Multivariate Analysis of Risk Factors Associated with a Community Outbreak of Cryptosporidiosis in Kansas, 2003

By

Lina Brou
MPH

Department of Epidemiology

Jonathan M. Liff, PhD
Faculty Advisor

Jonathan Yoder MPH, MSW
Field Advisor

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Lina Brou

Bachelor of Science, Biology
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Thesis Field Advisor: Jonathan Liff, PhD

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ABSTRACT

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Background: The chlorine-resistant protozoan, *Cryptosporidium*, commonly associated with daycare and swimming facilities, has emerged as the leading known cause of recreational waterborne diarrhea outbreaks in the United States. In the summer of 2003, an outbreak of cryptosporidiosis occurred among residents of one county in Kansas.

Methods: To determine the magnitude of the outbreak and identify risk factors for infection, we performed a secondary analysis of a county-wide matched case-control interview study. Subjects included laboratory-confirmed cryptosporidiosis cases (n=63), a random sample of clinical cases (n=88), and age-matched controls identified by random-digit dialing (n=302). Clinical cryptosporidiosis was defined as diarrhea (≥3 loose stools in a 24 hour period) for ≥ 3 days within a one week period after June 15, 2003. Conditional logistic regression was the primary statistical methodology used.

Results: The final model included the following predictors: treated recreational water (adjusted matched odds ratio = 7.753; 95% CI = 3.577, 16.804; p-value <0.0001), having a child in childcare outside of the home (amOR = 3.609; 95% CI = 1.69, 7.709; p-value = 0.0009), and having a household contact with diarrhea (amOR = 10.575; 95% CI = 5.102, 21.916; p-value<0.0001). To identify which facilities could be implicated, a second model resulted in the following predictors: Swimming Pool D (amOR = 4.324; 95% CI = 1.087, 17.209; p-value = 0.0377); Daycare 2 wading pool (amOR = 19.475; 95% CI = 2.719, 139.464; p-value = 0.0031); and having a household contact with diarrhea (amOR = 7.914; 95%CI = 2.744, 22.821; p-value = 0.0001). No interaction terms were significant and there was no indication of collinearity.

Conclusions: This is one of the largest reported U.S. community-wide cryptosporidiosis outbreaks and the first outbreak associated with this Cryptosporidium subtype. Although the original source of the outbreak was identified as a single contaminated swimming pool, the outbreak spread throughout the community via secondary and tertiary exposures (i.e., daycare exposure and person-to-person contact). It draws attention to the need for collaborative efforts between local, state, and federal agencies to define and develop policies that facilitate prompt intervention to prevent community-wide transmission of *Cryptosporidium*.

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Introduction

The parasites of the protozoan genus *Cryptosporidium* were first recognized as human pathogens which cause gastrointestinal disease in 1976 [1]. These parasites' ability to cause outbreaks associated with contaminated water, contaminated food, and contact with infected persons or animals [2] is attributed to their size [3], low infectious dose [4, 5], protracted communicability [6, 7], high oocyst titer in stool, [6, 7] and chlorine resistance [8, 9]. Contaminated water, both drinking and recreational water (e.g., lakes, oceans, rivers, swimming pools, hot tubs, water parks, and interactive fountains), are frequently associated with cryptosporidiosis. From 1984 to 2007, 143 waterborne cryptosporidiosis outbreaks were reported to the Centers for Disease Control and Prevention (CDC) [10]. One such reported outbreak occurred in Milwaukee in 1993, during which >400,000 people were infected; it raised awareness of this parasite as a drinking water contaminant and prompted drinking water regulatory action by the Environmental Protection Agency (EPA) [11, 12]. Recently the number of recreational water-associated outbreak reports has been increasing.

Cryptosporidium has recently emerged as the leading cause of recreational water-associated outbreaks in the United States, often associated with swimming pools and other treated recreational water venues (e.g., hot tubs, interactive fountains, and water parks) [2] . Between 1988 and 2006, 41.8% of recreational water-associated outbreaks of gastroenteritis were attributed to *Cryptosporidium* [13]. Furthermore, case reporting of cryptosporidiosis has increased in recent years. The total number of reported cases of cryptosporidiosis has increased from 2,972 in 1995 to 11,657 in 2007 [13]. Whether increased reporting is due to true increase in incidence, improved surveillance, improved awareness of *Cryptosporidium* and its exposures by the general public and medical community, or increased testing practices due to licensing of Nitazoxanide, a drug approved to treat cryptosporidiosis in young children in 2002 and in all age groups in 2004 [10], remains unclear. Increases in the number of reported cases and outbreaks provide evidence for the continued emergence of *Cryptosporidium* as an important cause of diarrheal illness.

Additionally, due to human behavior facilitating transmission through contaminated recreational water, the threat of cryptosporidiosis is unlikely to disappear. Preventing fecal contamination of recreational water is difficult because diarrhea is a very common illness in the United States [14] and swimming is the third most popular sports activity [15]. Cryptosporidiosis cases are more frequently reported in diaper-aged children among visitors to recreational water venues [16]. These fecally-incontinent children (or perhaps case-patients) have the potential to facilitate transmission of cryptosporidiosis into childcare centers [17] and their respective households [18]. The potential of recreational water-associated cryptosporidiosis to become community-wide via secondary and tertiary exposures indicates a need for preventative measures to be initiated before an outbreak occurs and effective control measures to be implemented in order to inhibit the outbreak from becoming widespread.

This thesis aims to compare risk factors associated with a community-wide outbreak of *Cryptosporidium hominis* infections that originated with a contamination of a swimming pool, but became widespread due to secondary and tertiary exposures (i.e. daycare and person-to-person exposure). This secondary analysis is relevant in further characterizing similar outbreaks and may lead to a better understanding of the mechanism of transmission of *Cryptosporidium* and risk factors associated with infection. It will aid in the development of more effective control measures for similar outbreaks and will provide the CDC and state public health agencies with accurate information to tailor revisions to its outbreak response literature and recommendations, perhaps enabling more rapid control of future outbreaks.

Background

Epidemiology

Diarrhea and cryptosporidiosis are common in the United States and globally. Surveys indicate that approximately 7.2-9.3% of the general public has had diarrhea in the previous month in the United States [2]. Annually, people experience approximately 0.6 episodes of acute diarrheal illness [19]. In developed countries in the world, people experience 0.1-3.5 cases of diarrhea each year [20]. Published studies suggest that about 2% of all stools tested for *Cryptosporidium* are positive [21]. Of an estimated 15 million annual physician visits for diarrhea in the U.S. each year, an estimated 300,000 cases are attributed to cryptosporidiosis [22] and studies indicate nearly 70% of Americans test positive for *Cryptosporidium* antibodies by the age of 70 [23, 24].

Cryptosporidium is the leading cause of recreational water-associated outbreaks causing gastroenteritis in the United States, particularly those associated with treated water venues, but less frequently it also causes foodborne outbreaks [2, 25]. Of the confirmed gastroenteritis outbreaks from 2001-2006, approximately 2.4% (68/2832) are caused by *Cryptosporidium*, including 29% (59/204) of the waterborne outbreaks and 0.3% of the foodborne outbreaks (9/2628) [19, 26-32]. Of the 143 waterborne cryptosporidiosis outbreaks between 1984 and 2007, 89.5% were associated with recreational water and of those, 89.1% were associated with treated water venues [10]. The magnitude of the recreational water outbreaks has been substantial. From 1988-2004, approximately 14, 679 people were involved in 68 recreational water-associated outbreaks of cryptosporidiosis in the U.S. [2, 25-27, 33-39]. These outbreaks exhibit a seasonality during the months of June-October, a ten-fold increase from January-March, which tracks the peak of recreational water use in the late summer and early fall [13].

Pathogen

Parasites in the genus *Cryptosporidium* cause disease in humans and in various animals. While *C. hominis* infects humans and *C. parvum* infects both humans and ruminants, reports of rare human infection caused by other species including *C. felis* in domestic cats, *C. muris* in mice, and *C. meleagridis* in birds, appear in literature [40]. Persons infected with *Cryptosporidium* might experience acute gastrointestinal illness, presenting with the symptoms of watery diarrhea, abdominal cramps, loss of appetite, low-grade fever, nausea, vomiting, and weight loss [40]. The incubation period for cryptosporidiosis is 3-22 days with an average of 1 week until symptoms appear [4]. However, some persons may be asymptomatic [41].

Cryptosporidiosis is transmitted through the ingestion of oocysts via the fecal-oral route [40] and as few as 10-30 oocysts can be infectious [4, 5]. Once infected with *Cryptosporidium*, one can shed 10^9 oocysts per bowel movement [6, 7] and excretion may continue up to 50 days after cessation of diarrhea [23, 24, 42]. Although small amounts of fecal contamination per person have been documented [43], heavily used areas are more likely to receive large amounts of excreted pathogens. Therefore, dispersal of oocysts through direct human contamination can occur to facilitate infection more readily.

Environment

The difficulty of preventing transmission stems from *Cryptosporidium* being ubiquitous in nature. The oocysts are persistent in the environment and remain infectious for months in freshwater [44, 45], seawater [45-47], and even longer in cold temperatures [44, 46-48]. Natural water sources can become contaminated either directly from fecal accidents or promiscuous defecation, or indirectly from other sources. Precipitation washes oocysts from zoonotic sources into watersheds, which results in contaminated surface water [2, 49, 50]. Also, since oocysts can be found in treated or untreated wastewater, sewer overflows or regular release of waste from treatment plants can contaminate natural water sources [51-54]. Contaminated water sources used for crop irrigation can then contaminate food sources, making raw vegetables vehicles of transmission as well [22].

Cryptosporidium is a particular concern in treated water venues such as swimming pools, hot tubs, and interactive fountains. Although treated water can be disinfected and remediated after contamination, sand and cartridge filters, which can typically filter particles as small as 10-25 microns, cannot efficiently filter *Cryptosporidium* oocysts due to their relatively small size of 4 to 6 microns [22]. Because the parasite is very tolerant of chlorine, [8, 9, 55-57] the disinfectant used to treat recreational water for over 80 years is largely ineffective [2]. *Cryptosporidium* survives for over 10 days at the chlorine level of 1 mg/L, which is usually the required level by most state and local pool codes in the United States [9]. The parasite's ability to overcome these primary transmission barriers presents obstacles for prevention and control measures.

Human Cryptosporidiosis

Although *Cryptosporidium* has characteristics which exacerbate its ability to cause infections (i.e., low infectious dose, small, high titer in stool, chlorine tolerance), its human hosts also have characteristics and exhibit behaviors which aid in the parasite's ability to transmit to new hosts. Although surveillance suggests no relationship between cryptosporidiosis and sex (51.2% of males in 2006; 49.6% of males in 2007; 49.7% of males in 2008), data indicate a bimodal age distribution with the greatest number of cases in the children ages 1-9 and adults ages 25-39 [13]. This could potentially represent waterborne transmission among young children, who may not be fully fecally-continent when swimming and subsequently spread infection to their adult caretakers [2, 13]. Also, race was found to not have a relationship with cryptosporidiosis based on national surveillance data and a case-control study of sporadic cases [13, 14]. The majority of cases of which data were available in 2006-2008 occurred among whites, followed by blacks, Asian/Pacific Islanders, and American Indians/Alaska Natives [13]. Data on race were lacking for 26.7% to 32.5% and data on ethnicity were lacking for 38% to 44% of total annual case reports [13].

Additionally, behavioral and social factors can put humans at risk for infection, particularly in recreational water-associated settings. CDC conducted focus groups in 1998 and 1999 and found that parents have misconceptions about the nature of swimming stating that it is not a form of communal bathing; it cannot transmit pathogens because pool water is "sterile"; and waterborne diseases are exclusive to developing countries [2, 58]. In 2004, the National Consumer League conducted a survey that found similar results. The survey found 14% of respondents believe pool water is sterile, 18% believe that swimming with diarrhea is acceptable, and 40% believe they are not likely to get ill from swimming in a pool [59]. These erroneous beliefs potentially can lead to risky swimming behaviors such as swallowing recreational water [60], maintaining poor personal hygiene, [43] and swimming with diarrhea [2]. In order to effectively prevent and control cryptosporidiosis outbreaks, these factors must be understood and addressed.

Risk Factors in Cryptosporidiosis Outbreaks

Contaminated Drinking Water

Contaminated drinking water has long been established as a risk factor for *Cryptosporidium* infections [10, 22, 61-64]. Drinking water sources are vulnerable to fecal contamination due to the presence of oocysts in treated and untreated wastewater, activated sludge effluent, sewer overflows, ground water, surface water, and even treated drinking water [22, 62, 63, 65]. As seen when effective treatment processes are compromised or circumvented, multiple large, community-wide outbreaks of cryptosporidiosis associated with drinking water contamination have occurred affecting thousands. Notable outbreaks of interest include the first reported waterborne cryptosporidiosis outbreak due to contaminated well water in Braun Station, Texas in 1984 which affected ~5,900 residents [22, 66]. Another outbreak, the first recognized among college students, was due to treatment plant failures in Carroll County, Georgia in 1987 affecting ~13,000 residents [22, 67]. As previously discussed, the largest reported waterborne disease outbreak in U.S. history in Milwaukee, Wisconsin in 1993 was due to treatment plant failures and inadequate distances between sewage outflows and water intakes [11, 12, 22, 68]. Drinking water-associated cryptosporidiosis outbreaks have affected other developed countries as well, including Spain, Portugal, the U.K., and Australia [52, 62, 69, 70]. Both the UK and Australian studies and others show that the risk of cryptosporidiosis following drinking unboiled water is dose-dependent [69-71].

Contaminated Recreational Water

Over 360 million annual visits to recreational water venues such as swimming pools, spas, lakes, river, and the ocean occurred in the United States, making swimming the most third most popular sports activity and most popular activity for children [2, 15]. In 2006, attendance at North American water parks reached approximately 78 million visits and is expected to increase in 5 years at a rate of 3 to 5% [72]. Thus, exposure to recreational water is very common. As previously indicated, *Cryptosporidium* is the leading cause of recreational water-associated waterborne disease outbreaks in the United States. From 1988-2004, 68 recreational water-associated cryptosporidiosis outbreaks were identified [2, 15, 16, 27, 33-37, 39, 73, 74]. Investigations using molecular typing of isolates from stool specimens from 35 of those cryptosporidiosis outbreaks indicate 23 were caused by *C. hominis,* 7 caused by *C. parvum,* 4 by both *C. hominis* and *C. parvum,* and 1 by both *C. hominis* and *C. meleagridis.*

Contaminated Food and Ill Food Handlers

Several contaminated food items have been implicated as vehicles of transmission of *Cryptosporidium* or identified as suspected vehicles. *Cryptosporidium* oocysts have been found on the surface of raw vegetables, with several instances of contamination in

Costa Rica [22, 75] and Peru [22, 76]. Fresh vegetables have the potential of being contaminated several ways: by contaminated irrigation water; by fertilizer composed of human or animal feces; by the soiled hands of farm workers, produce handlers, or other food workers; and from contact with contaminated surfaces where vegetables are prepared, packed, stored, or sold [22]. Nonetheless, a study of sporadic cryptosporidiosis found that eating raw vegetables has a significant protective effect (adjusted odds ratio (adjusted odds ratio [aOR])=0.5; 95% CI=0.3-0.7) [14]. It is suggested repeated exposure to small doses of *Cryptosporidium* over time might cause those who eat raw vegetables to be asymptomatic upon reinfection. Another explanation might be that the high-fiber content of a vegetable-rich diet physiologically alters the intestine and reduces the ability of the parasite to attach to the intestine.

Various foods have been implicated in cryptosporidiosis outbreaks. Several outbreaks have been associated with consumption of unpasteurized apple cider contaminated by *Cryptosporidium* [77-80]. Recently, spinach in contact with contaminated water has been shown to be infected with persistent oocysts, incapable of being disinfected [81]. Also, infectious oocysts have been found in shellfish including oysters, clams, and mussels from the Chesapeake Bay [22, 46, 82], Ireland [22, 83], Spain [22, 84], France [85], and Thailand [86], each identified as vehicles of transmission.

When preparing food, ill food handlers can inadvertently contaminate food with *Cryptosporidium.* In Minnesota, chicken salad was identified as the source of a cryptosporidiosis outbreak during a social event, which later was found to be most likely contaminated by a caterer who changed a baby’s diaper before preparing the chicken salad [22, 87]. However, the caterer denied knowledge of any diarrheal illness among the children she cared for and refused to submit a stool sample [87]. Similarly, a food handler was suspected to have caused a cryptosporidiosis outbreak in Spokane, Washington by improperly washing and preparing raw green onions [22, 88]. However, data from the investigation was inconclusive in implicating either the food handler or the green onions [88]. A recent study of the prevalence of *Cryptosporidium* in food handlers in Venezuela found that infection was frequent in the Zulia State, which could be attributed to outbreaks in that region [89].

Daycare Exposure

Cryptosporidiosis outbreaks associated with childcare exposure have been identified since 1984 [17, 18, 90-96]. Because many children in daycare centers are fecally-incontinent and have not developed adequate hygiene practices, they are prone to spread the parasite [18]. These infected children can transmit *Cryptosporidium* to staff members, and those who care for children in diapers are at highest risk for infection [17, 42, 95-97]. Daycare exposure associated with cryptosporidiosis has also been well-documented in Sweden [98] and South Africa [97]. As seen with the bacterium *Shigella*, which also has a fecal-oral route, the following factors can promote transmission of *Cryptosporidium* in daycare centers: allowing children access to soiled diapers, allowing participation in communal water activities, using untrained volunteers to change diapered children, employing staff who have not received formal hand washing training, keeping hand-washing supplies out of reach of children, and not supervising children's hand-washing activities [18].

Person-to-Person Contact

Outbreaks of cryptosporidiosis can easily spread out beyond the initial institutions or homes and into the community through person-to-person transmission. Studies of outbreaks find that transmission in the community is often associated with daycare exposure [93], with pathogens being transmitted to household contacts [17], and then to other relatives and neighbors [92] who have regular contact with an infected child [99]. A study of sporadic cryptosporidiosis cases in the U.S. found that any contact with persons less than ages 2-11 with diarrhea was significantly associated with cryptosporidiosis (aOR =3.0; 95% CI = 1.5-6.2) [14].

Even without being exposed to the primary source of infection, persons can be infected with *Cryptosporidium*, because secondary exposure in settings outside the home, such as daycare centers, can transmit the parasite to household contacts. For example, a an outbreak of cryptosporidiosis associated with a daycare center had a high attack rate of cryptosporidiosis (12-22%) among household contacts, who only had a single source of contact with the daycare center [91]. This may be because an outbreak can quickly amplify such that more household contacts are infected than daycare center attendees and staff [93]. However, children in daycare centers are not the only source of infection for household contacts. Adults who change diapers of infected children are at greater risk of infection than the infected child's siblings and adults who do not change diapers [42, 95]. Thus, household contacts make a sufficient vehicle of transmission of *Cryptosporidium* in outbreaks.

Animal and Farm Contact

Cryptosporidium infection has been linked to contact with calves or cows in a number of studies [100-102]. In a study of sporadic cases of cryptosporidiosis in the United States, the authors found that contact with calves was significantly associated with cryptosporidiosis (aOR = 3.5; 95% CI = 1.8-6.8) [14]. In addition to infecting humans, *C. parvum* infects calves and other ruminants, making them and other animal hosts potential reservoirs for human infection [22, 99]. Another risk factor for cryptosporidiosis is residing on a farm, which increases the likelihood of close contact with calves, other animal hosts, and their feces [102].

Travel History

Cryptosporidiosis has been reportedly associated with travel. People who travel in groups and meet regularly after returning from travel are at risk of infection [3, 25]. A study of sporadic cryptosporidiosis cases in the U.S. found that international travel was significantly associated with cryptosporidiosis (aOR = 7.7; 95% CI = 2.7-22.0) [14, 99]. Well-documented reports indicate travel within the United States and travel to the United Kingdom and Finland are associated with cryptosporidiosis [3, 7, 14, 103].

Manuscript

Introduction

The parasites of the protozoan genus *Cryptosporidium* were first recognized as human pathogens that cause gastrointestinal disease in 1976 [1]. This parasite's ability to cause outbreaks associated with contaminated water, contaminated food, and contact with infected persons or animals [2] is attributed to the small size of oocysts [3], low infectious dose [4, 5], protracted communicability [6, 7], high oocyst titer in stool, [6, 7] and chlorine resistance [8, 9]. Contaminated water, both drinking and recreational (e.g., lakes, oceans, rivers, swimming pools, hot tubs, water parks, and interactive fountains), has long been associated with cryptosporidiosis. One such reported outbreak occurred in Milwaukee in 1993, during which more than 400,000 people were infected, [11, 12]; it increased awareness of this parasite as a drinking water contaminant.

Cryptosporidium has recently emerged as the leading cause of recreational water-associated outbreaks in the United States, in particular those associated with swimming pools and other treated recreational water venues (e.g., hot tubs, interactive fountains, and water parks) [2] . Of the 143 waterborne cryptosporidiosis outbreaks between 1984 and 2007, 89.5% were associated with recreational water, and 89.1%of those were associated with treated water venues [10]. The magnitude of the recreational water outbreaks has been substantial. From 1988-2004, approximately 14, 679 people were involved in 68 recreational water-associated outbreaks of cryptosporidiosis in the U.S. [2, 25-27, 33-39]. These outbreaks exhibit a seasonality during the months of June-October, with a ten-fold increase from January-March which tracks the peak of recreational water use in the late summer and early fall [13].

Preventing contamination of recreational water is a daunting undertaking because diarrhea is a very common illness in the United States [14] and swimming is the third most popular sports activity, [15] and the most popular activity for children [2, 15]. Surveys indicate that approximately 7.2-9.3% of the general public has had diarrhea in the previous month in the United States [2]. Annually, people experience approximately 0.6 episodes of acute diarrheal illness [19]. In developed countries, people experience 0.1-3.5 cases of diarrhea each year [20]. In developing countries, children under the age of three experience an average of three episodes of diarrhea per year [104]. Published studies suggest that ~2% of all stools tested for *Cryptosporidium* in the U.S. are positive [21] and studies indicate nearly 70% of Americans will test positive for *Cryptosporidium* antibodies by the age of 70 [23, 24].

Persons infected with *Cryptosporidium* might experience acute gastrointestinal illness, presenting with watery diarrhea, abdominal cramps, loss of appetite, low-grade fever, nausea, vomiting, and weight loss [40]. The incubation period for the oocysts is 3-22 days with an average of 1 week until symptoms appear [4]. However, some persons may remain asymptomatic [41]. Cryptosporidiosis is transmitted through the ingestion of oocysts via the fecal-oral route [40] and as few as 10-30 oocysts can cause infection [4, 5]. Once infected with *Cryptosporidium*, one can shed 10^9 oocysts per bowel movement [6, 7] and excretion may continue up to 50 days after cessation of diarrhea [23, 24, 42].

Although *Cryptosporidium* oocysts have characteristics that exacerbate its ability to be pathogenic (i.e., low infectious dose, small size, high titer in stool, chlorine resistance), its human hosts also have characteristics and exhibit behaviors that aid in the parasite's infectivity. Although surveillance suggests no relationship between cryptosporidiosis and sex (males accounted for 51.2% of cases in 2006, 49.6% in 2007, and 49.7% in 2008), data indicate a bimodal age distribution with the greatest number of cases in children ages 1-9 and adults ages 25-39 [13]. This potentially could represent the relationship between young children, who may not be fully fecally-continent when swimming, and their adult caretakers [2, 13].

Additionally, behavioral and social factors can put humans at risk for infection, particularly in recreational water-associated settings. CDC conducted focus groups in 1998 and 1999 and found that parents have misconceptions about the nature of swimming such as that it is not a form of communal bathing; it cannot transmit illness because pool water is “sterile”; and waterborne diseases are exclusive to developing countries [2, 58]. These erroneous beliefs can potentially lead to risky swimming behaviors such as swallowing recreational water [60], maintaining poor personal hygiene, [43] and swimming with diarrhea [2]. In order to effectively prevent and control cryptosporidiosis outbreaks, these factors must be understood and addressed.

Cryptosporidiosis outbreaks associated with childcare exposure have been recognized since at least 1984 [17, 18, 90-96]. Because many children in daycare centers are fecally-incontinent and have not developed adequate hygiene practices, they are prone to spreading infection [18]. These infected children can transmit *Cryptosporidium* to staff members; those who care for children in diapers are at highest risk for infection [17, 42, 95-97].

Outbreaks of cryptosporidiosis can easily spread beyond the initial institutions or homes and into the community through person-to-person transmission. Studies of outbreaks find that transmission in the community is often associated with daycare exposure [93], with pathogens potentially transmitted to household contacts [17], and then to other relatives and neighbors [92] who have regular contact with an infected child [99]. A study of sporadic cryptosporidiosis cases in the U.S. found that any contact with persons between ages 2-11 with diarrhea was significantly associated with cryptosporidiosis (aOR =3.0; 95% CI = 1.5-6.2) [14]. However, children in daycare centers are not the only source of infection for household contacts. Adults who change diapers of infected children are at greater risk of infection than the infected child's siblings and adults who do not change diapers [42, 95].

The potential for recreational water-associated cryptosporidiosis to become community-wide via secondary and tertiary exposures indicates a need for preventative measures to be initiated immediately and accurately. These measures are better refined with the determination of the importance of certain risk factors for acquiring infection during such outbreaks. From June to September 2003, a community-wide outbreak of cryptosporidiosis occurred in Douglas County, Kansas. We conducted an epidemiologic investigation of the outbreak and a case-control study to identify potential risk factors for the infection.

Methods

This study is a secondary analysis of data obtained from a case-control study conducted by the CDC during an investigation of a cryptosporidiosis outbreak in Douglas County, Kansas in August of 2003. This study utilized four comprehensive questionnaires (adult case, pediatric case, adult control, and pediatric control) that were developed by the CDC's investigation team in conjunction with personnel at the Kansas Department of Health and Environment (KDHE). The questionnaires were used to collect data on the following parameters: basic demographics (age, sex, etc.), food and drinking water consumption, recreational water exposure, daycare exposure, household exposure, farm and animal contact, person-to-person contact, immune-compromised status, and travel history two weeks prior to onset of diarrhea.

The database used contained 151 cases and 302 controls. Laboratory-confirmed cases were identified through laboratory surveillance and defined as those persons with at least one positive stool sample for *Cryptosporidium spp.*; who had at least one gastrointestinal symptom (diarrhea, vomiting, abdominal cramping, etc.) with symptom onset after June 15, 2003; and lived in Douglas County within two weeks prior to onset of symptoms. The KDHE laboratory tested for *Cryptosporidium spp*. using a direct immunofluorescent assay (DFA), which is the gold standard in diagnostic microscopy. CDC's laboratory confirmed these results also with DFA.

Clinical cryptosporidiosis cases were identified using lists of individuals who sought health care for diarrheal symptoms since June 1, 2003. These lists were gathered from electronic medical records from one physician's office, the local emergency room, and two university health care centers. A clinical cryptosporidiosis case was defined as an individual who had three or more loose stools in a 24-hour period for at least 3 days after June 15th, 2003; lived in or visited Douglas County within two weeks prior to the onset of symptoms; and had no other explanation for diarrhea. Investigators recruited only one individual with the earliest onset date from each household in order to properly identify risk factors associated with cryptosporidiosis in the community.

Controls were identified by random digit dialing using a pre-screened sample obtained from the Behavioral Risk Factor Surveillance Study Computer-Assisted

Telephone Interviewing System [105]. Each control was a resident of Douglas County who reported no gastrointestinal illness since June 15, 2003 and was matched to cases by age group (<2 years old, 2 to <6 years old, 6 to <18 years old and≥ 18 years old). As with cases, only one person per household was interviewed.

Demographic characteristics and possible risk factors for exposure to *Cryptosporidium* infection were compared between cases and controls by using the chi squared test and Fisher's exact test. A p-value less than or equal to 0.05 was considered statistically significant in all of the analyses. Conditional logistic regression was used to estimate adjusted odds ratios and their associated 95% confidence intervals for the risk of *Cryptosporidium spp.* infection with respect to potential individual risk factors. Risk factors with a statistically significant association with cryptosporidiosis infection in initial models were included in a second conditional logistic regression model with the most significant variable, having a household contact with diarrhea. Those variables found to be significant in the second set of models were included in the initial multivariate model. The least significant variables were removed through backward hierarchical elimination until the remaining model was significant.

The variables in the logistic regression models were estimated by using maximum likelihood estimates with their corresponding Wald confidence intervals. Interaction terms, the products of relevant risk factors, were assessed. Likelihood ratio tests were used to determine the significance of each interaction terms. Collinearity was assessed using a macro [106] which determined condition indices and variance decomposition proportions. If two or more variables had a condition index greater than 30 and corresponding VDPs greater than 0.05, then these variables were considered for removal from the model, as these values indicate a collinearity problem. All data analysis was performed using SAS, version 9.2.

Results

In the original outbreak investigation, over 5,000 surveys were completed from July 24 to October 21, 2003 and 96 laboratory-confirmed cases of cryptosporidiosis were identified: 89 Douglas County residents and 7 residents of neighboring counties who were epidemiologically linked to the Douglas County outbreak (Figure 1). Of the 151 cases interviewed for this case-control study, 63 (42%) were confirmed cases and 88 (58%) met the probable case definition for infection with *Cryptosporidium*. Cases and controls were stratified by age group. Interviews were obtained for 34 cases in the 0-1 age group, 38 in the 2-5 year old age group, 40 in the 6-17 year old age group, and 39 in the 18 or older age group. Of the laboratory-confirmed cases, 49 stool specimens were genotyped and all were positive for *Cryptosporidium hominis* genotype H1-1dA17 (Figure 2) [105]. Symptoms reported by cases included diarrhea, anorexia, fever, nausea, abdominal cramping, headache, and vomiting (Table 1). Of the 151 cases, 106 (70%) reported waxing and waning of their symptoms, 86 (57%) sought medical care for their symptoms, 15 (10%) visited an emergency room, and 3 (2%) were hospitalized (range of 3-10 days). Furthermore, 111 (74%) of cases reported limited activity and 22 (15%) were forced to miss work due to illness.

In the initial conditional logistic regression models, several risk factors were significant (Table 2), including most of the recreational water exposures, both of the person-to-person contact exposures, eating raw vegetables and other cold salads (coleslaw, potato salad, etc.), contact with certain animals, drinking from city tap water or bottled water, having a child who received childcare outside of the home, providing care for someone with diarrhea, and having a household member with diarrhea. In the conditional logistic regression model that also included household contact with diarrhea and was conditioned on age (Table 3), recreational water (OR= 5.86; 95% CI= 2.98, 11.53), having a child who received childcare outside of the home (OR = 2.97, 95% CI = 1.54, 5.72), any contact with someone with diarrhea (OR = 3.09, 95% CI = 1.25, 7.61), having contact with a person in diapers (OR = 3.40, 95% CI = 1.08, 10.75), and contact with a calf (OR = 2.25, 95% CI = 0.999, 5.51) were significant.

Risk factors that were not significant after the bivariate analysis were not included in the subsequent multivariate models. The exposure variables that were included in the initial multivariate model were recreational water, having a child who received childcare outside of the home, having a household contact with diarrhea, any contact with someone in diapers, and the following interaction terms: recreational water and a child in the household who receives childcare outside of the home; recreational water and household contact with diarrhea; and a child in the household who receives childcare outside of the home and household contact with diarrhea. The reduced model excluded all of the interaction terms (Table 4) and likelihood ratio test yielded a p-value of 0.265. Therefore, none of the interaction terms were significant ($p>0.99$) and were dropped from the model. Using the backwards elimination approach, the final model (Table 5) retained the following variables: treated recreational water (hot tub, spa, or whirlpool; recreational water park; swimming pool) (adjusted matched odds ratio [amOR] = 7.753; 95% CI = 3.577, 16.804; p-value <0.0001), child in the household who receives childcare outside of the home (amOR = 3.609; 95% CI = 1.69, 7.709; p-value = 0.0009), and household member with diarrhea (amOR = 10.575; 95% CI = 5.102, 21.916; p-value<0.0001).

An additional model was run to assess whether individual swimming pools or daycare pools could be implicated in the outbreak. No interaction terms were significant in this model either. Using the same backwards elimination approach as the previous model but replacing summary variables (child in the household who receives childcare outside of the home and treated recreational water), one community swimming pool (Swimming Pool D: amOR = 4.324; 95% CI = 1.087, 17.209; p-value = 0.0377) and one daycare pool (Daycare 2 wading pool: amOR = 19.475; 95% CI = 2.719, 139.464; p-value = 0.0031) were significant when run in a model with household member with diarrhea (amOR = 7.914; 95%CI = 2.744, 22.821; p-value = 0.0001) (Table 6).

The collinearity assessment of the initial model yielded no condition indices greater than 30 (4.77). Therefore, there is no indication of collinearity in this model.

Discussion

This study analyzes a large community-wide cryptosporidiosis outbreak and the first to be associated with this *Cryptosporidium* subtype. The laboratory finding of a single genotype and subtype supports the epidemiological finding of a common original source of this outbreak. The range and magnitude of symptoms indicate that the morbidity of a cryptosporidiosis outbreak impacts daily activity and ability to work and likely had a substantial economic impact in this community. The distribution of the epidemic curve is consistent with the seasonality shown in other *Cryptosporidium* outbreaks.

The main exposures found to be significant in this outbreak were consistent with literature and with the original outbreak investigation [107]. Treated recreational water is consistently shown to be a major exposure in cryptosporidiosis outbreaks, and in this particular case it was the primary exposure associated with transmission. Once untreated water was removed from the reduced model, the significance of treated recreational water was reaffirmed. This inconsistency in the reduced model is due to the low incidence of participants who reported swimming in untreated water but not in treated water (4 cases and 15 controls). Having a child in the household who receives childcare outside of the home and having a household member with diarrhea were associated risks for person-to-person transmission. These represent secondary and tertiary exposures, accounting for the outbreak becoming community-wide, and amplifying the magnitude of the outbreak. The statistical significance associated with swimming in treated recreational water ($p < 0.0001$) in the final model is greater than the significance associated with exposure to any individual pool (Swimming Pool D: $p = 0.0377$; Daycare 2 Wading Pool: p-value = 0.0031) perhaps indicating that at least some of the cases swam in multiple pools and moreover, it was exposure to treated recreational water in general (including hot tubs, spas, whirlpools, and water parks) rather than exposure to a specific pool that increased one's risk of infection with *Cryptosporidium* in this outbreak. This also could be explained by the low response rate for this specific question. Many individuals indicated general treated recreational water activities, but did not specify which pools they swam in. A low response rate for survey questions could explain why other individual pool variables and other variables expected to be significant, such as having a household member with *Cryptosporidium* and providing childcare, were not significant in the initial univariate analysis.

Limitations

A major limitation of this study is that some potential confounders could not be assessed. Multiple pool exposure could alter the significance of the individual pool variables explaining why the significance of these individual variables is not as high as the summary treated recreational water variable. In this study, the individuals who specified individual swimming pools responded that they swam in between 2 and 7 different pools. Since no participants indicated they only swam in one pool, confounding could not be assessed. The same is true of multiple daycare exposure. Taking a child to more than one daycare center could affect the risk of infection by decreasing exposure to a daycare center with high infection rates. However, this analysis issue is not problematic for daycare centers, because no participant reported taking a child to more than one daycare facility. Employment status could affect infection by decreasing the amount of time spent at home, thereby reducing household member exposure. However, controls were not asked employment status. Several studies have shown that immune-compromised individuals are more susceptible to *Cryptosporidium* infection and this could be a possible effect modifier. In this study, four (2.65%) cases reported being immune-compromised; however, controls were not asked their immune status so any potential effect could not be assessed.

Contact with a calf was slightly significant in the bivariate analysis with household contact with diarrhea. However, since this outbreak has been confirmed to be caused by *Cryptosporidium hominis*, which is not known to be transmitted from calves, it was not included in the initial multivariate model analysis. Drinking water exposure was also not included in the multivariate analysis due to its insignificance when controlling for household member with diarrhea. Furthermore, no *Cryptosporidium* was recovered from raw or finished water when sampled from the two water treatment plants that supply Douglas County [107]. Municipal water from the treatment plants was tested and found to have acceptable chlorine levels and turbidity during the time of the outbreak [107]. Although bottle water was somewhat significant, no recalls, market withdrawals, or safety alerts during the time of the outbreak were reported according to a U.S. Food and Drug Administration review [99]. Food exposures (i.e., consumption of raw vegetables or cold salads) were excluded as well because they were not associated with secondary or tertiary exposure and were not implicated in the original investigation, therefore making them irrelevant to this study. Although cases were only matched to controls on age group, gender has not been seen to be a risk factor for cryptosporidiosis infection in the literature and was not significant in any conditional logistic regression analysis ($p = 0.9$).

This study illustrates how a cryptosporidiosis outbreak can easily become community-wide and emphasizes the need for instituting rapid response interventions to prevent continued morbidity. Because *Cryptosporidium* is the leading cause of recreational water- associated waterborne disease outbreaks, implementing preventive measures is essential to the reduction of the impact of these outbreaks. Preventive and control measures can be developed by local and state authorities using communication tools such as community-wide health alerts, which along with strategic control plans, could engage appropriate participants (healthcare providers, pool operators, daycare facilities, media outlets, and schools) and consequently inhibit community-spread of an outbreak. Once health alerts are distributed, recommendations could be tailored to ensure effective response takes place.

This secondary analysis adds to previous evidence confirming cryptosporidiosis outbreaks are associated with recreational water, daycare facilities, and household transmission. It draws attention to the need for collaborative efforts between local, state, and federal agencies to define and develop policies that facilitate prompt interventions to prevent community-wide transmission of *Cryptosporidium*.

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Table 1. Frequency of Symptoms and Post-Infection Characteristics among Cases, Douglas County, KS (n=151)

Symptoms*	**N (%)**
Diarrhea	151 (100%)
Anorexia	125 (83%)
Fever	92 (61%)
Nausea	89 (59%)
Abdominal Cramping	83 (55%)
Headache	69 (46%)
Vomiting	61 (40%)
Post-Infection Characteristics	**N (%)**
Limited Activity	111 (74%)
Sought healthcare for any symptoms	86 (57%)
Visited healthcare provider	62 (41%)
Missed work	22 (15%)
Went to the emergency room	15 (10%)
Hospitalized for 24 hours or more	**3 (2%)**

*70% of cases (n=106) reported waxing and waning of symptoms.

Table 2. Univariate Analysis of Risk Factors Associated with Community-Wide Transmission, KS 2003

Exposure Categories	Odds Ratio	95% CI		P-value	# Exposed Cases	Exposed Cases/Total (%)	# Exposed Controls	Exposed Controls/Total (%)
Drinking Water Exposure								
Municipal/City Water Direct From Tap	2.6	1.3	5.2	0.009	91	60.3	156	51.7
Commercially Bottled Water	1.7	1.0	2.8	0.040	70	46.4	131	43.4
Recreational Water Exposures								
Any recreational water exposure	7.8	4.2	14.6	<0.0001	121	80.1	138	45.7
Untreated Water (Lake, Pond, River, or Stream)	2.0	1.3	3.2	0.004	42	27.8	47	15.6
Treated Water (Hot Tub, Spa, Whirlpool, or Jacuzzi; Recreational Water Park; Swimming Pool)	7.3	4.1	13.0	<0.0001	114	75.5	116	38.4
Hot Tub, Spa, Whirlpool, or Jacuzzi	3.4	1.3	9.4	0.015	11	7.3	8	2.6
Recreational Water Park	2.3	1.3	4.0	0.004	29	19.2	28	9.3
Swimming Pool	6.8	3.9	11.9	<0.0001	111	73.5	114	37.7
Swimming Pool A	2.1	1.0	4.3	0.037	62	41.1	44	14.6
Swimming Pool B	1.9	0.6	5.7	0.253	13	8.6	6	2.0
Swimming Pool C	0.9	0.4	2.0	0.790	19	12.6	20	6.6
Swimming Pool D	5.6	1.6	20.1	0.008	21	13.9	10	3.3
Daycare Swimming Pools	6.9	2.0	23.9	0.002	25	16.6	5	1.7
Daycare 1	2.0	0.1	32.0	0.624	4	2.6	1	0.3
Daycare 2	9.2	2.1	40.3	0.003	21	13.9	4	1.3
Daycare Exposure								
Child in the Household Receives Childcare Outside the Home	2.7	1.6	4.5	0.000	52	34.4	57	18.9
Provides Childcare	1.7	0.5	5.46	0.405	5	3.3	6	2.0
Household Exposure								
Household Member with Diarrhea	9.3	5.3	16.5	<0.0001	96	63.6	51	16.9

Household Member with *Cryptosporidium*	3.4	1.6	∞	0.988	13	8.6	0	0.0
Household Member in Diapers	1.8	0.4	7.7	0.413	26	17.2	16	5.3
Person-to-Person Contact								
Any Contact with Someone with Diarrhea	5.4	2.5	11.4	<0.0001	32	21.2	21	7.0
Contact with Person in Diapers	2.6	1.2	5.8	0.016	19	12.6	26	8.6
Food Exposures								
Other Cold Salads	0.6	0.4	1.0	0.035	36	23.8	101	33.4
Raw Vegetables	0.6	0.4	1.0	0.050	87	57.6	207	68.5
Farm and Animal Contact								
Contact with a Calf	2.4	1.2	4.5	0.009	21	13.9	18	6.0
Contact with a Goat	3.6	1.5	8.4	0.003	17	11.3	12	4.0
Contact with Pigs	4.3	1.3	14.0	0.016	9	6.0	4	1.3
Contact with a Puppy	2.0	1.1	3.6	0.032	22	14.6	25	8.3
Contact with Any Animals (All Above)	2.1	1.3	3.5	0.004	123	81.5	212	70.2
Contact with Household Pets (Kitten, Cat, Puppy, Dog, or Rabbit)	1.7	1.0	2.7	0.043	116	76.8	208	68.9
Contact with Farm Animals (Calf, Cow, Horse, Pig, or Poultry)	2.1	1.3	3.5	0.002	39	25.8	41	13.6
Contact with a Farm (Calf, Cow, Horse, Pig, or Poultry; Visit, Work on, or Live on a Farm)	1.8	1.2	2.7	0.009	50	33.1	64	21.2
Travel History								
Travel Within 100 miles of Home	0.9	0.6	1.4	0.651	68	45.0	140	46.4
Travel More Than 100 miles from Home	0.7	0.4	1.1	0.141	33	21.9	85	28.1

Table 3. Bivariate Analysis of Risk Factors Associated with Community-Wide Transmission, KS 2003

Exposure*	OR	95% CI		Pr>ChiSq	Household contact with diarrhea OR	95% CI		Pr>ChiSq
Untreated Water (Lake, Pond, River, or Stream)	1.823	1.054	3.152	0.0317	9.767	5.4	17.667	<0.0001
Treated Water (Hot Tub, Spa, Whirlpool, or Jacuzzi; Recreational Water Park; Swimming Pool)	5.864	2.982	11.534	<0.0001	7.944	4.289	14.712	<0.0001
Hot Tub, Spa, Whirlpool, or Jacuzzi	6.86	1.928	24.401	0.0029	9.995	5.472	18.255	<0.0001
Swimming Pool	5.243	2.719	10.113	<0.0001	7.904	4.298	14.537	<0.0001
Child in the Household Receives Childcare Outside the Home	2.965	1.538	5.718	0.0012	11.042	5.805	21.004	<0.0001
Any Contact with Someone with Diarrhea	3.088	1.254	7.605	0.0142	7.041	3.527	14.057	<0.0001
Contact with Person in Diapers	3.401	1.075	10.754	0.0372	17.58	3.632	85.085	0.0004
Contact with a Calf	2.249	0.999	5.5059	0.0502	8.893	4.989	15.854	<0.0001

*Each model included the specified variable and household contact with diarrhea and was conditioned on age.

Table 4. Multivariate Analysis: Reduced Model of the Risk Factors Associated with Community-Wide Transmission, KS 2003

Parameters	Wald Chi-Square	P - Value
Treated recreational water	0	0.9952
Untreated recreational water	0	0.9959
Any Contact with Someone with Diarrhea	0.275	0.6
Contact with Person in Diapers	1.1805	0.2772
Child in the Household Receives Childcare Outside the Home	0.1954	0.6585
Household Member with Diarrhea	3.8197	0.0507

Table 5. Multivariate Analysis: Final Model of the Risk Factors Associated with Community-Wide Transmission, KS 2003

Parameters	Wald Chi-Square	P – Value	OR Estimate	95% CI	
Treated recreational water	26.9225	<0.0001	7.753	3.577	16.804
Child in the Household Receives Childcare Outside the Home	10.9893	0.0009	3.609	1.69	7.709
Household Member with Diarrhea	40.232	<0.0001	10.575	5.102	21.916

Table 6. Multivariate Analysis: Individual Swimming Pool Model

Parameters	Wald Chi-Square	P – Value	OR Estimate	95% CI	
Swimming Pool D	4.3168	0.0377	4.324	1.087	17.209
Daycare 2 Wading Pool	8.7376	0.0031	19.475	2.719	139.464
Household Member with Diarrhea	14.6545	0.0001	7.914	2.744	22.821

Figure 1. Date of Onset of Symptoms of Confirmed Cryptosporidium Cases by Group as of 10/9/03 - Douglas County, KS (n=96)

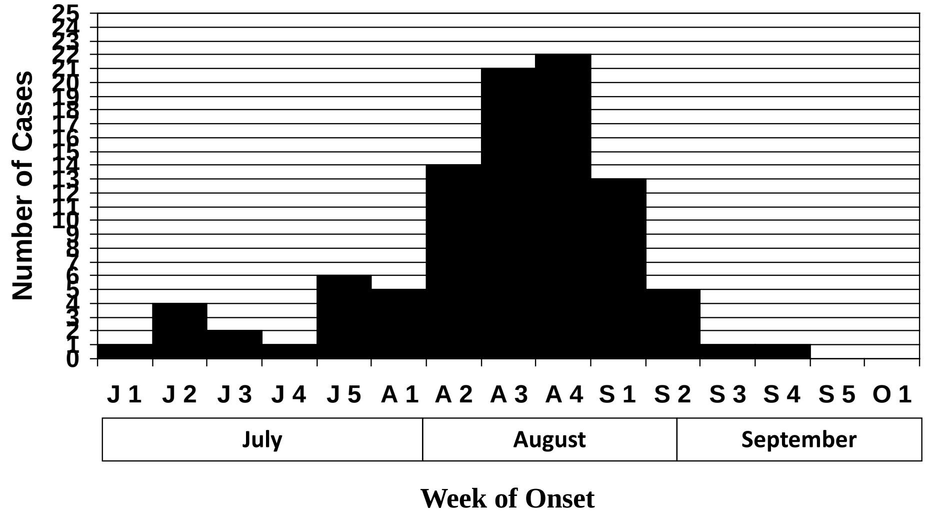
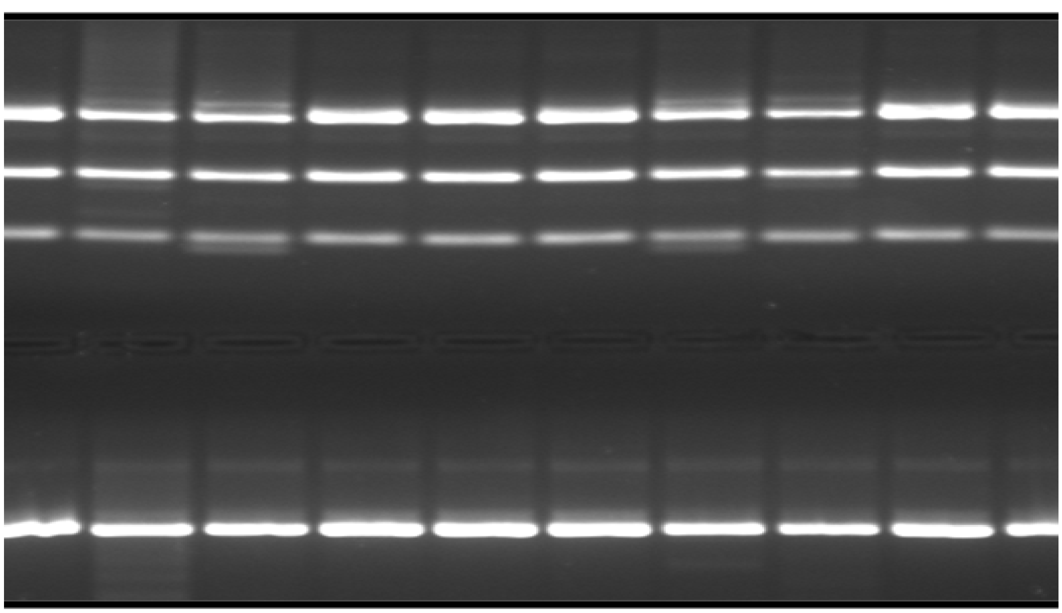


Figure 2. Restriction Fragment Length Polymorphism Gel of *Cryptosporidium hominis* genotype H1-1dA17. 18s RFLP, GP 60 subgenotype



Public Health Implications

This study illustrates how cryptosporidiosis can amplify and spread within a community and underscores the need for instituting rapid and concentrated environmental and behavioral interventions to prevent community-wide spread. The extreme chlorine resistance of *Cryptosporidium* emphasizes what important role chlorine-treated recreational water can play in community-wide amplification. Recreational water parks and community swimming pools represent popular venues with potentially high volume pool use, particularly in the summer months. Daycare facilities allow for particularly intense opportunities for close contact between children as well as childcare providers. These exposures allow for consumption of contaminated water in pools or other water activities or through person-to-person contact. Since these same young children in daycare are often of a vulnerable age for more severe cryptosporidiosis, morbidity can become more problematic.

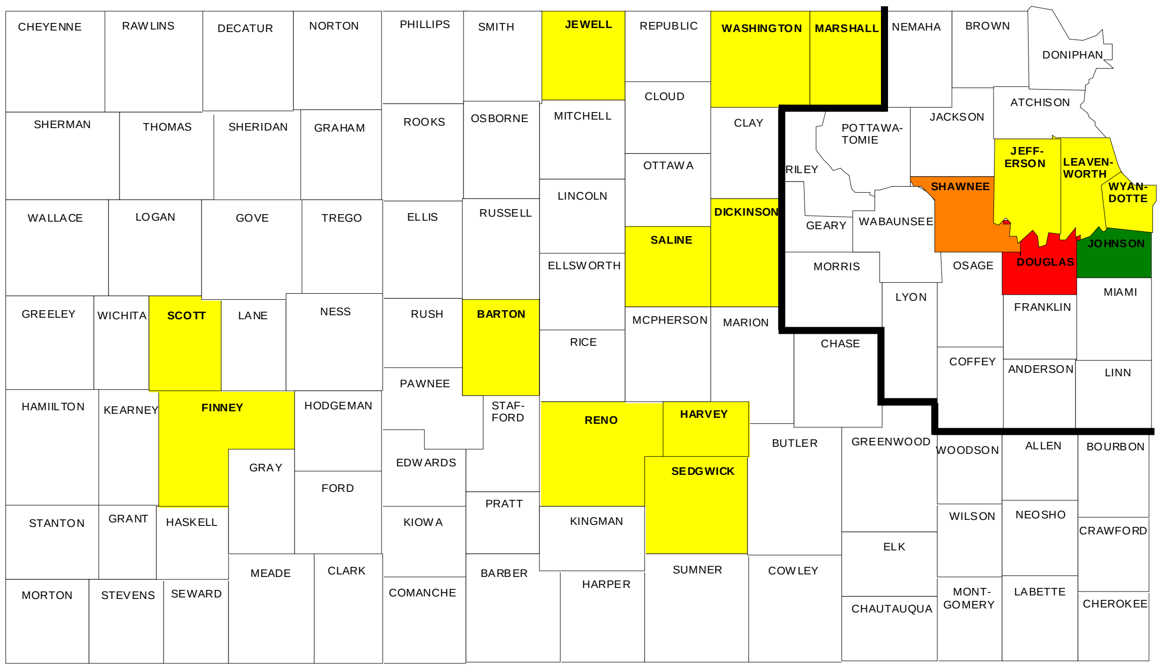
Because *Cryptosporidium* is the leading cause of recreational water- associated waterborne disease outbreaks, implementing preventive measures has the potential to be cost-effective. Preventive and control measures can be developed by local and state authorities using communicatory tools such as community-wide health alerts, which along with strategic control plans, could engage healthcare providers, pool operators, daycare facilities, media outlets, and schools and consequently inhibit community-spread of an outbreak. Once health alerts are distributed, recommendations could be tailored to ensure effective response takes place.

Daycares can be asked to discontinue water-related activities at daycares, tighten exclusion criteria for children with diarrhea, implement rigorous hygiene activities, and report cases to the local health department. Local community swimming facilities would direct pool operators to diligently maintain pool chemicals (i.e. periodic hyperchlorination of pools) and educate swimmers by posting large and informative signs at pools to encourage healthy swimming behaviors. Development of a health alert system requires collaborative efforts with all of the essential groups to inform them about upcoming amendments in health department policy so they would be aware of such changes and associated expectations of them during such an alert. An example of an effective health alert system directly related to this cryptosporidiosis outbreak was seen a similar in Ohio in 2004 [99]. Due to the updated rapid response recommendations made by the CDC after this community-wide Kansas outbreak occurred, transmission of *Cryptosporidium* in Ohio was severely inhibited [99].

This secondary analysis adds to previous evidence confirming cryptosporidiosis outbreaks are associated with recreational water, daycare facilities, and household members. It draws attention to the need for collaborative efforts between local, state, and federal agencies to define and develop policies that facilitate prompt intervention to prevent community-wide transmission of *Cryptosporidium*.

Appendix A: Additional Tables and Figures

Case Distribution by County, Kansas (n=136)
Jan 1, 2003 – Oct 2, 2003



1-3 cases | 4-6 cases | 7-9 cases | 10-15 cases | 16-20 cases | >20 cases

NOTE: Darkened line represents the region of enhanced surveillance.

Univariate Analysis of Risk Factors Associated with Community-Wide Transmission, KS 2003- All Exposures

Exposure Categories	Odds Ratio	95% CI		P-value	# Exposed Cases	Exposed Cases/Total (%)	# Exposed Controls	Exposed Controls/Total (%)
Drinking Water Exposure								
Municipal/City Water Direct From Tap	2.572	1.273	5.195	0.0085	91	60.26	156	51.7
Private Well Water	0.500	0.198	1.260	0.1415	0	0.00	3	1.0
Commercially Bottled Water	1.699	1.023	2.822	0.0404	70	46.36	131	43.4
Raw Water (i.e., Untreated Water from a Lake, River, or Stream)	1.901	0.849	4.257	0.1183	12	7.95	13	4.3
Filtered Tap Water	0.798	0.518	1.231	0.3079	20	13.25	55	18.2
Water from Refrigerator	0.761	0.493	1.175	0.2184	43	28.48	105	34.8
Other Drinking Water	1.139	0.564	2.302	0.7162	4	2.65	4	1.3
Recreational Water Exposures								
Any recreational water exposure	7.841	4.219	14.572	<0.0001	121	80.13	138	45.7
Untreated Water (Lake, Pond, River, or Stream)	2.020	1.257	3.245	0.0037	42	27.81	47	15.6
Lake, Pond, River, or Stream	2.020	1.257	3.245	0.0037	42	27.81	47	15.6
Treated Water (Hot Tub, Spa, Whirlpool, or Jacuzzi; Recreational Water Park; Swimming Pool)	7.270	4.080	12.955	<0.0001	114	75.50	116	38.4
Hot Tub, Spa, Whirlpool, or Jacuzzi	3.448	1.266	9.390	0.0154	11	7.28	8	2.6
Recreational Water Park	2.270	1.291	3.991	0.0044	29	19.21	28	9.3
Swimming Pool	6.787	3.867	11.91	<0.0001	111	73.51	114	37.7
Swimming Pool A	2.113	1.047	4.267	0.0368	62	41.06	44	14.6
Swimming Pool B	1.897	0.633	5.687	0.2528	13	8.61	6	2.0
Swimming Pool C	0.899	0.409	1.975	0.7903	19	12.58	20	6.6
Swimming Pool D	5.593	1.56	20.054	0.0082	21	13.91	10	3.3
Swimming Pool L	2.414	0.188	infinity	0.5	4	2.65	1	0.3
Swim Team B	3.847	0.413	infinity	0.25	7	4.64	0	0.0

Daycare Swimming Pools	6.907	1.998	23.879	0.0023	25	16.56	5	1.7
Daycare 1	2	0.125	31.975	0.624	4	2.65	1	0.3
Daycare 2	9.168	2.084	40.332	0.0034	21	13.91	4	1.3
Daycamp 1	0.781	0.069	8.876	0.8418	1	0.66	2	0.7
Daycare Exposure								
Child in the Household Receives Childcare Outside the Home	2.732	1.645	4.537	0.0001	52	34.44	57	18.9
Provides Childcare	1.667	0.509	5.461	0.405	5	3.31	6	2.0
Providing Care For Someone with Diarrhea	17.055	2.155	134.962	0.0072	9	5.96	2	0.7
Household Exposure								
Household Member with Diarrhea	9.324	5.267	16.505	<0.0001	96	63.58	51	16.9
Household Member with *Cryptosporidium*	3.379	1.563	∞	0.9877	13	8.61	0	0.0
Household Member in Diapers	1.826	0.432	7.713	0.4129	26	17.22	16	5.3
Person-to-Person Contact								
Any Contact with Someone with Diarrhea	5.366	2.526	11.400	<0.0001	32	21.19	21	7.0
Contact with Person in Diapers	2.646	1.198	5.840	0.016	19	12.58	26	8.6
Food Exposures								
Lettuce or Garden Salad	1.11	0.696	1.77	0.6626	78	51.66	156	51.7
Cold Cuts or Chicken/Egg Salad/Tuna Salad	1.024	0.666	1.576	0.9125	64	42.38	129	42.7
Other Cold Salads	0.607	0.381	0.966	0.0354	36	23.84	101	33.4
Raw Vegetables	0.635	0.403	0.999	0.0497	87	57.62	207	68.5
Raw Berries	0.842	0.569	1.245	0.3886	65	43.05	142	47.0
Raw Fruits	1.244	0.749	2.068	0.3987	112	74.17	220	72.8
Cider or Juice	0.782	0.523	1.171	0.2327	66	43.71	158	52.3
Dairy Products (Milk or Cheese)	0.795	0.348	1.817	0.5869	0	0.00	1	0.3

Cooked or Raw Shellfish	0.875	0.468	1.637	0.6769	0	0.00	1	0.3
Farm and Animal Contact								
Contact with a Calf	2.356	1.239	4.482	0.009	21	13.91	18	6.0
Contact with a Cow	1.708	0.774	3.772	0.1851	12	7.95	14	4.6
Contact with a Goat	3.592	1.527	8.446	0.0034	17	11.26	12	4.0
Contact with a Horse	1.645	0.877	3.087	0.121	19	12.58	25	8.3
Contact with Pigs	4.297	1.319	14	0.0155	9	5.96	4	1.3
Contact with Poultry	2.182	0.963	4.945	0.0616	12	7.95	11	3.6
Contact with a Kitten	1.1519	0.65	2.065	0.6174	20	13.25	35	11.6
Contact with a Cat	1.019	0.696	1.491	0.9226	71	47.02	140	46.4
Contact with a Puppy	1.961	1.06	3.628	0.0319	22	14.57	25	8.3
Contact with a Dog	1.447	0.945	2.218	0.0893	94	62.25	168	55.6
Contact with a Rabbit	1.961	0.821	4.681	0.1293	11	7.28	12	4.0
Contact with Reptiles	1.1819	0.87	3.804	0.1118	16	10.60	20	6.6
Contact with Other Animals	1.843	0.893	3.802	0.0981	15	9.93	17	5.6
Contact with Any Animals (All Above)	2.095	1.262	3.478	0.0042	123	81.46	212	70.2
Contact with Household Pets (Kitten, Cat, Puppy, Dog, or Rabbit)	1.654	1.017	2.689	0.0426	116	76.82	208	68.9
Contact with Farm Animals (Calf, Cow, Horse, Pig, or Poultry)	2.132	1.309	3.472	0.0024	39	25.83	41	13.6
Visit, Work on, or Live on a Farm	1.196	0.71	2.012	0.5015	28	18.54	48	15.9
Contact with a Farm (Calf, Cow, Horse, Pig, or Poultry; Visit, Work on, or Live on a Farm)	1.762	1.15	2.699	0.0093	50	33.11	64	21.2
Travel History								
Travel Within 100 miles of Home	0.910	0.603	1.371	0.6513	68	45.03	140	46.4
Travel More Than 100 miles from Home	0.705	0.443	1.123	0.1411	33	21.85	85	28.1
Travel to a Different Country	0.690	-2.970	∞	0.9963	1	0.66	3	1.0

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DRAFT OF DOUGLAS COUNTY, KANSAS CASE QUESTIONNAIRE
CRYPTOSPORIDIUM OUTBREAK

Date of interview ____
NAME OF INTERVIEWER____
CASE: LAST NAME______________________ FIRST NAME_________________
AGE OF CASE ____ TELEPHONE NUMBER______________________

|__| **CASE**
Beginning June 15, 2003 through the present:

- at least 3 days with 3 loose stools per day within one week
  or
- a positive cryptosporidium lab test

|__| **CONTROL**
- **NO** gastrointestinal illness since June 15, 2003

CASE report number |__|__|__| **Matched CONTROL report number** |__|__|__|

2 week exposure period |__|__|-|__|__|-|__|__| to |__|__|-|__|__|-|__|__|
MM DD YY MM DD YY

Telephone Contact History

Date (mm/dd)	Time (am/pm)	Outcome/Comment
1.___________	____________	___________________
2.___________	____________	___________________
3.___________	____________	___________________
4.___________	____________	___________________
5.___________	____________	___________________
6.___________	____________	___________________
7.___________	____________	___________________

OUTCOME CODES:

01 = completed interview	07 = no eligible respondent
02 = refused interview	08 = language barrier
03 = no answer	09 = interview terminated within questionnaire
04 = busy tone	11 = physical/mental impairment
05 = non-working number	12 = answering machine
06 = fax machine	13 = setting up a better time
05 = business phone	99 = unknown

YOU SHOULD HAVE COMPLETED THE CASE INTRODUCTION INTERVIEW AND BE SPEAKING WITH AN ADULT CASE. THERE IS A SEPARATE FORM FOR PEDIATRIC CASES.

BEFORE YOU INTERVIEW CASE: HAVE A CALENDAR IN FRONT OF YOU.

* TEXT IN REGULAR TYPE IS TO BE READ TO THE RESPONDENT. *** TEXT IN BOLD IS AN INSTRUCTION FOR THE INTERVIEWER AND SHOULD NOT BE READ TO THE RESPONDENT.**

Hello, my name is **______________________** and I am working with the Lawrence-Douglas County Health Department. I'm trying to reach [Name of Contact].

YOU SHOULD BE SPEAKING WITH THE ADULT CASE, OR A PARENT OR GUARDIAN OF A CASE. DO NOT INTERVIEW ANYONE YOUNGER THAN 18 WITHOUT THE PERMISSION OF THE PARENT OR GUARDIAN.

We are investigating cases of diarrhea occurring among people who live in Douglas County. We are conducting a survey to help us determine what may have played a role in causing illness among people living in our community.

We realize that you may have already spoken to the Health Department, however, we are interested in finding out more about this illness so that we can learn more about preventing and controlling Cryptosporidiosis, the diarrheal disease that we have seen in our community.

[*You or Name of Child*] has been selected to participate in this survey because of *(your, your child's)* illness. The answers that you give will remain confidential. Your participation in these efforts will greatly enhance our understanding of this illness in our community.

This should take approximately 30 minutes. Your participation is voluntary and all information you give will be kept confidential to the extent legally possible. Some of the questions may be sensitive. You may refuse to answer any question at any time. Neither [*Your, Your child's*] name nor any identifying information will appear on any report. We will be happy to answer all your questions at the end of the interview. A final report will be available at the health department.

Do you agree to participate in this survey?

___ NO, **END INTERVIEW**…Thank you for your time.

___ YES, **IF YES, CONTINUE INTERVIEW**... It would be helpful if you had a calendar n front of you as we will be discussing specific dates.

SECTION A: CLINICAL INFORMATION

FIRST, I WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT *(YOUR/NAME ______________'S)* HEALTH.

A1. Between Father's Day (June 15, 2003) and the present, did *(you/name ______________)* have any gastrointestinal illness? For example, did *(you/name ______________)* have any vomiting, stomach cramps, diarrhea or other such symptoms?

YES.. 1
NO.. 2 **(GO TO)**
REFUSED.................................. 88 **(GO TO)**
UNKNOWN............................... 99 **(GO TO)**

A2. Did *(you/name ______________)* have diarrhea (3 or more loose or watery stools in a 24 hour period) during this illness?

YES.. 1
NO.. 2 **(GO TO)** **terminate interview for lower three**
REFUSED.................................. 88 **(GO TO)**
UNKNOWN............................... 99 **(GO TO)**

A3. Did *(you, name______________)* have 3 days of diarrhea (3 or more loose watery stools per day) within a one week period?

YES.. 1

A3a. If yes, when did the diarrhea begin? |__|__|-|__|__|-|0|3|
MM DD YY

IF RESPONDENT CANNOT REMEMBER EXACT DATE DIARRHEA BEGAN, PROMPT FOR WEEK DIARRHEA BEGAN. ENTER DATE OF WEDNESDAY OF THAT WEEK

NO.. 2 **(GO TO)**
REFUSED.................................. 88 **(GO TO)**
UNKNOWN............................... 99 **(GO TO)**

AFTER GETTING THE DATE OF ONSET FOR ILLNESS (A3), MARK THE 2 WEEKS PRECEEDING THAT ONSET DATE ON THE CALENDAR AND IN THE SPACE BELOW FOR USE IN ASKING THE EXPOSURE QUESTIONS

THAT WOULD BE THE PERIOD FROM /___/___/___/ TO /___/___/___/.

A4. What was the <u>maximum</u> number of loose or watery stools *(you/name ______)* had in a 24 hour period during this illness?

NUMBER |__|__|
REFUSED............................88
UNKNOWN........................99

A5. Did *(you/name _____________)* have blood in *(your/his/her)* stool?

YES... 1
NO... 2
REFUSED.................................. 88
UNKNOWN............................... 99

A6. Was there a period when *(your, name_______________'s)* diarrhea went away for at least a day and then came back?

YES... 1
NO... 2 **(GO TO)**
REFUSED.................................. 88 **(GO TO)**
UNKNOWN............................... 99 **(GO TO)**

A7. How many times did this happen?

|__|__| Times

A8. Do you currently have diarrhea?

YES... 1 **(GO TO)**
NO... 2
REFUSED.................................. 88 **(GO TO)**
UNKNOWN............................... 99 **(GO TO)**

A9. If **NO**, what date did the diarrhea *completely* end (include all of the diarrhea free days if there were any)?

Date: |__|__| |__|__| 2003

A10. Which of the following symptoms did you have, and how long did you experience each from beginning to end, regardless if you felt better on some days in between? **[READ THE LIST OF SYMPTOMS. IF YES, CIRCLE THE CORRESPONDING DURATION FOR EACH.]**

SYMPTOM	0 days	1 day	2-5 days	6-14 days	>14 days	REF	UNK

a. Nausea	000	001	002	006	014	888	999
b. Vomiting	000	001	002	006	014	888	999
c. Fever **IF YES, ASK A7 AS WELL**	000	001	002	006	014	888	999
d. Loss of appetite	000	001	002	006	014	888	999
e. Abdominal cramps	000	001	002	006	014	888	999
f. Bloating/Gas	000	001	002	006	014	888	999
g. Headache	000	001	002	006	014	888	999

A11. IF YES TO FEVER, what was the highest temperature measured?

a. **NUMBER |__|__|__| . |__| degrees F OR b. NUMBER |__|__|__| . |__| degrees C**

Felt warm/feverish, but temperature not measured … 222
REFUSED........................……………………….... 888
UNKNOWN........................………………………. 999

A12. We would like to know about your medical history prior to your illness, in order to determine if some conditions make it easier to get cryptosporidiosis or cause more severe illness. Some of these questions are of a sensitive nature. You can refuse to answer any question at any time.
I will now read a list of health problems and ask if you ever had any of the following procedures or were told by a physician that you have any of the following illnesses. **[READ THE LIST. CIRCLE ALL THAT APPLY]**

ILLNESS/PROCEDURE	**1) Illness/Procedure**				**[IF YES IN 1) THAN ASK] 2) Time in relation to illness**				
	YES	**NO**	**REFUSED**	**UNKNOWN**	**BEFORE**	**DURING**	**AFTER**	**REFUSED**	**UNKNOWN**
Pregnancy									
f. Organ Transplant	001	002	888	999	003	004	005	888	999
j. Chronic Diarrhea	001	002	888	999	003	004	005	888	999
k. Crohn's Disease	001	002	888	999	003	004	005	888	999
l. Irritable Bowel Disease	001	002	888	999	003	004	005	888	999
p. HIV/AIDS	001	002	888	999	003	004	005	888	999
q. Other immunodeficiency r. Specify:	001	002	888	999	003	004	005	888	999
u. Other v. Specify:____________	001	002	005	999	003	004	005	888	999

A13. Did (*you/name* _____*)* seek health care for any symptoms?

YES... 1

NO.. 2 **(GO TO)**
REFUSED.................................. 88 **(GO TO)**
UNKNOWN............................... 99 **(GO TO)**

A14. The following questions are about treatment for *(your, name*_________*'s)* illness.

	Y	N	R	U
A14a. Was a healthcare provider consulted over the phone?	1	2	88	99
A14b. Did *(you/he/she)* visit a health care provider	1	2	88	99
A14c. Did *(you/he/she)* visit an Emergency Room	1	2	88	99
A14d. Were *(you/he/she)* hospitalized for more than 24 hours If yes how long hospitalized?	1	2	88	99

A15. Once your illness began, how long were you ill before you made your first healthcare visit?

NUMBER |__|__| days / weeks /months

REFUSED...88
UNKNOWN......................................99

A16. Did you take any anti-diarrheal medications for this illness?

YES... 1
NO.. 2
REFUSED.................................. 88
UNKNOWN............................... 99

A17. Were *(you/name ______________)* unable to go to work/ school/ camp/ daycare or to participate in *(your/his/her)* normal activities of daily life (e.g. unable to play, etc.) because of this illness?

YES... 1

A17a. If yes, how many days ? |___|___|

NO.. 2
REFUSED.................................. 88
UNKNOWN............................... 99

SECTION B. DIETARY EXPOSURES

I WOULD LIKE TO TALK ABOUT YOUR DIET DURING THE TWO WEEKS BEFORE YOU BECAME ILL **(QUESTION A3),** THAT WOULD BE THE PERIOD FROM /___/___/___/ TO /___/___/___/.

B1. During the 2 weeks before you became ill, how many times did you eat any of the following food items regardless of whether it was prepared in or out of your home?
(READ THE LIST. ENTER ALL THAT APPLY]

I WOULD DELETE THE QUANTITATION PORTION AND JUST ASK IT AS A YES/NO SINCE MUCH OF THIS WILL BE FOOD PREFERENCE.

FOOD	0	1-5	6-10	11-15	>15	REFUSED	UNKNOWN
a. Lettuce or garden salad	0	1	6	11	15	88	99
b. Cold cuts, chicken salad, egg salad, or tuna salad	0	1	6	11	15	88	99
c. Other cold salads such as coleslaw, potato salad, or pasta salad	0	1	6	11	15	88	99
d. Raw vegetables such as carrots, tomatoes, cucumbers, green onions	0	1	6	11	15	88	99
e. Raw berries (e.g. strawberries and raspberries)	0	1	6	11	15	88	99
f. Raw fruits *with* skin/peel (e.g., melons, apples)	0	1	6	11	15	88	99
g. Cider or juice	0	1	6	11	15	88	99
h. Raw shellfish	0	1	6	11	15	88	99
i. Cooked shellfish	0	1	6	11	15	88	99
j. Raw oysters	0	1	6	11	15	88	99
k. Cooked oysters	0	1	6	11	15	88	99

B2. If you consume unpeeled fresh fruit, lettuce or vegetables at home, do you wash them before you eat them?

ALWAYS………… 1
USUALLY……..….2
SOMETIMES…… 3
NEVER……………4
REFUSED…..........88
UNKNOWN.…...... 99

B3. If you consume raw berries at home, do you wash them before you eat them?

ALWAYS………… 1
USUALLY……..….2
SOMETIMES…… 3
NEVER……………4
REFUSED…..........88
UNKNOWN.…...... 99

B4. During the two weeks before you became ill, did you consume any of the following *unpasteurized* foods or drinks? This may include products supplied from health food stores or imported from other countries. **[READ THE LIST. ENTER ALL THAT APPLY]**

FOOD	YES	NO	REFUSED	UNKNOWN
a. Milk	1	2	88	99
b. Apple juice/cider	1	2	88	99
c. Other juices	1	2	88	99
d. Unpasteurized cheese (e.g. brie, goat cheese, white cheese, queso fresco)	1	2	88	99
e. Other f. Specify:	1	2	88	99

SECTION C. DRINKING WATER EXPOSURES

I WOULD LIKE TO TALK ABOUT YOUR EXPOSURE TO DRINKING WATER DURING THE TWO WEEKS BEFORE YOU BECAME ILL **(QUESTION A3),** THAT WOULD BE THE PERIOD FROM /___/___/___/ TO /___/___/___/.

C1. During the 2 weeks before your illness, what were your sources of drinking water *at home*? **[READ THE LIST. ENTER ALL THAT APPLY]**

QUESTION	YES	NO	REFUSED	UNKNOWN
a. Municipal or city water direct from tap	1	2	88	99
b. Municipal or city water with additional filtration or treatment	1	2	88	99
c. Refrigerator dispenser	1	2	88	99
d. Private well water	1	2	88	99
e. Commercially bottled water	1	2	88	99
f. Other g. Specify:	1	2	88	99
h. Does not drink water at home	1	2	88	99
i.. Unknown	1	2	88	99

C2. During the 2 weeks before your illness, what were your sources of drinking water *outside the home*, for example, at school or work? **[READ THE LIST. ENTER ALL THAT APPLY.]**

QUESTION	YES	NO	REFUSED	UNKNOWN
a. Municipal or city water direct from tap	1	2	88	99
b. Municipal or city water with additional filtration or treatment	1	2	88	99
c. Refrigerator dispenser	1	2	88	99
d. Private well water	1	2	88	99
e. Commercially bottled water	1	2	88	99
f. Does not drink water outside the home	1	2	88	99
g. Unknown	1	2	88	99
h. Other i. Specify:	1	2	88	99

C3. What was your usual source of *ice* during the 2 weeks before you became ill? **[READ THE LIST. ENTER ALL THAT APPLY]**

SOURCE	YES	NO	REFUSED	UNKNOWN
a. From your home	1	2	88	99
b. From outside your home	1	2	88	99
c. Do not use ice	1	2	88	99

C4. During the 2 weeks before your illness, did you drink any untreated water from a lake, river or stream?

YES.. 1
NO.. 2 **(GO TO)**
REFUSED................................... 88 **(GO TO)**
UNKNOWN................................ 99 **(GO TO)**

SECTION D: RECREATIONAL WATER EXPOSURE INFORMATION FOR CASES

I WOULD LIKE TO TALK ABOUT YOUR EXPOSURE TO RECREATIONAL WATER DURING THE TWO WEEKS BEFORE THE DIARRHEA BEGAN, **(QUESTION A3),** THAT WOULD BE THE PERIOD FROM /___/___/___/ TO /___/___/___/.

D1. During the 2 weeks before the diarrhea began, did you swim or enter water (other than in a bathtub or shower)?

YES..	1	
NO..	2	**(GO TO)**
REFUSED..................................	88	**(GO TO)**
UNKNOWN..............................	99	**(GO TO)**

D2. During the two weeks before the diarrhea began, which recreational water settings did you swim in, wade in, or enter? **[READ THE LIST. ENTER ALL THAT APPLY]**

Setting	Y N R U	**IF YES,** on how many days did you swim or enter the water in the two weeks before you became ill? Number of days?			**IF YES,** did you put your face under the water? Y N R U
a. Lake, Pond, River or Stream	1 2 88 99	1-5	6-10	11-15	1 2 88 99
b. Hot Tub, Spa, Whirlpool, Jacuzzi	1 2 88 99	1-5	6-10	11-15	1 2 88 99
c. Recreational Water Park	1 2 88 99	1-5	6-10	11-15	1 2 88 99

D3. During the two weeks before the diarrhea began, did you swim, wade in or enter a swimming pool?

YES..	1	
NO..	2	**(GO TO)**
REFUSED..................................	88	**(GO TO)**
UNKNOWN...............................	99	**(GO TO)**

D4. IF YES, During the two weeks before the diarrhea began, please list the swimming pools that you swam in or entered? **[READ THE LIST BELOW. ENTER ALL THAT APPLY]**

					IF YES, on how many days did you swim or enter the water in the 2 weeks before you became ill?	**IF YES,** on which dates did you swim or enter the water? **(IF CANNOT RECALL EXACT DATES, PLEASE REQUEST WEEK OF SWIMMING IN THIS LOCATION)**	**IF YES,** did you put your face under the water? I would delete and rely on questions below			
Pool	**Y**	**N**	**R**	**U**	**How many days?**	**List dates**	**Y**	**N**	**R**	**U**
a. Pool B	1	2	88	99			1	2	88	99
b. Pool C	1	2	88	99			1	2	88	99
c. Pool A	1	2	88	99			1	2	88	99
d. Pool D	1	2	88	99			1	2	88	99
e. Pool G	1	2	88	99			1	2	88	99
f. Pool E	1	2	88	99			1	2	88	99
g. Pool F	1	2	88	99			1	2	88	99
h. Pool H	1	2	88	99			1	2	88	99
i. Daycare 1 kiddie/ wading pool	1	2	88	99			1	2	88	99
j. Other	1	2	88	99			1	2	88	99

READ: THE FOLLOWING QUESTIONS ASK ABOUT TYPICAL SWIMMING ACTIVITIES DURING VISITS TO POOLS DURING THE 2 WEEKS PRIOR TO ONSET OF DIARRHEA

D5. On a typical visit during the 2 weeks before the diarrhea began, did *(you/name ______________)* usually wade or play in the water without swimming?

YES…………………....1
NO………………….2
REFUSED................88
UNKNOWN............99

D6. During the 2 weeks before the diarrhea began, did you get water *splashed in your face*?

YES…………… 1
NO……..……. 2
REFUSED…..........88
UNKNOWN.…...... 99

D7. During the 2 weeks before before the diarrhea began, did you put *your face in the water*?

YES…………… 1
NO……..……. 2
REFUSED…..........88
UNKNOWN.…...... 99

D8. During the 2 weeks before the diarrhea began, did you get *any* water in your mouth?

YES…………… 1
NO……..……. 2 **(GO TO)**
REFUSED…..........88 **(GO TO)**
UNKNOWN.…...... 99 **(GO TO)**

D9. During the 2 weeks before the diarrhea began, did you *swallow* any of this water?

YES…………… 1
NO……..……. 2 **(GO TO)**
REFUSED…..........88 **(GO TO)**
UNKNOWN.……..99 **(GO TO)**

D10. During the 2 weeks before the diarrhea began, did you *dive* into the water?

YES…………… 1
NO……..……. 2
REFUSED…..........88
UNKNOWN.…...... 99

D11. During the 2 weeks before the diarrhea began, did you *use a slide* to enter the water at a recreational area?

YES……………….1
NO……..…………2
REFUSED…...........88
UNKNOWN..…...... 99

D13. On a typical visit during the 2 weeks before the diarrhea began, did *(you/name _____________)* eat food purchased at a concession stand at the pool site during your visit?

YES……......………1
NO...................……2
REFUSED.................88
UNKNOWN............. 99

D14. On a typical visit to the pool during the 2 weeks before the diarrhea began, did *(you/name _____________)* consume any drink with ice, for example, ice tea or soda from the soda fountain?

YES...……………..……	1
NO...........……….	2
REFUSED..................	88
UNKNOWN...............	99

D15. Were you aware of any fecal accidents at the pools you attended during the 2 week period before the diarrhea began?

YES...……………..……	1
NO...........……….	2
REFUSED..................	88
UNKNOWN...............	99

D16. If **YES**, list pool and date:

Pool___________________________ Date___________________________

NOW WE WOULD LIKE TO ASK YOU SOME INFORMATION ABOUT EXPOSURES SPECIFICALLY Aquatic facilites in Douglas county DURING THE 2 WEEKS PRIOR TO THE ONSET OF YOUR ILLNESS

D17. During the two weeks before *illness*, did *(you/he/she)* swim or enter the water while at the Pool B?

YES.. 1
NO...2 **(GO TO)**
REFUSED................................. .88 **(GO TO)**
UNKNOWN............................... 99 **(GO TO)**

D18. During the two weeks before *illness*, did *(you/he/she)* participate as a member of any of the following groups at the Pool B? **READ ALL AND ENTER ALL THAT APPLY.**

Swim Team A…………………..01
Swim Team B…………………..02
Swim Team C…………………..03
Daycamp 1……………….……..04
None of the above.......................11

D19. During the two weeks before illness did you swim in the sectional swim meet July 11th-13th at the Pool B?

YES.. 1
NO...2 **(GO TO)**
REFUSED................................. 88 **(GO TO)**
UNKNOWN...............................99 **(GO TO)**

D20. When the Pool B closed (this is the period between August 16 and August 30, 2003) did *(you, name____________)* enter the water or swim at any other facility or recreational area?

YES.. 1 **(GO TO)**
NO...2 **(GO TO)**
REFUSED..................................88 **(GO TO)**
UNKNOWN............................... 99 **(GO TO)**

D21. Where did you swim or enter the water while the Pool B closed?
(WRITE IN NAME OF POOL/RECREATIONAL AREA)

Name of Pool/Recreational Area

a.______________________________________

b.______________________________________

c.______________________________________

d.______________________________________

D22. During the two weeks before *illness*, did *(you/he/she)* swim or enter the water while at the Pool A?

YES... 1
NO...2 **(GO TO)**
REFUSED.................................. .88 **(GO TO)**
UNKNOWN................................ 99 **(GO TO)**

D23. During the two weeks before *illness*, did *(you/he/she)* participate as a member of any of the following groups at the Pool A? **READ ALL AND ENTER ALL THAT APPLY.**

Swim Team A………………….01
Swim Team B…………………..02
Swim Team C………………...…03
Daycamp 1……………….……..04
None of the above.......................11

D24. When the Pool A closed (this is the period between August 22 and August 24, 2003) did *(you, name____________)* enter the water or swim at any other facility or recreational area?

YES... 1 **(GO TO)**
NO...2 **(GO TO)**
REFUSED....................................88 **(GO TO)**
UNKNOWN................................99 **(GO TO)**

D25. Where did you swim or enter the water while the Pool A closed?
(WRITE IN NAME OF POOL/RECREATIONAL AREA)

Name of Pool/Recreational Area

a.____

b.____

c.____

d.____

D26. Did you swim in any pools during the time you were having diarrhea or during the 2 weeks after your diarrhea stopped?

YES…...…………...….1
NO…………………….….2 **(GO TO)**
REFUSED................88 **(GO TO)**
UNKNOWN............ 99 **(GO TO)**

D27. If **YES**, please specify pools and dates
READ THE LIST BELOW. ENTER ALL THAT APPLY.

					IF YES, on how many days did you swim or enter the water while you had diarrhea or up to 2 wks after the diarrhea stopped?	**IF YES,** on which dates did you swim or enter the water?
Pool	**Y**	**N**	**R**	**U**	**How many days?**	**List dates**
a. Pool B	1	2	88	99		
b. Pool C	1	2	88	99		
c. Pool A	1	2	88	99		
d.Pool D	1	2	88	99		
e. Pool L	1	2	88	99		
f. Pool E	1	2	88	99		
g. Pool F	1	2	88	99		
h. Pool H	1	2	88	99		
i. Daycare1-kiddie/ wading (e.g., inflatable)	1	2	88	99		
j. Other	1	2	88	99		

SECTION E. PERSON TO PERSON CONTACT AND CHILDCARE INFORMATION

READ: NOW I WOULD NOW LIKE TO ASK A FEW QUESTIONS ABOUT YOUR HOUSEHOLD AND YOUR CONTACT WITH YOUNG CHILDREN AND PERSONS WITH DIARRHEA DURING THE 2 WEEKS BEFORE THE ONSET OF YOUR DIARRHEA.
/___/___/___/ TO /___/___/___/.

E1. What family members were living in *(your/name* **_____________** *'s)* household during the period between Father's Day (June 15th, 2003) and the present. Please give their age, relationship to you and whether or not they had diarrhea (at least 3 loose stools in 24 hours)?
HAVE RESPONDENT LIST AND FILL IN TABLE.

Relationship To Respondent	**Age**	**Sex** M=1 F=2	**Diarrhea** Y=1 N=2	**Date Onset mm/dd/yyyy**	Diarrhea within 2 wks prior to cases symptoms **YES**	**NO**
Self		1 2	1 2		1	2
		1 2	1 2		1	2
		1 2	1 2		1	2
		1 2	1 2		1	2
		1 2	1 2		1	2
		1 2	1 2		1	2
		1 2	1 2		1	2
		1 2	1 2		1	2

E2. Next, I would like to know about visitors who spent 2 or more consecutive nights in your house during the period between Father's Day (June 15th, 2003) and the present. Please give their age, relationship to you, and whether or not they had diarrhea (at least 3 loose stools in 24 hours). **HAVE RESPONDENT LIST AND FILL IN TABLE.**

Relationship To Respondent	**Age**	**Sex** M=1 F=2	**Diarrhea** Y=1 N=2	**Date Onset mm/dd/yyyy**	**Date of Beginning of Visit mm/dd/yyyy**	**# Days Visited**
		1 2	1 2			
		1 2	1 2			

		1 2	1 2			
		1 2	1 2			

E3. During the 2 weeks before the beginning of the diarrhea, did (*your child/name)* attend or go to any of the following childcare settings? **READ ALL CHOICES AND ENTER THE CORRECT RESPONSE.**

	Y	N	R	U
a.Out of home daycare center.......	1	2	88	99
b.In-home daycare……….	1	2	88	99
c.Out of home babysitter.................	1	2	88	99
d.In-home babysitter........................	1	2	88	99
e.Other …………………………….	1	2	88	99
specify ___________________				

E4. Did your child attend any of the following specific daycares in the two weeks prior to the beginning of diarrhea? **READ LIST BELOW. ENTER ALL THAT APPLY.**

	YES	**NO**	**REFUSED**	**UNKNOWN**
Daycare 1	1	2	88	99
Daycare 2	1	2	88	99
	1	2	88	99
	1	2	88	99
Other Specify:	1	2	88	99

E5. IF YES TO E4, Were any children at your child's preschool or at the location at which your child received childcare *in diapers*?

YES.. 1
NO... 2
REFUSED.. 88
UNKNOWN.. 99

E6. During the 2 weeks before the beginning of the diarrhea, did your child swim in a pool at his/her daycare?

YES...1
NO..2
REFUSED..88
UNKNOWN.. 99

E7. If **YES**, give type of pool:

Inflatable wading pool…………..1
Permanent wading pool…………2
In-ground swimming pool………3
REFUSED...................................88
UNKNOWN................................ 99

E8. Were any children in your household in a *day camp* during the 2 weeks before you became ill? By a day camp I mean a center with activities where children spend all or part of the day, often during the summer months when school is out. By comparison, a day care center is often for toddlers.

YES.. 1
NO.. 2
REFUSED.................................. 88
UNKNOWN................................ 99

E9. During the 2 weeks before illness, did you *provide* childcare in any of the following childcare settings? **READ THE LIST. ENTER ALL THAT APPLY**

SETTING	YES	NO	REFUSED	UNKNOWN
a. Out-of-home childcare center	1	2	88	99
b. In-home childcare center	1	2	88	99
c. Out-of-home babysitter	1	2	88	99
d. In-home babysitter	1	2	88	99
e. Other f. Specify:	1	2	88	99

E10. If **YES** to any above (**E9**), please list name___________________ dates_______________

E11. During the 2 weeks before illness, did you have contact with or change any children in diapers?

YES... 1
NO.. 2 **(GO TO)**
REFUSED.............................. 88 **(GO TO)**
UNKNOWN.......................... 99 **(GO TO)**

E12. During the 2 weeks before you became ill, did you come in contact with anyone who had diarrhea?

YES..1
NO..2 **(GO TO)**
REFUSED..88 **(GO TO)**
UNKNOWN.................................... 99 **(GO TO)**

E13. Did they include: **READ THE LIST. ENTER ALL THAT APPLY**

	YES	NO	REFUSED	UNKNOWN
a. Children ≤ 3 years of age	1	2	88	99
b. Children >3 to <12 years of age	1	2	88	99
c. Teenagers 12 to <18 years	1	2	88	99
d. Adults	1	2	88	99

E14. During the 2 weeks before your diarrhea began, did you provide direct care to a person with diarrhea?

YES.. 1
NO.. 2
REFUSED.................................... 88
UNKNOWN................................. 99

READ: NOW I WOULD NOW LIKE TO ASK YOU A FEW QUESTIONS ABOUT YOUR CONTACT WITH OTHERS DURING THE TIME YOU HAD DIARRHEA AND 2 WEEKS AFTER YOUR DIARRHEA STOPPED

E15. During the time of diarrhea and the 2 weeks after it ended, did (*your child/name)* attend or go to any of the following childcare settings? **READ ALL CHOICES AND ENTER THE CORRECT RESPONSE.**

	Y	N	R	U
Out of home daycare center.......	1	2	88	99
In-home daycare……….	1	2	88	99
Out of home babysitter.................	1	2	88	99
In-home babysitter........................	1	2	88	99
Other …………………………….	1	2	88	99
specify __________________				

E16. Did your child attend any of the following specific daycares during or 2 weeks after the diarrhea stopped? **READ LIST BELOW. ENTER ALL THAT APPLY.**

	YES	NO	REFUSED	UNKNOWN
Daycare 1	1	2	88	99
Daycare 2	1	2	88	99
	1	2	88	99
	1	2	88	99
Other Specify:	1	2	88	99

E17. Did you *provide* childcare in any of the following childcare settings while you had diarrhea or up to 2 weeks after the diarrhea stopped? **READ THE LIST. ENTER ALL THAT APPLY**

SETTING	YES	NO	REFUSED	UNKNOWN
a. Out-of-home childcare center	1	2	88	99
b. In-home childcare center	1	2	88	99
c. Out-of-home babysitter	1	2	88	99
d. In-home babysitter	1	2	88	99
e. Other f. Specify:	1	2	88	99

E18. If **YES** to any above (**E17**), please list name (of daycare center)____________________ and dates__________________

E19. During the time you had diarrhea, or up to 2 weeks after your diarrhea stopped, did you provide care for individuals in an institutional setting? (for example, hospital, skilled nursing facility, mental health facility)

YES..1
NO..2 **(GO TO)**
REFUSED..88 **(GO TO)**
UNKNOWN.................................... 99 **(GO TO)**

E20. If **YES**, please enter type of facility:

		IF YES, on which dates did you provide care while you had diarrhea or up to 2 weeks after diarrhea stopped?
Type of facility	**Y N R U**	**List dates**
a. Hospital	1 2 88 99	
b. Skilled		

nursing facility	1 2 88 99	
c. Mental health facility	1 2 88 99	
d.Correctional facility	1 2 88 99	
e. Physiciam's office/ clinic	1 2 88 99	

SECTION F. EVENTS

F1. During the two weeks before *(you/name ______________)* became ill, did *(you/name ______________)* attend any large social gatherings with 50 or more persons present, such as, picnics, county fairs or other events?

YES..1
NO..2 **(GO TO)**
REFUSED..88 **(GO TO)**
UNKNOWN..................................... 99 **(GO TO)**

F2. Did you attend the Douglas County Fair July 29 – Aug 3, 2003?

YES.. 1
NO... 2
REFUSED................................... 88
UNKNOWN................................ 99

SECTION G. TRAVEL HISTORY

G1. During the 2 weeks before you became ill, did you travel **within** 100 miles from your home?

YES.. 1
NO.. 2
REFUSED.................................. 88
UNKNOWN............................... 99

G2. During the 2 weeks before you became ill, did you travel out of your state but stay within the United States?

YES.. 001
NO.. 002
REFUSED.................................. 888
UNKNOWN............................... 999

G3. During the two weeks before you became ill, did you travel or take a cruise to another country?

YES.. 001
NO.. 002 **(GO TO H5)**
REFUSED.................................. 888 **(GO TO H5)**
UNKNOWN............................... 999 **(GO TO H5)**

G4. IF YES TO TRAVEL OUTSIDE U.S/CRUISE, Please tell me which country/countries you visited and the number of days you spent in each country.

	COUNTRY CODE (see code list)	DAYS	REFUSED (888)	UNKNOWN (999)
a.	|__|__|	|__|__|	|__|__|__|	|__|__|__|
b.	|__|__|	|__|__|	|__|__|__|	|__|__|__|
c.	|__|__|	|__|__|	|__|__|__|	|__|__|__|
d.	|__|__|	|__|__|	|__|__|__|	|__|__|__|
e.	|__|__|	|__|__|	|__|__|__|	|__|__|__|

SECTION H. ANIMAL CONTACT

H1. During the 2 weeks before your illness, did you have contact with any animals?

YES.. 1
NO.. 2 **(GO TO)**
REFUSED.................................... 88 **(GO TO)**
UNKNOWN................................. 99 **(GO TO)**

H2. IF **YES,** to which of the following animals?

READ THE LIST OF ANIMALS. ENTER AND ASK THE CORRESPONDING QUESTIONS.

Animal	Contact with animal (feeding, petting, playing)?				Animal have diarrhea?			
	Y	**N**	**R**	**U**	**Y**	**N**	**R**	**U**
a. Calf	1	2	88	99	1	2	88	99
b. Cow	1	2	88	99	1	2	88	99
c. Goat/Sheep/Lamb	1	2	88	99	1	2	88	99
d. Horse	1	2	88	99	1	2	88	99
e. Pigs	1	2	88	99	1	2	88	99
f. Poultry (chicken, turkey, etc.)	1	2	88	99	1	2	88	99
g. Kitten (<6 months)	1	2	88	99	1	2	88	99
h. Cat	1	2	88	99	1	2	88	99
i. Puppy (<6 months)	1	2	88	99	1	2	88	99
j. Dog	1	2	88	99	1	2	88	99
k. Rabbit	1	2	88	99	1	2	88	99
l. Amphibian/reptile (frog, turtle, lizard,, etc)	1	2	88	99	1	2	88	99
m. Other (Specify)	1	2	88	99	1	2	88	99

H3. During the 2 weeks before your illness, did you touch or shovel animal waste/ manure or walk through any area where animal waste/ manure was on the ground?

YES..	1
NO..	2
REFUSED...................................	88
UNKNOWN................................	99

H4. Do you live on a farm?

YES..	1
NO..	2
REFUSED...................................	88
UNKNOWN................................	99

SECTION I: DEMOGRAPHIC INFORMATION

I1. Relation between respondent and case:

Self ……………………….1
Mother…………………..2
Father……………………3
Other ……………...…….4 specify ___________________

I2. What is *(your/name _________'s)* date of Birth?

|___|___| - |___|___|
MONTH YEAR

WHAT IS THE GENDER OF THE CASE:

I3. MALE …………..…… 1
FEMALE ………… 2
REFUSED…………88
UNKNOWN………99

I4. What county do you live in? _________________________________

IF RESPONDENT ANSWERS "DON'T KNOW", ASK:

I5. What city do you live in?___________________________________

I6. Are you a member of any of the following groups?

KU swimming/ diving team…………....1
Swim Team B………………………….2
Children's Learning Center Daycare…..3
Other daycare…………...……………...4
Boys and Girls Club……..................…5
Master's swim club……...……………..6
Other…………………...………………7 (please list ____________________)

END OF QUESTIONNAIRE: This concludes our questionnaire. I would like to thank you very much for your time, patience, and cooperation in answering our questions. We would be happy to answer any questions you may have at this point.