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Full Length Research paper

Cryptosporidiosis among children in relation to toilet facilities and water sources in Ijebu and Remo areas, southwestern Nigeria

[1*]Egberongbe, Haneefat O., [2]Agbolade, Olufemi M., [1]Adesetan, Titilayo O. [1]Mabekoje, Oladele O. and [1]Olugbode, Adebayo M

[1]Department of Microbiology, Olabisi Onabanjo University, P.M.B. 2002, Ago-Iwoye, ogun state, Nigeria
[2]Parasitology and Medical Entomology Laboratory, Department Of Plant Science and Applied Zoology, Olabisi Onabanjo University, P.M.B. 2002, Ago-Iwoye, Ogun State, Nigeria

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Cryptosporidium **is an important cause of diarrhoea in humans which causes significant morbidity and mortality in immunocompromised individuals, young children and old persons. We studied childhood cryptosporidiosis in relation to toilet types and water sources in Ijebu and Remo areas of Ogun State, Nigeria. Fresh faeces from 420 children aged 0-8 years attending three referral hospitals were examined using a modified Ziehl-Neelsen method between February and June 2009. The parent/guardian of each child was interviewed on toilet type and water source. Overall, 90 (21.4%) of the children were infected with *Cryptosporidium* species which was significantly more prevalent among those with diarrhoeic faeces ($P < 0.001$). The prevalences among males (25.0%) and females (16.7%) were statistically similar ($P > 0.05$), but 3-5 years age group were most infected (36.2%). The infection was commonest among children from households using nearby bush as toilet (46.3%), and those using stream/pond as water source (47.6%). The study showed that childhood cryptosporidiosis is common among children in close relation with lack of sanitation and potable water in Ijebu and Remo areas of Ogun State, Nigeria. There is need to enforce existing laws on provision of functional household toilets and environmental sanitation.**

Keywords: Cryptosporidium, children, toilet facility, water source, Nigeria.

INTRODUCTION

Cryptosporidium, a coccidian protozoan parasite, is an important causative agent of human and animal gastrointestinal illness globally. The parasite causes severe but often self-limiting diarrhoea in immunocompetent humans, but can cause significant morbidity and mortality in immunocompromised individuals (such as HIV/AIDS patients), very young children and old persons (Heyneman, 2004). Transmission is through faecal-oral route, following direct or indirect contact with *Cryptosporidium* oocysts via person-to-person, animal-to-person, water-borne, food-borne or air-borne contact (Leav *et al*., 2003; Huang *et al*., 2004; Caccio, 2005; Mor and Tzipori, 2008). Molecular studies have revealed that there are two main species, *C. hominis* and *C. parvum*, infecting humans of which *C. parvum* is more ubiquitous (Xiao and Ryan, 2004).

The increasing public health importance of *Cryptosporidium* has made the infection to be in the limelight of scientific investigations world over. Several recent reports on the epidemiology and outbreaks of cryptosporidiosis in humans abound in literature from other parts of Africa and elsewhere (Endeshaw *et al*., 2004; Jones *et al*., 2006; Chalmers *et al*., 2009; Huh *et al*., 2009; Ponka *et al*., 2009). In Nigeria, human cryptosporidiosis has been earlier reported from the northern (Kwaga *et al*., 1988), central (Banwat *et al*., 2003; Udeh *et al*., 2008), eastern (Okafor and Okunji, 1994, 1996) and western (Reinthaler *et al*., 1987; Nwabuisi, 2001) parts.

To the best of our knowledge, none of the cryptosporidiosis studies from Nigeria assessed the possible relationship between the disease, and toilet

*Corresponding author E-mail: bimpeegbe@yahoo.com; Tel: +2348054576094

Table 1: Prevalence of *Cryptosporidium* species in relation to age and gender of children in southwestern Nigeria

Age group (years)	Males		Females		Total	
	No. examined	No. (%) positive	No. examined	No. (%) positive	No. examined	No. (%) positive
0-2	80	17 (21.3%)	60	10 (16.7%)	140	27 (19.3%)
3-5	60	25 (41.7%)	45	13 (28.9%)	105	38 (36.2%)
6-8	100	18 (18.0%)	75	7 (9.3%)	17	25 (14.3%)
Total	240	60 (25.0%)	180	30 (16.7%)	420	90 (21.4%)

Among genders $\chi^2 = 1.65$, df = 1, $P > 0.05$

facilities and sources of water. Yet the importance of sanitation and water supply in disease control cannot be overemphasized. In addition, the only previous report from Ogun State (Reinthaler *et al*., 1987) did not include Ijebu and Remo areas of the State, which are the parts covered in this study. Also in view of the widespread epidemics of HIV/AIDS in Nigeria, knowledge of the current status of cryptosporidiosis among children in Ijebu and Remo areas of Ogun State is desirable.

In view of the foregoing, this study aimed at elucidating the current status of *Cryptosporidium* infection among children in Ijebu and Remo areas of Ogun State, Nigeria. The relationship between the infection, and types of toilet facility and sources of water was also studied. We hope that the findings of this study will supply basic epidemiological data useful to health planners and workers in their bid to control cryptosporidiosis, particularly among children, in the study area.

MATERIALS AND METHODS

Study area and population

The study area consisted of Ijebu-Ode (in Ijebu area), Sagamu and Ilisan (in Remo area), Ogun State, southwestern Nigeria. It lies in the rainforest belt within latitudes 6^0 40´ and 7^0 00´ N, longitudes 3^0 32´ and 3^0 50´ E. The study population consisted of children aged 0-8 years attending the General Hospital (GH), Ijebu-Ode, the Olabisi Onabanjo University Teaching Hospital (OOUTH), Sagamu, and the Babcock University Teaching Hospital (BUTH), Ilisan. All are referral hospitals, GH and OOUTH are public government-owned while BUTH belongs to a private University (Babcock University).

Ethical issues

Before the study commenced, the authorities of the three referral hospitals were contacted for permission and ethical approval of the study. In addition, informed consents of the parents/guardians of the children included in the study were also duly obtained.

Interview, collection and examination of faecal samples

A total of 420 (240 males, 180 females) children with diarrhoeic or soft formed faeces were included in the study which occurred between February and June 2009. The number of children from GH, OOUTH and BUTH were 175, 140 and 105, respectively. All the children were out-patients with diarrhoeal complaints. The parent/guardian of each participating child was interviewed about type of toilet used at home and source of water for drinking, bathing and other domestic purposes.

A wide-mouthed specimen bottle was used to collect one fresh faecal sample from each child directly or indirectly through the nappy. The faecal samples were not concentrated prior to microscopic examination. A thin smear was made from each sample which was subsequently air-dried, fixed with methanol and stained using a modified cold Ziehl-Neelsen method as earlier described (Chessbrough, 1998). The stained smears were observed microscopically for oocysts of *Cryptosporidium* at x40 magnification and morphology confirmation was done using oil immersion objective.

Statistical analysis

The chi-square (χ^2) test was used to compare prevalences of *Cryptosporidium* infection among groups.

RESULTS

Sixty-two (14.8%) of the examined children had diarrhoeic faeces while 358 (85.2%) had soft formed faeces. The numbers of children positive for *Cryptosporidium* species infection according to hospitals were 40/175 (22.9%), 32/140 (22.9%) and 18/105 (17.1%) in GH, OOUTH, and BUTH, respectively, which were statistically similar ($\chi^2 = 1.07$, df = 2, $P > 0.05$). Overall, 90 (21.4%) of the children were infected with *Cryptosporidium* species. The prevalence of infection among children with diarrhoeic faeces (83.9%, 52/62) was significantly higher than the prevalence among those with soft formed faeces (10.6%, 38/358) ($\chi^2 = 56.86$, df = 1, $P < 0.001$).

The prevalence of *Cryptosporidium* species in relation to age and gender of the examined children is summarized in Table 1. The total prevalences among males (25.0%) and females (16.7%) were statistically similar ($\chi^2 = 1.65$, df = 1, $P > 0.05$). Among the age groups, 3-5 years had statistically highest *Cryptosporidium* species prevalence (36.2%) followed

Table 2. Prevalence of *Cryptosporidium* species among children in relation to type of toilet facility in southwestern Nigeria

Toilet facility	No. examined	No. (%) positive
Water closet	250	41 (16.4%)
Pit latrine	116	24 (20.7%)
Nearby bush	54	25 (46.3%)
Total	420	90 (21.4%)

$\chi^2 = 18.80$, df = 2, $P < 0.001$

Table 3. Prevalence of *Cryptosporidium* species among children in relation to source of water in southwestern Nigeria

Source of water	No. examined	No. (%) positive
Stream/pond	82	39 (47.6%)
Public piped-water	190	33 (17.4%)
Borehole	148	18 (12.2%)
Total	420	90 (21.4%)

$\chi^2 = 28.40$, df = 2, $P < 0.001$

sequentially by 0-2 years (19.3%) and 6-8 years (14.3%) ($\chi^2 = 11.32$, df = 2, $P < 0.01$).

The prevalence of *Cryptosporidium* species among the examined children in relation to types of toilet facility is shown in Table 2. 12.9% (54/420) of the children came from households using nearby bush as toilet among whom the infection was statistically most common (46.3%) followed by those from households using pit latrine (20.7%) and water closet (16.4%), respectively ($\chi^2 = 18.80$, df = 2, $P < 0.001$).

Table 3 shows the prevalence of *Cryptosporidium* species among the examined children in relation to sources of water supply. 19.5% (82/420) of the children were from households using stream/pond as their source of water among whom the infection was statistically most common (47.6%), followed by those from households using pipe-borne water (17.4%) and borehole (12.2%), respectively ($\chi^2 = 28.40$, df = 2, $P < 0.001$).

DISCUSSION

The presence of *Cryptosporidium* species in children in the study area corroborates an earlier opinion that cryptosporidiosis in an emerging infectious disease in many parts of sub-Saharan Africa, including Nigeria (Coker *et al*., 2000; Mor and Tzipori, 2008). The high prevalence of *Cryptosporidium* species infection in Ijebu and Remo areas of Ogun State in this study is worrisome but agreed with the prevalences recorded from some parts of Nigeria (Kwaga *et al*., 1988; Okafor and Okunji, 1996) and Ethiopia (Endeshaw *et al*., 2004). The recorded prevalence in this study is higher than those previously reported from the western (Reinthaler *et al*., 1987; Nwabuisi, 2001) and central (Banwat *et al*., 2003; Udeh *et al*., 2008) parts of Nigeria, and this may indicate that the infection is increasing in public health importance in the western parts of the country. This is not surprising because *Cryptosporidium* species is one of the important opportunistic parasitic infections in HIV/AIDS (Heyneman, 2004; Arora and Arora, 2009). The significance of the recorded high prevalence of *Cryptosporidium* species in this study is further showcased by the fact that some previous studies recorded absence of the infection in some parts of Nigeria (Oyerinde *et al*., 1989; Nwokediuko *et al*., 2002). However, the recorded prevalence in this study was lower than those reported by some workers from outside Nigeria (Tumwine *et al*., 2005; Chalmers *et al*., 2009; Ponka *et al*., 2009) where immunological and molecular (especially polymerase chain reaction – based) techniques were used. This suggests that some false negatives might have been recorded in the present study which is otherwise detectable with more sensitive diagnostic methods.

Cryptosporidiosis appeared more associated with diarrhoeic faeces in this study in agreement with some previous reports (Okafor and Okunji, 1996; Banwat *et al*., 2003). The *Cryptosporidium* species positive cases with soft formed faeces may be freshly-established cases or indication of partial immunity against the infection in such children (Chappell *et al*., 1999).

The similar prevalences of *Cryptosporidium* species among both genders in this study contradict some previous reports (Kwaga *et al*., 1988; Okafor and Okunji, 1994). However, the infection occurred most in children aged 3-5 years contrary to a report (Nwabuisi, 2001) in which 0-2 years aged children were most infected. The reason for this may be that many of the examined children in the 0-2 years age group were adequately breastfed.

The use of nearby bush as toilet by some households in the study area is an unwholesome practice which portrays indiscriminate defaecation and lack of adequate sanitation. The matter is worsened by the fact that most of the infections were recorded in children whose households were without functional toilet facilities. It is known that *Cryptosporidium* species is transmissible via person-to-person, air-borne and food-borne contact (Leav *et al*., 2003; Huang *et al*., 2004; Mor and Tzipori, 2008). Therefore, it is no exaggeration that such children are readily exposed to *Cryptosporidium* species infection and re-infection. In addition, the infected school-age children from such households constitute potential channels of infection to many of their 'innocent' school-mates. The occurrence of *Cryptosporidium* species infection in children from households using water closet and pit-latrine may be due to absence of or improper hand-washing after defaecating and/or before meals, and other unhygienic habits such as finger sucking, finger-nail nibbling and food-picking from the ground or floors which are innately associated with many children in the study area. A study has shown that many dump sites in the

study area are frequently contaminated with parasite-positive human faeces (Agbolade *et al*., 2009). This problem coupled with the common unhygienic habits of many food-handlers and vendors (Idowu and Rowland, 2006) show additional channels of infection with *Cryptosporidium* species and other related intestinal parasitic infections in the study area.

The practice of water fetching from streams and ponds for drinking and other domestic purposes is another source of concern in the study area. Unfortunately, almost half of the children from households using stream/pond water were positive for *Cryptosporidium* species infection. An unreported study by the second author and his colleagues showed that some streams and ponds in Ijebu area are heavily contaminated by faeces and other human-generated wastes and, therefore, are unsuitable for direct human use. The presence of *Cryptosporidium* species in those using public pipe-borne water may be supportive of the known fact that the oocysts of the parasite are resistant to most water purification methods including chlorination (Leav *et al*., 2003). Nevertheless, the possibility of the infection through some other means, as indicated above, including contact with faeces of suitable non-human hosts is further demonstrated by the fact that even some that used borehole water were not free from *Cryptosporidium* species infection. It has been repeatedly advocated that adequate improved sanitation, personal hygiene and provision of potable water are sine-qua-non for meaningful and sustainable control of many parasitic and other infectious diseases (WHO, 2002; Heyneman, 2004).

This study has shown that *Cryptosporidium* species infection is common among children in Ijebu and Remo areas of Ogun State, Nigeria. The infection appeared closely related to lack of adequate sanitation and potable water. There is a drastic need for education of parents and guardians in the study area on the relevance of personal hygiene, and enforcement of the existing health-related laws on provision of functional household toilets and adequate environmental sanitation.

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