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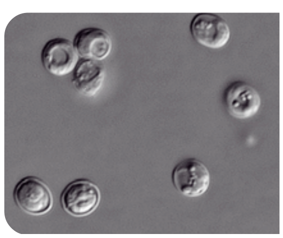
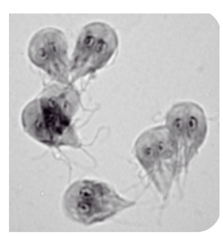
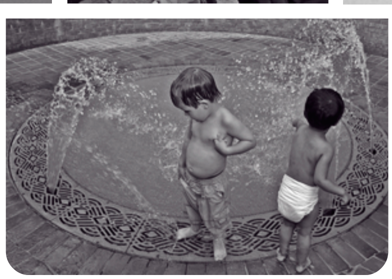
Cryptosporidiosis Surveillance — United States, 2003–2005

and

Giardiasis Surveillance — United States, 2003–2005







DEPARTMENT OF HEALTH AND HUMAN SERVICES

CENTERS FOR DISEASE CONTROL AND PREVENTION

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Cryptosporidiosis Surveillance — United States, 2003–2005

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Abstract

Problem/Condition: Cryptosporidiosis, a gastrointestinal illness, is caused by protozoa of the genus *Cryptosporidium*.

Reporting Period: 2003–2005.

System Description: State and two metropolitan health departments voluntarily reported cases of cryptosporidiosis through CDC's National Notifiable Diseases Surveillance System.

Results: During 2003–2005, the total number of reported cases of cryptosporidiosis increased from 3,505 for 2003 to 3,911 for 2004 and to 8,269 for 2005. All reporting areas submitted reports, with more reports from northern states. Compared with other age groups, a greater number of case reports were received for children aged 1–9 years and adults aged 30–39 years. Peak onset of illness occurred annually during early summer through early fall.

Interpretation: Transmission of cryptosporidiosis occurs throughout the United States, with increased diagnosis or reporting occurring in northern states. An increase in cases reported for 2005 was attributable primarily to the occurrence of a single large recreational water-associated outbreak. State incidence figures should be compared with caution because individual state surveillance systems have varying capabilities to detect cases, and reporting might vary. The seasonal peak in age-specific case reports coincides with the summer recreational water season and might reflect increased use of communal swimming venues (e.g., lakes, rivers, swimming pools, and water parks) by young children.

Public Health Action: Cryptosporidiosis surveillance provides data to educate public health practitioners and health-care providers about the epidemiologic characteristics and the disease burden of cryptosporidiosis in the United States. These data are used to improve reporting of cases, plan prevention efforts, and establish research priorities.

Introduction

Cryptosporidiosis is a gastrointestinal illness caused by protozoa of the genus *Cryptosporidium* (*1*). In otherwise well persons, clinical illness is characterized by watery diarrhea, which can be accompanied by abdominal cramps, loss of appetite, low-grade fever, nausea, vomiting, and weight loss; however, asymptomatic infection occurs frequently (*2*). *Cryptosporidium* also can cause an opportunistic infection in human immunodeficiency virus (HIV)–infected patients, who might experience life-threatening infection with profuse, watery, cholera-like diarrhea. However, incidence of this parasitic infection among the HIV-infected population has decreased since the introduction of highly active antiretroviral therapy (HAART) for HIV infection (*3*). Nitazoxanide is the only broad-spectrum antiparasitic drug that has been approved in the United States for treatment of cryptosporidiosis. Nitazoxanide can be prescribed for children aged >1 year and adults, but it has not proven effective for immunocompromised persons (*4,5*).

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Cryptosporidium is a genus of protozoan parasites within the phylum *Apicomplexa*, and its taxonomy continues to evolve. Cryptosporidiosis is a zoonotic disease that causes clinical disease in both humans and animals; species names are based primarily on the animal species serving as host (*6*). The majority of human isolates were believed previously to belong to a single species, *Cryptosporidium parvum*, but recent advances in molecular methods have led to a more complete understanding of the taxonomy of *Cryptosporidium*. Revised taxonomic understanding has clarified that multiple species infect humans, including *C. hominis* (known previously as *C. parvum* genotype I), which primarily infects humans, and *C. parvum* (known previously as *C. parvum* genotype II), which infects both humans and ruminants. To a lesser extent, human infections also have been documented with *C. felis,* from cats; *C. canis,* from dogs; *C. meleagridis,* from birds; *C. suis,* from pigs; *C. muris,* from rodents; and a *C. cervine* genotype from various animals (*6*). Illnesses caused by infection from the different *Cryptosporidium* species are similar clinically (*7*). Molecular studies also have demonstrated that humans are susceptible to multiple subtypes of *C. parvum* and *C. hominis* (*6*). Infected cattle serve as an important reservoir of *C. parvum* and therefore are substantial contributors to sporadic human cryptosporidiosis in certain areas (*8,9*). A study conducted during 1996–2004 in the United Kingdom suggests that improvements in drinking water treatment and source water protection might be responsible for decreasing the number of cryptosporidiosis cases in humans caused by *C. parvum* from ruminants (*10,11*). This benefit was influenced by the culling of cattle herds during the British outbreak of foot-and-mouth disease, which appeared to have had a substantial impact on the transmission peak occurring during the spring calving season (*10–12*).

Cryptosporidium infection is transmitted by the fecal-oral route and results from the ingestion of *Cryptosporidium* oocysts through the consumption of fecally contaminated food or water or through direct person-to-person or animal-to-person contact. The oocysts are infectious immediately upon being excreted in feces. The infectious dose is low; feeding studies have demonstrated that the ingestion of as few as 10–30 oocysts can cause infection in healthy persons (*13,14*). Infected persons have been reported to shed 10^8–10^9 oocysts in a single bowel movement and to excrete oocysts for up to 50 days after cessation of diarrhea (*15,16*).

Persons at increased risk for infection include 1) persons who have contact with infected animals, 2) persons who have ingested contaminated recreational (e.g., lake, river, pool, or hot tub) or drinking water, 3) close contacts of infected persons (e.g., those in the same family or household or in day care settings), and 4) travelers to disease-endemic areas (*1,8,9*)

Although cryptosporidiosis cases occur sporadically, outbreaks have been well documented since the first reported U.S. drinking water-associated outbreak in 1984 (*17*) and the first U.S. recreational water-associated outbreak in 1988 (*18*). During 1988–2004, *Cryptosporidium* was identified as the causal agent of 33% (63 of 189) of reported recreational water-associated outbreaks and of 5.5% (12 of 219) of reported drinking water-associated outbreaks of gastroenteritis (*18–29*). *Cryptosporidium* has emerged as the most frequently recognized cause of recreational water-associated outbreaks of gastroenteritis, particularly in treated (disinfected) venues. In addition, foodborne outbreaks of cryptosporidiosis linked to ill foodhandlers and unpasteurized apple cider have been reported (*30,31*). Outbreaks resulting from person-to-person transmission in day care centers and from animal-to-person transmission in an animal nursery also have been reported (*32,33*).

In 1994, the Council of State and Territorial Epidemiologists agreed to reporting of cryptosporidiosis as a nationally notifiable disease; the first full year for reporting began in 1995. Surveillance data for 1995–2002 have been published previously (*34,35*). This report summarizes national cryptosporidiosis surveillance data for 2003–2005.

Methods

A confirmed case is one that has a positive laboratory finding. Confirmed cases of cryptosporidiosis in humans are reported voluntarily to CDC. Confirmed cryptosporidiosis is defined as the detection (in symptomatic or asymptomatic persons) of *Cryptosporidium*

- oocysts in stool or intestinal fluid by microscopic examination with or without staining (e.g., modified acid-fast) or by fluorescent antibody assays, either direct (DFA) or indirect (IFA); or
- oocyst or sporozoite antigens in stool or intestinal fluid by immunodiagnostic methods (e.g., enzyme immunoassay [EIA]); or
- parasite DNA in stool, in intestinal or other bodily fluids (e.g., bile or sputum), or in tissue samples by polymerase chain reaction techniques when available; or
- life-cycle stages (e.g., trophozoites or merozoites) in tissue samples (*36,37*).

A probable case of cryptosporidiosis is a clinically compatible case that is linked epidemiologically to a confirmed case. Because the case definition used by CDC does not include probable cases (*36*), certain states or areas report only confirmed cases of cryptosporidiosis. However, certain jurisdictions also report probable cases. A discussion has been initiated with partners regarding adding probable cases to the case definition. This surveillance summary includes both confirmed and probable cases as reported by jurisdictions.

Testing for *Cryptosporidium* is not always included in routine examination of stool for ova and parasites (*1*). Commercially available immunoassay kits are available and might be more sensitive and specific than routine microscopic examination. DFA is an extremely sensitive and specific detection method and is considered the “gold standard” by many laboratorians; other immunodiagnostic kits that do not require microscopy (e.g., EIA and rapid immunochromatographic cartridge assays) also are available (*38*). Rapid immunoassays do not take the place of routine ova and parasite examination but might be useful in diagnosing *Cryptosporidium* infections. Only molecular testing (e.g., polymerase chain reaction) can be used to speciate *Cryptosporidium*; however, no species data are reported to CDC.

State, District of Columbia (DC), and New York City (NYC) health department jurisdictions voluntarily report cases of cryptosporidiosis to CDC through the National Notifiable

Diseases Surveillance System (NNDSS). Reports include the patient's place of residence (i.e., state and county), age, sex, race, ethnicity (i.e., Hispanic or non-Hispanic) and date of illness onset and indicate whether the case is linked to a known outbreak. An outbreak-related case is a laboratory-confirmed or probable case that is linked epidemiologically to at least one laboratory-confirmed case. Before analysis, these surveillance data were verified for accuracy by the reporting source and were finalized as of February 16, 2007. Because this surveillance summary includes probable cases of cryptosporidiosis and the data were finalized by the reporting jurisdiction more recently, the number of cases might differ slightly from the number reported in CDC's annual Summary of Notifiable Diseases.

Analysis of national cryptosporidiosis surveillance data for 2003–2005 was conducted using SAS® v.9.1 (SAS Institute Inc.; Cary, North Carolina) and the Food Safety Information Link (FSI Link). FSI Link is an intranet-based tool available to CDC staff that provides access to NNDSS data and is used to monitor trends in, and investigate outbreaks of, reportable foodborne and waterborne diseases. Population data from the U.S. Census Bureau were used to calculate incidence rates.

Results

During 2003–2005, the total number of reported cases of cryptosporidiosis increased 11.6%, from 3,505 for 2003 to 3,911 for 2004, and then increased 111.4% to 8,269 for 2005 (Table 1). Cases reported to be outbreak related ranged from 6.6% of all cases reported for 2003 to 41.7% of all cases reported for 2005 (Table 1). All jurisdictions reported cryptosporidiosis cases during the reporting period, and the number of jurisdictions reporting more than four cases per 100,000 population increased from five in 2003 to seven in 2005 (Table 1).

For 2005, incidence of cryptosporidiosis per 100,000 population ranged from 0.1 cases (in multiple states) to 18.2 cases (in New York), with 12 jurisdictions reporting >2.5 cases per 100,000 population (Figure 1; Table 1). The higher incidence of cryptosporidiosis in New York was influenced by a single large outbreak among >3,000 persons. Increased reporting of cases occurred in northern states.

These surveillance data display a bimodal age distribution, with the greatest number of reported cases occurring among children aged 1–9 years and among adults aged 30–39 years (Figure 2). Increased reporting among younger children in 2005 was influenced by reporting of a single large outbreak in New York that comprised many probable cases. When reports for which a patient's sex was unknown or missing are excluded, the percentage of cases reported to have occurred among males varied annually from 49.6% (4,069 of 8,197) for 2005 to 55.9% (1,919 of 3,430) for 2003 (Table 2).

A tenfold increase in reported cryptosporidiosis cases by illness onset date occurred during June–October compared with January–March (Figure 3). Age-specific analysis indicated that the seasonality in onset of illness was exhibited across all age groups, particularly among children aged 1–4 and 5–9 years (Figure 4).

The majority of cases for which data on race were available for 2003–2005 occurred among whites, followed by blacks, Asians/Pacific Islanders, and American Indians/Alaska Natives (Table 2). However, data on race were lacking for 28.3%–47.1% of total annual case reports. Of patients for whom data on ethnicity were reported, 10.5%–11.5% were reported to be Hispanic (Table 2). However, data on ethnicity were lacking for 41.0%–60.9% of total annual case reports for 2003–2005.

Discussion

National cryptosporidiosis surveillance data are used to assess the epidemiologic characteristics and disease burden of cryptosporidiosis in the United States. The total number of cases reported annually increased during 2003–2005. Whether this increase reflects changes in reporting patterns and diagnostic testing practices or a real change in infection and disease caused by *Cryptosporidium* is unclear but was clearly influenced by outbreak-related case reporting. Outbreak-related probable case reporting does not account for the entire increase in reporting (Figure 5). This increase also follows the introduction of nitazoxanide, the first licensed treatment for the disease (*4*). Nitazoxanide was licensed in 2002 for children aged 1–11 years and in 2004 for children aged >11 years and adults. This drug introduction might have affected clinical practice by increasing the likelihood of health-care providers requesting *Cryptosporidium* testing, leading to an increase in subsequent case reports. The geographic variation, age distribution, and late-summer through early-fall seasonality were consistent with previous cryptosporidiosis surveillance summaries (*34,35*).

Cryptosporidiosis is widespread geographically in the United States. These data and data from previous national cryptosporidiosis surveillance summaries indicate that the diagnosis or reporting of cryptosporidiosis might be higher in northern states (*34,35*). However, differences in cryptosporidiosis surveillance systems and reporting among states can affect the capability to detect and report cases, making interpretation of this observation difficult.

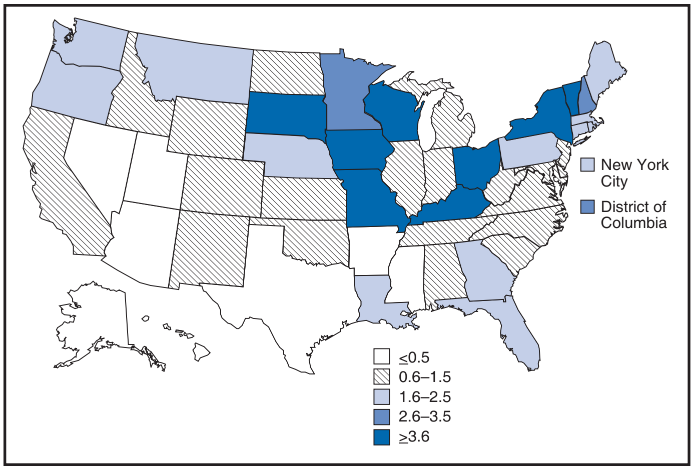
TABLE 1. Number* and percentage† of cryptosporidiosis case reports, by jurisdiction — United States,§ 2003–2005

Jurisdiction	2003				2004				2005			
	No.	(%)	Rate¶	No. outbreak cases**	No.	(%)	Rate	No. outbreak cases	No.	(%)	Rate	No. outbreak cases
Alabama	56	(1.6)	1.2		25	(0.7)	0.6		29	(0.4)	0.6	
Alaska	1	(<0.1)	0.2		NR††				3	(<0.1)	0.5	
Arizona	6	(0.2)	0.1		17	(0.5)	0.3		11	(0.1)	0.2	
Arkansas	22	(0.6)	0.8		16	(0.4)	0.6		8	(0.1)	0.3	
California	287	(8.2)	0.8		574	(14.7)	1.6	336	214	(2.6)	0.6	
Colorado	38	(1.1)	0.8		59	(1.6)	1.3		50	(0.6)	1.1	8
Connecticut	20	(0.6)	0.6		31	(0.9)	0.9		84	(1.0)	2.4	
Delaware	5	(0.1)	0.6		1	(0.0)	0.1		6	(0.1)	0.7	
District of Columbia	14	(0.4)	2.5		16	(0.4)	2.9		18	(0.2)	3.3	
Florida	128	(3.7)	0.8	14	149	(4.1)	0.9	7	350	(4.2)	2.0	83
Georgia	122	(3.5)	1.4		177	(4.9)	2.0		152	(1.8)	1.7	
Hawaii	NR				2	(0.1)	0.2		1	(<0.1)	0.1	
Idaho	27	(0.8)	2.0		28	(0.8)	2.0		15	(0.2)	1.0	
Illinois	102	(2.9)	0.8		161	(4.4)	1.3	37	160	(1.9)	1.3	17
Indiana	126	(3.6)	2.0		79	(1.0)	1.3		94	(1.1)	1.5	
Iowa	122	(3.5)	4.1	38	90	(2.5)	3.0	1	122	(1.5)	4.1	24
Kansas	174	(5.0)	6.4	96	31	(0.9)	1.1		40	(0.5)	1.5	7
Kentucky	27	(0.8)	0.7		47	(0.6)	1.1	2	149	(1.8)	3.6	102
Louisiana	5	(0.1)	0.1		7	(0.2)	0.2		83	(1.0)	1.8	25
Maine	20	(0.6)	1.5		22	(0.6)	1.7		30	(0.4)	2.3	
Maryland	29	(0.8)	0.5		26	(0.7)	0.5		34	(0.4)	0.6	
Massachusetts	78	(2.2)	1.2		58	(1.6)	0.9		152	(1.8)	2.4	3
Michigan	152	(4.3)	1.5	1	157	(4.3)	1.6	2	112	(1.4)	1.1	1
Minnesota	155	(4.4)	3.1	23	147	(4.0)	2.9		166	(2.0)	3.2	6
Mississippi	10	(0.3)	0.3		30	(0.8)	1.0		3	(<0.1)	0.1	
Missouri	52	(1.5)	0.9		78	(2.1)	1.4		246	(3.0)	4.2	
Montana	18	(0.5)	2.0		34	(0.9)	3.7	16	23	(0.3)	2.5	
Nebraska	33	(0.9)	1.9		29	(0.8)	1.7		29	(0.4)	1.6	
Nevada	8	(0.2)	0.4		2	(0.1)	0.1		13	(0.2)	0.5	
New Hampshire	26	(0.7)	2.0	26	30	(0.8)	2.3		40	(0.5)	3.1	
New Jersey	19	(0.5)	0.2		46	(1.3)	0.5		58	(0.7)	0.7	
New Mexico	17	(0.5)	0.9		21	(0.6)	1.1		18	(0.2)	0.9	
New York§§	266	(7.6)	1.4		323	(8.9)	1.7	49	3,513	(42.5)	18.2	2,995¶¶
New York City	126	(3.6)	1.5		(138)	(3.8)	1.7		(148)	(1.8)	1.8	1
North Carolina	57	(1.6)	0.7	2	76	(0.9)	0.9	6	92	(1.1)	1.1	
North Dakota	15	(0.4)	2.4		12	(0.3)	1.9		5	(0.1)	0.8	
Ohio	171	(4.9)	1.5	21	224	(6.2)	2.0	33	774	(9.4)	6.8	124
Oklahoma	24	(0.7)	0.7		22	(0.6)	0.6		46	(0.6)	1.3	
Oregon	36	(1.0)	1.0		32	(0.9)	0.9	1	69	(0.8)	1.9	26
Pennsylvania	167	(4.8)	1.4	3	208	(5.7)	1.7		271	(3.3)	2.2	5
Rhode Island	17	(0.5)	1.6		4	(0.1)	0.4		19	(0.2)	1.8	
South Carolina	16	(0.5)	0.4		24	(0.7)	0.6		24	(0.3)	0.6	
South Dakota	49	(1.4)	6.4		44	(1.2)	5.7	2	31	(0.4)	4.0	
Tennessee	43	(1.2)	0.7		49	(1.3)	0.8		49	(0.6)	0.8	
Texas	80	(2.3)	0.4		105	(2.9)	0.5		115	(1.4)	0.5	1
Utah	20	(0.6)	0.8		6	(0.2)	0.2		11	(0.1)	0.4	1
Vermont	32	(0.9)	5.2		25	(0.7)	4.0		39	(0.5)	6.3	
Virginia	56	(1.6)	0.8		66	(1.8)	0.9		77	(0.9)	1.0	
Washington	62	(1.8)	1.0		63	(1.7)	1.0		100	(1.2)	1.6	
West Virginia	4	(0.1)	0.2		6	(0.2)	0.3		21	(0.3)	1.2	
Wisconsin	486	(13.9)	8.9	6	428	(11.8)	7.8	8	497	(6.0)	9.0	
Wyoming	5	(0.1)	1.0		4	(0.1)	0.8		3	(<0.1)	0.6	
Total	**3,505**		**1.2**	**230**	**3,911**		**1.3**	**500**	**8,269**		**2.8**	**3,445**

Sources: Population estimates are from the Population Division, U.S. Census Bureau. Annual estimates of the population for the United States: April 1, 2001 to July 1, 2005 (NST-EST 2005 01) available at http://www.census.gov/popest/states/tables/NST-EST2005-01.xls. Estimates of the New York City population: Annual estimates of the population for incorporated places over 100,000, ranked by July 1, 2005 population: April 1, 2001 to July 1, 2005 (SUB-EST 2005-01) available at http://www.census.gov/popest/cities/tables/SUB-EST2005-01.xls.

* Certain jurisdictions report probable cases despite this category being absent from the CDC case definition.
† Percentages might not total 100% because of rounding.
§ No reports were received from Puerto Rico, Freely Associated States, or U.S. territories.
¶ Per 100,000 population on the basis of U.S. Census Bureau population estimates.
** Number of cases linked epidemiologically to a laboratory-confirmed case.
†† No cases reported.
§§ New York state case reports include New York City.
¶¶ Includes cases from a large recreational water outbreak in New York state.

FIGURE 1. Incidence* of cryptosporidiosis, by jurisdiction — United States, 2005



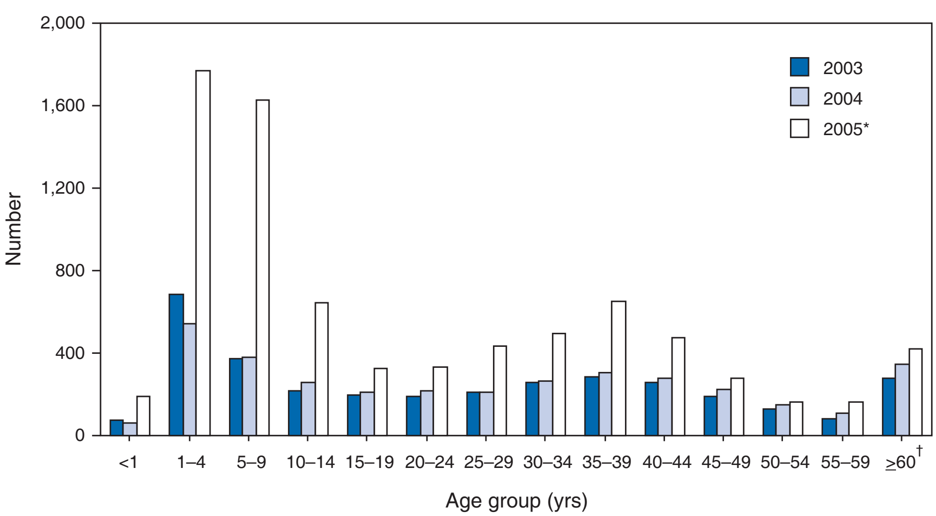
* Per 100,000 population.

Although cryptosporidiosis affects persons in all age groups, the number of reported cases was highest among children aged 1–9 years and adults aged 30–39 years (Figure 2). These data are consistent with reports of cryptosporidiosis incidence being higher among younger children and of transmission to their caregivers (e.g., child care staff, family members, and other household contacts) (*32,34,35,39,40*). Because information regarding immune system status is not collected as part of NNDSS cryptosporidiosis reporting, the number of immunosuppressed persons aged 30–39 years included in these surveillance data is unknown. However, the introduction of HAART therapy has decreased the amount of severe cryptosporidiosis being diagnosed in the United States (*3*).

A tenfold increase in transmission of cryptosporidiosis occurred during summer through early fall. This increase coincided with increased outdoor activities (e.g., swimming during the summer recreational water season) and might reflect use of community swimming (essentially communal bathing) venues by younger children (*8,18–29*). *Cryptosporidium* is the leading cause of reported recreational water-associated outbreaks of gastroenteritis (*19*). Transmission through recreational water is facilitated by the substantial number of *Cryptosporidium* oocysts that can be shed by a single person; the extended periods of time that oocysts can be shed (*15,16*); the low infectious dose (*13,14*); the resistance of *Cryptosporidium* oocysts to chlorine (*41*); and the prevalence of improper pool maintenance (i.e., insufficient disinfection, filtration, and recirculation of water), particularly of children's wading pools (*18–29,42*). This seasonal variation also has been noted in state, Canadian provincial, and previous U.S. national surveillance data for cryptosporidiosis and giardiasis (*34,35,39,40,43,45*).

The marked seasonal variation, higher incidence among children, and link to recreational water for cryptosporidiosis reflects the substantial increase in cases reported for 2005 compared with previous years (Figure 5). Of the 8,269 cases reported, 3,513 were reported by New York state, including 2,995 outbreak-related cases. In July–August, 2005, New York state experienced a cryptosporidiosis outbreak that sickened >3,000 persons, including at least 425 persons with confirmed cases, primarily children (*46*). The outbreak was associated with use of a recreational water interactive fountain (i.e., a fountain or water/spray feature intended for or accessible to recreational use that typically does not have standing water as part of the design). *C. hominis* was detected in patient stools and the holding tank of the interactive fountain. Although the interactive fountain was filtered and chlorinated, the treatment was not sufficient to inactivate *Cryptosporidium*, which has high chlorine resistance. This outbreak likely occurred as a result of fecal contamination by an infected patron and demonstrates why *Cryptosporidium* has become the leading cause of outbreaks of gastrointestinal illness associated with disinfected recreational water venues (*19*).

FIGURE 2. Number of cryptosporidiosis case reports, by age group and year — United States, 2003–2005



* Includes cases from a single large outbreak in New York state, primarily among children.
† Case reports decreased with increased age. For each 5-year subgroup, the number of reported cases was fewer than the number reported for persons aged 55–59 years.

TABLE 2. Number and percentage* of cryptosporidiosis case reports, by selected demographic characteristics — United States, 2003–2005

Demographic characteristics	2003 No.	2003 (%)	2004 No.	2004 (%)	2005 No.	2005 (%)
Sex						
Male	1,919	(54.8)	1,945	(49.7)	4,069	(49.2)
Female	1,511	(43.1)	1,608	(41.1)	4,128	(49.9)
Unknown/Missing	75	(2.1)	358	(9.2)	72	(0.9)
Total	**3,505**		**3,911**		**8,269**	
Race						
AI/AN†	21	(0.6)	14	(0.3)	13	(0.2)
API§	36	(1.0)	42	(1.1)	56	(0.7)
Black	269	(7.7)	339	(8.7)	378	(4.6)
White	2,140	(61.1)	2,146	(54.9)	3,587	(43.4)
Other	46	(1.3)	97	(2.5)	337	(4.1)
Unknown/Missing	993	(28.3)	1,273	(32.5)	3,898	(47.1)
Total	**3,505**		**3,911**		**8,269**	
Ethnicity						
Hispanic	235	(6.7)	247	(6.3)	339	(4.1)
Non-Hispanic	1,833	(52.3)	1,906	(48.7)	2,892	(35.0)
Unknown/Missing	1,437	(41.0)	1,758	(45.0)	5,038	(60.9)
Total	**3,505**		**3,911**		**8,269**	

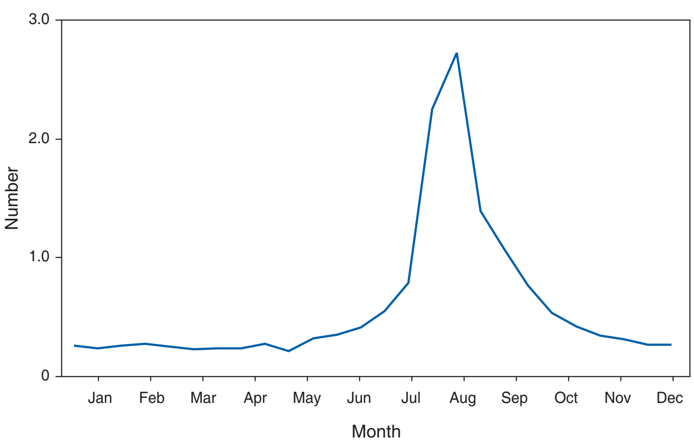
* Percentages might not total 100% because of rounding.
† American Indian/Alaska Native.
§ Asian/Pacific Islander.

Outbreak reports reflecting the multiple routes of transmission for cryptosporidiosis also were reported during 2003–2005. In 2003, unpasteurized apple cider made from contaminated apples sickened 144 persons with cryptosporidiosis (*47*). The cider was treated with ozone despite the fact that no data exist regarding the efficacy of ozone in treating food or juice products whose turbidity and low temperature render ozonation less effective. Also in 2003, a cryptosporidiosis outbreak that was associated with a middle- and high-school educational farm program was reported (*48*). Students participated in animal science classes and had contact with calves; transmission was associated with inadequate hygiene practices following animal contact. The propensity for cryptosporidiosis outbreaks to expand into communitywide outbreaks was underscored by a Kansas outbreak in 2003; the investigation identified 96 laboratory-confirmed cases of *Cryptosporidium* infection and >600 probable cryptosporidiosis cases (*19*). Multiple modes of transmission were identified, including swimming pools used by different swim teams and day camps and multiple day care facilities in which water activities were prevalent (*19*). The need to educate swim staff and develop work policies for employees who are ill with diarrhea was demonstrated by a 2004 outbreak associated with a recreational water park in California in which 336 people were sickened (*49*). Many water park employees were ill with a median onset date that preceded that for ill members of the public. Park policy required employees to be in the water regularly, and no policy was in place for reassigning employees who were ill with diarrhea (*49*).

Although previous surveillance reports have repeatedly demonstrated more reported cases among males (*34,35,39*), a majority of reported cases in 2005 occurred among females. Because data on race and ethnicity are incomplete, conclusions cannot be made about differences in the epidemiology of cryptosporidiosis among members of different racial and ethnic populations.

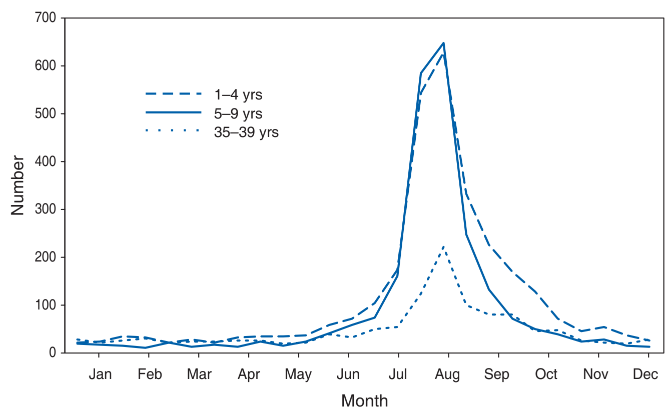
The data reported likely underestimate the cryptosporidiosis burden in the United States. Infection with enteric pathogens

FIGURE 3. Number* of cryptosporidiosis case reports, by month of illness onset — United States, 2003–2005



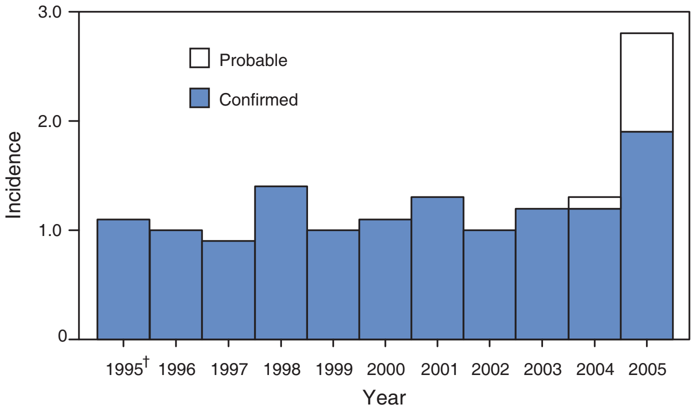
* In 1,000s.

FIGURE 4. Number of cryptosporidiosis case reports, by selected age group* and month of illness onset — United States, 2003–2005



* The 1–4- and 5–9-year age groups are presented because they have the highest numbers of cryptosporidiosis case reports and have the greatest seasonality. The 35–39-year age group was chosen to illustrate the less pronounced seasonality of the other age groups.

FIGURE 5. Incidence* of cryptosporidiosis, by year — United States, 2003–2005 (n = 40,510)



* Per 100,000 population.
† First full year of national reporting.

is highly underreported because 1) not all infected persons are symptomatic, 2) those who are symptomatic do not always seek medical care (*50,51*), 3) health-care providers infrequently include laboratory diagnostics in their evaluation of nonbloody diarrheal diseases (*50*), 4) a majority of laboratories do not test for *Cryptosporidium* unless it is specifically requested (*52*), and 5) case-reports are not always completed for positive laboratory results or forwarded to public health officials (*53*). The licensing of the first treatment for cryptosporidiosis (*4*) might influence health-care providers to request *Cryptosporidium* testing more often when ova and parasite exams are ordered. Although the true burden of cryptosporidiosis in the United States is unknown, an estimated 300,000 cases occur annually (*53*).

Its low infectious dose (*13*), protracted communicability (*15,16*), and chlorine resistance (*41*) make *Cryptosporidium* ideally suited for transmission through drinking and recreational water, food, and both person-to-person and animal-to-person contact. Although no formalized national prevention plan exists for cryptosporidiosis, multiple efforts are focused on reducing the transmission of the parasite through two major routes of transmission. For drinking water, the Environmental Protection Agency (EPA) has implemented multiple regulations designed to improve the safety of surface water (e.g., lakes and rivers) supplies, including multiple regulatory changes following an outbreak in 1993 in Milwaukee, Wisconsin, that sickened >400,000 persons using the city water supply (*19,20,54*). Since 1993, no *Cryptosporidium* outbreaks associated with use of community surface water supplies have occurred (*20,22–26*). The signing of EPA's Groundwater Rule in 2006 marked an increased effort to decrease the risk associated with use of groundwater (well) supplies (*20*). This regulatory change is likely to decrease the continued occurrence of *Cryptosporidium* outbreaks associated with groundwater use.

For recreational water, *Cryptosporidium* remains the leading cause of diarrheal illness outbreaks, especially in chlorinated venues (*19*). Efforts to reduce the transmission of this chlorine-resistant pathogen in pools will require a concerted effort to move beyond existing pool practices to include new technology (ultraviolet light or ozone inactivation), operational improvements (use of filtration enhancements that improve *Cryptosporidium* removal), and public education to reduce the continued swimming of people ill with diarrhea. In the United States, no federal oversight of chlorinated swimming venues occurs. All pool codes are reviewed and approved by state or local public health officials. As a result, no uniform national standards exist governing design, construction, operation, and maintenance of swimming pools and other treated recreational water venues. To provide guidance and improve pool code uniformity across the nation, CDC has initiated an effort to develop a National Model Aquatic Health Code and Risk Reduction Plan (available at http://www.cdc.gov/healthyswimming/model_code.htm). This effort will involve state, local, and federal public health officials and the aquatics industry in creating a voluntary model regulatory structure for state and local health departments to use in developing pool codes.

Continued vigilance regarding risk reduction efforts and improving diagnosis and reporting of cryptosporidiosis are needed to decrease the transmission of cryptosporidiosis in the United States. Recommendations include prevention measures (Box 1) and measures to improve surveillance for cryptosporidiosis and increase understanding of its epidemiology and the associated disease burden (Box 2). General information about cryptosporidiosis is available from CDC at http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht_cryptosporidiosis.htm.

Acknowledgments

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BOX 1. Recommendations to prevent and control cryptosporidiosis

Always practice good hand hygiene.

- Wash hands with soap and water for at least 20 seconds, rubbing hands together vigorously and scrubbing all surfaces
  - — after using the toilet,
  - — before handling food,
  - — after every diaper change (even if wearing gloves),
  - — after direct contact with preschool-aged children, and
  - — after any contact with animals or their feces.

Prevent contamination of recreational water (e.g., swimming pools, spas, interactive fountains, lakes, rivers, and oceans).

- Do not swim while experiencing diarrheal illness (e.g., swimming in or entering the water at pools, spas, interactive fountains, lakes, rivers, or oceans) and for 2 weeks after diarrhea or symptoms resolve if one has received a diagnosis of cryptosporidiosis or during an outbreak of cryptosporidiosis.
- Take children on frequent bathroom breaks and check their diapers often.
- Change diapers in the bathroom, not at the poolside.
- Wash children thoroughly (especially their bottoms) with soap and water after they use the toilet or their diapers are changed and before they enter the water.
- Shower before entering the water.

Information about recreational water illnesses and how to stop them from spreading is available from CDC at http://www.cdc.gov/healthyswimming.

Prevent infection and illness caused by water that might be contaminated.

- Do not swallow water in swimming pools, spas, or interactive fountains.
- Do not swallow untreated water from lakes, rivers, springs, ponds, streams, or shallow wells.
- Reduce persistent contamination of treated recreational water venues by having pool operators install in-line supplementary disinfection systems (e.g., ultraviolet light or ozone) to inactive this chlorine-resistant parasite.
- Do not drink inadequately treated water during communitywide outbreaks caused by contaminated drinking water.
- Do not use or drink inadequately treated water when traveling in countries where the water supply might be unsafe.
- If the safety of drinking water is in doubt,
  - — disinfect it by heating the water to a rolling boil for 1 minute, or
  - — use a filter that has been tested and rated by National Safety Foundation (NSF) Standard 53 or NSF Standard 58 for cyst reduction; filtered water will need additional treatment to kill or inactivate bacteria and viruses.

Information about preventing infection and illness caused by water that might be contaminated also is available from CDC at http://www.cdc.gov/healthyswimming. Information about water filters and bottled water is available from CDC at http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht_crypto_prevent_water.htm.

Prevent infection and illness caused by eating food that might be contaminated.

- Use properly treated water to wash all food that will be eaten raw.
- Do not eat uncooked foods when traveling in areas where cryptosporidiosis is common.

Prevent contact and contamination with feces during sex.

- Use a barrier during oral-anal sex.
- Wash hands immediately after handling a condom used during anal sex and after touching the anus or rectal area.

Additional recommendations for prevention and control of cryptosporidiosis for persons with compromised immune systems.

- Minimize contact with the stool of all animals, particularly young animals.
  - — Have others change litter boxes and clean cages.
  - — Wear disposable gloves when cleaning up after a pet and always wash hands when finished.
- Wash hands after any contact with animals or their living areas.
- Wash hands after gardening, even if wearing gloves.
- Wash, peel, and, if needed, cook, all raw vegetables.
- Boil or filter drinking water to ensure its safety, particularly in an area experiencing an outbreak; filtered water will need additional treatment to kill or inactivate bacteria and viruses.

BOX 2. Recommended measures to improve surveillance for cryptosporidiosis and increase understanding of its epidemiology and associated disease burden

- Encourage health-care providers to consider and specifically request testing for *Cryptosporidium* in the evaluation of gastrointestinal illness.
- Encourage laboratories that examine stool for ova and parasites to test routinely for *Cryptosporidium*.
- Continue to educate health-care providers as well as public and private laboratories to improve reporting of cases of cryptosporidiosis to jurisdictional health departments.
- Encourage jurisdictional health departments to transmit cryptosporidiosis data to CDC through the National Electronic Disease Surveillance System (NEDSS), which will replace the National Notifiable Diseases Surveillance System (NNDSS).
- Publish and distribute cryptosporidiosis surveillance data regularly for public health education purposes.
- Conduct further epidemiologic studies of the geographic variability, incidence, and risk factors for cryptosporidiosis.

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Giardiasis Surveillance — United States, 2003–2005

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Abstract

Problem/Condition: Giardiasis, a gastrointestinal illness, is caused by the protozoan parasite *Giardia intestinalis*.

Reporting Period: 2003–2005.

Description of System: State, commonwealth, territorial, and two metropolitan health departments voluntarily reported cases of giardiasis through CDC's National Notifiable Disease Surveillance System.

Results: During 2003–2005, the total number of reported cases of giardiasis remained relatively stable. Reporting increased from 20,084 for 2003 to 20,962 for 2004 and then decreased to 20,075 for 2005. A total of 49 jurisdictions reported giardiasis cases; the number of areas reporting >15 cases per 100,000 population increased from four areas in 2003 to seven in 2005. Compared with other age groups, a greater number of case reports were received for children aged 1–9 years and for adults aged 30–39 years. Incidence of giardiasis was highest in northern states. Peak onset of illness occurred annually during early summer through early fall.

Interpretation: Transmission of giardiasis occurs throughout the United States, with increased diagnosis or reporting occurring in northern states. State incidence figures should be compared with caution because individual state surveillance systems have varying capabilities to detect cases. The seasonal peak in age-specific case reports coincides with the summer recreational water season and might reflect increased outdoor activity and exposures such as use of communal swimming venues (e.g., lakes, rivers, swimming pools, and water parks) by young children.

Public Health Action: Giardiasis surveillance provides data to educate public health practitioners and health-care providers about the epidemiologic characteristics and the disease burden of giardiasis in the United States. These data are used to improve reporting of cases, plan prevention efforts, and establish research priorities.

Introduction

Giardia intestinalis (also known as *G. lamblia* and *G. duodenalis*) is the most common intestinal parasite identified by public health laboratories in the United States (*1*). This flagellated protozoan causes a generally self-limited clinical illness (i.e., giardiasis) typically characterized by diarrhea, abdominal cramps, bloating, weight loss, and malabsorption; asymptomatic infection also occurs frequently (*2–4*). Case reports indicate that giardiasis also might be associated with the development of reactive arthritis (*5*). In addition, giardiasis affects domestic and wild mammals (e.g., cats, dogs, cattle, deer, and beavers) (*2*).

Giardia infection is transmitted by the fecal-oral route and results from the ingestion of *Giardia* cysts through the consumption of fecally contaminated food or water or through person-to-person (or, to a lesser extent, animal-to-person) transmission. The cysts are infectious immediately upon being excreted in feces. The infectious dose is low; ingestion of 10 cysts has been reported to cause infection (*6*). Infected persons have been reported to shed $<10^8$–10^9 cysts in their stool per day and to excrete cysts for months (*6–8*). Effective treatment alternatives are available for patients with symptomatic giardiasis, including metronidazole, nitazoxanide, tinidazole, paromomycin, furazolidone, and quinacrine.

Persons at increased risk for infection include 1) travelers to disease-endemic areas, 2) children in child care settings, 3) close contacts of infected persons (e.g., those in the same family or household or in the child care setting), 4) persons who ingest contaminated drinking water, 5) persons who swallow contaminated recreational water (e.g., water in lakes, rivers, and pools), 6) persons taking part in outdoor activities (e.g., backpacking or camping) who consume unfiltered, untreated water or who fail to practice good hygienic behaviors (e.g., hand washing), 7) persons who have contact with infected animals, and 8) men who have sex with men (*2,9–13*), although giardiasis does not appear to be opportunistic in persons infected with human immunodeficiency virus. The relative contribution of person-to-person, animal-to-person,

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foodborne, and waterborne transmission to sporadic human giardiasis in the United States is unknown.

Although giardiasis cases occur sporadically, outbreaks are well documented. During 1995–2004, *Giardia* was identified as a causal agent of five (3.7%) of 136 reported cases of recreational water-associated gastroenteritis outbreaks and of 14 (13%) of 108 reported cases of drinking water-associated gastroenteritis outbreaks (*14–20*). In addition, foodborne outbreaks of giardiasis linked to infected foodhandlers and to uninfected foodhandlers who diapered infected children prior to handling food have been reported (*21*). Outbreaks resulting from person-to-person transmission in child care centers also have been reported (*22*). Communitywide outbreaks might be waterborne initially but spread subsequently through the community by person-to-person transmission (*23*). Few direct animal-to-human outbreaks have been documented although linkages have been identified between canine and human transmission (*24*). In addition, animal contamination of water (e.g., an infected dead beaver in a water system intake) has been associated with drinking water outbreaks (*25*). However, the zoonotic transmission of giardiasis is not believed to play a major role in human disease (*26*).

In 1992, the Council of State and Territorial Epidemiologists assigned an event code for giardiasis (code 11570) to facilitate transmission of reported giardiasis data to CDC. Surveillance data for 1992–2002 have been published previously (*27,28*). Reporting of giardiasis as a nationally notifiable disease began in 2002. This report summarizes national giardiasis surveillance data for 2003–2005.

Methods

A confirmed case of giardiasis in humans is one that has a positive laboratory finding. Confirmed and probable cases of giardiasis are reported voluntarily to CDC. Confirmed giardiasis is defined as the detection (in symptomatic or asymptomatic persons) of *Giardia intestinalis*

- cysts in stool specimens or trophozoites in stool specimens, duodenal fluid, or small-bowel tissue by microscopic examination using staining methods (e.g., trichrome) or direct fluorescent antibody assays (DFA); or
- antigens in stool specimens by immunodiagnostic testing (e.g., enzyme-linked immunosorbent assay) (*29*).

A probable case of giardiasis is a clinically compatible case that is linked epidemiologically to a confirmed case (*29*).

Because *Giardia* cysts can be excreted intermittently, multiple stool collections (i.e., three stool specimens collected every other day) increase test sensitivity (*30*). The use of concentration methods and trichrome staining might not be sufficient to demonstrate *Giardia* because variability in the concentration of organisms in the stool can make this infection difficult to diagnose. For that reason, fecal immunoassays with greater sensitivities and specificities are available. DFA is extremely sensitive and specific (*31*). Rapid immunochromatographic cartridge assays also are available and are useful for diagnosing *Giardia* infections, but they do not take the place of routine ova and parasite examination.

Health departments in the 50 states, the District of Columbia (DC), New York City (NYC), the Commonwealth of Puerto Rico, and Guam voluntarily report laboratory-confirmed and probable cases of giardiasis to CDC through the Nationally Notifiable Disease Surveillance System (NNDSS). Reports include the patient's place of residence (i.e., state and county), age, sex, race, ethnicity (i.e., Hispanic or non-Hispanic), and date of illness onset and indicate whether the case is linked epidemiologically to a known outbreak. An outbreak-related case is a case that is linked epidemiologically to at least one laboratory-confirmed case. Before analysis, data were verified for accuracy by the reporting jurisdiction and finalized as of February 16, 2007. For this reason, the number of cases provided in this report might differ slightly from the number published in CDC's annual Summary of Notifiable Diseases.

Analysis of the national giardiasis surveillance data for 2003–2005 was conducted using SAS® v.9.1 (SAS Institute, Inc.; Cary, North Carolina) and the Food Safety Information Link (FSI Link). FSI Link is an intranet-based tool available to CDC staff that provides access to NNDSS data and is used to monitor trends in and investigate outbreaks of reportable foodborne and waterborne diseases. Population data from the U.S. Census Bureau were used to calculate incidence rates.

Results

During 2003–2005, the total number of reported cases of giardiasis remained relatively stable. Case reports increased 4.4% from 20,084 for 2003 to 20,962 for 2004 and then decreased 4.2% to 20,075 for 2005 (Table 1). Cases reported to be outbreak related made up 1.1%–2.6% of the total number of cases reported annually for 2003–2005. During this period, 49 jurisdictions reported giardiasis cases; the number of jurisdictions reporting >15 cases per 100,000 population increased from four in 2003 to seven in 2005.

For 2005, among jurisdictions reporting outbreaks, incidence of giardiasis per 100,000 population ranged from 1.4 cases in Louisiana to 30 cases in Vermont. Two states (Vermont and Minnesota) reported the greatest number of cases per 100,000 population for each of the 3 years of the

TABLE 1. Number and percentage* of giardiasis case reports, by jurisdiction — United States, 2003–2005

	2003				2004				2005			
Jurisdiction	No.	(%)	Rate†	No. outbreak cases§	No.	(%)	Rate	No. outbreak cases	No.	(%)	Rate	No. outbreak cases
Alabama	216	(1.1)	4.8		189	(0.9)	4.2		197	(1.0)	4.3	
Alaska	89	(0.4)	13.7		101	(0.5)	15.4		110	(0.5)	16.6	1
Arizona	256	(1.3)	4.6		176	(0.8)	3.1		183	(0.9)	3.1	
Arkansas	155	(0.8)	5.7		123	(0.6)	4.5		88	(0.4)	3.2	
California	2,281	(11.4)	6.4	11	2,160	(10.3)	6.0	3	2,404	(12.0)	6.7	3
Colorado	467	(2.3)	10.3		515	(2.5)	11.2	1	534	(2.7)	11.4	5
Connecticut	369	(1.8)	10.6	1	506	(2.4)	14.5		395	(2.0)	11.3	
Delaware	56	(0.3)	6.8		49	(0.2)	5.9		61	(0.3)	7.2	
District of Columbia	61	(0.3)	10.9		76	(0.4)	13.7		56	(0.3)	10.2	
Florida	1,132	(5.6)	6.7	139	1,126	(5.4)	6.5	81	987	(4.9)	5.5	58
Georgia	853	(4.2)	9.8		898	(4.3)	10.1		754	(3.8)	8.3	
Hawaii	94	(0.5)	7.5	94	80	(0.4)	6.3		63	(0.3)	4.9	2
Idaho	206	(1.0)	15.1		212	(1.0)	15.2		155	(0.8)	10.8	2
Illinois	940	(4.7)	7.4		807	(3.8)	6.3	1	772	(3.8)	6.0	1
Indiana	NR¶				NR				NR			
Iowa	277	(1.4)	9.4	17	305	(1.5)	10.3		280	(1.4)	9.4	1
Kansas	234	(1.2)	8.6		221	(1.1)	8.1		213	(1.1)	7.8	
Kentucky	NR				NR				NR			
Louisiana	15	(0.1)	0.3		57	(0.3)	1.3		64	(0.3)	1.4	
Maine	184	(0.9)	14.1		155	(0.7)	11.8		202	(1.0)	15.3	
Maryland	118	(0.6)	2.1		160	(0.8)	2.9		210	(1.0)	3.7	
Massachusetts	851	(4.2)	13.3	105	787	(3.8)	12.3	1	729	(3.6)	11.4	10
Michigan	781	(3.9)	7.7		718	(3.4)	7.1		783	(3.9)	7.7	
Minnesota	851	(4.2)	16.8	27	1,398	(6.7)	27.4		1,241	(6.2)	24.2	7
Mississippi	NR				NR				NR			
Missouri	515	(2.6)	9.0		578	(2.8)	10.0		522	(2.6)	9.0	
Montana	115	(0.6)	12.5		82	(0.4)	8.8		81	(0.4)	8.7	
Nebraska	145	(0.7)	8.3		154	(0.7)	8.8		116	(0.6)	6.6	
Nevada	139	(0.7)	6.2		131	(0.6)	5.6		113	(0.6)	4.7	
New Hampshire	44	(0.2)	3.4	44	48	(0.2)	3.7		66	(0.3)	5.0	
New Jersey	520	(2.6)	6.0		507	(2.4)	5.8		457	(2.3)	5.2	
New Mexico	55	(0.3)	2.9		76	(0.4)	4.0		92	(0.5)	4.8	
New York**	2,498	(12.4)	13.0	56	2,616	(12.5)	13.6	98	2,287	(11.4)	11.9	56
New York City	1,214	(6.0)	14.9		1,088	(5.2)	13.3		875	(4.4)	10.7	
North Carolina	NR				NR				NR			
North Dakota	50	(0.2)	7.9		25	(0.1)	3.9		26	(0.1)	4.1	
Ohio	901	(4.5)	7.9	13	807	(3.8)	7.0	60	817	(4.1)	7.1	18
Oklahoma	145	(0.7)	4.1		166	(0.8)	4.7		197	(1.0)	5.6	
Oregon	411	(2.0)	11.5	1	442	(2.1)	12.3	2	415	(2.1)	11.4	2
Pennsylvania	1,024	(5.1)	8.3		1,024	(4.9)	8.3		885	(4.4)	7.1	8
Rhode Island	126	(0.6)	11.7		130	(0.6)	12.0		132	(0.7)	12.3	
South Carolina	175	(0.9)	4.2		130	(0.6)	3.1		106	(0.5)	2.5	
South Dakota	89	(0.4)	11.6	2	87	(0.4)	11.3	7	118	(0.6)	15.2	1
Tennessee	200	(1.0)	3.4		237	(1.1)	4.0	10	233	(1.2)	3.9	
Texas	NR				NR				NR			
Utah	380	(1.9)	16.0		365	(1.7)	15.1	4	398	(2.0)	16.1	44
Vermont	122	(0.6)	19.7		168	(0.8)	27.0	11	187	(0.9)	30.0	
Virginia	426	(2.1)	5.8		563	(2.7)	7.5	1	602	(3.0)	8.0	
Washington	435	(2.2)	7.1		444	(2.1)	7.2		434	(2.2)	6.9	
West Virginia	64	(0.3)	3.5		63	(0.3)	3.5		55	(0.3)	3.0	
Wisconsin	630	(3.1)	11.5	4	966	(4.6)	17.6	1	938	(4.7)	16.9	5
Wyoming	23	(0.1)	4.6		27	(0.1)	5.3		31	(0.2)	6.1	
Total 50 states	**19,718**		**6.8**	**514**	**20,655**		**7.0**	**281**	**19,789**		**6.7**	**224**
Guam	2	(<0.1)	1.2		5	(<0.1)	3.0		11	(0.1)	6.5	
Puerto Rico	364	(1.8)	9.4	1	302	(1.4)	7.7		274	(1.4)	7.0	
Total	**20,084**		**6.8**	**515**	**20,962**		**7.0**	**281**	**20,075**		**6.7**	**224**

Sources: Population estimates are from the Population Division, US Census Bureau. Annual estimates of the population for the United States and States and Puerto Rico: April 1, 2001 to July 1, 2005 (NST-EST 2005 01) available at http://www.census.gov/popest/states/tables/NST-EST2005-01.xls. Estimates of the New York City population: Annual estimates of the population for incorporated places over 100,000, ranked by July 1, 2005 population: April 1, 2001 to July 1, 2005 (SUB-EST 2005-01) available at http://www.census.gov/popest/cities/tables/SUB-EST2005-01.xls. Estimates of the population of Guam and Puerto Rico: International Data Base (IDB) data access – spreadsheet, available at http://www.census.gov/ipc/www/idb.

* Percentages might not total 100% because of rounding.
† Per 100,000 population on the basis of U.S. Census Bureau population estimates.
§ Number of cases linked epidemiologically to a laboratory-confirmed case.
¶ No cases reported.
** New York state case reports include New York City.

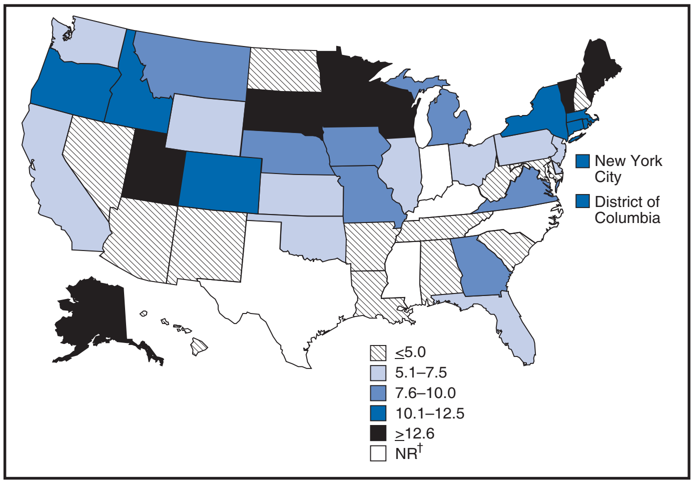
reporting period. Northern states reported more cases annually per 100,000 population than southern states (Figure 1; Table 1).

These surveillance data display a bimodal age distribution, with the greatest number of reported cases occurring among children aged 1–4 and 5–9 years and adults aged 35–44 years (Figure 2). When reports for which a patient's sex was missing or unknown are excluded, the percentage of cases reported to have occurred among males varied annually from 55.0% (9,694 of 17,624) for 2003 to 55.9% (11,542 of 20,641) for 2004.

A twofold increase in reported giardiasis cases by onset of illness occurred during June–October compared with January–March (Figure 3). Age-specific analysis indicated a twofold increase in onset of illness during June–October among all age groups. The highest numbers of giardiasis cases were reported among children aged 1–4 and 5–9 years and adults aged 35–39 years (Figure 4).

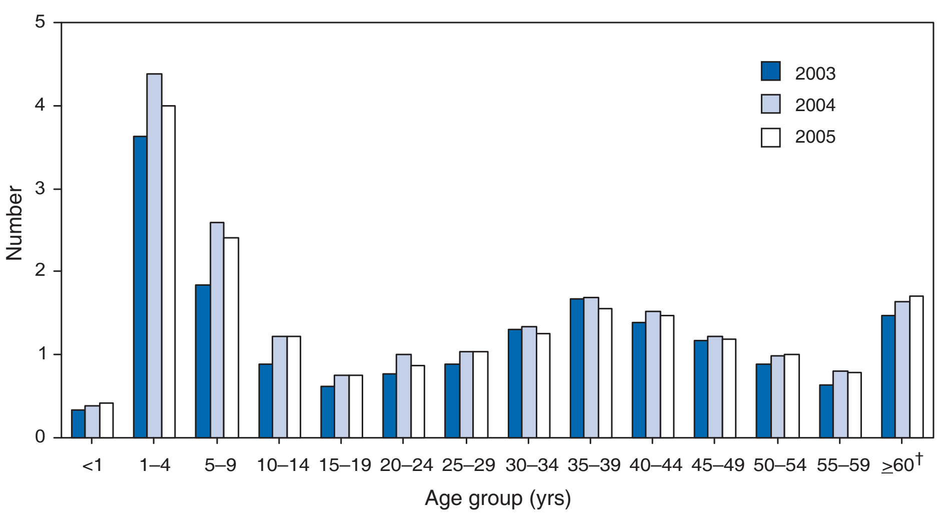
The majority of cases for which data on race were available for 2003–2005 occurred among whites, followed by blacks, Asians/Pacific Islanders, and Native Americans/Alaska Natives (Table 2). However, data on race were not included for 40.1%–48.7% of total annual case reports. Although 13.7%–15.0% of patients for whom data on ethnicity were reported were identified as Hispanic, data on ethnicity were lacking for 47.8%–57.2% of total annual case reports.

FIGURE 1. Incidence* of giardiasis, by state — United States, 2005



* Per 100,000 population.
† No cases reported to CDC.

FIGURE 2. Number* of giardiasis case reports, by age group and year — United States, 2003–2005



* In 1,000s.
† Case reports decreased with increased age. For each 5-year subgroup, the number of reported cases was fewer than the number reported for persons aged 55–59 years.

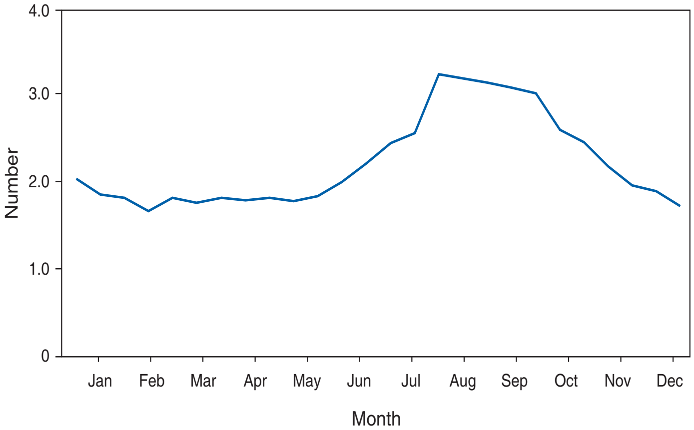
Discussion

National giardiasis surveillance data are used to assess the epidemiologic characteristics and disease burden of giardiasis in the United States. During 2003–2005, the total number of cases reported remained relatively stable, with a slight increase during 2003–2004 and a slight decrease during 2004–2005. However, following a gradual decline in case reports during 1996–2001 (*27,28*), the number of case reports appears to have stabilized thereafter, coinciding with the disease becoming nationally notifiable in 2002 (Figure 5). The reason for this gradual decline is unknown.

Giardiasis is widespread geographically in the United States. These data and data from previous national giardiasis surveillance summaries (*27,28*) indicate that the diagnosis or transmission of giardiasis might be higher in northern states (Figure 1). However, because differences in giardiasis surveillance systems among states can affect the capability to detect cases, whether this finding is of true biologic significance or is only the result of differences in case detection or reporting is difficult to determine.

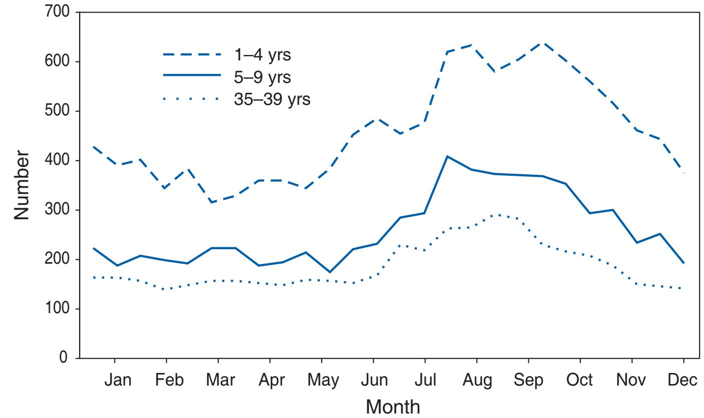
Although giardiasis affects persons in all age groups, the number of reported cases was highest among children aged 1–9 years and adults aged 35–44 years. These data for younger age groups are consistent with reports published previously of giardiasis incidence being higher among younger children as well as contributing to transmission to their caregivers (e.g., day care staff, family members, and other household contacts) (*2,27,28,32,33*). A multicenter study

FIGURE 3. Number* of giardiasis case reports, by month of illness onset — United States, 2003–2005



* In 1,000s.

FIGURE 4. Number of giardiasis case reports, by selected age group* and month of illness onset — United States, 2003–2005



* The three age groups (1–4, 5–9, and 35–39 years) with the highest numbers of giardiasis case reports during 2003–2005 are presented; all age groups exhibited a twofold increase.

identified *Giardia* as the cause of diarrhea in 15% of nondysenteric children examined in outpatient clinics (*34*). Investigation of a giardiasis outbreak in a day care facility determined that 47% of ill children transmitted the infection to more than one household contact (*35*).

A marked seasonality in the onset of illness occurs in early summer through early fall. A twofold increase in transmission of giardiasis occurred during the summer, coinciding with increased outdoor activities (e.g., swimming and camping). This increase might reflect increased use of community swimming (essentially communal bathing) venues by younger children. In addition to animal contamination of surface water, transmission through use of surface water (e.g., lakes and rivers) and disinfected venues (e.g., swimming pools and water parks) is facilitated by the substantial number of *Giardia* cysts that can be shed by a single person (*7*); the extended periods of time that cysts can be shed (*8*); the low infectious dose (*6*); the moderate resistance to chlorine of *Giardia* (*36*); the prevalence of improper pool maintenance (i.e., insufficient disinfection, filtration, and recirculation of water), particularly of children's wading pools (*37*); the prevalence of *Giardia* in fecal material in pools (*38*); and documented transmission of *Giardia* infection among diapered children (*22,34,35,39*) who use swimming venues regularly. This seasonal variation also has been noted in state, Canadian provincial, and previous U.S. national surveillance data for giardiasis and as for cryptosporidiosis (*27,28,32,33*).

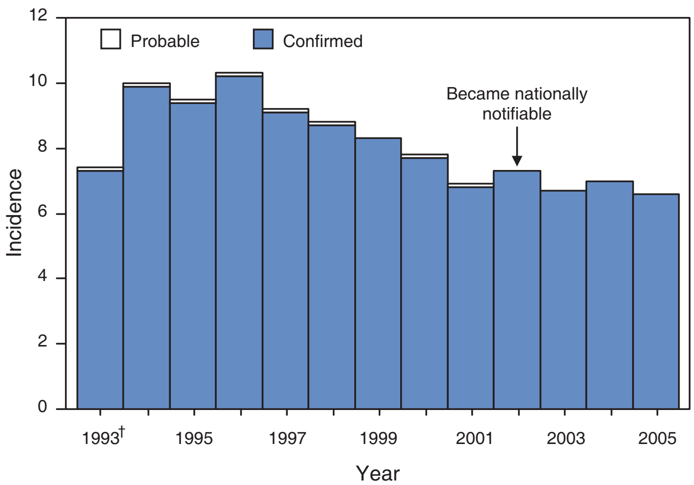
The importance of water and food in the transmission of *Giardia* is highlighted by recent giardiasis outbreaks. In 2003, a communitywide outbreak of giardiasis in Massachusetts was traced to use of a wading pool at a membership club (*23*). In addition to the 30 case-patients with primary exposures to the pool, an additional 105 cases were caused by secondary person-to-person transmission. Also in 2003, a communitywide outbreak in Iowa implicated a wading pool at a day care center that was filled with water from the municipal water supply (*14*). From the child care center, illness spread into the community via secondary transmission, sickening an estimated 100 persons with giardiasis, cryptosporidiosis, or both. In 2004, a drinking water-associated outbreak in Ohio that sickened 1,450

TABLE 2. Number and percentage* of giardiasis case reports, by selected demographic characteristics — United States, 2003–2005

Demographic characteristics	2003 No.	2003 (%)	2004 No.	2004 (%)	2005 No.	2005 (%)
Sex						
Male	9,694	(48.3)	11,542	(55.1)	10,909	(54.3)
Female	7,930	(39.5)	9,099	(43.4)	8,813	(43.9)
Unknown/Missing	2,460	(12.2)	321	(1.5)	353	(1.8)
Total	**20,084**		**20,962**		**20,075**	
Race						
AI/AN†	69	(0.3)	88	(0.4)	76	(0.4)
API§	459	(2.3)	1,343	(6.4)	1,578	(7.9)
Black	957	(4.8)	1,640	(7.8)	1,398	(7.0)
White	8,430	(42.0)	8,342	(39.8)	8,321	(41.4)
Other	382	(1.9)	783	(3.7)	644	(3.2)
Unknown/Missing	9,787	(48.7)	8,766	(41.8)	8,058	(40.1)
Total	**20,084**		**20,962**		**20,075**	
Ethnicity						
Hispanic	1,173	(5.8)	1,600	(7.6)	1,524	(7.6)
Non-Hispanic	7,420	(37.0)	9,074	(43.3)	8,965	(44.7)
Unknown/Missing	11,491	(57.2)	10,288	(49.1)	9,586	(47.8)
Total	**20,084**		**20,962**		**20,075**	

* Percentages might not total 100% because of rounding.
† American Indian/Alaska Native.
§ Asian/Pacific Islander.

FIGURE 5. Incidence* of giardiasis, by year — United States, 1993–2005 (n = 294,435)



* Per 100,000 population.
† First year with assigned reporting number.

persons was caused by multiple pathogens, including *Giardia* (*42*). Contamination of noncommunity public and private wells with sewage led to this communitywide outbreak. Foodborne outbreaks associated with ice, vegetables, and chicken salad also were reported in 2004 and 2005 (*43*).

Among patients for whom data on sex were reported, a majority of cases occurred among males. This sex-related difference might be attributable in part to sexual contact among men who have sex with men (*11*). However, the majority of cases occurred in males in nearly every age group (except those aged <1 year and >59 years), which suggests the influence of other factors (Table 2). Because data on race and ethnicity are incomplete, conclusions cannot be made regarding the differences noted in the epidemiology of giardiasis among members of different racial and ethnic populations.

The data reported likely underestimate the giardiasis burden in the United States. Giardiasis is highly underreported because 1) not all infected persons are symptomatic, 2) those who are symptomatic do not always seek medical care (*44,45*), 3) health-care providers do not always include laboratory diagnostics in their evaluation of nonbloody diarrheal diseases (*44*), and 4) case reports are not always completed for positive laboratory results or forwarded to public health officials (*46*). Although the true burden of cryptosporidiosis in the United States is unknown, an estimated 2 million cases occur annually (*46*).

Its low infectious dose, protracted communicability, and moderate chlorine resistance make *Giardia* ideally suited for transmission through drinking and recreational water, food, and person-to-person contact. Strategies to reduce the incidence of giardiasis have focused on reducing waterborne and person-to-person transmission. In response to parasitic drinking water outbreaks related to treated surface water, the Environmental Protection Agency (EPA) enacted the Surface Water Treatment Rule (SWTR) and the Interim Enhanced SWTR (*15*). These regulations have decreased the number of giardiasis outbreaks associated with community drinking water systems (*15,17–20*). In 2006, EPA finalized the Ground Water Rule to address contamination of public ground water (well) systems, which is likely to reduce the number of groundwater-associated outbreaks of giardiasis. Person-to-person transmission of *Giardia* is difficult to interrupt in a systematic fashion, particularly in day care settings (*47*). Adherence to appropriate infection control (e.g., hand washing, diaper changing, and separation of ill children) policies is recommended for controlling giardiasis, and other enteric pathogens, in group settings such as daycares (*48*).

Prevention measures (Box 1) and measures to improve surveillance for giardiasis and increase understanding of its epidemiology and the associated disease burden (Box 2) have been recommended. General information about giardiasis is available from CDC at http://www.cdc.gov/ncidod/dpd/parasites/giardiasis/factsht_giardia.htm.

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BOX 1. Recommendations to prevent and control giardiasis

Always practice good hand hygiene.

- Wash hands with soap and water for at least 20 seconds, rubbing hands together vigorously and scrubbing all surfaces
  - — after using the toilet,
  - — before handling food,
  - — after every diaper change (even if wearing gloves),
  - — after direct contact with preschool-aged children, and
  - — after any contact with animals or their feces.

Prevent contamination of recreational water (e.g., swimming pools, spas, interactive fountains, lakes, rivers, and oceans).

- Do not swim while experiencing diarrheal illness (e.g., swimming in or entering the water at pools, spas, interactive fountains, lakes, rivers, or oceans) or for 2 weeks after diarrhea or symptoms resolve if one has received a diagnosis of giardiasis or during an outbreak of giardiasis.
- Take children on frequent bathroom breaks and check their diapers often.
- Change diapers in the bathroom, not at the poolside.
- Wash children thoroughly (especially their bottoms) with soap and water after they use the toilet or their diapers are changed and before they enter the water.
- Shower before entering the water.

Information about recreational water illnesses and how to stop them from spreading is available from CDC at http://www.cdc.gov/healthyswimming.

Prevent infection and illness caused by water that might be contaminated.

- Do not swallow water in swimming pools, spas, or interactive fountains.
- Do not swallow untreated water from lakes, rivers, springs, ponds, streams, or shallow wells.
- Do not drink inadequately treated water during communitywide outbreaks caused by contaminated drinking water.
- Do not use or drink inadequately treated water when traveling in countries where the water supply might be unsafe.
- If the safety of drinking water is in doubt,
  - — disinfect it by heating the water to a rolling boil for 1 minute,
  - — use a filter that has been tested and rated by National Sanitation Foundation (NSF) Standard 53 or NSF Standard 58 for cyst reduction (filtered water will need additional treatment to kill or inactivate bacteria and viruses), or
  - — treat it with chlorine or iodine; however, these chemical methods are less effective against *Giardia* than boiling or filtering because they are highly dependent on the temperature, pH, and cloudiness of the water.

Prevent infection and illness caused by eating food that might be contaminated.

- Use properly treated water to wash all food that will be eaten raw.
- Do not eat uncooked foods when traveling in areas where giardiasis is common.

Prevent contact and contamination with feces during sex.

- Use a barrier during oral-anal sex.
- Wash hands immediately after handling a condom used during anal sex and after touching the anus or rectal area.

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BOX 2. Recommended measures to improve surveillance for giardiasis and increase understanding of its epidemiology and associated disease burden

- Encourage health-care providers to consider and specifically request testing for *Giardia* in the evaluation of gastrointestinal illness (i.e., order testing of stool for ova and parasites).
- Continue to educate health-care providers and public and private laboratories to improve reporting of cases of giardiasis to jurisdictional health departments.
- Encourage jurisdictional health departments to transmit giardiasis data to CDC through the National Electronic Disease Surveillance System (NEDSS), which will replace the National Notifiable Disease Surveillance System (NNDSS).
- Publish and distribute giardiasis surveillance data regularly for public health education purposes.
- Conduct further epidemiologic studies of the geographic variability, incidence, and risk factors for giardiasis.

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