**CYCLOSPORA CAYETANENSIS INFECTIONS IN HAITI: A COMMON OCCURRENCE IN THE ABSENCE OF WATERY DIARRHEA**

MARK L. EBERHARD, EVA K. NACE, AMANDA R. FREEMAN, THOMAS G. STREIT, ALEXANDRE J. DA SILVA, AND PATRICK J. LAMMIE

*Division of Parasitic Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia*

**Abstract.** Stool samples from a population-based cohort of mothers and children living in Leogane, Haiti were tested for *Cyclospora cayetanensis* from January 1997 through January 1998. Data on gastrointestinal symptoms were also collected. During the winter months of January to March, the infection was detected in 15–20% of the persons sampled. Most infections did not appear to be causing diarrhea and most infected persons had few oocysts detectable in concentrates of stool. The infection appears to have marked seasonality, with highest rates during the driest and coolest time of the year. It may be that in this tropical setting, high summer temperature is the critical environmental factor that influences the seasonality of infection. This study demonstrates that *Cyclospora* infections in Haiti are common in the general population.

The occurrence of *Cyclospora cayetanensis* in Haiti has been recognized for some time, since it was in travelers with diarrhea returning from this country that oocysts of this protozoa were often identified. Although it was originally thought to be a cyanobacter-like or blue-green alga, the observation of sporulated oocysts permitted the recognition of this organism as a coccidian. In 1994, it was reported that in a human immunodeficiency virus (an HIV)-positive population in Port-au-Prince, the prevalence of *Cyclospora* was about 11%. In this study, infected patients experienced diarrhea for at least three weeks, patients rapidly responded to treatment with trimethoprim-sulfamethoxazole, and in persons monitored for one month or longer after treatment, symptoms recurred in 43%, suggesting reinfection. However, there is no information on the occurrence of *Cyclospora* infections in Haiti among persons without HIV infection.

This report describes the occurrence of the parasite in a population-based cohort study conducted in a small rural community of Haiti.

**MATERIALS AND METHODS**

The study was conducted in Leogane, a small community of approximately 10,000 inhabitants, located 30 km west of Port-au-Prince, Haiti. The study protocol was approved by the Institutional Review Boards at the Hospital St. Croix (Leogane, Haiti) and at the Centers for Disease Control and Prevention. The primary study population consisted of cohorts of mothers and children in several neighborhoods who were being monitored for other parasitic infections, including intestinal parasites and for gastrointestinal symptoms. After verbal consent was obtained, stool collection containers were distributed house-to-house and picked up the following morning. Because this was part of an ongoing study, the families were familiar with the procedure. The general state of health and nutritional status of the mothers and children was, given the setting, good, and were typical for the neighborhoods, which have been described previously.

Stool samples were collected at six time points between January 1997 and January 1998 through house-to-house visits. The consistency of each stool sample was recorded, a portion of each sample was fixed in 10% formalin, and subsequently concentrated using the standard formalin-ethyl acetate (FE) procedure. Sediment from the FE concentrate was examined using UV fluorescent microscopy for the detection of *Cyclospora* oocysts. *Cyclospora*-positive samples were further examined using acid-fast or hot safranin stain procedures. The remainder of unpreserved stool from positive persons was placed into potassium dichromate to allow the oocysts to sporulate. Individuals testing positive for *Cyclospora* were revisited and questioned briefly about any recent history of diarrheal illness.

Some of the individuals who tested positive or negative had stools re-examined at 3–6-month intervals. In households in which a positive *Cyclospora* stool sample was detected, the mother was asked about the health of that individual (themselves or one of their children); children more than eight years old were also asked directly. In effect, this amounted to a self assessment (comparison) of how they felt currently in relation to how they usually felt.

Weather information for 1995, 1996, and 1997, including rainfall amounts and daily high and low temperature readings, were recorded as part of another study and these data were available for analysis.

**RESULTS**

The results of the stool examinations are presented in Table 1. The prevalence of *Cyclospora* was highest in March, when 16% of those examined had detectable oocysts in their stool. In July and November, no infections were detected. To estimate the persistence of infection, 15 individuals who had been positive in January were re-examined in March; nine (60%) were still passing oocysts. In July, 26 persons who tested positive in either January or March were re-examined and only one (4%) was positive. The rainfall and temperature data for 1995–1997 are shown in Figure 1.

There did not appear to be an increased risk of infection based on sex, with an overall male:female risk ratio of 1.04. In the youngest age group, 0–5 years old, more males than females were infected, with an odds ratio of 2.1, whereas in the oldest age group, > 20 years old, only females were infected. However, in the oldest age group, the sex ratio was highly skewed to women, since the study encompassed cohorts of women and their children. Men were under-represented in the study cohort.

The number of stool specimens that were both diarrhetic...
and positive for *Cyclospora* varied between 6% and 12%. At the same time points, the number of stool samples that were diarrhetic but without detectable *Cyclospora* oocysts ranged between 3% and 11%. Generally, the percentage of *Cyclospora*-positive samples that were diarrhetic was slightly higher than the overall number with diarrhea at any given time point, but the differences were not statistically significant.

Intestinal parasitism in this setting is common. For instance, in the January 1997 sample collection, 20% were positive for *Necator*, 25% for *Ascaris*, 56% for *Trichuris*, 31% for *Giardia*, and more than 60% had nonpathogenic protozoa such as *Entamoeba coli*, *Iodamoeba butschlii*, or *Endolimax nana*. No organisms were detected in only 12% of the samples. Of the 16 *Cyclospora*-positive samples, eight (50%) were coinfected with *Giardia*; none of the 16 were single infections with *Cyclospora* only. In the March 1997 samples, 13 (72%) of 18 *Cyclospora*-positive samples had one or more coinfections, two (11%) with *Giardia*. In 5 (28%) of the 18, only *Cyclospora* was identified.

![Monthly mean rainfall](image1.png)

**Figure 1.** Weather conditions recorded for Leogane, Haiti for the years 1995 through 1997. The upper panel shows fluctuations in rainfall and the lower panel shows fluctuations in temperature (vertical bars encompass upper and lower extremes).

**Table 1**

<table>
<thead>
<tr>
<th>Date</th>
<th>No. of samples</th>
<th>No. <em>Cyclospora</em>-positive (%)</th>
<th>Prevalence of diarrhea in <em>Cyclospora</em>-negative persons</th>
<th>Prevalence of diarrhea in <em>Cyclospora</em>-positive persons</th>
<th>Sex of <em>Cyclospora</em>-positive persons (M/F)</th>
<th>Age (years) of <em>Cyclospora</em>-positive persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1997</td>
<td>140</td>
<td>16 (12%)</td>
<td>7/124 (6%)</td>
<td>2/16 (12%)</td>
<td>10/6</td>
<td>7M/3F</td>
</tr>
<tr>
<td>March 1997</td>
<td>116</td>
<td>18 (16%)</td>
<td>8/98 (9%)</td>
<td>1/18 (6%)</td>
<td>10/8</td>
<td>5M/3F</td>
</tr>
<tr>
<td>July 1997</td>
<td>15†</td>
<td>9 (60%)</td>
<td>–</td>
<td>3/9 (33%)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Sept/Oct 1997</td>
<td>26†</td>
<td>1 (4%)</td>
<td>–</td>
<td>0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>November 1997</td>
<td>92</td>
<td>5 (5%)</td>
<td>NA</td>
<td>NA</td>
<td>3/2</td>
<td>2M/1F</td>
</tr>
<tr>
<td>January 1998</td>
<td>183</td>
<td>10 (5%)</td>
<td>6/173 (3%)</td>
<td>1/10 (10%)</td>
<td>5/5</td>
<td>5M/3F</td>
</tr>
</tbody>
</table>

*NA* = not available.
† Individuals who tested positive at previous time points and were re-examined.

**Discussion**

Based on the results of this longitudinal survey in one community, we believe that *Cyclospora* is a common infection in Haiti and is not restricted to the HIV-positive population. Although we did not test HIV status on any of the participants in the present study, the prevalence in this community is estimated by local health care providers to be 2–3%. Although *Cyclospora* seems to be associated with severe diarrhea in the HIV population, in our study group, most persons passing oocysts had stool consistency graded as soft to formed. In Peru, the prevalence of diarrhea in children ranged between 11% and 28%, figures slightly higher than reported here. It is more difficult to compare the results of the present study to those published for Nepal, since those were conducted in a population that were seen in a diarrhea clinic, and were thus skewed towards persons with clinical manifestations. In the present study, participants were seen at home, and diarrhea was used as the primary clinical feature for which an association was sought. In studies in travelers and foreign residents in Nepal, other more subtle clinical features such as malaise, nausea, fatigue, increased gas, or weight loss were recorded for *Cyclospora*-positive individuals seen at a diarrhea clinic. Given the living conditions of the majority of the population in the present study, it is not likely that these clinical conditions could be evaluated or differentiated from background.

In the present study, because so many of the individuals were asymptomatic, the medical staff at the hospital who provided medical back-up for the study chose to adopt a policy to not treat those infected with *Cyclospora* unless diarrhea was prolonged for more than two or three days. This policy was reinforced by several reactions to sulpha drugs that were encountered among children who were treated (trimethoprim, 5 mg/kg; sulfamethoxazole, 25 mg/kg twice a day for seven days) for their *Cyclospora* infection. The parents and medical staff alike found the sulpha reaction and the attendant care to be much more troubling than the diarrhea. Daily stool samples were collected from several of the treated individuals, and between days 3 and 4 of treatment, oocysts could no longer be detected.

Because we were not conducting surveillance, we must exercise caution in extrapolating our results to the community level. However, the data are certainly suggestive that...
there is seasonality in the occurrence of *Cyclospora* infection in Haiti. Haiti does not have a well-characterized rainy season, although there is a clear decrease in rainfall during the late fall and winter months. However, this encompasses only a difference of several inches of rainfall from one month to the next. On the other hand, *Cyclospora* infections were most prevalent during January through April, the coolest months. The factors that influence seasonality of *Cyclospora* are often thought to be associated with the warm and/or rainy season, but may be different in different geographic areas. In Guatemala, the prevalence of *Cyclospora* markedly increases when the rainy season begins (Bern C, unpublished data). In Lima, Peru, however, which is located in a high desert region, rainfall is minimal and temperature fluctuations may initiate the season. In our study site in Haiti, which is at sea level and the most tropical of the sites where *Cyclospora* has been studied in any detail, temperature fluctuations seem to more closely follow the *Cyclospora* infection rates, and may be the more likely modulator of the infection seasonality. In tropical areas, high temperatures may be detrimental to survival of oocysts, thus the relatively cooler time of the year corresponds to peak transmission season.

Since the study was longitudinal in nature, we were able to monitor many of the same persons over time. A significant percentage of individuals found to be infected in January were still passing oocysts three months later. Because no stool samples were examined between these two time points, we cannot be certain that these individuals did not lose their infection and become reinfected in the interval. Expanded studies to examine this issue would seem warranted, since they would have major implications for the epidemiology of the disease, as well as providing significant insight into the development of immunity and ability to become reinfected in a short time interval after previous infection. It should be noted that in all the positive cases, the number of oocysts observed on FE wet mounts or in stools stored in potassium dichromate was typically very low. We graded the numbers on an arbitrary scale, but more than 50% had fewer than 10 oocysts per coverslip of FE concentrate, and many of these had only one or two. Individuals scoring as having many oocysts, in fact, only had 30–50 oocysts per coverslip of FE concentrate. Interestingly, diarrhetic stool samples did not contain greater numbers of oocysts. In fact, most of the samples judged to have moderate to high numbers of oocysts were formed stools. We were not able to answer the question of whether the number of oocysts shed was a reflection of the age of the infection, the age of the individual, or whether possible previous exposure modulated the numbers. However, many of the infections were detected in young children, some as young as three months, and even in these cases, the number of oocysts was always low. This is a general pattern also observed in Peru and Guatemala, where most infections seem to result in small numbers of organisms being passed, at least in immunocompetent persons.

The present data suggest that *Cyclospora* infections in Haiti are more common in children than adults. This needs to be investigated through more rigorouse collection of surveillance data before extrapolating these results to the general population. In Peru, infection is rare among adults living in shanty towns, suggesting that exposure and immunity develop early in life.

*Cyclospora cayetanensis* appears to be a relatively common infection in this rural Haitian community, but with a marked seasonality. Further studies are clearly needed to establish whether children have a higher infection rate than adults, and to more clearly establish the role of *Cyclospora* in causing diarrhea in this community. The present study does, however, expand considerably our understanding of *Cyclospora* in Haiti.

Authors’ addresses: Mark L. Eberhard, Eva K. Nace, Amanda R. Freeman, Alexandre J. da Silva, and Patrick J. Lammie, Division of Parasitic Diseases, Centers for Disease Control and Prevention, Mailstop F-13, 4770 Buford Highway, NE, Atlanta, GA 30341–3724. Thomas G. Streit, Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556.

Reprint requests: Mark L. Eberhard, Division of Parasitic Diseases, Centers for Disease Control and Prevention, Mailstop F-13, 4770 Buford Highway, NE, Atlanta, GA 30341–3724.

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