Ubiquity of the water-borne pathogens, *Cryptosporidium* and *Giardia,* in KwaZulu-Natal populations

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Abstract

The prevalence of the diarrhoea disease caused by the water-borne pathogens *Cryptosporidium* and *Giardia* in KwaZulu-Natal, was determined from pathology laboratory data. *Cryptosporidium* and *Giardia* were found to be endemic in KwaZulu-Natal with laboratory-confirmed incidences ranging from 2.9 to 3.7% and 2.9 to 3.0% respectively of diarrhoea samples submitted for protozoan parasite analysis. Increases in the number of samples submitted for *Cryptosporidium* or *Giardia* analysis were independent of the actual incidence of either protozoan pathogen. Female and male patients tested for cryptosporidiosis had similar positive percentages while giardiasis was more prevalent in female patients. *Cryptosporidium* and *Giardia* prevalence in children under 5 years indicated that *Cryptosporidium* was most prevalent (39.3%) in the <1 year age group while *Giardia* was most prevalent in the 3 to 4 year age group (38.5%). A low percentage of *Cryptosporidium* and *Giardia* positive cases were recorded in symptomatic (4.5% and 5.3% respectively) and asymptomatic (2.4% and 0.8% respectively) HIV patients. The incidence of *Cryptosporidium* and *Giardia* did not appear to correlate (Pearson's correlation test) with climatic factors such as rainfall, season or year, possibly indicating that water-borne transmission is not the predominant route and other factors such as personal hygiene, potable water supply, sanitation and education probably have a more significant impact.

Introduction

Inadequate water supply and sanitation are largely responsible for more than 800 m. estimated cases of diarrhoeal disease and 4.5 m. associated deaths in developing countries every year (Esrey et al., 1990). In South Africa more than 7 m. people (approximately 17% of the population) do not have access to an adequate potable water supply (Dept. Water Affairs and Forestry, 1999) and nearly 21 m. (54%) lack basic sanitation (Dept. Water Affairs and Forestry, 1996) that further highlights the potential of infection by waterborne disease. At present updated figures for households with basic sanitation are not available, but tools are being developed to monitor and evaluate the implementation of sanitation (Crowder, 1999). Although there are many causes of diarrhoea, the enteric protozoa *Cryptosporidium parvum* and *Giardia lamblia* have been recognised as important causes of both outbreak-related and sporadic diarrhoea in humans (Casemore, 1990). Their major means of transmission is the faecal-oral route (person-to-person) while water and zoonotic transmission are also of importance and *Giardia* has been reported to be sexually transmitted (Phillips et al., 1981). Person-to-person transmission, particularly involving children and cross infection from patient-to-patient and between patients and staff in hospitals is common (Casemore et al., 1997). Zoonotic exposure occurs during farming of livestock particularly during the lambing and calving seasons, educational trips to farms and livestock markets and during backpacking excursions (Kreier and Baker, 1987; Casemore, 1990). Companion animals, particularly cats and dogs, have occasionally been implicated in human cryptosporidiosis (Casemore et al., 1997). Cryptosporidiosis and giardiasis have emerged as important causes of travelers' diarrhoea suggesting a common epidemiology involving contaminated water or food and poor hygiene practices (Fayer and Ungar, 1986; Casemore, 1990).

The survival of *Cryptosporidium* oocysts in animal and human faeces is highlighted by the fact that 60% of oocysts were non-viable after 176 d. Once in a receiving body of water (e.g. river) the die-off rate increases dramatically as the length of time *Cryptosporidium* oocysts or *Giardia* cysts survive in water is dependent on the temperature. After 176 d, 96% of oocysts stored in water in a laboratory flow-through system at room temperature were non-viable (Robertson et al., 1992). *Giardia* cysts have survived at least 77 d in water at less than 10°C whilst above 20°C, cyst viability decreased after 3 d storage (DeRegnier et al., 1989). However, high temperatures (above 45°C) render (oo)cysts in water non-infectious (DeRegnier et al., 1989; Fayer,1994). High-risk categories for infection by both protozoa include young children (< 5 years) and immuno-compromised patients (Current and Haynes, 1983). In South Africa 11 out of 110 children who were infected with cryptosporidiosis died, according to a study by Moodley et al. (1991a) and relatively high mortalities in patients with diarrhoea due to *Cryptosporidium* have also been reported by Smith and Van den Ende (1986) (22.6%) and Wittenberg et al. (1987) (23%). In economic terms, diarrhoeal disease in South Africa is estimated to cost R 3 375 m./a and in KwaZulu-Natal R 785 m./a (Pegram et al., 1998).

The occurrence of cryptosporidiosis and giardiasis is probably higher than recorded as only one in fourteen people with diarrhoea in South Africa seek formal treatment from a health practitioner, clinic or hospital every year, while approximately 43 000 South Africans have been estimated to die every year from diarrhoea (Pegram et al., 1998). Many symptomatic people do not seek medical treatment as they cannot get to a hospital or they visit traditional healers. Medical treatment is also not sought if the infection is mild or due to ignorance of the symptoms.

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A need to determine the prevalence of *Cryptosporidium* and *Giardia* in KwaZulu-Natal required a survey of hospital and private pathology laboratory recordings of their occurrence. Laboratory-based surveys are, however, subject to a variety of biases; ascertainment will inevitably vary according to specimen selection criteria (clinical and laboratory), diagnostic test method, availability of facilities and reporting systems (Casemore, 1991). This paper presents the number of cryptosporidiosis and giardiasis cases recorded from January 1996 to March 1998. Results were evaluated with regard to rainfall, race, gender and distribution of occurrence in children younger than five years of age. Results of the presence or absence of the protozoa in a group of HIV positive patients with and without diarrhoea, were evaluated and the percentage occurrence was calculated.

Methods

Source of data

The information used in this study was obtained from two government hospital pathology laboratories and a private pathology laboratory from January 1996 to March 1998. This represents 9.7% (3/31) of laboratories in KwaZulu-Natal that test for *Cryptosporidium* and 6.0% (3/50) of laboratories testing for *Giardia* (Haynes, 1998).

The study population varied with respect to race and income as the private pathology laboratory tests non-formed stools from patients of a higher income bracket and predominantly from the White and Indian population in the Durban and Pietermaritzburg metropolitan areas, while government hospitals test non-formed stools from patients of various race and socio-economic backgrounds within KwaZulu-Natal.

The test criteria required for the analysis of stools for *Cryptosporidium* and *Giardia* at Government hospital laboratories differed. The one laboratory tests all stools for *Cryptosporidium* while *Giardia* analyses are only performed on request from the doctor. The other government hospital laboratory tests all stools received from patients younger than two years of age or on request from the doctor for the presence of *Cryptosporidium* while *Giardia* testing is performed on all stools received. The private pathology laboratory analyses are performed for *Cryptosporidium* in

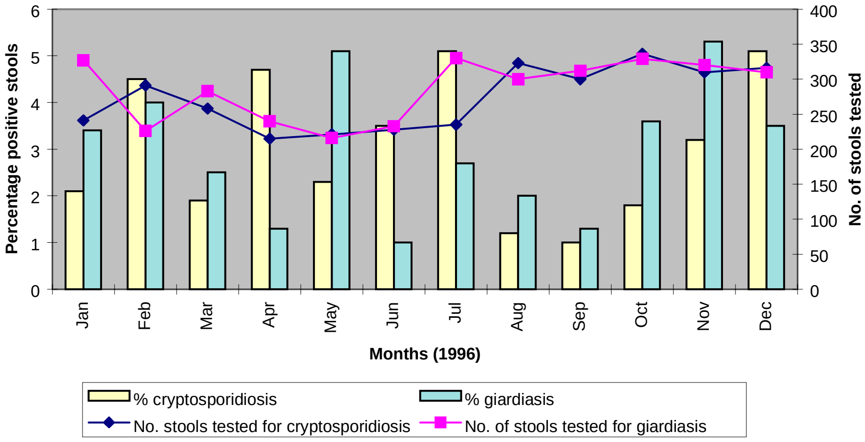

Figure 1
The percentage of Cryptosporidium *and* Giardia *positive cases recorded each month during 1996*

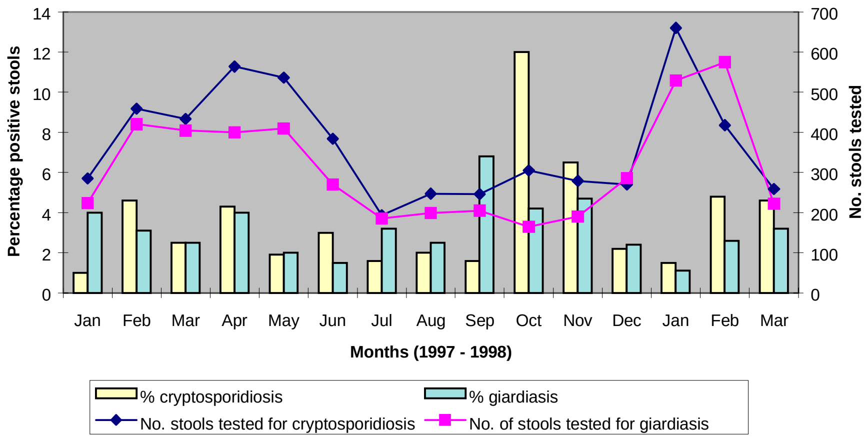

Figure 2
The percentage of Cryptosporidium *and* Giardia *positive cases recorded each month from January 1997 to March 1998*

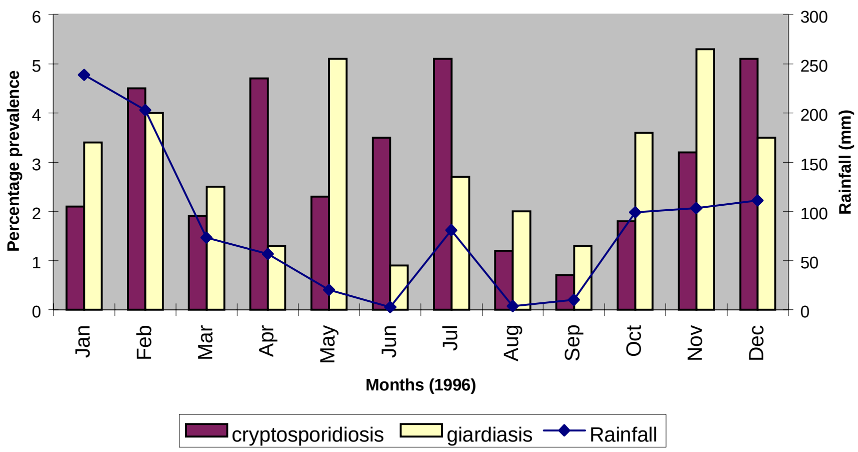

Figure 3
The percentage prevalence of cryptosporidiosis and giardiasis, in patients tested, with respect to rainfall during 1996

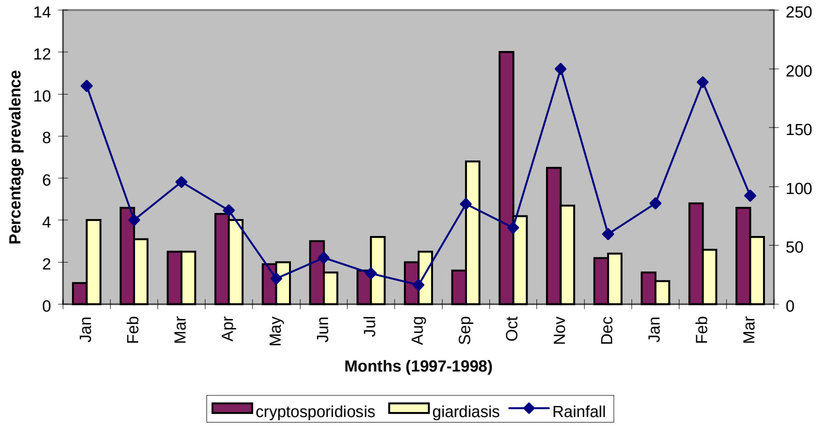

Figure 4
The prevalence of cryptosporidiosis and giardiasis, in diarrhoea patients tested, with respect to rainfall from January 1997 to March 1998

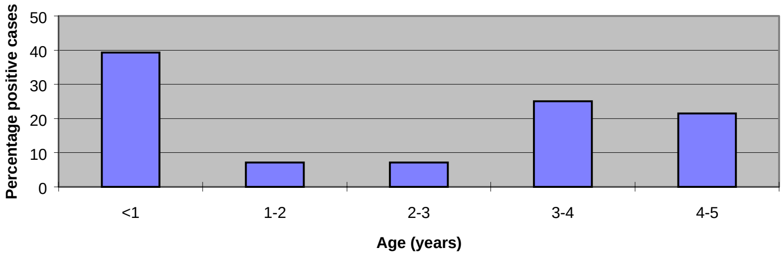

Figure 5
Distribution of cryptosporidiosis cases in diarrhoeic children under 5 years of age tested

non-formed stools of children younger than 5 years, or on request from the doctor while stools are only analysed for *Giardia* on request from a doctor or those tested for occult blood or reducing agents.

The government laboratories in this study either stain *Cryptosporidium* oocysts by the modified Ziehl-Neelsen technique (Henricksen and Pohlenz., 1981) or by Sheather's flotation (Moodley et al., 1991b) while the private pathology laboratory uses the phenol auramine O stain (Nichols and Thom, 1984). The cysts of *Giardia* are not stained but are detected using bright field microscopy (Wahlquist et al., 1991).

Data indicating positive and negative *Cryptosporidium* and *Giardia* results were used to determine the prevalence of the protozoa (Figs. 1 and 2).

Rainfall data

Rainfall data were compared with seasonal variation in the occurrence of *Cryptosporidium* and *Giardia*. The assumption was made that high runoff from faecally contaminated land or farm slurry can contaminate water sources resulting in the infection of those using the water further downstream.

Rainfall for each month from January 1996 to March 1998 was averaged from data collected at two points namely Durban Heights Waterworks, Durban (coastal) and Darvill Wastewater Works (a meteorological station), Pietermaritzburg (inland).

Statistical analysis

Pearson's correlation coefficient was used to examine possible relationships of the incidence of *Cryptosporidium* or *Giardia* with respect to rainfall, month and year, from results recorded by laboratories in the Pietermaritzburg (inland) and Durban (coastal) areas. The relationship between the prevalence of *Cryptosporidium* and *Giardia* was also examined.

Results

Occurrence

During 1996, 2.9% (96/3 274) of patients who were tested for cryptosporidiosis were tested positive while 3.0% (102/3 426) were tested positive for giardiasis (Fig. 1).

From January 1997 to March 1998, 3.7% (193/5 161) of stools analysed were tested positive for *Cryptosporidium* and 2.9% (135/4 683) were tested positive for *Giardia* (Fig. 2).

Rainfall

Cryptosporidium and *Giardia* occurred throughout 1996 and monthly prevalence varied between 0.7 to 5.1% and 0.9 to 5.3% respectively (Fig. 3). Prevalence of cryptosporidiosis infections was higher in February, April, July and December while giardiasis infection prevalence was high in February, May and November. The number of diarrhoeal samples analysed increased during January, August, September, October, November and December while high rainfall occurred in January, February, November and December.

Cryptosporidiosis prevalence was high during January, September, October and November of 1997 while giardiasis prevalence was higher during February, April, October and November. The prevalence of diarrhoeal samples submitted for analysis increased during February, March, April and May while rainfall increased in January, March, April and November. During 1998 *Cryptosporidium* and *Giardia* cases were more prevalent in February and March while diarrhoeal prevalence and rainfall also increased during these months.

Age

Of the cryptosporidiosis cases recorded for children < 5 years, the highest percentage (39.3%) (1100/2 800) occurred in the < 1 year age group (Fig. 5) with the fewest cases occurring in the 1 to 2 year and 2 to 3 year age group (200/2 800).

The race distribution of cryptosporidiosis cases varied with respect to age and gender (Table 1). Black male children had the highest incidence of *Cryptosporidium* in all age groups < 5 years, except the 1 to 2 year and 4 to 5 year age group. Black female children had the highest occurrence of cryptosporidiosis in all age groups except the 4 to 5 year age group. White male cases were predominant in the 1 to 2 year age group while Asian male children had the highest occurrence in the 4 to 5 year age group. An equal

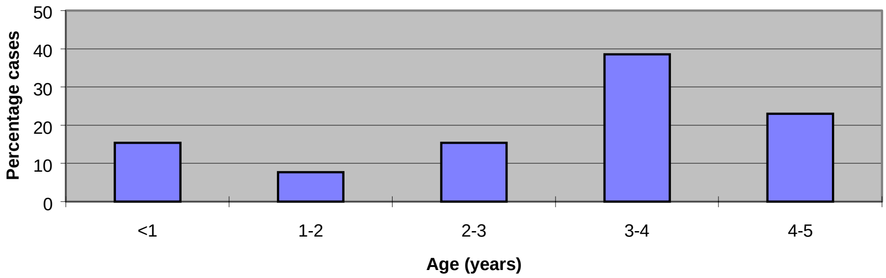

Figure 6
Distribution of giardiasis cases in diarrhoeic children under 5 years of age tested

TABLE 1
Distribution of Cryptosporidiosis cases within the < 5 year age groups

Age (years)	Percentage Cryptosporidiosis cases for each gender and race					
	Male			Female		
	Black	White	Asian	Black	White	Asian
< 1	45.8 (110/240)	20.8 (50/240)	33.3 (80/240)	75 (90/120)	16.7 (20/120)	8.3 (10/120)
1 to 2	26.1 (60/230)	52.2 (120/230)	21.7 (50/230)	56.7 (170/300)	10.0 (30/300)	33.3 (100/300)
2 to 3	100 (20/20)	N/d	N/d	50 (30/60)	33.3 (20/60)	16.7 (10/60)
3 to 4	50 (20/40)	25 (10/40)	25 (10/40)	66.7 (20/30)	N/d	33.3 (10/30)
4 to 5	N/d	33.3 (10/30)	66.6 (20/30)	50 (20/40)	50 (20/40)	N/d

N/d = no data recorded

TABLE 2
Percentage *Cryptosporidium* cases for each gender and age group

Age group (years)	Percentage male (%) (sample size)	Percentage female (%) (sample size)
<1	66.7 (240/360)	33.3 (120/360)
1 to 2	30.3 (230/760)	69.7 (530/760)
2 to 3	25.0 (20/80)	75.0 (60/80)
3 to 4	57.1 (40/70)	42.9 (30/70)
4 to 5	42.9 (30/70)	58.2 (40/70)

number of positive cases were present in Black female and White female children between 4 and 5 years of age (Table 1).

The proportion of males and females in each age group is shown in Table 2. Overall, 41.8% (560/1 340) of children under the age of 5 years who had cryptosporidiosis were male and 58.2% (780/1 340) were female.

The highest occurrence (38.5%) (500/1 300) of giardiasis cases was in the 3 to 4 year age group (Fig. 6) while the lowest number of cases occurred in the 1 to 2 year age group (100/1 300).

Within each age group, the distribution of giardiaisis cases differed with respect to race and gender (Table 3). The highest number of giardiasis cases occurred in Black male children between 4 and 5 years (100%) and Black female children < 1 year (100%), 3 to 4 year (83.3%) and 4 to 5 year age groups (100%). In the 1 to 2 year age group, White male children (75%) and Asian female children (55.6%) had the highest incidence of giardiasis (Table 4).

Of the giardiasis positive children < 5 years of age, 32.5% were male (130/400) and 67.5% were female (270/400). The proportion of males and females with giardiasis is shown in Table 4.

Overall, 32.5% (130/400) of children under the age of 5 years who had giardiasis were male and 67.5% (270/400) were female (Table 4).

TABLE 3
Distribution of giardiasis cases within the < 5 year age groups

Age (years)	Percentage giardiasis cases for each gender and race					
		Male			Female	
	Black	White	Asian	Black	White	Asian
< 1	50 (10/20)	N/d	50 (10/20)	100 (10/10)	N/d	N/d
1 to 2	12.5 (10/80)	75.0 (60/80)	12.5 (10/80)	11.1 (10/90)	33.3 (30/90)	55.6 (50/90)
2 to 3	N/d	N/d	N/d	50 (10/20)	50 (10/20)	N/d
3 to 4	50 (10/20)	50 (10/20)	N/d	83.3 (100/120)	8.3 (10/120)	8.3 (10/120)
4 to 5	100 (10/10)	N/d	N/d	100 (30/30)	N/d	N/d

N/d = no data recorded

Race group

The race group of only 64% of patients, tested by the pathology laboratories, for cryptosporidiosis was recorded (2 690/4 201), of which 93% were Black (2 502/2 690), 2.5% were Asian (67/2 690) and 5% were White (134/2 690). Of the 151 cryptosporidiosis positive cases, 75.5% were Black (114/151), 13.2% were Asian (20/151) and 11.3% were White (17/151). Within race groups, however, 4.6% of Black patients (114/2 502), 12.7% of White patients (17/134) and 29.9% of Asian patients (20/67) tested for cryptosporidiosis were positive.

The race group of only 56.8% of patients who were tested by the pathology laboratories for giardiasis were recorded (3 250/5 720), of which 80.8% were Black (2 626/3 250), 7.0% were Asian (227/3 250) and 12.2% were White (396/3 250). Of the *Giardia* positive patients, 80.9% were Black (76/107), 14.9% were White (14/107) and 4.3% were Asian (4/107). Within race groups 2.9% (76/2 626) of Black patients tested positive for giardiasis while 3.5% (14/396) of White patients tested positive and 1.8% (4/227) of Asian patients tested positive.

Gender

From data that recorded the gender of the patient, 47.7% (210/440) of females had cryptosporidiosis compared to 52.3% (230/440) of males while 63.6% (140/220) of female cases and 36.4% (80/220) of males tested positive for giardiasis. Each gender was further divided into age groups as shown in Tables 5 and 6.

Cryptosporidiosis cases were predominant in males in the 5 to 10 and 30 to 50 year age groups while female cases were highest in the 10 to 20 and 20 to 30 year age groups (Table 5). The highest number of giardiasis cases for males was recorded in the 30 to 50 year age group while female cases were predominant in the 5 to 10 and 10 to 20 year age groups (Table 6).

TABLE 4
Percentage *giardia* cases for each gender and age group

Age group	Percentage male (%)	Percentage female (%)
<1	66.7 (20/30)	33.3 (10/30)
1 to 2	47.1 (80/170)	52.9 (90/170)
2 to 3	N/d	100 (20/20)
3 to 4	14.3 (20/140)	85.7 (120/140)
4 to 5	25.0 (10/40)	75.0 (30/40)

N/d = no data recorded

HIV

Of the HIV patients who exhibited diarrhoea, 4.5% (6/133) were tested positive for cryptosporidiosis (symptomatic) while 2.4% (3/124) without diarrhoea had oocysts in their stools (asymptomatic). Seven of the 133 HIV patients with diarrhoea (5.3%) (symptomatic) had giardiasis while about 0.8% (1/124), without diarrhoea, were *Giardia* positive (asymptomatic).

TABLE 5
Distribution of cryptosporidiosis cases with respect to gender and age

Age (years)	Percentage cryptosporidiosis cases for each gender and age group	
	Male	Female
5 to10	100 (20/20)	N/d
10 to 20	N/d	100 (30/30)
20 to 30	44.4 (40/90)	55.6 (50/90)
30 to 50	75.0 (30/40)	25.0 (10/40)

N/d = no data recorded

TABLE 6
Distribution of giardiasis cases with respect to gender and age

Age (years)	Percentage giardiasis cases for each gender and age group	
	Male	Female
5 to10	42.9 (3/7)	57.1 (4/7)
10 to 20	25.0 (1/4)	75.0 (3/4)
20 to 30	N/d	N/d
30 to 50	83.3 (10/12)	16.7 (2/12)

N/d = no data recorded

Statistical analysis

The distribution of the data was tested and found to follow the Poisson distribution. The incidence of *Cryptosporidium* or *Giardia* was found to be not significantly related to climatic factors such as rainfall, month or year, despite the large sample size (8 435 from January 1996 to December 1996 and 8 109 from January 1997 to March 1998). *Cryptosporidium* and *Giardia* were also not significantly related ($p < 0.05$). This points, therefore, to some other factor(s), social or environmental, which are controlling the incidence of these diseases.

Discussion

Laboratory-based survey

The recording of data associated with *Cryptosporidium* and *Giardia* testing by most laboratories was found to be insufficient. Often only samples that tested positive were recorded. Only 20% of the data recorded made reference to race or gender or to the age of the patient.

The rates of stool positivity vary according to diagnostic techniques employed (Bogaerts et al., 1984; Crawford and Vermund., 1988) making it difficult to gain an accurate picture of incidence rates or of prevalence. However, the data do indicate the ubiquity of the parasite (Current, 1994). Reports of laboratory-confirmed *Cryptosporidium* incidence in developed countries generally yield figures of approximately 1-2% overall (Fayer and Ungar, 1986). *Cryptosporidium* rates are generally higher in developing countries (2.5 to >30%; mean 8.5%), especially in children younger than 2 years, where it may be symptomatic or asymptomatic (cited by Casemore et al., 1997). Similarly *Cryptosporidium* and *Giardia* results in KwaZulu-Natal were 2.9 to 3.7% and 2.9 to 3.0% respectively indicating that infection due to these protozoa is endemic.

Pathology laboratories should be encouraged to include *Cryptosporidium* diagnostic techniques with the routine diagnosis of stool specimens as 62% (31/50) of laboratories are unable to test for *Cryptosporidium*. There is a need for conformity in testing and a standard diagnostic test needs to be devised so that the results are comparable countrywide, a view shared by Moodley et al. (1991b). Recording of socio-economic data would also provide further information for use in investigating the causes or contributing factors affecting the prevalence of diseases.

The total number of diarrhoeal cases submitted for analysis to provincial hospital laboratories from January 1996 to March 1998, is not available. However, surveillance data have been collected from April 1998 to date (Taylor, 1999). From this data it can be estimated that a total of 15 828 cases are probably submitted for analysis each year. If all cases submitted were tested for *Cryptosporidium* and *Giardia*, in addition to bacterial analyses, there is the potential for 540 cryptosporidiosis cases and 461 giardiasis cases per annum in KwaZulu-Natal, based on the data collected from the three laboratories used in this study. However, the cases that are sent for analysis could be a small proportion of diarrhoeal prevalence in KwaZulu-Natal and the prevalence of *Cryptosporidium* and *Giardia* could be far greater.

Occurrence and rainfall

Cryptosporidium and *Giardia* occurred throughout each year and the monthly incidence varied between 0.7 to 6.8% and 0.7 to 11.8%, of diarrhoeal cases submitted for protozoan analysis, respectively (Figs. 3 and 4).

High numbers of *Cryptosporidium* and *Giardia* cases were generally recorded during the summer rainfall months of November, December, January, February and March each year, although the incidence of either disease did not correlate statistically with rainfall. *Giardia* was found to be more prevalent, although sporadic outbreaks of *Cryptosporidium* occurred every year. It is possible that contamination of rivers by stormwater runoff, containing faeces of infected humans and animals, resulted in the higher numbers of cryptosporidiosis and giardiasis cases during high rainfall months, if water transmission occurred. Moodley et al. (1991a) also found *Cryptosporidium* infections in children, admitted to a hospital in Durban, KwaZulu-Natal, to be more prevalent during high rainfall seasons.

Results from the analysis of diarrhoea samples indicated that cholera, salmonella, amoebic dysentery, *Shigella,* or enteropathic *E.coli* were often the cause of diarrhoea in samples testing negative for *Cryptosporidium* or *Giardia.*

Age

The difference in prevalence of the two diseases was dependent on the accurate recording of data that was often limited and therefore may not represent the actual occurrence within the age groups. Cases of cryptosporidiosis were found to be most prevalent in the < 1 year age group whereas Walters et al. (1988) found 100% positivity for cryptosporidiosis (8/8) in the <1 year age group attending a day-care centre in Durban. Surveys in the United Kingdom and in some developing countries have also found *Cryptosporidium* to be common in children <1 year (Casemore, 1990). High occurrence of cryptosporidiosis infection in children < 2 years of age is consistent with the findings of others such as Shahid et al. (1988) and Smith and Van den Ende (1986) who analysed samples from Bangladesh and Durban respectively.

This high occurrence of cryptosporidioisis may be attributed to malnourished babies with immunocompromised systems, unsterilised feeding bottles or faecal-oral transmission by care-givers who change the baby's nappies. Faecal-oral transmission by care-givers has been reported by others (Walters et al., 1988).

The high occurrence of *Giardia* in the 3 to 4 year age group could be as a result of faecal-oral transmission particularly at crèches where children play together in sand-pits and handle toys. In rural situations this infection may arise as a result of contact with animals. Contaminated water could also be a major source (Nimri and Batchoun, 1994).

Parents, care-givers, crèches and hospital personnel need to be well-informed of the risks of transmission in order to prevent the spread of infection.

Race

Although a larger portion of the Asian and White race groups tested positive for cryptosporidiosis and giardiasis compared to the Black patients, the sample size of the Black population was approximately ten times greater. It is possible that fewer Asian and White people suffer from diarrhoea or are not tested for the aetiology of diarrhoeal disease, but are merely prescribed anti-diarrhoeic medicines.

However, overall a higher percentage of Black patients were tested positive for *Cryptosporidium* and *Giardia*. This is probably due to socio-economic conditions, as many people in KwaZulu-Natal do not have access to an adequate potable water supply or sanitation.

Gender

Male and female patients tested for cryptosporidiosis had similar positive percentages. Giardiasis, on the other hand, was found to be more prevalent in female patients tested. A study of hospitilized children in Delhi found *Cryptosporidium* infection to be predominant in males (Mahajan et al., 1992) while an increased prevalence was found for females in Nigeria (Okafor and Okunji, 1994). In rural communities of developing countries, UNICEF found that girls may be more susceptible to diarrhoeal disease as they are often fed less, given less nutritious food, provided with less health care and given more work (Doyle, 1995).

HIV

A low percentage of *Cryptosporidium* and *Giardia* positive cases were recorded in the HIV patients sampled, but the percentages were similar in both symptomatic and asymptomatic patients. Asymptomatic *Cryptosporidium* infections have been documented previously in AIDS cases (Zar et al., 1985). The prevalence of asymptomatic infections has not been determined and its potential may be underestimated. The 4.5% positive cases for cryptosporidiosis in HIV patients were comparable with 4.2 to 6.2% reported by Sorvillo et al. (1994).

Statistical analysis

As rainfall, season or year did not appear to be correlated with the prevalence of *Cryptosporidum* or *Giardia,* water-borne transmission does not appear to be the primary route and other factors such as personal hygiene, sanitation, education or potable water availability probably have a more significant impact on the incidence of these diseases.

Conclusions

- *Cryptosporidium* and *Giardia* were found to be endemic in KwaZulu-Natal with laboratory-confirmed prevalence ranging from 2.9 to 3.7% and 2.9 to 3.0%, of cases submitted for analysis, respectively.
- *Cryptosporidium* and *Giardia* prevalence did not appear to correlate statistically with rainfall, month or year indicating that water-borne transmission is not important and other factors such as personal hygiene, potable water supply, sanitation and education probably have a more significant impact on their incidence. However, the graphs appeared to indicate that prevalence of diarrhoea and infection increased when rainfall increased.
- Increases in the number of diarrhoeal samples submitted for *Cryptosporidium* or *Giardia* analysis were independent of the prevalence of either protozoan pathogen.
- Overall, female and male diarrhoeal patients had similar percentages of cryptosporidiosis while giardiasis was more prevalent in female patients. However, the prevalence of both diseases for each gender differed with respect to age.
- *Cryptosporidium* and *Giardia* prevalence in children younger than 5 years indicated that *Cryptosporidium* was most prevalent (39.3%) in the <1 year age group while *Giardia* was most prevalent in the 3 to 4 year age group (38.5%).
- In cryptosporidiosis positive children < 5 years of age, 41.8% were male and 58.2% were female while 32.5% of giardiasis positive children were male and 67.5% were female.
- A low percentage of *Cryptosporidium* and *Giardia* positive cases were recorded in symptomatic (4.5% and 5.3% respectively) and asymptomatic (2.4% and 0.8% respectively) HIV patients.
- Clear recording and storage of data including gender, age, race, environment (location) and socio-economic factors of the patients are essential so that trends and outbreaks may be easily identified.
- Detection techniques need to be enhanced and standardised so that results can be comparable.

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