

Research Article

Prevalence of Intestinal Coccidiosis and Other Associated Intestinal Parasitic Infections Among Children in Koranic Schools in Dakar

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Abstract

Intestinal coccidiosis has been on the rise since the emergence of HIV infection. It is responsible for severe diarrhoea associated with malnutrition in children and poses a serious threat to their lives. The lack of effective treatments means that coccidiosis remains a public health concern in Senegal. The aim of this study is to determine the prevalence of intestinal coccidiosis among children attending Koranic schools in the Dakar region. We conducted a cross-sectional study between January and May 2018. Koranic schools were selected using simple random sampling, and data on sociodemographic characteristics and factors associated with prevalence were collected. Stool samples were collected and processed accordingly. Statistical analysis was performed using STATA IC 12.1. A total of 497 participants were included. The mean age was 11.56 years, with a sex ratio of 8.94. The prevalence of *Cryptosporidium sp.* (the only species identified) was 2.10%. The other parasitic infections found were *Ascaris lumbricoides* and *Entamoeba coli*, at 28.97% and 28.03% respectively. *Giardia intestinalis* (9.34%). *Trichuris* (5.6%). The combinations *Ascaris lumbricoides* + *Entamoeba coli* (i), *Ascaris lumbricoides* + *Giardia intestinalis* (ii), *Ascaris lumbricoides* + *Trichuris* (iii), *Entamoeba coli* + *Giardia intestinalis* (iv), *Entamoeba coli* + *Trichuris* (v), accounting for 9.09%, 2.02%, 4.04%, 1.01% and 1.01% respectively. Intestinal parasitic infections have been found to be very common among children. Consequently, health education, improvements in learning and living conditions, and deworming treatment for these vulnerable children are essential. Testing for coccidia should be carried out systematically in cases of persistent diarrhoea and in malnourished children.

Keywords

Cryptosporidium spp., Helminths, Protozoa, Koranic Schools, Dakar

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1. Introduction

Cryptosporidiosis, caused by an intracellular protozoan of the genus *Cryptosporidium sp.*, has evolved from a rare and largely asymptomatic disease into a major cause of diarrhoea in animals and humans worldwide [1]. *Cryptosporidium hominis* and *Cryptosporidium parvum* are commonly associated with human infection. Ingestion of sporulated oocysts that are completely resistant to chlorine also triggers infection in humans. Following the ingestion of oocysts, the upper small intestine becomes the site of infection, where the parasite develops as the sporozoite penetrates the enterocyte and matures [2].

In sub-Saharan Africa, the scale of the AIDS pandemic and the often poor hygiene conditions make cryptosporidiosis a common parasitic infection, and it is estimated that between 1.3% and 22.2% of diarrhoeal diseases may be linked to this protozoan infection in developing countries [3].

In Senegal, studies conducted several years ago had shown a significant prevalence of 13.9% cryptosporidiosis, particularly among people living with HIV [4].

Cryptosporidium infection in children under 5 years was estimated to be associated with 44.8 million diarrheal episodes and 48,300 deaths globally [5]. Of these, the vast majority were from Africa, accounting for 75% of the diarrheal episodes and 88% of the deaths [5]. In particular, the burden of *Cryptosporidium*-associated diarrhea is greatest in Sub-Saharan Africa, especially Nigeria and the Democratic Republic of the Congo (DRC) where about 48% of the under-5 associated deaths occur [5].

However, it should be noted that the disease is under-reported because in most healthcare facilities with a laboratory, the modified Ziehl-Neelsen technique developed by Henriksen and Pohlenz, which is the gold standard in the country, is not available. Given the lack of epidemiological data, we decided to conduct this study, the aim of which was to assess the prevalence of cryptosporidiosis among children living in poor sanitary conditions whose serological status was unknown.

2. Patients and Methods

2.1. Study Area

This study was conducted in health districts located in the Dakar region, after identifying the Koranic schools of the district.

2.2. Study Design and Population

A cross-sectional study was conducted from January to October 2018 in selected Koranic schools and all children living in the said schools were included in this study. A simple random sampling method was performed prior to the inclusion of Koranic schools. Informed consent of legal representatives of children was required prior to the inclusion in the study.

2.3. Study Procedure

A code was given to every child after his/her legal representative's informed consent. All the children were examined by a physician prior to a biological assessment which included stool samples. The children were interviewed directly on the symptoms as well as sociodemographic characteristics using a standard questionnaire. Data obtained from physical examination and interviews of the legal representatives were entered on a case report form (CRF).

2.4. Biological Assessment

The children were given a clearly labelled, wide-mouth and screw-capped containers and were instructed to bring their early morning stool samples the next day. The collected samples were transported (within 5 hours of collection) in suitable cool boxes at temperature between 4 and 6° C for examination at the Department of Parasitology of the Faculty of Medicine, University of Dakar. Stool samples were examined macroscopically for colour, consistency, presence of blood, mucus, pus and large worms. A portion each of the stool samples was processed for direct examination using a modified Ritchie technique. For the *Cryptosporidium* spp fresh samples were collected and examined the same day by our experienced laboratory staff using modified Ziehl-Neelsen staining acid) to determine the presence of *Cryptosporidium* spp. and other pathogenic parasites.

2.5. Data Analysis

Our data were entered into Excel and analysed using STATA IC 12.1. Qualitative variables were described in terms of the number of cases and the percentage of responses; quantitative variables were described in terms of means and standard deviations. Comparisons of proportions were carried out using Pearson's chi-square test or Fisher's exact test, depending on the conditions of applicability. For quantitative variables, comparisons of means were carried out using Student's t-tests or an ANOVA test after verifying the conditions for their application. Where these conditions were not met, non-parametric tests (Mann-Whitney) were used. The significance thresholds for the statistical tests were set at 5%.

3. Results

3.1. Sociodemographic Characteristics of the Study Population

Our study included 497 participants. Their ages ranged from 0 to 23 years. With an average age of 11.56, the group consisted mainly of males, numbering 447 (90.94%), whilst females accounted for 10.06%. The sex ratio was 8.94. Children aged between 0 and 15 accounted for 86.12% of our study population, whilst those aged over 15 accounted for

13.88%.

55.53% of the children were from urban areas, accounting

for more than half of the study population. Children from sub-urban areas accounted for 44.47% of our sample.

Table 1. Characteristics of study participants.

Variable	Frequency (n=497)	Percentage (%)	95% IC
Age group			
0 - 15 ans	428	86,12	78,1-94,6
≥15 ans	69	13,88	10,8-17,5
Sex			
Female	50	10,0	7,5-13,2
Male	447	89,94	81,7-98,6
ZONE			
Urban	276	55,53	49,1-63,4
Peri-urban	221	44,47	38,7-50,7

3.2. Overall Prevalence of Coccidia Detected Using the Modified Ziehl-Neelsen Method

Of the 497 stool samples tested, 9 tested positive for *Cryptosporidium* sp. (the only species detected), representing a prevalence of 1.81%.

Table 2. Overall prevalence of coccidia detection using the modified Ziehl-Neelsen method.

Ziehl Neelsen	Staff numbers	Percentage (%)	IC 95%
Positif	9	1,81	0,8-3,4
Négatif	488	98,19	89,6-100

3.3. Prevalence of Coccidiosis Detected Using the Ziehl-Neelsen Method by Age Group

Table 3. Prevalence of coccidiosis detected using the Ziehl-Neelsen method by age group.

Age group	Staff numbers	Percentage (%)
1 à 15 ans (n =428)		
Positif	9	2,10
Négatif	419	97,90

Age group	Staff numbers	Percentage (%)
≥15 ans (n =69)		
Positif	0	0,00
Négatif	69	100

Cryptosporidium sp. was detected in 9 out of 428 children under the age of 15, representing a prevalence of 2.10% in this age group, which was the only one affected. No cases of coccidiosis were observed in children over the age of 15. There was no statistically significant difference in the distribution of coccidiosis by age ($p=0.224$).

3.4. Prevalence of Coccidiosis Using the Modified Ziehl-Neelsen Method, Based on Clinical Signs

The modified Ziehl-Neelsen method identified two cases of *Cryptosporidium* sp. among the 154 children who were underweight. Similarly, one case of *Cryptosporidium* sp. was observed among the 12 children who were overweight. Pruritus, 5 cases of *Cryptosporidium* sp and anaemia, 1 case of *Cryptosporidium* sp were observed in 171 and 80 children, respectively, who tested positive following modified Ziehl-Neelsen method. Furthermore, no cases of *Cryptosporidium* sp were observed in any of the 10 children complaining of abdominal pain.

Table 4. Prevalence of coccidiosis using the modified Ziehl-Neelsen method, based on clinical signs.

Clinical signs	Ziehl Neelsen Positif (n'/N')	Percentage (%)	P value
Anaemia			
Yes	1/80	1,25	0,664
No	8/407	1,97	
Itching			
Yes	5/169	2,99	0,159
No	4/330	1,21	
Abdominal pain			
Yes	0/10	0,00	0,664
No	9/487	1,85	
Underweight			
Yes	2/154	1,30	0,219
No	152/154	98,70	
Overweight			
Yes	1/12	8,33	0,219
No	11/12	91,67	

3.5. Overall Prevalence of Stool Testing and Parasitic Species

Of the 497 stool samples tested, 98 children representing 19.72% of the population were found to be carrying at least one parasite following direct stool examination.

In total, 98 parasitic infections were identified through direct stool examination, including 5 mixed infections: *Ascaris lumbricoides* + *Entamoeba coli* (i), *Ascaris lumbricoides* + *Giardia intestinalis* (ii), *Ascaris lumbricoides* + *Trichuris trichiura* (iii), *Entamoeba coli* + *Giardia intestinalis* (iv), *Entamoeba coli* + *Trichuris* (v), accounting for 9.09%, 2.02%, 4.04%, 1.0% and 1.01% respectively.

Table 5. Distribution of the identified parasitic species.

Parasitic species	Positive direct stool tests (N=497)	Percentage (%)
<i>Ascaris lumbricoïdes</i>	41	8,25
<i>Giardia intestinalis</i>	14	2,82
<i>Entamoeba coli</i>	34	6,84
<i>Trichocephale</i>	8	1,61
<i>Schistosoma mansoni</i>	1	0,20

4. Discussion

Cryptosporidiosis is a protozoan infection found worldwide that can cause diarrhoea or gastroenteritis, which can be severe and prolonged in vulnerable patients, whether they are immunocompromised individuals or young children. The risk of sporadic or epidemic transmission via water highlights the importance of cryptosporidiosis for public health.

The prevalence of intestinal coccidiosis is limited to that of *Cryptosporidium* sp. among children between January and July 2018 and is estimated at 1.81% (1.36% in suburban areas and 2.17% in urban areas) out of 497 stool samples examined.

Faye. et al., in a prospective, descriptive and analytical study conducted from July 2011 to September 2011 at the Albert Royer National Children's Hospital in Dakar and the Vélingara health district, involving children under 15 years of age regardless of serological status, reported a prevalence of *Cryptosporidium* spp. of 4.53%. The prevalence in rural areas was 2%, whilst the prevalence in hospitals was 7.4%, including 1.8% (1/57) in urban areas and 9.8% (12/122) in suburban areas [6].

Our results using ZNM staining showed a prevalence of 1.81%, which is lower than that recorded in Dakar in 2011 (4.53%). Furthermore, the prevalence of 1.8% in urban areas and 2% in rural areas in 2011 is almost identical to the Figures we obtained.

Previous studies conducted at the CHUN Fann Parasitology

Laboratory on the prevalence of cryptosporidiosis report higher rates.

In a retrospective study conducted between 1989 and 1991 at CHUN Fann, DIENG T. et al. found a rate higher than ours, at 13.25% [7].

This decline is likely linked to advances in the clinical management of these populations, as well as increased awareness and improvements in daily hygiene practices.

The fact that the rates remain virtually unchanged between the 2011 findings by Faye B. and our results supports this notion of a decline.

Coccidiosis accounts for 4–7% of sporadic cases of gastroenteritis in humans [8]. In Latin America, Asia and Africa, the number of human infections is estimated at between 200 and 500 millions each year [9].

The significant variations in these Figures are thought to be due to the influence of climate, season, age of individuals and hygiene conditions [8].

In 2004, FAYER reported the results of studies conducted in 40 countries on the detection of oocysts in faeces. This enabled the prevalence of human infection to be established in different parts of the world: 2.6% to 21.3% in Africa, 1.3% to 13.1% in Asia, and 3.2% to 31.5% in Latin America [10].

Prevalence studies using serum samples from individuals have been conducted; prevalence rates ranged from 25% to 91%, thus highlighting a higher level of exposure to infection than the faecal examination results would suggest. (Chalmers R. M. et al.) [11].

It should therefore be emphasised that the actual prevalence of coccidiosis is often underestimated. Indeed, the sensitivity of stool examination using the ZNM method may be inadequate for low oocyst loads [12].

In developed countries, 14% of people with AIDS who have diarrhoea are infected with *Cryptosporidium* spp. In contrast, the Figure is 24% in developing countries [9]. According to a study conducted in Europe, 3–4% of people with AIDS have cryptosporidiosis at the time of AIDS diagnosis, and the same proportion will develop cryptosporidiosis during the course of their illness. In developing countries, these Figures are significantly higher, at over 50%.

A cross-sectional study conducted by Adegbola RA. among Gambian children found *Cryptosporidium* sp. in 53 out of 600 children, or 9%. [13].

Adjei AA et al. reports prevalence rates of 27.8% and 15.6% among children in Ghana in a study conducted at the Department of Child Health, Korle-Bu Teaching Hospital, Accra, between October 2001 and June 2002 [14].

These other studies on cryptosporidiosis have shown very high prevalence rates compared with our findings on the frequency of coccidiosis by age. This disease is therefore predominantly found in children, despite the statistically insignificant difference ($p=0.224\%$).

Analysis of the clinical observations in our cases revealed that the prevalence of pruritus (2.99%), followed by under-

weight (1.30%) and overweight (8.33%) – which are associated with malnutrition – were the predominant signs. Our results are consistent with data in the literature, which indicates that malnutrition is associated with the symptoms of cryptosporidiosis in children.

In the study conducted in Gabon, for example, 31.8% of undernourished children were infected with *Cryptosporidium* spp, compared with only 16.8% of adequately nourished children [15].

Similarly, two epidemiological studies on cryptosporidiosis in urban and suburban areas of Libreville, Gabon, in Equatorial Africa, were conducted among children by Duong et al., revealing infection rates of around 24% among malnourished children and during the rainy season [16, 17]. At the National Hospital of Niamey in Niger, Gay-Andrieu E. showed that 10 of the 12 children infected with *Cryptosporidium* spp. were malnourished, representing a prevalence of 83% [17, 18].

5. Conclusion

It has been found that intestinal parasitic infections are very common among children. Consequently, health education, improved learning and living conditions, and deworming treatments for these vulnerable children are essential. Coccidiosis causes severe diarrhoea, which, when combined with malnutrition in children, poses a serious threat to their lives. The lack of effective treatments means that coccidiosis remains a public health concern in Senegal. Screening for coccidia should be carried out systematically in cases of persistent diarrhoea and in children suffering from malnutrition.

Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
CRF	Case Report Form
DRC	Democratic Republic of the Congo
HIV	Human Immunodeficiency Virus
ZNM	Ziehl-Neelsen Method

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Author Contributions

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Data Availability Statement

All data generated or analysed during this study are included in this manuscript and are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no competing interest.

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