

Prevalence of *Giardia lamblia* and Risk Factors for Infection Among Children Attending Day-Care Facilities in Denver

THOMAS E. NOVOTNY, MD
RICHARD S. HOPKINS, MD, MSPH
PAMELA SHILLAM
EDWARD N. JANOFF, MD

Dr. Novotny is a Medical Epidemiologist with the Office on Smoking and Health, Centers for Disease Control. Dr. Hopkins is an Assistant Professor with the Department of Preventive Medicine, Ohio State University. Ms. Shillam is a Senior Disease Control Specialist with the Colorado Department of Health in Denver. Dr. Janoff is Assistant Professor of Medicine at the University of Minnesota School of Medicine, and is on the staff of the Infectious Disease Section, Veterans Administration Medical Center, Minneapolis.

Tearsheet requests to Thomas E. Novotny, MD, Park Bldg. 1-10, Rockville, MD 20857.

Synopsis

A sample of children in the toddler age group was surveyed in Denver, CO, to determine the prevalence of Giardia lamblia and to identify risk factors for the intestinal disease. The sample consisted of 236 children attending day-care centers (DCC) and 79 who were not attending.

Thirty-eight children (16 percent) attending DCCs and 7 (9 percent) who had not were positive for G. lamblia in stool samples. Risk factors for those attending DCC facilities included increasing duration of attendance, time per week attending DCCs, low family income, and large family size. The only risk factor for those not attending DCC facilities was travel to Colorado mountains.

Multivariate analysis showed that risk factors for all children in the sample included travel to Colorado mountains, large family size, and attending DCC facilities. Infection was not associated with symptoms.

GIARDIA LAMBLIA is the most commonly identified bowel parasite in the United States (1). A 1977 study of giardiasis in Colorado suggested that two-thirds of investigated cases were attributable to drinking untreated water in the mountains (2). However, interviews of Colorado residents with reported cases of giardiasis in 1983 indicated that 46 percent of all *G. lamblia* infections may have been associated with children attending day-care centers (DCC), or person-to-person spread from diaper-age children (3).

We conducted stool and questionnaire surveys of randomly selected children in the toddler age group in the Denver area in order to determine *G. lamblia* prevalence and risk factors related to attending DCCs. As an outbreak of cryptosporidiosis had occurred in a DCC in Denver just prior to our survey, we also examined stool specimens for this parasite. Reports of cryptosporidiosis outbreaks in DCCs have appeared recently (4,5).

Methods

A DCC toddler was defined as a child aged 12 to 42 months being cared for in that part of a DCC facility designated for toddlers. A DCC was defined as a facility caring for eight or more children.

A two-stage cluster sampling technique was used to select toddlers from DCCs in the metropolitan Denver area. The process ensured that each toddler had an equal chance of selection, without bias resulting from DCC size (6). The size of the sample to be selected was estimated at 259, based on an expected 25 percent prevalence of *G. lamblia*. Thus, 37 clusters of seven children each were needed from 118 eligible DCCs. We used a table of random numbers to select the starting DCC and child in a cluster, the two stages of the sampling technique.

A comparison group of toddlers not attending a DCC was selected from four large prepaid health-plan clinics and from the well-child clinic of a large local health department. We selected well children aged 12 to 42 months who had no history of attending a DCC.

The DCC staff collected one preserved stool specimen from each attending subject. Parents collected specimens from children in the comparison group. The specimens from both groups were examined for *G. lamblia* at the Colorado Department of Health laboratory using formalin-ether sedimentation concentration (7) and the Wheatley modified trichrome stain (8). Each concentrated

specimen also was stained for *Cryptosporidium* oocysts with the modified Kinyoun Acid-Fast (cold) Technique (9).

A questionnaire addressing risk factors for giardiasis was given parents of selected children. Risk factors included family size, household income, history of giardiasis or diarrhea in the family, drinking water sources, travel to Colorado mountains or out-of-State travel in the 2 months prior to sampling, history of attending a day-care home (defined as a facility caring for fewer than eight children), length of time in a DCC, and number of hours per week in a DCC. Symptoms of diarrhea, abdominal discomfort, or poor weight gain in the 2 months prior to sampling were determined.

DCC supervisors were questioned about the size of the DCC, number of attendees, separation of diapered and non-diapered children, child-to-staff ratios, training of staff, type of diapers used, number of diaper-changing areas and sinks, and policies concerning food preparation and exclusion for illness. These data were linked to selected DCC children.

Rate ratios (RR) and 95-percent confidence limits (CL) for each variable were calculated. Multivariate logistic regression (MLR) analyses were performed. Risk factors included as parameters in the models were those found to have elevated RRs in the univariate analyses, as well as those risk factors shown in other studies, to be associated with *G. lamblia* infection (10). Odds ratios and 95-percent CLs are reported.

Results

Stool specimens were submitted for 236 of 259 (91 percent) selected children attending DCCs from 37 cooperating DCCs (38 clusters). The sample represented 11 percent of all toddlers attending licensed DCCs in the Denver area and 32 percent of all DCCs with toddlers. Specimens were submitted for 79 of 100 (79 percent) selected nonattending subjects. The DCC-attending and nonattending groups did not differ by age, gender, ethnicity, or socioeconomic status.

Thirty-eight of the 236 children (16 percent) attending DCCs and 7 of 79 (9 percent) not attending were positive for *G. lamblia* in the stool. The prevalence in the DCC population was higher than, but not significantly different, from the prevalence in the non-DCC population (RR 1.8, 95-percent CL 0.8, 3.8). *Cryptosporidium* was identified in only two DCC-attending toddlers (0.8 percent) and in none of the nonattending.

Table 1. Selected risk factors associated with *Giardia lamblia* infection among toddlers attending day-care facilities in Denver

Variable	Positive (N = 38)	Negative (N = 198)	Rate ratios	95-percent CL
Family income less than \$20,000 per year	16	30	2.8	1.6, 4.6
Family size 4 members or more	22	75	1.5	1.0, 2.1
Family history of giardiasis	3	7	2.2	0.4, 9.2
Family history of diarrhea	10	38	1.4	0.7, 2.5
Drank untreated water	4	13	1.6	0.4, 4.8
Traveled to Colorado mountains	16	62	1.3	0.8, 2.0
Attended day-care center 6 months or longer	32	133	1.3	1.0, 1.4
Attended day-care center 20 hours per week or more	34	148	1.2	1.0, 1.3
Attended day-care home	11	81	0.7	0.4, 1.2

NOTE: CL = confidence limits.

'Eradication of G. lamblia in all infected day-care children is not practical because of the constant potential for reinfection and the cost and side effects of treatment.'

Table 1 shows the association of *G. lamblia* in stools of DCC-attending toddlers with attending a DCC 6 months or longer, attending 20 hours a week or longer, a family size of four or more, and a family income of \$20,000 a year or less. The association between infection and duration of DCC attendance remained significant after controlling for age of child. We selected parental income, hours per week in a DCC, duration of DCC attendance in months, age, family size, and attending a day-care home as independent variables in a MLR model. Only larger family size (four or more members) was significantly associated with *G. lamblia*-positive stools (table 2).

Six of the seven infected children not attending a DCC had traveled to Colorado mountains in the 2 months prior to sampling (table 3), compared with 21 of 72 noninfected children (RR 2.9, 95-percent CL 1.3, 3.6). No other risk factors were identified for nonattending children. We analyzed risk factors for aggregated DCC-attending and nonattending

Table 2. Estimated odds ratios and confidence limits (CL) for risk factors for *Giardia lamblia* infection among toddlers attending and not attending day-care facilities in Denver (multivariate analyses)

Variable	Odds ratio	95-percent CL
Attending day-care facilities:		
Family income less than \$20,000 a year	1.4	0.5, 5.1
Family size 4 members or more ..	2.1	1.6, 7.1
Attended day-care center 6 months or longer	1.4	0.9, 3.9
Attended day-care center 20 hours per week or more	1.3	0.8, 3.9
Attended day-care home	0.8	0.3, 4.5
Age (continuous variable)
Aggregate of those attending and those not attending day-care facilities:		
Family income less than \$20,000 a year	1.1	0.7, 6.4
Family size 4 members or more	1.8	1.2, 9.0
Traveled to Colorado mountains	2.0	1.3, 9.8
Attended day-care center 6 months or more	2.4	1.9, 7.8
Attended day-care home	0.6	0.4, 10.1
Age (continuous variable)

Table 3. Selected risk factors associated with *Giardia lamblia* infection among toddlers not attending day-care facilities in Denver

Variable	Positive (N = 7)	Negative (N = 72)	Rate ratios	95-percent CL
Family income less than \$20,00 per year	0	19
Family size 4 members or more	6	46	1.3	0.7, 1.6
Family history of giardiasis	2	9	2.3	0.3, 7.5
Family history of diarrhea	2	10	2.1	0.2, 6.6
Drank untreated water ...	1	7	1.5	0.03, 8.3
Traveled to Colorado mountains	6	21	2.9	1.3, 3.6
Attended day-care home ..	4	28	1.5	0.5, 2.5

NOTE: CL = confidence limits.

'Handwashing and proper diaper-changing techniques reduce the spread of enteric pathogens and are more acceptable options to control the organism than the medical treatment of asymptomatic carriers.'

subjects, again using MLR. Independent variables included attending a DCC, age, family size, travel to mountains, parental income, and attending a DCC home. Travel to mountains, attending a DCC, and large family size were associated with *G. lamblia* (table 2). When toddlers who had recently traveled to mountains were excluded, 21 of 158 subjects attending DCCs and 1 of 52 not attending were positive for *G. lamblia* in stools (RR 7.8, 95-percent CL 1.1, 44.5). *G. lamblia* was not associated with reported diarrhea, gastrointestinal symptoms, or poor weight gain in either DCC-attending or non-attending subjects.

Of the characteristics of DCCs reported by supervisors, only cloth diaper use was associated with giardiasis (5 of 10, as opposed to 29 of 162 for noncloth diaper use [RR 2.8, 95-percent CL 1.23, 6.32]). When children from the only center that used cloth diapers exclusively were excluded, cloth diaper use was no longer a significant risk.

Discussion

More than 11 million children in the United States receive day care outside the home (11). Public health personnel frequently investigate outbreaks of diarrheal disease in DCCs, and *G. lamblia* often is discovered in asymptomatic children (12). The significance of the asymptomatic carrier state is not completely known, but studies of DCC children in Texas (13) and Israel (14) suggest no long-term adverse effects.

Because *G. lamblia* has been a common cause of waterborne outbreaks of diarrheal disease in Colorado (15), we expected to find a high prevalence of this organism in Denver children. We found that Denver-area DCC-attending subjects actually had a lower prevalence than had been reported in other States (13, 16-18). We also found a prevalence of 9 percent in subjects not attending DCCs. Although the sample size was small, the rate contrasts sharply with a 2 percent prevalence found in other studies of subjects not attending DCCs (16,17). Because we used only a single stool specimen, a method whose sensitivity is about 85 percent (16), our results could underreport the prevalence of *G. lamblia* by about 15 percent.

Few data are available on the background prevalence of *Cryptosporidium* in DCCs in the non-outbreak setting (19). We found that less than 1 percent of DCC-attending subjects (2 children) were infected with the parasite in Denver; both infected children were symptomatic. The data suggest that in contrast to *G. lamblia* infections,

Cryptosporidium infections are not endemic in Denver DCCs.

The use of cluster sampling for DCC-attending subjects may have decreased the precision of the prevalence estimates. The clusters were small, but the children selected appeared to be representative of all children that age attending DCCs in Denver. The main reason for cluster sampling was to obtain a truly random sample of all DCC-attending subjects; other studies have usually sampled several DCCs completely, thus sacrificing population representation.

In Colorado, traveling to the mountains and consuming untreated or inadequately treated water is likely to be a recurrent source of *G. lamblia* infection for both DCC-attending and non-attending toddlers; DCC attendance provides the potential for person-to-person spread in this vulnerable group.

Recommendations

The frequency of asymptomatic giardiasis in this and other studies demonstrates that *G. lamblia* infection usually is well tolerated. We do not recommend that children without symptoms be treated or excluded from DCCs. We suggest, however, that parents of stool-positive children consult a physician if diarrhea becomes prolonged, because chronic symptomatic disease has been associated with growth disturbance (20).

Eradication of *G. lamblia* in all infected DCC-attending children is not practical because of the constant potential for reinfection and the cost and side effects of treatment. Current guidelines regarding disinfection and handwashing were reinforced to the participating DCCs. Handwashing and proper diaper-changing techniques reduce the spread of enteric pathogens (21) and are more acceptable options to control the organism than the medical treatment of asymptomatic carriers.

References.....

1. Centers for Disease Control: Intestinal parasite surveillance, United States, 1976. MMWR 27: 167-168, May 19, 1978.
2. Wright, R. A., et al.: Giardiasis in Colorado: an epidemiologic study. Am J Epidemiol 105: 330-336 (1977).
3. Colorado Department of Health: Giardiasis in Colorado: a summary of questionnaire data from reported cases. Colorado Dis Bull 12: 1-2 (1984).
4. Centers for Disease Control: Cryptosporidiosis among children attending day-care centers—Georgia, Pennsylvania, Michigan, California, New Mexico. MMWR 33: 599-601, Oct. 26, 1984.

5. Taylor, J. P., et al.: Cryptosporidiosis outbreak in a day-care center. Am J Dis Child 139: 1023-1025 (1985).
6. Levy, P. S., and Lemeshow, S.: Sampling for health professionals. Lifetime Learning Publications, Belmont, CA, 1980.
7. Ritchie, L. S.: An ether sedimentation technique for routine stool examination. Bull U.S. Army Med Dept 8: 326-334 (1948).
8. Melvin, D. M., and Brooke, M. M.: Laboratory procedures for the diagnosis of intestinal parasites. DHEW Publication No. (CDC) 75-8282. Centers for Disease Control, Atlanta, GA, 1974.
9. Garcia L. S., et al.: Techniques for the recovery and identification of *Cryptosporidium* oocysts from stool specimens. J Clin Microbiol 18: 185-190 (1983).
10. Greenberg, R. S., and Kleinbaum, D. G.: Mathematical modeling strategies for the analysis of epidemiologic research. Annu Rev Public Health 6: 223-245 (1985).
11. The Child Day Care Infectious Disease Study Group: Public health considerations of infectious diseases in child day care centers. J Pediatr 105: 683-701 (1984).
12. Bartlett, A. V., et al.: Diarrheal illness among infants and toddlers in day care centers. I. Epidemiology and pathogens. J Pediatr 107: 494-502 (1985).
13. Pickering, L. K., et al.: Occurrence of *Giardia lamblia* in children in day care centers. J Pediatr 104: 522 (1984).
14. Sagi, E. F., Shapiro, M., and Deckelbaum, R. I.: *Giardia lamblia*: prevalence, influence on growth, and symptomatology in healthy nursery children. Isr J Med Sci 19: 815-817 (1983).
15. Hopkins, R. S., et al.: Waterborne disease in Colorado: three year's surveillance and 18 outbreaks. Am J Public Health 75: 254-257 (1985).
16. Sealey, D. P., and Schuman, S. H.: Endemic giardiasis and day care. Pediatrics 72: 154-158 (1983).
17. Black, R. E., et al.: Giardiasis in day-care centers: Evidence of person-to-person transmission. Pediatrics 60: 486-491 (1977).
18. Craft, J. C.: *Giardia* and giardiasis in childhood. Ped Infect Dis 1: 196-211 (1982).
19. Wolfson, J. S., et al.: Cryptosporidiosis in immunocompetent patients. N Engl J Med 312: 1278-1281 (1985).
20. Farthing, M. J., et al.: Natural history of *Giardia* infection of infants and children in rural Guatemala and its impact on physical growth. Am J Clin Nutr 43: 395-405 (1986).
21. Black, R. E., et al.: Handwashing to prevent diarrhea in day-care centers. Am J Epidemiol 113: 445-451 (1981).