



Prevalence of *Cryptosporidium* Infection among Inhabitants of 2 Rural Areas in White Nile State, Sudan

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Abstract: *Cryptosporidium*, a protozoan parasite that causes watery diarrhea, is found worldwide and is common in areas with low water hygiene. In February 2014, 866 stool samples were collected from the inhabitants of 2 rural areas in White Nile State, Sudan. These stool samples were assessed by performing modified acid-fast staining, followed by examination under a light microscope. The overall positive rate of *Cryptosporidium* oocysts was 13.3%. *Cryptosporidium* oocysts were detected in 8.6% stool samples obtained from inhabitants living in the area having water purification systems and in 14.6% stool samples obtained from inhabitants living in the area not having water purification systems. No significant difference was observed in the prevalence of *Cryptosporidium* infection between men and women (14.7% and 14.1%, respectively). The positive rate of oocysts by age was the highest among inhabitants in their 60s (40.0%). These findings suggest that the use of water purification systems is important for preventing *Cryptosporidium* infection among inhabitants of these rural areas in Sudan.

Key words: *Cryptosporidium*, oocyst, prevalence, water purification, Sudan

Apicomplexan parasite *Cryptosporidium* is found worldwide. Although *Cryptosporidium* infection usually causes acute self-limiting diarrhea in immunocompetent individuals, it can also result in chronic and severely dehydrating diarrhea in immunodeficient individuals. In addition, *Cryptosporidium* infection is associated with childhood malnutrition and growth deficits [1]. In humans, this infection develops after the ingestion of food or drinking water contaminated with *Cryptosporidium* oocysts [2].

Sudan is situated in the Nile Valley of Northeast Africa. Epidemiological surveys have indicated that infections caused by *Schistosoma* spp., soil-transmitted helminths, *Plasmodium* spp., and food- and water-borne protozoa are endemic to Sudan [3-6]. However, limited information is available on the prevalence of cryptosporidiosis in Sudan. The present study investigated the prevalence of *Cryptosporidium* infection among the

inhabitants of White Nile State, which is located on the basin of the White Nile in Sudan.

In February 2014, 866 stool samples were collected from the inhabitants in 2 rural areas, Al Hidaib (186 samples) and Khour Ajwal (680 samples) (Fig. 1). Information on sex and age was available only for 776 of these 866 samples. Water purification systems were available in Al Hidaib but not in Khour Ajwal. Fecal samples obtained were directly smeared on slides and were transferred to the laboratory of Konkuk University, Seoul, Korea. The smears were stained using a modified acid-fast staining method [7] and were examined under a light microscope. Samples having red oocysts of 4-5 μ m in diameter were considered positive for *Cryptosporidium* infection. The results obtained were statistically analyzed using chi-square test, with $P < 0.05$ being considered statistically significant.

Of the 866 fecal samples, 115 (13.3%) showed the presence of *Cryptosporidium* oocysts. As shown in Table 1, the oocyst positive rate was higher in Khour Ajwal (14.6%) compared to that in Al Hidaib (8.6%) ($P = 0.034$). Overall, 14.7% (39/266) samples obtained from men and 14.1% (72/510) samples obtained from women had oocysts, indicating no significant difference in the prevalence of *Cryptosporidium* infection between

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men and women. The prevalence of *Cryptosporidium* infection was the highest among inhabitants in their 60s (40.0%) followed by 40s (25.0%), 30s (18.8%), 20s (16.9%), and under 10 (14.9%) (Table 2).

The results of the present study showed a strong correlation between the use of water purification systems and prevalence of *Cryptosporidium* infection. The oocyst positive rate of inhabitants in the area having water purification systems was lower than that in the area not having water purification systems. During the rainy season and the early dry season, inhabitants of areas not having water purification systems, as Khour Ajwal, obtained drinking water from different sources such as surface water, streams, and seepage. However, in the late dry season, these inhabitants obtained drinking water from the main stream of the White Nile.

Cryptosporidiosis is a waterborne as well as a zoonotic disease, with a broad host range. We observed that cattle, the main reservoir host of *Cryptosporidium*, were pastured in the areas surveyed in this study. Recent studies have shown that the

overall prevalence of cryptosporidiosis in cattle was 7.1-31.2% in the lower part of the Nile in Egypt, with *C. parvum* being responsible for 65.7-74.2% of these infections [8,9]. The surveyed areas are located on the basin of the White Nile, 1 of the 2 main tributaries of the Nile. Some Arab tribes usually bring their cattle into grazing areas near the shores of the White Nile.

Taken together, these findings suggest that *C. parvum* was the common *Cryptosporidium* species in the surveyed areas. Previous studies showed that surface water can be easily contaminated with *Cryptosporidium* oocysts at the end of the rainy season [10,11]. During the rainy season, heavy rainfall helps the spread of *Cryptosporidium* oocysts from cattle feces, leading to contamination of drinking water. Therefore, use of water purification systems and prohibition of grazing cattle near the shores of the White Nile are important for preventing *Cryptosporidium* infection.

In the present study, gender was not a risk factor for *Cryptosporidium* infection. This is consistent with the results of several studies performed in Ethiopia and the Philippines that did not report any gender-associated difference in the prevalence of *Cryptosporidium* infection [12,13]. This may be because of similar hygiene practices of the both sexes. The prevalence of cryptosporidiosis is high among young individuals with a weak immune system [1]. Our results showed that the prevalence of cryptosporidiosis was higher among children in Sudan than among children in surrounding countries such as Ethiopia and Egypt [12,14]. In our study, we also found that individuals aged 60-69 years showed the highest positive rate. This is consistent with the results of several studies that showed higher prevalence of *Cryptosporidium* infection in elder individuals



Fig. 1. Surveyed areas (●) in White Nile State, Sudan.

Table 1. Prevalence of *Cryptosporidium* infection among the inhabitants according to the surveyed areas

Area	No. examined	No. positive (%)	P-value
Al Hidaib	186	16 (8.6)	0.034
Khour Ajwal	680	99 (14.6)	
Total	866	115 (13.3)	

Table 2. Age-related prevalence of *Cryptosporidium* infection among the inhabitants of the surveyed areas

Age		0-9	10-19	20-29	30-39	40-49	50-59	60-69	> 70	Total	
Area	Al Hidaib	No. examined	37	64	19	11	7	6	1	1	146
	No. positive (%)	5 (13.5)	3 (4.7)	1 (5.3)	2 (18.2)	2 (28.6)	1 (16.7)	0 (0)	0 (0)	14 (9.6)	
Khour Ajwal	No. examined	312	116	52	74	45	23	4	4	630	
	No. positive (%)	47 (15.1)	12 (10.3)	11 (21.6)	14 (18.9)	11 (24.4)	0 (0)	2 (50.0)	0 (0)	97 (15.4)	
Total	No. examined	349	180	71	85	52	29	5	5	776	
	No. positive (%)	52 (14.9)	15 (8.3)	12 (16.9)	16 (18.8)	13 (25)	1 (3.5)	2 (40)	0 (0)	111 (14.3)	

[15,16]. A high prevalence of cryptosporidiosis is correlated with a close contact with cattle [12]. Therefore, elderly individuals who usually manage cattle, especially in rural areas, may have a high risk of exposure to *Cryptosporidium* oocysts [17].

In this study, the small numbers in the adult group in Al Hidaib is an obstacle for further analysis. The reason for this age-related pattern should be assessed in future studies by detecting *Cryptosporidium* oocysts in livestock, surface water, wells, reservoirs, and by assessing the immunological competence of inhabitants in the surveyed areas. Efficacious vaccines and drug treatments for cryptosporidiosis are not available to date [18]. Therefore, it is necessary to build more water purification systems and sanitation facilities to improve the access of inhabitants of these areas to clean drinking water for preventing *Cryptosporidium* infection.

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CONFLICT OF INTEREST

We have no conflict of interest related to this work.

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