characteristics as observed in this study associates the level of household income to a significant relationship with infection ($P= 0.028$). Prevalence was higher among the average to low income class, than it was among the higher income earners. This study and others support the conclusion that low socioeconomic status is closely related to enteric parasite infections [50-54]

Some occupational practices have been associated with enteric parasitic infections [55]. Subjects from farming families at Zuru were significantly at risk for infection compared to other occupations tested in this study. Zoonotic exposures and other agricultural practices in some regions are key factors for transmission.The use and recycling of wastes, household sewage, human and animal excreta in agriculture and aquaculture has a long history in many counturies [56-60]. The reuse of excreta and wastewater for crops and fish ponds may provide many positive benefits, such as cheap fertilizer, reliable source of nutrition and water, reduce commercial fertilizers, improve soil-structure and increase productivity [61–65]. However, transmission of enteric pathogens is a fundamental public health issue associated to these practices. In developing countries, excreta-related diseases are very common, and faecal sludge and wastewater contain high concentrations of excreted pathogens such as viruses, bacteria, protozoa cysts, and helminthes eggs that may cause gastrointestinal infections in humans. The pathogens most commonly found in the waste water include faecal protozoa (*Cyclosporacayetanensis*, *Cryptosporidium parvum*, *Entamoeba histolytica*, and *Giardia intestinalis*), soil-transmitted helminths (*Ascaris* spp., *Trichuris*spp., and hookworm) and other microbes [55].

It is so alarming to observe that despite the wide spread occurrence of this infection in the areas, more than half of the subjects i.e. 1144 (54.5%) had no idea how *Cryptosporidium* infection is transmitted. About 6% believed that the infection is caused by evil spirits. Such ignorance/superstition is a common feature in most parasite endemic communities. And should call for concerted efforts by relevant stake holders to combat this, through basic health education and enlightenment campaigns.

6. Conclusion

In conclusion, the presence of Cryptosporidiosis in the two communities is associated to a significant extent with a few important variables of human behaviour, certain environmental and socio-demographic factors. Sustainable intervention measures should be implemented to reduce the burden of this neglected disease, part of which should include health education, improved access to clean water and adequate sanitation. More studies are needed in this and other settings with similar epidemiological features to further evaluate these factors.

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