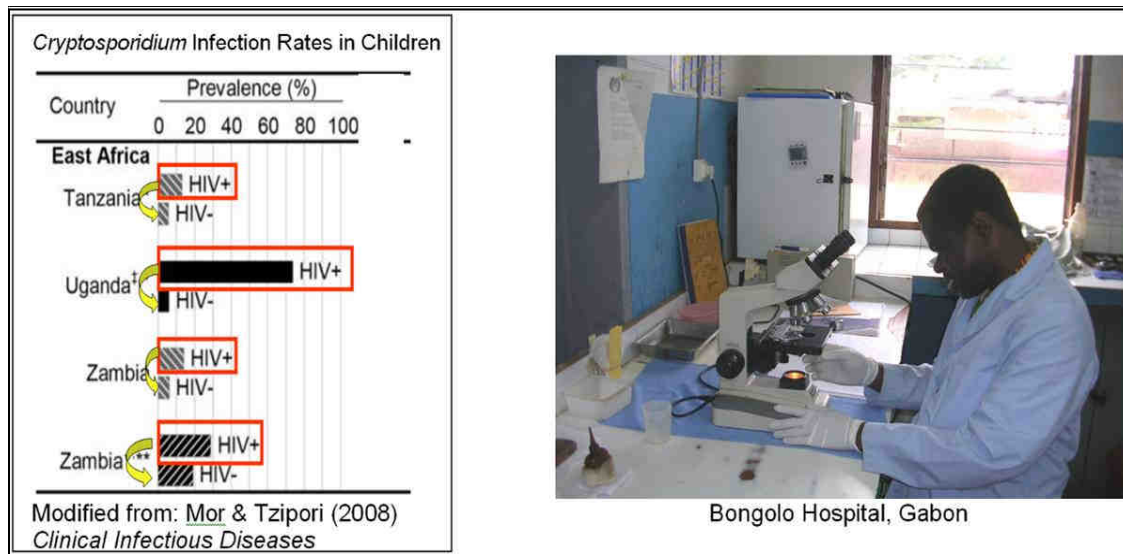


# WATERBORNE PATHOGEN INFECTION RATES FOR PEOPLE LIVING WITH HIV/AIDS

A CAWST Literature Summary  
November 2009 Edition

## PART I - ASIA





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**Acronyms**

CAWST	Centre for Affordable Water and Sanitation Technology
HIV	Human Immunodeficiency Virus
AIDS	Acquired Immune Deficiency Syndrome
ART	antiretroviral treatment
PCR	polymerase chain reaction
CD4	cluster difference 4
CD	chronic diarrhea
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
MIT	Massachusetts Institute of Technology

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## Introduction

This document has been prepared for individuals working in either the fields of public health or water treatment, particularly those who work in resource-limited countries. There is increasing awareness that waterborne pathogens are an important cause of morbidity and mortality for people living with HIV/AIDS in resource-limited countries. This document focuses on pathogens that are commonly or sometimes waterborne. As noted in the journal *HIV Medicine*:

“Since the first reported case of HIV infection in 1981, many HIV-seropositive patients have died as a result of diarrhea induced by opportunistic protozoal infections: pathogens that would normally cause only a transient illness in immunocompetent individuals” (Miao and Gazzard).

The readers of this document are advised that the percent positive rates for different waterborne pathogens are likely higher than the infection rates summarized in this document as noted in the following from an article in *HIV Medicine*:

“Stool light microscopy and culture are highly specific but not particularly sensitive tests. Newer polymerase chain reaction (PCR) techniques are available, but these tests are costly and time-consuming and therefore not routinely available in hospital practice. The sensitivity of PCR techniques for both cryptosporidia and microsporidia may be much better than currently available techniques. Thus, some of the individuals formerly diagnosed with pathogen-negative diarrhoea may have been infected with these organisms” (Miao and Gazzard).

In a study conducted in the GHESKIO Centers in Haiti with the University of Virginia, Cornell University and the University of the Philippines, microscopy only detected *Cryptosporidium* oocysts in about 30% of the patients for which real-time PCR detected oocysts (Eyma et al.).

Besides the *Cryptosporidium* infection rates described in this document, the prolonged duration and severity of illness associated with Cryptosporidiosis and AIDS patients (Hunter and Nichols) is also important. In addition, higher waterborne pathogen infection rates in the community lead to increased quantities of pathogens that can potentially contaminate drinking water sources given the inadequate sanitation that exists in many resource-limited countries. In a study conducted by the University of Texas and Tufts University, total oocysts shed per person ranged from  $5 \times 10^6$  to  $1 \times 10^{10}$ , the latter occurring in the volunteer with the longest episode of diarrhea and oocyst shedding (Chappell et al.). The same study found that the dose of *Cryptosporidium* oocysts high enough to infect 50% of the volunteers was estimated to be only 10 oocysts.

The reader should note the following relative to data contained in this document on relative to infection rates for *Entamoeba Histolytica*:

“Diagnosis of infection is complicated by the morphologically similar, but non-pathogenic, *E. dispar*. Microscopy is ineffective at distinguishing between the two species, and since the *E. dispar* infection-rate is 10-fold higher than that of *E. histolytica*, there is high incidence of misdiagnosis and treatment.” (Herbein et al.)

Because of the large volume of information provided in this document, colored lines have been added to make comparison of data in many of the tables easier.

**References for Introduction Section**

Chappell et al. "*Cryptosporidium Hominis*: Infectivity and Illness in Healthy Adults" Presented at ASTMH 2005 Annual Meeting

Eyma et al. "Improved diagnosis of Cryptosporidial and Microsporidial infections by PCR in patients with AIDS and diarrhea in Haiti" Presented at ASTHM Annual Meeting 2006

Herbein J, Buss S, Haque R., Ayeh-Kum<sup>3</sup> P, Petri WA, Lyerly DM. "Evaluation of a rapid fecal diagnostic test for *Entamoeba histolytica* infection" *Am J Trop Med Hyg* 2004 Oct; 71(4 Suppl):12-30.

Hunter PR and Nichols G. "Epidemiology and Clinical Features of *Cryptosporidium* Infection in Immunocompromised Patients" *Clinical Microbiology Reviews*, 2002

Miao YM and Gazzard BG. "Management of protozoal diarrhoea in HIV disease" *HIV Medicine* 2000

## ASIA

**Cambodia.** Chhin S, Harwell JI, Bell JD, Rozycki G, Ellman T, Barnett JM, Ward H, Reinert SE, Pugatch D. "Etiology of Chronic Diarrhea in Antiretroviral Naive Patients with HIV Infection Admitted to Norodom Sihanouk Hospital, Phnom Penh, Cambodia" *Clinical Infectious Diseases* 2006; 43:925–932.

Etiology and Prevalence of Pathogens identified in stool samples of 80 patients with HIV

Pathogen or finding	% of patients <b>with chronic diarrhea</b> (n=40)	% of patients <b>without chronic diarrhea</b> (n=40)
<i>Cryptosporidium</i> species	40	50
<i>Entamoeba histolytica</i>	22.5	20
Hookworm species	22.5	20
<i>Strongyloides stercoralis</i>	17.5	12.5
<i>Giardia</i>	10	2.5

**China.** Chen Y, Zhang Y, Yang B, Qi T, Lu H, Cheng X, Tachibana H. "Short Report: Seroprevalence of *Entamoeba histolytica* Infection in HIV-Infected Patients in China" *Am. J. Trop. Med. Hyg.*, 77(5), 2007, pp. 825–828.

- In 215 HIV-positive individuals, the positive rates for *Entamoeba histolytica* antigens were 12.1% and 7.9%, for 2 different antigens; these rates were significantly higher than the rates of 3.1% and 0.5% respectively, in patients with gastrointestinal symptoms who were HIV-negative.
- The subjects were selected randomly, but all were receiving anti-retroviral therapy.
- "It is unclear whether HIV infection is a risk factor for *E. histolytica* infections. However, the higher seropositivity in patients with a CD4+ cell count of  $< 200/\text{mm}^3$  in this study suggests that a deficiency in cellular immunity caused by HIV affects the chance of infection with *E. histolytica*. This observation is in accordance with a study in the United States, which estimated the risk ratios of *E. histolytica/E. dispar* infection in HIV-infected patients with CD4+ T cell counts of 0–99 and 100–199/ $\text{mm}^3$  as 1.7 and 1.5, respectively, compared with HIV patients with a CD4+ T cell count  $> 200/\text{mm}^3$ . It remains unclear how immunodeficiency affects the chance of *E. histolytica* infection. However, it is likely that patients with lower CD4+ T cell counts may be subjected to more testing or that a lower CD4+ T cell count may reflect an increased accumulated risk for amebiasis caused by reactivation of latent infection or increased susceptibility to new infection."



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**China.** Le XH, Wang H, Gou JZ, Chen XC, Yang GL, Yang QT, Li XH, Zhou BP, Li HQ, Cai WP. "Detection of *Cryptosporidium* infection among AIDS patients in Guangdong and Yunnan" *Zhonghua Shi Yan He Lin Chuang Bing Du Xue Za Zhi*. 2008 Oct; 22(5):339-41.

- Stool samples collated from AIDS confirmed patients in Southern China. The infection rate of *Cryptosporidium* in AIDS patients was 4.25% (9/212),
- "The infectious rate of oocyst in patients with antiretroviral therapy (ART) was also significantly lower ( $P = 0.0000$ ); we found the patients coinfecting with *Cryptosporidium* with CD4 count all below 100 cells/microl."

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**China-Taiwan.** Hung CC, Deng HY, Hsiao WH, Hsieh SM, Hsiao CF, Chen MY, Chang SC, Su KE, "Invasive Amebiasis as an Emerging Parasitic Disease in Patients With Human Immunodeficiency Virus Type 1 Infection in Taiwan" *ARCH INTERN MED* VOL 165, FEB 28, 2005.

- "Whether risk of invasive amebiasis due to *Entamoeba histolytica* is higher among human immunodeficiency virus (HIV)-infected persons than uninfected persons remains unclear ..."
- "Our objective was to determine the prevalence of invasive amebiasis and intestinal colonization by *E. histolytica* and *E. dispar* in HIV-infected persons and uninfected controls." Study included 951 HIV-positive patients.
- "The major findings of this large retrospective case study of persons with HIV infection in Taiwan are that invasive amebiasis occurs much more frequently than reported in Western countries and is a relatively common parasitic disease at a time when CD4 counts are relatively high. Findings from serologic studies indicate that there is a high frequency of previous exposure to *E. histolytica*".
- "The key microbiologic finding was our ability to identify *E. histolytica* in 25% of the colonizing strains in the stool. The higher rate of invasive disease in Taiwan and other areas in the Asia-Pacific region compared with Western countries is best explained by the higher endemicity of intestinal colonization with *E. histolytica*."
- "In conclusion, this study demonstrates that HIV infected persons compared with uninfected persons in Taiwan are at increased risk for invasive amebiasis and exhibit a relatively high frequency of elevated antibody titers and intestinal colonization with *E. histolytica*."

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**India.** Agarwal SK, Makhija A, Anuradha S, Singh NP, Baveja UK; "The Spectrum of opportunistic infections in HIV -AIDS patients in a tertiary care hospital in New Delhi, India." *Int Conf AIDS*. 2002 Jul 7-12; 14: abstract no. ThPeB7220.

- The spectrum of opportunistic infections in HIV/AIDS patients in a major tertiary care hospital of New Delhi, India was studied.
- 80 patients confirmed HIV-positive were screened for the presence of opportunistic infections. The CD4 cell counts were assessed in all these patients and the correlation of the various opportunistic infections and CD4 cell counts was evaluated.
- For the 10 patients that had chronic diarrhea *Cryptosporidium* (4/10), *Cyclospora* (1/10), *Isospora* (1/10), *E. histolytica* (1/10) were the responsible organisms.

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**India.** Ajjampur SSR, Asirvatham JR, Muthusamy D, Gladstone BP, Abraham OC, Mathai D, Ward H, Wanke C, Kang G. "Clinical features & risk factors associated with cryptosporidiosis in HIV infected adults in India" *Indian J Med Res* 126, December 2007, pp 553-557.

- "423 asymptomatic (no diarrhoea) and 111 symptomatic (with diarrhoea) HIV-infected adults who presented to the outpatient unit or who were admitted to the Christian Medical Hospital, Vellore, were screened for *Cryptosporidium* oocysts by microscopy using modified acid-fast staining between September 2002 and August 2004."
- The most common parasites seen in patients with diarrhoea were *Cryptosporidium* - 25% (28/111) and *Isospora* - 20% (22/111).
- "Of the 28 cases with cryptosporidial diarrhoea, 17 patients had acute diarrhoea and 11 patients had persistent diarrhoea. Among these patients, 10 patients reported diarrhoea for more than 3 months, 8 patients had three or more episodes of diarrhoea in the previous 12 months, while for 10 patients the current diarrhoeal episode was the first episode in a 12 month period."

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**India.** ANAND L, DHANACHAND C; BRAJACHAND N. "Prevalence and epidemiologic characteristics of opportunistic and non-opportunistic intestinal parasitic infections in HIV positive patients in Manipur." *J Commun Dis*. 1998 Mar; 30(1):19-22.

- *Cryptosporidium* sp. (94.4 percent) and *Isospora* sp. (10.7 percent) were predominant over *Entamoeba histolytica* (5.6 percent) and *Ascaris lumbricoides* (4.6 percent)

**India.** Attili SVS, AK Gulati AK, Singh VP Varma DV, Rai M, Shyam Sundar S. "Diarrhea, CD4 counts and enteric infections in a hospital – based cohort of HIV-infected patients around Varanasi, India" *BMC Infectious Diseases* 2006, 6:39.

**Table 3: Relationship between cd4, symptoms and enteric pathogens.**

Causative Agent	No. of patients	CD4 Range	CD4 (Mean $\pm$ SEM)	% of stools containing organism
E. Histolytica	24	28–186	112.35 $\pm$ 55.73	17.1%
Cryptosporidiosis	8	32–106	49.4 $\pm$ 22.6	5.71%
Isospora	4	65–70	67.5 $\pm$ 2.88	2.86%
Candida	4	80–85	82.5 $\pm$ 2.88	2.86%
Helminthes	2	155–125	140 $\pm$ 15	1.43%

**India.** Ballal M, Prabhu T, Chandran A, Shivananda PG. "Cryptosporidium and Isospora belli diarrhoea in immunocompromised hosts" *Indian J Cancer*. 1999 Mar; 36(1):38-42.

- Between 1996 and 1997, a total of 75 immunocompromised patients presenting with diarrhea were investigated both for *Cryptosporidium* and *Isospora*. The study group consisted of cancer and AIDS patients with history of diarrhea. *Cryptosporidium* oocysts were detected in 46.7% of patients.

**India.** Banerjee P, Chakrabarti T, Banerjee KL. "Stool pathogens in diarrhoea associated with HIV illness and importance of *Cryptosporidium*-a 7 year study in Calcutta, India". *Int Conf AIDS*. 1998; 12: 539-40 (abstract no. 31222).

- The study over 7 years (August '90 to Dec. '97) was undertaken in School of Tropical Medicine, Calcutta, India. Out of 141 HIV-positive cases, 9 had diarrhea of which *Cryptosporidium* was isolated in 7 of the 9, *Giardia* in 1 and *E. coli* in 1 case.
- Out of 83 AIDS cases, 30 had diarrhea, of these: 18/30 due to *Cryptosporidium* and one each by *E.coli* and *Salmonella enteritidis*.
- CONCLUSION: "Though AIDS patients are easily affected by all opportunistic infections, the most common cause of diarrhoea in Calcutta, India seems to be *Cryptosporidium*."

**India.** Beena U, Bineeta K, Preena B “A study of enteric pathogens in HIV/AIDS from a tertiary care hospital.” *Indian J Community Med* 2009;34:237-42

- *Cryptosporidium*, *Isospora* and *Entamoeba Histolytica* detected more frequently for HIV-positive patients than for HIV-negative patients.

Table 3: Enteric microbial pathogens other than parasites identified in stool samples of study and control subjects

Pathogen other than parasite	HIVseropositive with diarrhea study group (n=50) number (%)	HIV seropositive without diarrhea control group I (n=50) number (%)	HIV seronegative with diarrhea control group II (n=50) number (%)
<i>Candida</i> species	18 (45)	6 (46.2)	1 (4)
<i>Salmonella</i> species	2 (5)	0	0
<i>Shigella</i> species	1 (2.5)	0	0
<i>Vibrio cholerae</i>			
Ogawa	2 (5)	0	9 (36)
Inaba	0	0	4 (16)
<i>Clostridium difficile</i>	5 (12.5)	2 (15.4)	0
Enteropathogenic <i>Escherishia coli</i>	8 (20)	3 (23.1)	9 (36)
Enteroinvasive <i>Escherishia coli</i>	4 (10)	2 (15.4)	2 (8)
Total	40	13	25

**India.** Dwivedi et al., "Enteric Opportunistic Parasites among HIV Infected individuals Associated Risk Factors and Immune Status" *Japan Journal of Infectious Disease* 60, 2007, pp.76-81.

Table 1. Prevalence of different enteric parasites among HIV/AIDS patients with comparison to CD4<sup>+</sup> T-lymphocyte count

Parasite <sup>1)</sup>	Diarrheal (n = 50)		Non-diarrheal (n = 25)		P value <sup>3)</sup>
	%	Mean CD4 count (cells/mm <sup>3</sup> )	%	Mean CD4 count (cells/mm <sup>3</sup> )	
<i>Cryptosporidium parvum</i> <sup>2)</sup>	46	125	8	301	<0.001
<i>Giardia lamblia</i>	16	166	8	479	<0.01
Microsporidium	10	56	0	–	–
<i>Isospora belli</i>	4	96	0	–	–
<i>Entamoeba coli</i>	8	185	12	243	NS
<i>Cyclospora cayetanensis</i>	0	–	0	–	–
<i>Ascaris lumbricoide</i>	18	132	12	507	<0.001
<i>Ancylostoma duodenale</i>	6	50	8	354	<0.05
<i>Strongyloides stercoralis</i>	0	–	0	–	–
All protozoa	70	126	28	341	<0.001
All helminths	24	91	20	431	<0.005
Total infected	72	132	44	355	<0.05

<sup>1)</sup>: The number of parasites may exceed the number of patients, as more than one parasite was found in some patients.  
<sup>2)</sup>: P-value < 0.005 (chi-square test).  
<sup>3)</sup>: Student *t* test to compare CD4 count between diarrheal and non-diarrheal cases.

### Conclusions:

- *Cryptosporidium*, *Giardia*, Microsporidia and *Isospora* rates higher among HIV-positive patients with diarrhea than without diarrhea (*Cryptosporidium* dramatically higher and *Giardia* much less so).
- Low *Isospora* and *Cyclospora* rates may be due to the fact that some patients had taken medication for *p. carinii* pneumonia that is also quite effective against *Isospora* and *Cyclospora*.
- High *Cryptosporidium* prevalence could be due to overcrowding and poor sanitation and also because direct IFA method has higher detection than conventional acid fast staining method.

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**India.** Deodhar L, Maniar JK, Saple DG. “*Cyclospora* infection in acquired immunodeficiency syndrome” *J Assoc Physicians India*. 2000 Apr; 48(4):404-6.

- *Cyclospora* was identified in 22/334 fecal specimens (6.6 percent).

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**India.** Gautam H, Bhalla P, Saini S, Uppal B, Kaur R, Baveja C, Dewan R, “Epidemiology of Opportunistic Infections and Its Correlation With CD4 T-Lymphocyte Counts and Plasma Viral Load Among HIV-Positive Patients at a Tertiary Care Hospital in India” *J Int Assoc Physicians AIDS Care* first published on September 15, 2009

A total of 43 “drug naïve” patients were enrolled in the study. Among patients with diarrhea:

- *Giardia lamblia* detected in 31% patients, OR = 3.0 for CD4 counts  $\leq 100$  cells/mm<sup>3</sup>
- *Cryptosporidium* in 17.2% patients, OR = 1.8 for CD4 counts  $\leq 100$  cells/mm<sup>3</sup>
- Shigellosis was present in 3.6% patients

**India.** Gupta S, Narang S, Nunavath V, Singh S. "Chronic diarrhoea in HIV patients: Prevalence of coccidian parasites" *Indian J Med Microbiol* 2008; 26:172-5.

Parasite detected	HIV status		
	Positive		Negative
	With diarrhoea*	Without diarrhoea	
<b>Coccidian parasites</b>			
<i>Cryptosporidium</i> spp.**	7 (29.2%)	2 (14.3%)	0
<i>Isoospora belli</i> ***	14 (58.3%)	5 (35.7%)	0
<i>Cyclospora</i> spp.	1 (4.2%)	0	0
<b>Non-coccidian parasites</b>			
<i>Entamoeba histolytica</i>	0	1 (7.1%)	3 (23%)
<i>Giardia lamblia</i>	1 (4.2%)	2 (14.3%)	7 (53.8%)
<i>Ascaris lumbricoides</i>	0	0	1 (7.6%)
Hook worms	0	0	1 (7.6%)
<i>Strongyloides stercoralis</i>	1 (4.2%)	0	0
Others	0	4 (28.6%)	1 (7.6%)
Total parasites recovered	24	14	13

\*The prevalence in diarrhoeal HIV patients as compared to non-diarrhoeal HIV patients,  $P < 0.001$ ; \*\*  $P < 0.01$ ; \*\*\*  $P < 0.001$

### Conclusions

- *Cryptosporidium* and *Isoospora* much more common in HIV-positive than HIV-negative individuals and also more common for HIV-positive with diarrhea than without diarrhea.
- *Cyclospora* was more common in HIV-positive individuals though rates pretty low.
- *Giardia* and *Entamoeba histolytica* less common in HIV-positive individuals than HIV-negative, and less common for "with diarrhea" than "without diarrhea" for HIV-positive patients. *Giardia* and *Entamoeba histolytica* were not associated with diarrhea for HIV-positive patients in this study.
- Microsporidia were presumably not analyzed for.

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**India.** Jayalakshmi J, Appalaraju B, Mahadevan K. "Evaluation of an enzyme-linked immunoassay for the detection of *Cryptosporidium* antigen in fecal specimens of HIV/AIDS patients." *Indian J Pathol Microbiol.* 2008 Jan-Mar; 51(1):137-8.

- About 89 stool specimens obtained from HIV-positive patients with diarrhea were analyzed and the prevalence of *Cryptosporidium* diarrhea was found to be 12.4% (11/89).
- Other enteric pathogens detected were *Isospora belli* (3/89), *Giardia* cyst (3/89), and *Entamoeba histolytica* cyst (1/89).

---

**India.** Joshi M, Chowdhary AS, Dalal PJ, Maniar JK. "Parasitic diarrhoea in patients with AIDS." *Natl Med J India.* 2002 Mar-Apr; 15(2):72-4.

- *Isospora belli* was the most frequently encountered parasite in 17% of patients, followed by *Entamoeba histolytica* in 14.9% and *Cryptosporidium* in 8.5%. *Strongyloides stercoralis* and *Giardia lamblia* were detected in 5.3% and 4.3% of patients.

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**India.** Kang G, Ward HD, Wanke CA, Dheepa M. "MOLECULAR EPIDEMIOLOGY OF CRYPTOSPORIDIAL INFECTIONS IN HIV INFECTED INDIVIDUALS IN SOUTHERN INDIA" Abstracts of the 53<sup>rd</sup> Annual meeting of the American Society of Tropical Medicine and Hygiene November 7-11, 2004

- *Cryptosporidium* was identified in 40% (22 of 55) patients with symptoms (2.1 stool specimens/person).
- Of 232 asymptomatic patients who submitted a mean of 1.8 stool specimens, *Cryptosporidium* was been identified in 6% of patients.
- The median CD4 count of the symptomatic patients was 171.5 cells/mm<sup>3</sup>. The median CD4 count of the asymptomatic patients was 269.5 cells/mm<sup>3</sup>

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**India.** Kaushik K, Khurana S, Wanchu A, Malla N. "Evaluation of staining techniques, antigen detection and nested PCR for the diagnosis of cryptosporidiosis in HIV seropositive and seronegative patients" *Acta Trop.* 2008 Jul;107(1):1-7. Epub 2008 Feb 29.

- The study was designed to determine the efficacy of modified Ziehl-Neelsen (ZN), safranin methylene blue (SM) staining, antigen detection ELISA and a nested PCR assay (specific for *Cryptosporidium parvum*) for detection of *Cryptosporidium* in HIV-positive and HIV-negative patients with diarrhea.
- *Cryptosporidium* was detected in 4.9%, 4.4%, 18.9% and 13.1% of 206 HIV-positive patients by ZN staining, SM staining, antigen detection ELISA and PCR, respectively.
- *Cryptosporidium* was detected in 4.6%, 3.9%, 13.7% and 11.1% of 153 HIV-negative patients by ZN staining, SM staining, antigen detection ELISA and PCR, respectively.
- None of the 50 apparently healthy control subjects were found to be infected with *Cryptosporidium* by any of the techniques.
- Based on the criteria of 'true positive' samples positive by at least any two techniques out of ZN staining, antigen detection and PCR, sensitivity of ZN and SM staining techniques was 37% and 33.3% in HIV-positive and 41.2% and 35.3% in HIV-negative patients, respectively. Sensitivity of antigen detection ELISA was 92.6% and 94.1% in HIV-positive and HIV-negative patients, respectively, while sensitivity of PCR was 100% each in HIV-positive and HIV-negative patients.
- "The staining techniques were found less sensitive as compared to antigen detection and PCR for detection of *Cryptosporidium* in HIV seropositive patients with CD4 count >200cells/microl."

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**India.** Kulkarni SV, Kairon R, Sane SS, Padmawar PS, Kale VA, Thakar MR, Mehendale SM, Risbud AR. "Opportunistic parasitic infections in HIV/AIDS patients presenting with diarrhoea by the level of immune suppression" *Indian J Med Res* 130, July 2009, pp 63-66.

Of 137 HIV/AIDS patients:

- *Cryptosporidium parvum* (12%) was the most common pathogen found,
- *Isospora belli* - 8%,
- *Entamoeba histolytica/Entamoeba dispar* - 7%,
- Microsporidia - 1%,
- *Cyclospora* - 0.7%

In HIV-positive patients with CD4 count < 200 cells/ $\mu$ l (AIDS patients):

- *Cryptosporidium parvum* was the most commonly observed pathogen (20%)
- *Isospora belli* - 12%
- Microsporidia - 3 %
- *Cyclospora* – 2%

**India.** Kumar SS, Ananthan S, Lakshmi P. "Intestinal parasitic infection in HIV infected patients with diarrhoea in Chennai" *Indian J Med Microbiol* 2002 20 (2) pp. 88-91.

Parasite species	Acute diarrhoea n=41	Chronic diarrhoea n=59	Control* n=50
<i>Isospora belli</i>	3	11	0
<i>Cryptosporidium parvum</i>	7 <sup>f</sup>	7 <sup>ff</sup>	4
<i>Microsporidia</i>	0	1	0
<i>Cyclospora cayetenensis</i>	0	1	0
<i>Ancylostoma duodenale</i>	4	1	1
<i>Entamoeba histolytica</i>	1	2	0
<i>Strongyloides stercoralis</i>	0	1	1
<i>Hymenolepis nana</i>	0	0	1

\*HIV infected individuals without diarrhoea

**India.** Kumar SS, Ananthan S Joyee AG. "Detection of *Enterocytozoon bienewisi* (Microsporidia) by polymerase chain reaction (PCR) using species-specific primer in stool samples of HIV patients" *INDIAN J MED RES* APRIL 2005.

Parasites	Chronic diarrhoea (n = 105)	No diarrhoea (n = 48)
Microsporidia*	10	0
<i>Cryptosporidium parvum</i>	16	2
<i>Isospora belli</i>	13	1
<i>Giardia lamblia</i>	7	2
<i>Cyclospora cayetanensis</i>	5	0
<i>Strongyloides stercoralis</i>	4	1
<i>Entamoeba histolytica</i>	2	0
<i>Ascaris lumbricoides</i>	1	0

\*Confirmed as *Enterocytozoon bienewisi* by PCR using species-specific primer

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**India.** Lanjewar D, Chappell C, Dupont H, Gharpure H, Hira S. "Isosporosis in AIDS-associated diarrhea: Bombay study" *Int Conf AIDS*. 1996 Jul 7-12; 11(2):447 (abstract no. Pub.B.1057).

- Between March 1994 to December 1995 157 patients with HIV/AIDS presenting with diarrhea were studied at ARCON centre at J.J Hospital, Bombay.
- The prevalence of Isosporosis was 15.45%.

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**India.** Mohandas et al. "Prevalence of Intestinal parasitic pathogens in HIV-seropositive individuals in Northern India" *Jpn J Infect Dis*. 2002 Jun; 55(3):83-4.

- Thirty-six patients (30%) were found to harbor an intestinal parasite. *Cryptosporidium parvum* was the most common (10.8%), followed by *Giardia lamblia* (8.3%).

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**India.** Mukhopadhyaya A, Ramakrishna BS, Kang G, Pulimood AB, Mathan MM, Zachariah A, Mathai DC. "Enteric pathogens in southern Indian HIV-infected patients with & without diarrhoea" *Indian J Med Res*. 1999 Mar; 109:85-9.

- Stools from 111 consecutive HIV-positive patients (50 without and 61 with diarrhea) were examined by microscopy and culture.
  - Protozoa accounted for 71.8 per cent of all pathogens isolated.
  - *Isospora* was significantly more common in patients with (11/61) than without (2/50) diarrhea ( $P < 0.05$ ).
  - Bacterial pathogens were isolated more commonly from patients with diarrhea (12/61) than without (2/50,  $P < 0.05$ ).
  - *Isospora belli* and bacterial enteropathogens were more likely to be associated with diarrhea.
-

**India.** Muthusamy et al. "Multilocus Genotyping of *Cryptosporidium* sp. Isolates from Human Immunodeficiency Virus-Infected Individuals in South India" *JOURNAL OF CLINICAL MICROBIOLOGY*, Feb. 2006, Vol. 44, No. 2 p. 632–634.

- *Cryptosporidium* was the pathogen most often found in individuals whether they had "no diarrhea", "acute diarrhea" or "persistent diarrhea".
- For persistent diarrhea, *Cryptosporidium* (24%) and *Isospora* (22%) were the most common pathogens detected.

TABLE 1. Enteric pathogens isolated in HIV-infected individuals in southern India<sup>a</sup>

Pathogen	No diarrhea (n = 423)	Acute diarrhea (n = 70)	Persistent diarrhea (n = 41)
<b>Parasites</b>			
<i>Isospora belli</i>	10	14	9
<i>Cryptosporidium</i> spp.	20	17	11
<i>Giardia</i> spp.	18	6	4
<i>Cyclospora</i> spp.	2	1	1
<i>Strongyloides</i> spp.	8	8	3
Hookworm	6	4	3
<i>Hymenolepis nana</i>	4	2	2
<b>Bacteria</b>			
<i>Shigella</i> spp.	ND	3	2
<i>Salmonella</i> spp.	ND	2	0
<i>Aeromonas</i> spp.	ND	3	1
Non-O1 <i>Vibrio cholerae</i>	ND	2	0

<sup>a</sup> Patients without diarrhea submitted a mean of 1.3 specimens, and patients with diarrhea submitted a mean of 1.9 specimens. Specimens were not tested for *Campylobacter* species and diarrheagenic *Escherichia coli*. ND, not done.

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**India.** Mutnal MB, Nagamoti MB, Patil CS; "Spectrum of parasitic pathogens in AIDS related diarrhea in a tertiary care hospital, Belgaum, India" International Conference on AIDS (2004: Bangkok, Thailand. Jul 11-16; 15: abstract no. C10433).

- The study was undertaken during July 2001 to June 2003 and included 200 HIV-positive patients.
- *Cryptosporidium parvum* was the most common (36%) intestinal parasite
- *Isospora belli* was the 2<sup>nd</sup> most common (27%).
- Microsporidia and *Cyclospora* were detected in 9% of patients.
- Other parasites included *E. histolytica*, *Giardia lamblia*, *A. lumbricoides* and *Strongyloides stercoralis*.

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**India.** Nagalingesnaran K, Flanigan T, Mahajan A, Amalraj E, Mayer K, Solomon S; International Conference on AIDS. "Comparative Study of chronic diarrhea in persons with HIV in South India" *Int Conf AIDS*. 2000 Jul 9-14; 13: abstract no. MoPeB2268.

- 30 HIV-positive persons who had chronic diarrhea and 30 HIV-positive controls who had no diarrhea were studied between Jan and Dec 1999 at YRG Centre for AIDS Research and Education, Chennai, India.
  - 24% of the individuals in each group were on cotrimoxazole prophylaxis. Only 33.3% of the study subjects reported using boiled drinking water whereas it was reported by 66.7% of the controls. ( $P > 0.05$ ).
  - *Cryptosporidium* was isolated in 70% of the study subjects and in 81.5% of the controls.
  - Other organisms isolated in the study patients but not in the controls were *Ascaris lumbricoides* (10%), *Cyclospora* (3.3%), Microsporidia (3.3%) and *Trichuris trichiura* (3.3%).
  - The mean CD4+ T cell count of the study patients was 221 and that of the controls was 406 ( $P > 0.05$ ).
-

**India.** Prasad KN, Nag VL, Dhole TN, Ayyagari A. "Identification of enteric pathogens in HIV-positive patients with diarrhea in northern India." *J Health Popul Nutr.* 2000 Jun; 18(1):23-6.

- *Isospora* was the most frequent parasite isolated, followed by *Cryptosporidium*.

Table. Spectrum of pathogens isolated from 26 patients with HIV-related diarrhoea		
Enteric pathogen	No. detected	%
Emerging pathogens (n=13; 50%)*		
<i>Isospora belli</i>	7	26.9
<i>Cryptosporidium</i>	3	11.5
<i>Blastocystis hominis</i> (>10/HPF)	2	7.7
<i>Isospora belli</i> + <i>Strongyloides stercoralis</i>	1	3.8
Conventional pathogens (n=5; 19.2%)*		
<i>Entamoeba histolytica</i>	2	7.7
<i>Giardia lamblia</i>	1	3.8
Enteropathogenic <i>Escherichia coli</i>	1	3.8
<i>Campylobacter jejuni</i>	1	3.8
Conventional + emerging pathogens		
<i>E. histolytica</i> + <i>Cryptosporidium</i>	1	3.8
<b>Total</b>	<b>19</b>	<b>73.1</b>
* Emerging vs conventional pathogens in HIV-related diarrhoea (p<0.05)		

**India.** Ramakrishnan et al. "Prevalence of Intestinal Parasitic Infestation in HIV/AIDS Patients with Diarrhea in Madurai City, South India" *Jpn. J. Infect. Dis.*, 200760 (4), 209-210.

Table 2. Specieswise prevalence of intestinal parasites among study group

Study group	Intestinal parasite						
	<i>Cryptosporidium parvum</i>	<i>Entamoeba histolytica</i>	<i>Entamoeba coli</i>	<i>Ascaris lumbricoides</i>	<i>Hymenolepis nana</i>	<i>Giardia lamblia</i>	<i>Isospora belli</i>
AIDS-positive (%) n = 80	23* (28.7)	14* (17.5)	16* (20)	6 (7.5)	1 (1.2)	3 (3.7)	1 (1.2)
AIDS/HIV-negative (%) n = 80	3 (3.7)	3 (3)	3 (3.7)	2 (2.5)	1 (1.2)	0	0

\*: Significant at AIDS positive cases by student *t* test ( $P < 0.05$ ).

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**India.** Ramana KV and Mohanty SK “Opportunistic intestinal parasites and TCD4+ cell counts in human immunodeficiency virus seropositive patients” *Journal of Medical Microbiology* 2009 58 (12): 1664.

- The study included 452 HIV-positive individuals who were not on antiretroviral therapy from January 2004 to December 2007.
  - *Cryptosporidium* sp. was detected in 17.8% patients
  - *Entamoeba histolytica* -15.6 %
  - *Giardia lamblia* - 12.6 %
  - *Cyclospora* sp. - 10 %
  - Study found that “In contrast to previous studies where coccidian parasitic infections were associated with CD4+ counts less than 100 cells mm<sup>3</sup>, our study revealed higher CD4+ counts”.
  - “The higher counts in our study can be attributed to the early infection. The high incidence of opportunistic intestinal parasitic infection in our study may be due to low socioeconomic status, poor hygiene, unavailability of safe drinking water and frequent contact with livestock. Emphasis on specific measures to prevent opportunistic infections, and initiating appropriate antiparasitic therapy, are important because of the limitations of highly active antiretroviral therapy (HAART).”
  - “In conclusion, our findings highlight and reassert the importance of screening the stool samples of HIV-seropositive individuals and evaluating the absolute TCD4+ counts regularly. Our study also suggests that the intestinal parasitic infections vary with the geographical areas and studies must be carried out in respective regions to evaluate the frequent causes of intestinal parasitic infections in HIV-seropositive individuals.
  - “Early diagnosis of opportunistic infections and prompt treatment definitely contribute to an increased life expectancy of infected individuals by delaying the progression to AIDS.”
-

**India.** Sadraei J, Rizvi MA, Baveja UK. "Diarrhea, CD4<sup>+</sup> cell counts and opportunistic protozoa in India HIV-infected patients" *Parasitol Res* (2005) 97,pp. 270-273.

Table 3 Distribution of parasites on CD<sup>+</sup> 4 count in the HIV-infected patients with diarrhea

CD4 (cells/ $\mu$ L)	Parasites frequency				
		<i>Cryptosporidium</i> *	<i>Microsporidium</i>	<i>G. lamblia</i>	<i>E. histolytica</i> **
< 200	(Per.)	56.5*	30.4	40	28.9**
	(No.)	26	14	18	13
200-500	(Per.)	32	24	5	17.4
	(No.)	8	6	1	4
> 500	(Per.)	40	40	0	20
	(No.)	2	2	0	1

\* $P=0.037$  (with CD4 groups); \*\* $P=0.007$  (with CD4 groups)

- Cryptosporidium* rates highest of all pathogens analyzed for. *Cryptosporidium*, Microsporidia and *Entamoeba histolytica* rates significant for HIV-positive patients in study whether had progressed to AIDS or not but *Cryptosporidium* and *E. histolytica* rates even higher for AIDS patients. This study found high infection rates even at high CD4 counts (except for *Giardia*).

**India.** Singh A, Bairy I. "Cryptosporidiosis in HIV seropositive patients in Kasturba Hospital, Manipal, Karnataka, South India" *Journal of Institute of Medicine* (2005) 27, 2.

- This study was of *Cryptosporidium* infection in HIV-positive patients (with acute or chronic diarrhea) admitted in Kasturba Hospital, Manipal, South India. 30/70 (42.85%) of HIV-positive patients positive for *Cryptosporidium parvum* oocysts.

**India.** Suresh A, Gulati AK, and Singh VP, and Varma DV, Rai M, Sundar, S. "Diarrhea, CD4 counts and enteric infections in a hospital – based cohort of HIV-infected patients around Varanasi, India" *BMC Infectious Diseases* 2006, 6:39.

Pathogen	% of stools containing organisms
<i>E. Histolytica</i>	17.1
<i>Cryptosporidium</i>	5.7
<i>Isospora</i>	2.9
Helminths	1.4



**India.** Tuli L, Gulati AK, Sundar S, Mohapatra TM. "Correlation between CD4 counts of HIV patients and enteric protozoan in different seasons – An experience of a tertiary care hospital in Varanasi (India)" *BMC Gastroenterology* 2008, 8:36.

**Table 3: Correlation between seasonal variation and parasitic diarrhoea**

Parasites Isolated	Summer (March–June)		Rainfall (July–October)		Winter (Nov–Feb)	
	Cases	Controls	Cases	Controls	Cases	Controls
<i>Cryptosporidium</i> spp.	19 (5.1%)	13 (6.5%)	11 (30.3%)	23 (11.5%)	16 (4.3%)	6 (3%)
<i>Microsporidia</i> spp.	32 (8.7%)	--	33 (10.3%)	--	28 (7.6%)	--
<i>Cyclospora</i> spp.	56 (15.3%)	2 (1%)	25 (6.8%)	1 (0.5%)	7 (1.1%)	--
<i>Giardia</i> spp.	9 (2.4%)	--	1 (5.7%)	--	7 (1.1%)	--
<i>Entamoeba</i> spp.	5 (1.3%)	1 (0.5%)	4 (1.0%)	3 (1.5%)	2 (0.5%)	--
<i>Isospora belli</i>	2 (0.5%)	--	--	--	--	--
Hookworm	5 (1.3%)	10 (5%)	12 (3.2%)	27 (13.5%)	--	3 (1.5%)
<i>Trichuris trichiura</i>	4 (1.0%)	--	3 (0.8%)	--	2 (0.5%)	--
<i>H. nana</i>	--	--	2 (0.5%)	4 (2%)	--	2 (1%)

Figures in parentheses express the percentage (%) of parasites isolated.

- *Cryptosporidium* infection rates dramatically higher in HIV-positive individuals during rainy season. High prevalence of *Microsporidia* in HIV-positive patients.
- *Entamoeba* prevalence low. *Isospora* rates low but could be due to HIV drug regimens that inactivate *Isospora*.
- *Cyclospora* was less in rainy season than in hot season - March-June possibly indicating more of a food than water issue.

**Table 1: Comparison of the parasites isolated from the stool samples of AIDS patients and normal controls.**

Parasites isolated	Percentage of parasites isolated in HIV positive patients with diarrhoea. (n = 366)	Percentage of parasites isolated in HIV negative persons with diarrhoea. (n = 200)
<i>Cryptosporidium</i> spp.	16 (39.8%)	2 (21.0%)
<i>Microsporidia</i> spp.	9 (26.7%)	--
<i>Cyclospora</i> spp.	8 (24.0%)	3 (1.3%)
<i>Giardia</i> spp.	3 (10.1%)	--
<i>Entamoeba</i> spp.	1 (3.0%)	4 (2.0%)
<i>Isospora belli</i>	2 (0.5%)	--
Hookworm	17 (4.6%)	40 (20.0%)
<i>Trichuris trichiura</i>	9 (2.4%)	--
<i>Hymenolepis nana</i>	2 (0.5%)	6 (3%)
<i>Ascaris lumbricoides</i>	--	44 (22.0%)
Mixed infections	92 (25.1%)	--

Figures in parentheses express the percentage (%) of parasites isolated.

**Table 2: The associations between type of diarrhoea, parasites isolated and CD4 counts of 366 AIDS patients.**

Parasites isolated	CD4 cells < 200 cells/ $\mu$ l		CD4 cells 200–350 cells/ $\mu$ l		CD4 cells 350–500 cells/ $\mu$ l	
	Acute cases n = 57	Chronic cases n = 179	Acute cases n = 34	Chronic cases n = 42	Acute cases n = 21	Chronic cases n = 33
<i>Cryptosporidium</i> spp.	38/57 (66.6%)	56/179 (31.2%)	11/34 (32.3%)	20/42 (47.6%)	8/21 (38%)	13/33 (39.3%)
<i>Microsporidia</i> spp.	15/57 (26.3%)	68/179 (37.9%)	5/34 (14.7%)	7/42 (16.6%)	3/21 (14.2%)	--
<i>Cyclospora</i> spp.	4/57 (7.0%)	43/179 (24.0%)	3/34 (8.8%)	28/42 (66.6%)	5/21 (23.8%)	5/33 (15.5%)
<i>Giardia</i> spp.	11/57 (19.3%)	7/179 (3.91%)	8/34 (23.5%)	4/42 (9.5%)	4/21 (19.5%)	3/33 (9.5%)
<i>Entamoeba</i> spp.	4/57 (7%)	1/179 (0.5%)	5/34 (14.7%)	--	1/21 (4.7%)	--
<i>Isospora belli</i>	--	2/179 (1.1%)	--	--	--	--
Hookworm	1/57 (1.7%)	6/179 (3.3%)	--	5/42 (11.9%)	2/21 (9.5%)	3/33 (9%)
<i>Trichuris trichiura</i>	--	3/179 (1.6%)	4/34 (11.7%)	--	2/21 (9.5%)	--
<i>H. nana</i>	--	1/179 (0.5%)	--	1/42 (2.3%)	--	--
Total	73	187	36	65	25	24

Figures in parentheses express the percentage (%) of parasites isolated.

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**India.** Vignesh R, Balakrishnan P, Shankar EM, Murugavel KG, Hanas S, Cecelia AJ, Thyagarajan SP, Solomon S, Kumarasamy N. "High proportion of isosporiasis among HIV-infected patients with diarrhea in southern India" *Am J Trop Med Hyg.* 2007 Nov; 77(5):823-4.

- *Isospora belli* (26.1%) was the most common parasite.
- *Entamoeba histolytica/dispar* (3.3%)
- *Cryptosporidium* spp. (2.9%)
- *Giardia intestinalis* (1.6%)
- *Strongyloides stercoralis* (1.2%)
- "Interesting trends of significant increase in the number of cases of *Isospora belli* and decline in *Cryptosporidium* spp. were observed during the study period."

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**Indonesia.** Kurniawan A, Karyadi T, Dwintasari SW, Sari IP, Yuniastuti E, Djauzi S, Smith HV. "Intestinal parasitic infections in HIV/AIDS patients presenting with diarrhoea in Jakarta, Indonesia." *Trans R Soc Trop Med Hyg.* 2009 Sep;103(9):892-8.

- Investigated the occurrence of intestinal parasites in Indonesian HIV/AIDS patients with chronic diarrhoea prior to administering antiretroviral therapy.
- *Cryptosporidium* and *Cyclospora* - 11.9% and 7.8%.
- *Blastocystis hominis* (72.4%) was the most commonly occurring protest usually occurring as a co-infection.
- Intestinal protozoan pathogens were detected more frequently in cases with CD4 counts  $\leq 200/\text{mm}^3$ .

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**Malaysia.** Zaidah R, Chan YY, Asma S, Abdullah H S et al. Nurhaslindawati AR, Salleh M. , Zeehaida M, Lalitha P, Mustafa M and Ravichandran M "DETECTION OF *CRYPTOSPORIDIUM PARVUM* IN HIV-INFECTED PATIENTS IN MALAYSIA USING A MOLECULAR APPROACH" *SOUTHEAST ASIAN J TROP MED PUBLIC HEALTH* Vol 39 No. 3 May 2008 pp. 511-516.

- "In Malaysia, *Cryptosporidium* is rarely detected in clinical specimens, probably due to the use of conventional methods which have low sensitivity."
- 16% were positive for *Cryptosporidium*, (11 of 59 samples)
- 8 were identified using PCR alone; 2 using microscopy only; and 1 was positive by both methods, indicating that PCR has a much higher ability to detect *Cryptosporidium*.

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**Nepal.** Adhikari NA, Rai SK, Singh A, Dahal S, Ghimire G. "Intestinal parasitic infections among HIV seropositive and high risk group subjects for HIV infection in Nepal" *Nepal Med Coll J.* 2006 Sep; 8(3):166-70.

- The helminth *Trichuris trichiura* was the most common parasite detected in HIV-positive subjects (50.0%). *Cryptosporidium parvum* was detected in 5.2% of HIV-positive subjects.

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**Nepal.** Ghimire P, Sapkota D, Manandhar S P "Cryptosporidiosis: Opportunistic Infection in HIV/AIDS Patients in Nepal" *J Trop Med Parasitol* 2004;27:7-10.

- Among the total 75 cases studied, 13 were full-blown AIDS and 62 HIV-positive cases.
- *Cryptosporidium* was found in 10.7% of the total 75 cases studied. Out of 75 cases, 30.7% suffered from diarrhea, of which *Cryptosporidium parvum* accounted for 34.8% of cases.
- 4 off 62 (6.5%) HIV-seropositive patients and 4 of 13 (30.8%) of AIDS patients were found infected with *Cryptosporidium parvum*.
- In AIDS patients, all four infections were accompanied by chronic watery diarrhea and wasting. "In conclusion, *Cryptosporidium parvum* is probably the most prevalent parasitic pathogen found in patients with diarrhea in HIV/AIDS individuals."

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**Nepal.** Mukhopadhyay C, Wilson G, Pradhan D, Shivananda PG. "Intestinal protozoal infestation profile in persistent diarrhea in children below age 5 years in western Nepal" *Southeast Asian J Trop Med Public Health.* 2007 Jan; 38(1):13-9.

- "Unlike acute diarrhea, the role of pathogens in persistent diarrhea in children in Nepal is unclear. Protozoal parasites are suspected to be a major cause."
  - Stool samples were collected from 253 children with persistent diarrhea, from 155 children with acute diarrhea (disease controls) and from 100 healthy children from the community (normal controls).
  - HIV infection and severe malnutrition were associated with *Cyclospora* and *Cryptosporidium* spp causing persistent diarrhea.
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**South Korea.** Guk SM, Seo M, Park YK, Oh MD, Choe KW, Kim JL, Choi MH, Hong ST, Chai JY. "Parasitic infections in HIV-infected patients who visited Seoul National University Hospital during the period 1995-2003" *Korean J Parasitol.* 2005 Mar; 43(1):1-5.

- Samples were collected from 67 patients for intestinal parasite examinations in HIV-positive patients who visited Seoul National University Hospital from 1995 to 2003
- *Cryptosporidium parvum* - 10.5% (7 of 67)
- *Isospora belli* - 7.5% (5 of 67)
- *Giardia lamblia* - 1.5% (1 of 67)
- Of the 11 intestinal parasite-infected patients showed that all suffered from diarrhea.

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**Thailand.** LEELAYOOVA S, VITHAYASAI N, WATANAVEERADEJ ,V; CHOTPITAYASUNONDH T, THERAPONG V, NAAGLOR T, MUNGTHIN M, "Intestinal microsporidiosis in HIV-infected children with acute and chronic diarrhea" *Southeast Asian journal of tropical medicine and public health* 2001, vol. 32, n<sup>o</sup>1, pp. 33-37.

- Study of microsporidiosis in HIV-positive children was conducted at the Queen Sirikit National Institute of Child Health and Phramongkutklo Hospital, Bangkok, Thailand.
  - Hospitalized HIV-positive children with and without diarrhea were enrolled in this study.
  - *Cryptosporidium parvum* and Microsporidia were the most common protozoa found in the present study, (7.1% for each).
  - Microsporidia was significantly more common in those who had diarrhea.
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**Thailand.** Manatsathit S, Tansupasawasdikul S, Wanachiwanawin D, Setawarin S, Suwanagool P, Prakasvejakit S, Leelakusolwong S, Eampokalap B and Kachintorn U “Causes of chronic diarrhea in patients with AIDS in Thailand: A prospective clinical and microbiological study” *Journal of Gastroenterology* 1996 Aug;31(4):533-7.

- The most commonly found enteric pathogen was *Cryptosporidium parvum* (20.0%).
- *Salmonella* spp. (15.5%)
- *Mycobacterium avium intracellulare* (6.6%)
- *Strongyloides stercoralis* (4.4%)
- *Giardia lamblia* (4.4%)
- *Campylobacter* (2.2%)
- *Cyclospora cayetanensis* (2.2%)

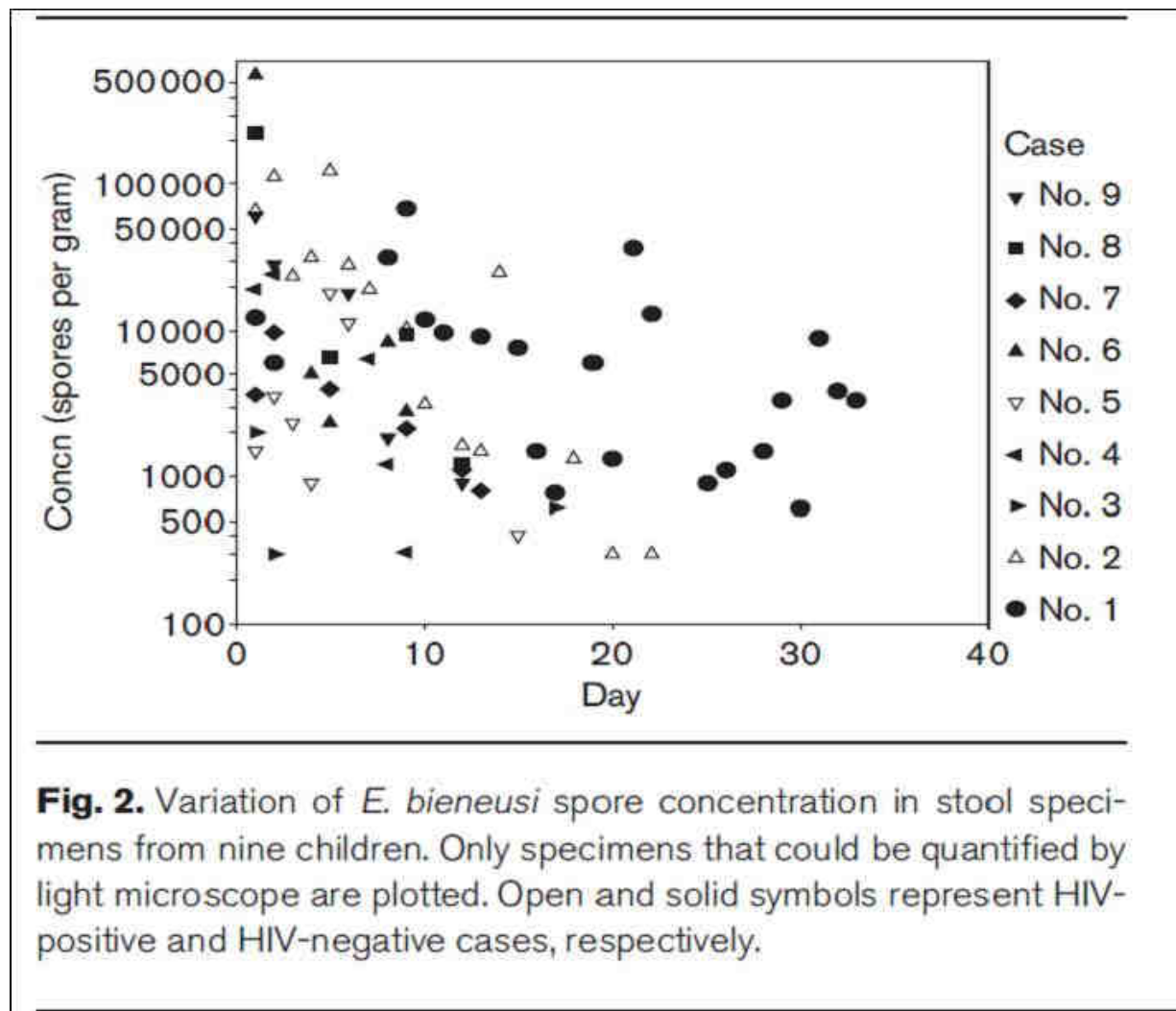
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**Thailand.** MOOLASART P, EAMPOKALAP B, RATANASRITHONG M, KANTHASING P, TRANSUPASWASKUL S, TANCHANPONG C. “Cryptosporidiosis in HIV infected patients in Thailand” *Southeast Asian journal of tropical medicine and public health* 995, vol. 26, 2, pp. 335-338.

- Study of cryptosporidiosis in HIV-positive patients (adults and children), in the period of 6 years from 1988 to 1993 at Bamrasnaradura Hospital in Nonthaburi, Thailand.
  - *Cryptosporidium* was found in 8.8% of 250 HIV-positive patients with diarrhea.
  - Prevalence of cryptosporidiosis among children was 19% and among adults was 7.9%.
  - “The common features were chronic diarrhea (84.6%), mostly watery diarrhea and weight loss/malnutrition (100%)”.
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**Thailand.** Mungthin M, Subrungruang I, Naaglor T, Aimpun P, Areekul W, Leelayoova S, “Spore shedding pattern of *Enterocytozoon bieneusi* in asymptomatic children” *Journal of Medical Microbiology* (2005), 54, 473–476.

- “The spore shedding pattern and intensity in these children was variable. We found that light microscopy may not detect low levels of spore shedding. Thus, the role of the asymptomatic group as the source of infection is important and might be underrated. Using detection methods with a high sensitivity, such as PCR, should be useful in providing more epidemiological data.”
- “Low sensitivity of light microscopy has been shown in several studies. A multicentre study showed that PCR detected as little as  $10^2$  spores per gram while a detection limit of  $10^4$  spores per gram of stool was shown by light microscopy.”



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**Thailand.** Nuchjangreed C, Boonrod K, Ongertth J and. Karanis P, "Prevalence and molecular characterization of human and bovine *Cryptosporidium* isolates in Thailand" *Parasitology Research* 2008 Nov;103(6):1347-53.

- This study was performed to determine the prevalence and genotypes of *Cryptosporidium* species among HIV-positive patients and cattle in Thailand.
- Stool specimens were collected from 46 HIV-positive patients from central Thailand.
- 200 fecal samples from dairy cattle were collected from seven farms in the eastern part of Thailand.
- In HIV-positive patient samples, the *Cryptosporidium* detection rate was 28.7% by AFS and 4.35% by nested PCR.
- In cattle samples, the detection rate was 13% by AFS and 9.63% by nested PCR.
- 7 PCR-positive *Cryptosporidium* samples were genotyped and found to be *C. parvum*.

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**Thailand.** Pinlaor S, Mootsikapun P, Pinlaor P, Pipitgool V, Tuangnadee R, "Detection of opportunistic and non-opportunistic intestinal parasites and liver flukes in HIV-positive and HIV-negative subjects" *Southeast Asian J Trop Med Public Health*. 2005 Jul; 36(4):841-5.

- Study of HIV-positive (n = 78) and HIV-negative patients (n = 78) from two hospitals in Khon Kaen Province, Thailand, from November 1998 to August 2000. These subjects were divided according to the presence of diarrhea and CD4 counts. A single stool sample was obtained and analyzed.
  - The prevalence rates of *Cryptosporidium* spp (11.5%) and *Strongyloides stercoralis* (17.9%) in the HIV-positive group were significantly ( $p < 0.05$ ) higher than those in the HIV-negative group (1.0% for *Cryptosporidium* spp and 7.7% for *S. stercoralis* infections).
  - "The prevalences of these two parasites were 28% for *Cryptosporidium* spp and 20% for *S. stercoralis* in HIV-seropositives with diarrhea and CD4 counts lower than 100 cells/mm<sup>3</sup>, and were higher compared with patients without diarrhea or with high CD4 counts. These results suggest that infection with these parasites increases during HIV infection."
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**Thailand.** PUNPOOWONG B; VIRIYAVEJAKUL P.; RIGANTI M.; PONGPONARATN E.; CHAISRI U.; MANEERAT Y.; "Opportunistic protozoa in stool samples from HIV-infected patients" *Southeast Asian journal of tropical medicine and public health* 1998, vol. 29, no.1 pp. 31-34.

- 22 cases of HIV-positive patients from submitted to the Department of Tropical Pathology, all had chronic diarrhea.
- Microsporidia (27.3%),
- *Cryptosporidium* (9.1%)
- *Isospora belli* (4.5%)
- *Giardia intestinalis* (9.1%)

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**Thailand.** Saksirisampant W, Eampokalap B, Rattanasrithong M, Likanonsakul S, Wiwanitkit V, Nasingkarn A, Denmasae N, "A prevalence of *Cryptosporidium* infections among Thai HIV-infected patients" *J Med Assoc Thai.* 2002 Jun; 85 Suppl 1:S424-8.

- The prevalence of *Cryptosporidium* in 156 HIV-positive Thai patients who had acute diarrheal illness at Bamrasnaradura Infectious Diseases Hospital in 2001.
- The prevalence of cryptosporidiosis in the present series was 12.8%. "Comparing this prevalence to a report in the previous 5 years in the same hospital, the same high rate can be seen."

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**Thailand.** Saksirisampant W, Prownebon J, Mungthin M, Leelayoova S, "GENOTYPE OF OPPORTUNISTIC PROTOZOA IN LATE-STAGE HIV-INFECTED THAI PATIENTS" *Protistology* 5 (1) 9\_91 (2007)

- Study of opportunistic intestinal parasitic infections in HIV/AIDS patients attending Wat Prabaht Nam Phu, a hospice AIDS care center in Thailand (February 2004 - January 2005).
  - Of 90 Thai HIV/AIDS patients with diarrhea, 59 (65.6%) had full-blown AIDS. Only 20 patients (22.2%) had a history of antiretroviral treatment. The mortality rate was 43.3% during a one-year period.
  - By nested PCR, *Cryptosporidium* was the most common parasite found (34.4%). 87% of oocysts were the human form *C. hominis* and 13% were as *C. meleagridi*.
  - *Microsporidia Enterocytozoon bienewisi* was identified (5.6%) by PCR, *Enterocytozoon intestinalis* was not detected.
  - *Cyclospora cayatonensis* and *Isospora belli* were each detected in only 1/90 patients.
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**Thailand.** Srisuphanun, M, Suvedyathavorn V, Suputtamongkol Y, Arnantapunpong S, Wiwanitkit V, Satitvipawee P, Tansupasawadikul S, "Potential risk factors for *Cryptosporidium* infection among HIV/AIDS patients in central areas of Thailand" *Journal of Public Health*, Volume 16, Number 3, June 2008, pp. 173-182.

- In 143 HIV/AIDS adult patients with diarrhea, cryptosporidiosis rate was 16.1%.

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**Thailand.** Tiangtip R, Jongwutiwes S. "Molecular analysis of *Cryptosporidium* species isolated from HIV-infected patients in Thailand" *Trop Med Int Health*. 2002 Apr; 7(4):357-64.

- 29 isolates from four children and 25 adults attending King Chulalongkorn Memorial Hospital in Bangkok during 1996 and 2000 were analyzed. All patients suffered from chronic watery diarrhoea and had all but two patients had CD4+ < 200/mm<sup>3</sup>.
- Based on a limited number of isolates analyzed; only *C. meleagridis* and *C. muris* were found in HIV-positive children, whereas the genotype 1 of *C. parvum* (human) predominated in HIV-positive adults.

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**Thailand.** Uga S, Kunaruk N, Rai SK, Watanabe M. "*Cryptosporidium* infection in HIV-seropositive and seronegative populations in southern Thailand" *Southeast Asian J Trop Med Public Health*. 1998 Mar; 29(1):100-4.

- *Cryptosporidium* oocysts were detected in 10% of HIV-seropositive and in 2% of HIV-negative subjects.

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**Thailand.** Viriyavejakul P, Nintasen R, Punsawad C, Chaisri U, Punpoowong B, Riganti M. "High prevalence of Microsporidium infection in HIV-infected patients" *Southeast Asian J Trop Med Public Health*. 2009 Mar; 40(2):223-8.

For 64 HIV-positive patients, the most frequently found pathogens were:

- Microsporidia (81.2%),
- *Cryptosporidium parvum* (20.3%),
- *Blastocystis hominis* (10.9%).
- Less frequently found pathogens were *Giardia intestinalis* (6.2%), *Cyclospora* (4.7%), *Strongyloides stercoralis* (3.1%) and hookworm ova (1.6%).

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**Thailand.** WANACHIWANAWIN D, CHOKEPHAIBULKIT K, LERTLAITUAN P, ONGROTCHANAKUN J, CHINABUT P, THAKERNGPOL K, "Intestinal microsporidiosis in HIV-infected children with diarrhea" *Southeast Asian journal of tropical medicine and public health* 2002 Jun;33(2):241-5.

- Study of 182 hospitalized HIV-positive and HIV-negative children with diarrhea.
- For microsporidiosis: HIV-positive - 25.3% and for HIV-negative children - 14.9%.
- *Cryptosporidium parvum* was a common co-infective parasite.
- Malnutrition was more common in the HIV-positive group (79.2% vs. 23.1%;  $p = 0.003$ ).
- "This study indicates that intestinal microsporidiosis is an important disease in both HIV-infected and uninfected Thai children with diarrhea."

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**Thailand.** . WANKE C A, COHAN D, THUMMAKUL T, JONGWUITIWES S, GRAYSON ML, HAMMER S M, HANVANICH M, "DIARRHEAL DISEASE IN PATIENTS INFECTED WITH HUMAN IMMUNODEFICIENCY VIRUS IN BANGKOK, THAILAND" *Am. J. Trop. Med. Hyg.*, 60(5), 1999, pp. 871–874.

- Study included 24 HIV-positive patients in Bangkok, Thailand compared with a group of 19 HIV-positive patients without diarrhea cared for at the same clinic.
  - One individual with diarrhea and advanced disease by CD4 cell count had Microsporidia.
  - Patients with diarrhea had a tendency toward a lower nutritional status, as measured by body mass index and mid arm circumference.
  - *Cryptosporidium parvum* appeared to be associated with prolonged symptoms in the patients with more advanced disease as measured by CD4 cell counts.
  - Percentages of different pathogens were not included in article.
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**Thailand.** WAYWA D, KONGKRIENGDAJ S, CHAIDATCH S, TIENGRIM S, KOWADISAIBURANA B, HAIKACHONPAT S, SUWANAGOOL S, CHAIPRASERT A, CURRY A, BAILEY W, SUPUTTAMONGKOL Y, BEECHING N, "Protozoan enteric infection in AIDS related diarrhea in Thailand" *Seminar on Food-Borne Parasitic Zoonoses* No. 3, 2001, vol. 32, SUP2 (249 p.)

Of 288 consecutive patients screened in the 10 month period:

Protozoan pathogens

- *Cryptosporidium* - 19.2%
- Microsporidia - 11%
- *Isospora* - 4.5%
- *Giardia* - 3.8%
- *Entamoeba histolytica* - 0.9%

Bacterial pathogens:

- *Campylobacter* - 7.1%
- *Salmonella* - 4.3%
- *Shigella* - 0.5%.
- *Clostridium difficile* - 15.6%
- *Mycobacterium* - 6.2%

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**Thailand.** Wiwanitkit V. "Intestinal parasitic infections in Thai HIV-infected patients with different immunity status" *BMC Gastroenterology* (2001) 1:3.

For 60 HIV-positive individuals:

- *Isospora belli* (5 %),
  - *Cryptosporidium* (3.33 %),
  - *Strongyloides stercoralis* (3.33 %),
  - Microsporidia (1.67 %).
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