New York City Department of Health & Mental Hygiene
Bureau of Communicable Disease
&
New York City Department of Environmental Protection
Bureau of Water Supply

Waterborne Disease Risk Assessment Program
2021 Annual Report

March 2022

Prepared in accordance with Section 8.1 of the NYSDOH

2017 NYC Filtration Avoidance Determination

NYC Environmental Protection

NYC Health

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

Acronym	Description
ADM	Anti-diarrheal medication
BCD	Bureau of Communicable Disease
CGAP	*Cryptosporidium* and *Giardia* Action Plan
CIDT	Culture independent diagnostic test
CUSUM	Cumulative sums
DEP	Department of Environmental Protection
DOHMH	Department of Health and Mental Hygiene
ED	Emergency Department
GI	Gastrointestinal
ICA	Intra-City Agreement
NYC	New York City
NYSDOH	New York State Department of Health
O&P	Ova and parasite test
OTC	Over the counter medication
PCR	Polymerase chain reaction
UHF	United Hospital Fund
WDRAP	Waterborne Disease Risk Assessment Program

ACKNOWLEDGMENTS

This report was prepared by:

Lisa Alleyne, MPA (DOHMH)
Corinne Thompson, PhD (DOHMH)
Robert Fitzhenry, PhD (DOHMH)
Anne Seeley, MPH (DEP)
With Robert Mathes, Kerri Alderisio (DEP), and other members of the WDRAP Team

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THE WATERBORNE DISEASE RISK ASSESSMENT PROGRAM TEAM

The Waterborne Disease Risk Assessment Program (WDRAP) is an inter-agency program involving the NYC Departments of Environmental Protection and Health and Mental Hygiene

- **New York City Department of Health and Mental Hygiene (DOHMH)**
  Bureau of Communicable Disease
  42-09 28th Street, CN-22A, Long Island City, NY, 11101-4132
  Vasudha Reddy, MPH, Acting Assistant Commissioner
  Don Weiss, MD, MPH, Medical Director, Surveillance
  Corinne Thompson, PhD, Epidemiologist (*WDRAP Coordinator for DOHMH*)
  Robert Fitzhenry, PhD, Epidemiologist
  Lisa Alleyne, MPA, Public Health Epidemiologist (*WDRAP Asst. Coordinator*)

  Tracey Assanah-Deane, Dominique Balan, Judy Chen, Daniel Chijioke, Ashley Cintron, Eva Fabian, Anupa George, Fatema Haque, Fabiana Jeanty, Vincent Law, Robert Mathes, Michelle Middleton, Jose Poy, Renee Pouchet, Gloria Rivera, Rajmohan Sunkara, Tingting Gu-Templin and Anna Xing

- **New York City Department of Environmental Protection (DEP)**
  Bureau of Water Supply
  59-17 Junction Blvd., 4th Floor, L-R, Flushing, NY, 11373-5108

  Lori Emery, MPA, Director, Water Quality & Innovation Directorate
  Allison Dewan, MS, Deputy Director, Watershed Water Quality Operations
  Anne Seeley, MPH, Section Chief, Health Assessment & Policy Coordination (*WDRAP Coordinator for DEP*)
  Kerri Alderisio, Research Microbiologist, Water Quality Science & Research

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WDRAP reports can be downloaded from the DEP website. See Section 4 for link.
(If link problems/questions, you may contact aseeley@dep.nyc.gov).

Copies of the questionnaires used for disease surveillance are available from lalleyn@health.nyc.gov.

EXECUTIVE SUMMARY

NYC's Waterborne Disease Risk Assessment Program (WDRAP) helps assure the microbial safety of the municipal water supply, and it is a component of NYC's 2017 Filtration Avoidance Determination (FAD). The primary objectives of WDRAP at this time are to: (a) obtain data on the rates of giardiasis and cryptosporidiosis, along with demographic and risk factor information on patients; and (b) provide a system to track gastrointestinal illness (diarrhea or vomiting) to ensure rapid detection of any outbreaks. The program began in 1993 and is jointly administered by two NYC agencies: the Department of Health and Mental Hygiene (DOHMH) and the Department of Environmental Protection (DEP). This report provides an overview of program activities, and highlights of data collected in 2021.

DISEASE SURVEILLANCE

This report presents the number of cases and case rates for giardiasis and cryptosporidiosis in 2021. Citywide 2021 data is provided, along with citywide data from the prior nine years for context. Demographic information for cases of giardiasis and cryptosporidiosis diagnosed in 2021 is also summarized. Telephone interviews of cryptosporidiosis patients were conducted to gather potential risk exposure information, and selected results are presented.

In 2020, the count and rate of reported cases of giardiasis and cryptosporidiosis were lower than in recent years. In 2021, there were 811 reported cases of giardiasis, compared to 636 in 2020. The rate of giardiasis cases reported per 100,000 population increased from 7.6 in 2020 to 9.8 in 2021, which was within the range of observed rates over the last decade (rate range 2011–2020: 7.6–14.3; median: 10.6). In 2021, there were 278 reported cases of cryptosporidiosis, compared to 135 in 2020. The rate of cryptosporidiosis per 100,000 population increased from 1.6 in 2020 to 3.4 in 2021. The 2021 rate of reported cryptosporidiosis cases was within the range of rates observed over the last decade (rate range 2011–2020: 1.1–4.7; median: 1.6).

The COVID-19 pandemic had an impact on reported incidence of both cryptosporidiosis and giardiasis in NYC in 2020. As with all other reportable diseases, the counts of new cases detected and reported decreased sharply starting in March 2020 when stay-at-home orders were instituted by New York State (New York State 2020). As discussed in the 2020 WDRAP report, the drop in parasitic infections was likely a combination of genuine reduction in disease transmission and a decrease in healthcare seeking behavior. Incidence of most reportable diseases began to increase as NYC reopened, including cryptosporidiosis and giardiasis. Case counts returned approximately to pre-pandemic levels by 2021with the introduction of COVID-19 vaccination, resumption of international travel, and reopening of schools, restaurants, and other settings where people congregate leading to opportunities for parasitic enteric disease transmission.

As mentioned in previous WDRAP reports, a new type of diagnostic test known as syndromic multiplex PCR panels were introduced in 2015 and have continued to grow in use because they are generally simpler to administer and less expensive than traditional testing. The increased number of cases of parasitic disease observed beginning in 2015, and apparent until 2020 when the pandemic started, are hypothesized to reflect an increase in the detection of cases and not a true increase in disease for both cryptosporidiosis and giardiasis. This trend has been observed across the United States. DOHMH expects the trend to continue as the effects of the COVID-19 pandemic subside.

SYNDROMIC SURVEILLANCE AND OUTBREAK DETECTION

The tracking of sentinel populations (e.g., nursing homes) or surrogate indicators of disease (e.g., anti-diarrheal drug sales) through "syndromic surveillance" can be useful in assessing gastrointestinal (GI) disease trends in the general population. Such tracking programs provide greater assurance against the possibility that a citywide outbreak would remain undetected. In addition, such programs can play a role in limiting the extent of an outbreak by providing an early indication of an outbreak so that control measures are rapidly implemented.

DOHMH maintains four distinct and complementary outbreak detection systems: one system involves the tracking of chief complaints from hospital emergency department (ED) databases; a second system monitors the sale of over-the-counter (non-prescription) anti-diarrheal medications; a third system tracks the number of stool specimens submitted to a clinical laboratory for microbiological testing; the fourth system involves DOHMH monitoring and assisting in the investigation of GI outbreaks in a number of sentinel nursing homes. A summary of syndromic surveillance findings for 2021 pertaining to GI illness is presented. Citywide trends and signals observed in the ED system were generally consistent with GI viral trends. There was no evidence of a drinking water-related outbreak in NYC in 2021 (consistent with prior years).

INFORMATION SHARING, RESPONSE PLANNING & SPECIAL PROJECTS

Information on *Cryptosporidium* and *Giardia*, WDRAP, and related topics, is available on the websites of NYC's DEP and DOHMH as listed in Section 4 of this report. Included are annual reports on program activities, fact sheets on giardiasis and cryptosporidiosis, and results from the DEP's source water protozoa monitoring program. The annual update of NYC's *"Hillview Reservoir Cryptosporidium and Giardia Action Plan"* (CGAP) was issued in 2021.

1. INTRODUCTION

The Waterborne Disease Risk Assessment Program (WDRAP) is a multi-faceted public health assessment program that provides enhanced assurance of the microbial safety of New York City's (NYC) drinking water supply. This program is a critical element of NYC's Filtration Avoidance Determination (FAD), which was developed in response to US Environmental Protection Agency's Surface Water Treatment Rule regulations. WDRAP is a joint-agency program involving the NYC Department of Health & Mental Hygiene (DOHMH) and NYC Department of Environmental Protection (DEP). This partnership was originally established in 1993 and has continued under a series of joint-agency (DEP-DOHMH) agreements (i.e., Memorandum of Understandings or "MOUs" and Intra-City Agreements or "ICAs"). The agreements have laid out the organizational and funding foundation for WDRAP. In 2021, DEP and DOHMH began work on a new ICA, which is to take effect July 2022.

The primary objectives of WDRAP at this time are to:

- Obtain data on the rates of giardiasis and cryptosporidiosis, along with demographic and risk factor information on patients; and
- Provide a system to track gastrointestinal illness (diarrhea and vomiting) to ensure rapid detection of any waterborne disease outbreaks.

This report provides a summary of WDRAP highlights and data for the year 2021. Reporting revisions were implemented this year for enhanced efficiency and based on a review of past program findings and current system conditions. Water treatment practices are currently in place such that the entire NYC Water Supply System (i.e., Catskill, Delaware, & Croton Systems) meets the inactivation requirements for both *Giardia* and *Cryptosporidium*, based on the NYS Sanitary Code. Earlier WDRAP Annual Reports can be accessed for additional information: See Section 4 for weblink to earlier reports.

2. DISEASE SURVEILLANCE

2.1 Continuing Impact of the COVID-19 Pandemic

The COVID-19 pandemic was unquestionably devastating for NYC in 2020; and it remained a significant challenge throughout 2021 with the emergence of new SARS-CoV-2 variants, the presence of anti-vaccination sentiment in certain NYC populations, and continued transmission of the virus. As one of the first epicenters in the United States (Thompson et al. 2020), NYC suffered a particularly harsh first wave, with over 200,000 confirmed cases, 54,000 hospitalizations and 18,500 deaths in the first three months (New York City Department of Health and Mental Hygiene 2021). During the first wave of the pandemic, the healthcare systems of NYC were quickly overwhelmed and DOHMH made urgent recommendations for NYC residents to stay at home and not seek care unless severely ill (New York City Department of Health and Mental Hygiene 2020a). New York State issued stay-at-home orders starting March 22, 2020 (New York State 2020), which extended through mid-May, 2020. The United States Government issued a series of travel limitations starting early in 2020 (Centers for Disease

Control and Prevention 2020), severely curtailing international travel both to and from the United States. Recommendations for social distancing, remote work, mask wearing, and other measures, remained in effect through 2020.

In late 2020, NYC began to reopen gradually, with schools partially reopening in September 2020, reduced indoor dining reopening in February 2021, mass transit resuming 24-hour service in May, and international tourism resuming in November 2021. As NYC began reopening, the incidence of a number of reportable diseases began to increase as people were exposed to pathogens through social contact, dining and traveling. Also, people began returning to more "normal" health care seeking patterns, which would increase case capture by health reporting systems.

Despite the continued impacts of the COVID-19 pandemic on NYC, the activities of WDRAP were fulfilled. DOHMH was able to maintain its ability to receive and follow up on reports of giardiasis and cryptosporidiosis throughout 2021 as well as maintain its syndromic surveillance system.

2.2 Trends in Syndromic Multiplex Panel Testing

Syndromic multiplex panels are highly sensitive and specific in the detection of a large variety of enteric pathogens, including *Giardia* and *Cryptosporidium* (Navidad et al. 2013; Madison-Antenucci et al. 2016). These panels are also a quick and less expensive method to screen for a large number (>20) of enteric pathogens, and their use has increased in recent years. In a manuscript published by the DOHMH-based team in 2020, we noted that the reported incidence of cryptosporidiosis increased significantly after the introduction of syndromic multiplex panels in 2015 (Alleyne et al. 2020). The median age-adjusted annual incidence increased from 1.46/100,000 in 2000–2014 to 2.11/100,000 during 2015–2018, following the introduction of syndromic multiplex panels (incidence rate ratio: 1.49, 95% CI: 1.17–1.91). Additionally, a manuscript from Columbia University Medical Center detailed the increased sensitivity of these panels in comparison with the traditional microscopy assay. The authors found that traditional testing identified a pathogen in 4% of samples from 2012–2015 compared to 29% of samples positive for a pathogen using syndromic multiplex panel on samples from 2015–2017 (Axelrad et al. 2019). In 2015, the proportion of giardiasis and cryptosporidiosis patients diagnosed exclusively by a syndromic multiplex panel at a hospital or commercial laboratory was 5% and 20%, respectively. By 2021, these values had reached 48% for giardiasis and 80% for cryptosporidiosis. Laboratories with syndromic multiplex panels are now used in all five boroughs, leading to an increase in reported incidence of cryptosporidiosis across a range of neighborhoods in NYC.

The proportion of giardiasis cases diagnosed in NYC exclusively by syndromic multiplex panels was less than that of cryptosporidiosis, which may potentially be related to the higher sensitivity of traditional diagnostics like an ova and parasite exam for giardiasis compared to cryptosporidiosis. Importantly, DOHMH has also observed substantial increases in reported incidence of a range of additional enteric infections included on syndromic multiplex panels across NYC. These trends have been mirrored across a number of different jurisdictions in the United States (Huang et al. 2016; Marder et al. 2017).

2.3 Giardiasis

Giardiasis is a notifiable disease in NYC, per the NYC Health Code, and *Giardia* positive laboratory results are reported to DOHMH via an electronic laboratory reporting system. Case investigations for giardiasis are conducted only for patients who are known or suspected to be in a secondary transmission risk category (e.g., food handler, health care worker, child attending childcare, or childcare worker), or when giardiasis clusters or outbreaks are suspected. Note that some tables and figures referenced in this report section are located later in the report, in Section 5, *Additional Tables and Figures*, and are labeled as such (e.g., *Table 5.x*).

2.3.1 Basic Trends and Demographics

During 2021, a total of 811 cases of giardiasis were reported to DOHMH resulting in an annual case rate of 9.8 per 100,000 (Table 2.1). For some historical context, Table 2.1 includes annual case counts and rates for the prior ten years, along with the current reporting year. Figure 2.1-Part A is a graphical presentation of the annual case counts for the same years of data as Table 2.1. The dotted vertical line in this figure indicates the year that the first NYC laboratory reported results from syndromic multiplex panels for enteric diseases. For a more granular view, Figure 2.1- Part B provides monthly case counts, for the last five years (Figure 2.1). The annual giardiasis case count increased 28% from 2020 to 2021. Case numbers and rates in 2020 were notably lower than expected: a decrease attributed to the COVID-19 pandemic (as discussed previously). In 2021, giardiasis case numbers and rates in NYC increased notably, but still appear lower than might have been predicted (given the impact of SMP method introduction), and thus are considered likely still impacted (lowered) to some extent by the pandemic.

Table 2.1: Giardiasis, number of cases and case rates, New York City, 2011–2021.

Year	Number of Cases	Case Rate per 100,000
2011	918	11.2
2012	872	10.7
2013	767	9.2
2014	864	10.4
2015	869	10.2
2016	899	10.5
2017	975	11.4
2018	1,112	12.9
2019	1,205	14.3
2020	636	7.6
2021	811	9.8

Note: Minor variations in the data may be related to reporting delays, corrections, the removal of duplicate reports, and other data processing refinements. Yearly case numbers and rates in this table may therefore differ from case numbers and rates that appeared in prior WDRAP reports.

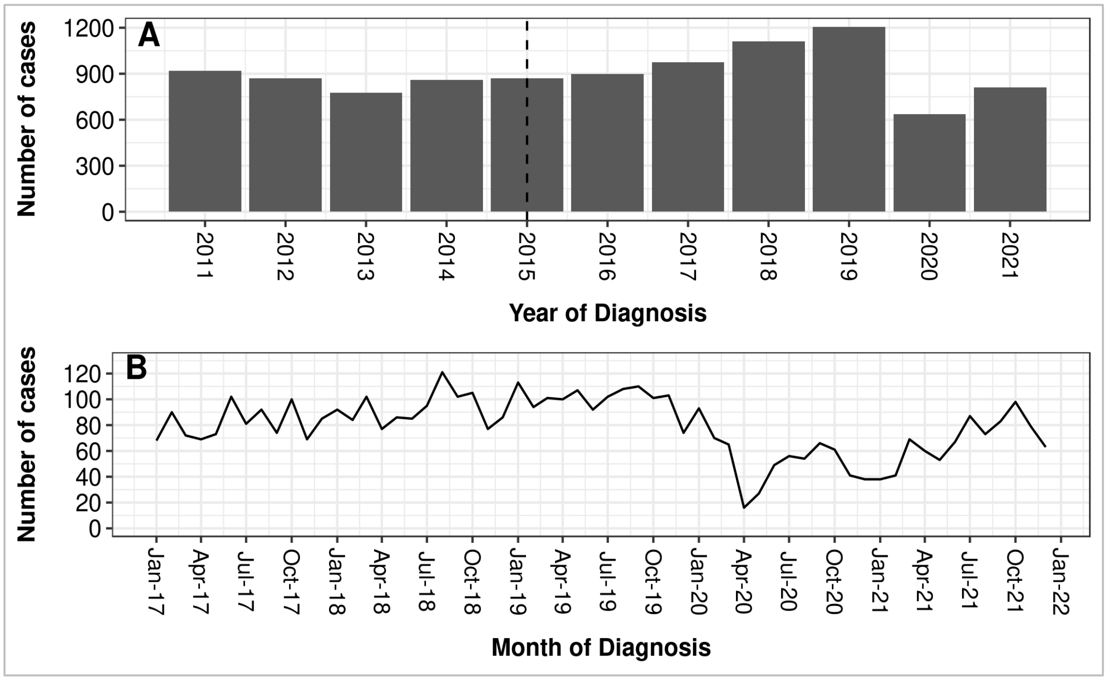

Figure 2.1: (A) Annual **giardiasis** counts, NYC, 2011–2021; and (B) Monthly giardiasis counts for the last five years. The vertical dotted line shows the date when the first NYC laboratory reported results from syndromic multiplex panels for enteric diseases.

Giardiasis was most common in the borough of Manhattan (18.4) cases per 100,000) (Table 5.1), and in the UHF neighborhood of Chelsea-Clinton in Manhattan (41.7 cases per 100,000) (Figure 2.2).

Giardiasis was most common in males (14.9 per 100,000), and specifically males in Manhattan (30.8 cases per 100,000) (Table 5.1). As we have seen in previous years, the highest age group-specific case rate for giardiasis was among persons aged 20–44 years (13.4 cases per 100,000), and the highest age group and sex-specific case rate was among males aged 20–44 years (21.4 cases per 100,000) (Table 5.2). By borough and age, giardiasis was most frequent in persons aged 20–44 years in Manhattan (25.6 cases per 100,000), followed by persons aged 45–59 years in Manhattan (21.0 cases per 100,000) (Table 5.3). Race and ethnicity data were infrequently available for giardiasis cases (0.6% of cases).

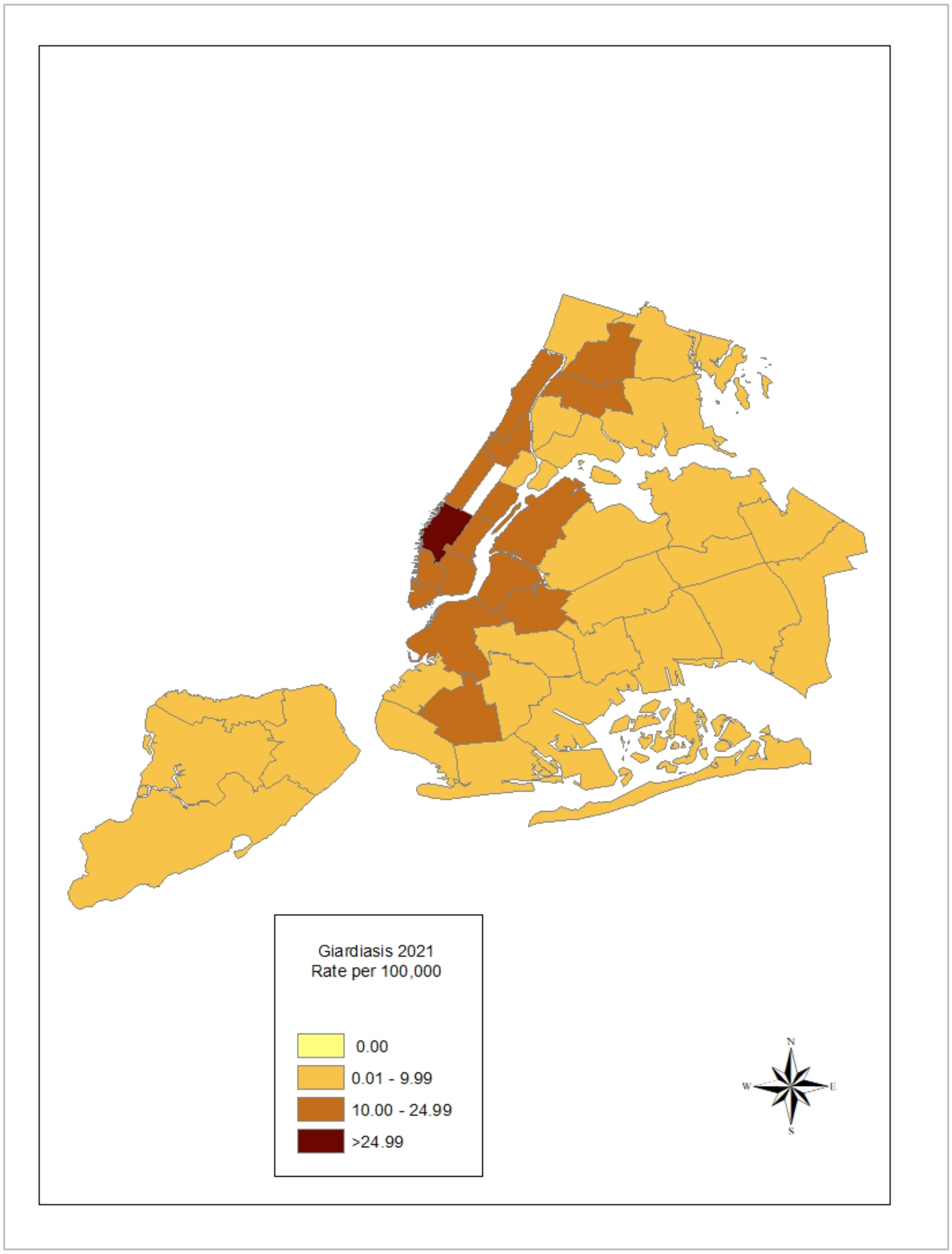

Figure 2.2: Map of **giardiasis** annual case rate per 100,000 population by United Hospital Fund Neighborhood, NYC, 2021.

2.3.2 Risk Factors

In 2021, five patients diagnosed with giardiasis were investigated. Two of the cases were excluded from work or school to reduce the risk of secondary transmission: one case was a child attending childcare, and the other case worked as a healthcare professional. Three cases were not found to be in a secondary transmission risk category. No cases were associated with outbreaks.

As in previous years, the age/sex demographic group with the largest number of diagnosed giardiasis cases in 2021 was adult men aged 20–44 years (39.5%, 321/811) followed by adult men aged 45–59 years (13.7%, 111/811). Giardiasis rates have historically and consistently been elevated in Chelsea-Clinton, a neighborhood in Manhattan with a higher prevalence of men who have sex with men compared to the rest of NYC (Bureau of Epidemiology Services New York City Department of Health and Mental Hygiene 2017). It is hypothesized that giardiasis is a sexually transmissible enteric infection among men who have sex with men in NYC and accounts for a considerable burden of reported disease.

Giardiasis is known to be a sexually transmissible enteric infection among men who have sex with men (Mitchell and Hughes 2018). Studies from several decades in NYC demonstrated that giardiasis and amebiasis were commonly detected in this population (Phillips et al. 1981; Kean, William, and Luminais 1979). The authors of one study hypothesized that enteric parasitic infections are hyperendemic in men who have sex with men because of three factors: a high prevalence in the population, the prevalence of sexual behavior that facilitates transmission, and the frequency of exposure to infected persons (Phillips et al. 1981). However, information on exposures such as sexual behavior is not routinely collected for giardiasis patients in NYC, so it is not possible to determine how prevalent sexual behavior with increased risk of fecal/oral contact is among reported giardiasis patients.

2.4 Cryptosporidiosis

Cryptosporidiosis is also a notifiable disease in NYC, per the NYC Health Code, and *Cryptosporidiosis* positive laboratory results are reported to DOHMH via an electronic laboratory reporting system. Patient interviews for demographic and risk factor data are attempted for all confirmed cases. As in the previous section, some tables and figures referenced in the text have been located later in the report in Section 5, *Additional Tables and Figures*, and are labeled as such (e.g., *Table 5.x*).

2.4.1 Basic Trends and Demographics

During 2021, a total of 278 cases of cryptosporidiosis were reported to DOHMH, resulting in an annual case rate of 3.4 per 100,000 (Table 2.2). For historical context, Table 2.2 includes annual cryptosporidiosis case counts and rates for the prior ten years, along with the current reporting year. Figure 2.3 – Part A is a graphical presentation of the annual case counts for the same years of data as Table 2.2. The dotted vertical line in this figure indicates the year that the first NYC laboratory reported results from syndromic multiplex panels for enteric diseases. For a more granular view, Figure 2.3 – Part B provides monthly case counts, for the last five years (Figure 2.3). Cryptosporidiosis is highly seasonal in NYC, as shown in Figure 2.3 with cases most often diagnosed in August and September.

Table 2.2: Cryptosporidiosis, number of cases and case rates, New York City, 2011–2021

	Number of Cases	Case Rate per 100,000
2011	86	1.1
2012	125	1.5
2013	80	1.0
2014	102	1.2
2015	133	1.6
2016	192	2.2
2017	163	1.9
2018	250	2.9
2019	395	4.7
2020	135	1.6
2021	278	3.4

Note: Minor variations in the data may be related to reporting delays, corrections, the removal of duplicate reports, and other data processing refinements. Yearly case numbers and rates in this table may therefore differ from case numbers and rates that have appeared in prior WDRAP reports.

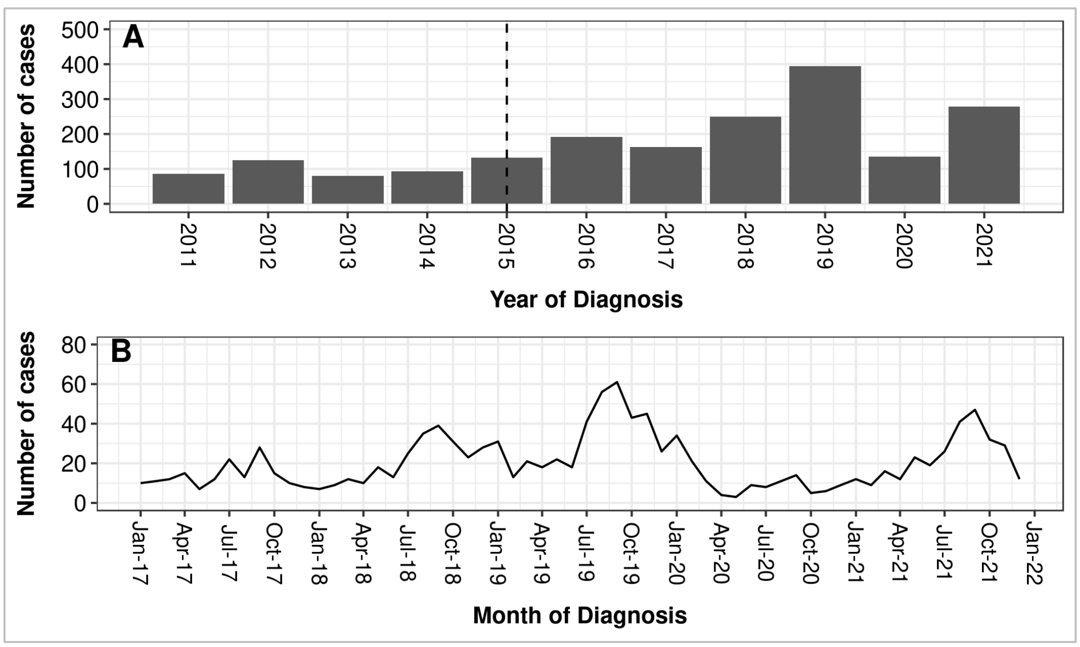

Figure 2.3: (A) Annual **cryptosporidiosis** counts, NYC, 2011–2021; and (B) monthly cryptosporidiosis counts for the last five years (B). The vertical dotted line in Part A of Figure 2.3 shows the date when the first NYC laboratory reported results from syndromic multiplex panels for enteric diseases.

The annual case count increased 106% from 2020 to 2021. Cryptosporidiosis case numbers and rates in 2020 were notably lower than expected: a decrease attributed to the COVID-19 pandemic (as discussed previously). In 2021, cryptosporidiosis case numbers and rates in NYC increased very notably, but still appear to be likely impacted (lowered) to some extent by the pandemic – i.e., given the impact suggested of SMP method introduction on case capture, and based on numbers immediately preceding the pandemic. Further data would help better understand the trends.

Manhattan had the highest borough-specific annual case rate (7.6 cases per 100,000) (Table 5.4, and the Chelsea-Clinton UHF neighborhood had highest rate overall (19.9 cases per 100,000) (Figure 2.4).

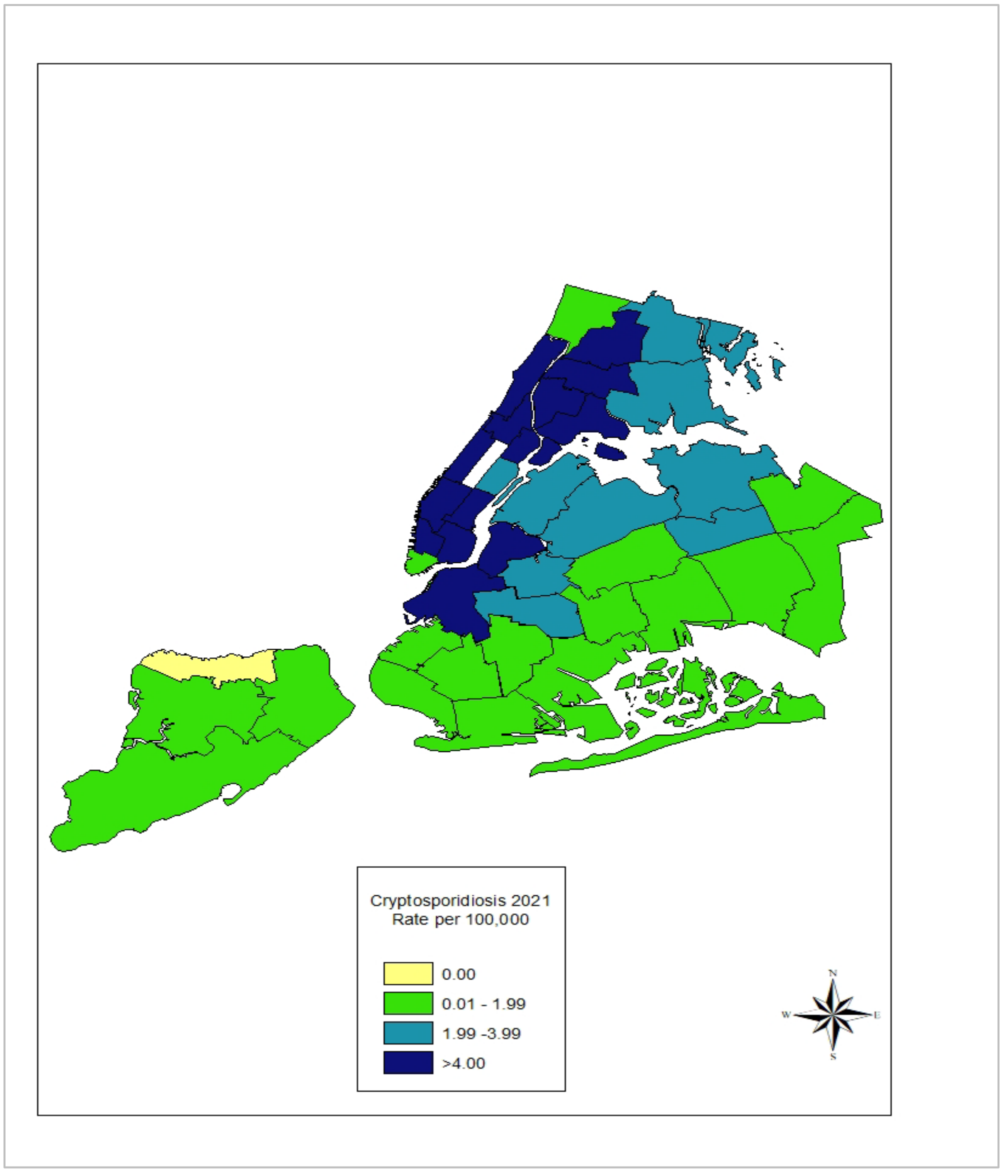

Figure 2.4: Map of **cryptosporidiosis** annual case rate per 100,000 population by United Hospital Fund neighborhood, NYC, 2021.

Cryptosporidiosis was most common in males (5.0 cases per 100,000), and specifically males in Manhattan (12.3 cases per 100,000) (Table 5.4). By age, the rate of cryptosporidiosis was greatest among persons aged 20–44 years (5.5 cases per 100,000), and again males in this age group were most frequent (8.3 cases per 100,000) (Table 5.5). The highest age group and borough-specific case rates occurred in persons aged 20–44 years in Manhattan (11.6 per 100,000) (Table 5.6).

Race/ethnicity data was available for the majority of cryptosporidiosis patients (90%). Among the major racial/ethnic groups, White, non-Hispanic followed by Hispanic persons had the highest cryptosporidiosis rate (4.0 and 3.4 per 100,000, respectively) (Table 5.7). Cryptosporidiosis rates were highest among White, non-Hispanic persons in Manhattan (9.0 per 100,000), and next highest among Hispanic persons in Manhattan (6.1 per 100,000) (Table 5.7). By age group, rates were highest among White non-Hispanic persons aged 20–44 years and Hispanic persons aged 0–4 years (6.9 and 6.7 cases per 100,000, respectively (Table 5.8). This paragraph does not describe some race/ethnic groups due to relatively small number of people in those groups (as findings would be more impacted by random events due to small numbers).

The count of cryptosporidiosis cases among persons living with HIV/AIDS has continued to decline over time, with only 75 cases reported in 2021 (representing 27% of all cases). The count of cryptosporidiosis cases among immunocompetent patients has increased since 2015, however, rising from 78 to 313 in 2019 (a 300% increase). In 2020, the count of cryptosporidiosis cases among immunocompetent patients fell to 90 coinciding with the overall reduction related to COVID-19 but increased to 196 cases in 2021. This trend of increasing cases reported starting in 2015 is also coincident with the introduction of syndromic multiplex panels in 2015 and likely reflects a broader population being tested for the pathogen more frequently. As cryptosporidiosis infection can be particularly severe among people living with HIV/AIDS (Blanshard et al. 1992; Rashmi and Kumar 2013; Poznansky et al. 1995), physicians were historically more likely to consider cryptosporidiosis in their differential diagnosis of diarrheal disease among persons living with HIV/AIDS than in a person without HIV/AIDS. However, now that syndromic multiplex panels can be ordered for diagnosis of any diarrheal infection in hospitals and clinics that have adopted these assays, cryptosporidiosis is more frequently identified in immunocompetent patients who likely would not have been tested for cryptosporidiosis before 2015.

2.4.2 Risk Factors

In 2021, five patients diagnosed with cryptosporidiosis were excluded from work or school to reduce the risk of secondary transmission. The exclusions were children aged <5 years in childcare or preschool (n=4), followed by a food handler (n=1).

Of the 278 cryptosporidiosis cases diagnosed among NYC residents in 2021, questionnaires concerning potential exposures were completed for 197 (71%) patients. For patients with missing interview data, investigators were either unable to locate the patient (58 cases, 21%) or the patient refused interview (23 cases, 8%). The interview data is compiled and reviewed by DOHMH.

As in previous years, and similar to giardiasis, the age/sex demographic group with the largest number of diagnosed cryptosporidiosis cases in 2021 was adult men aged 20–44 years (45%, 125/278). Adult men aged 45–59 years accounted for an additional 12.6% of all people diagnosed with cryptosporidiosis in 2021. This demographic group has been consistently over-represented in surveillance data since the WDRAP began, again similar to the profile of giardiasis. Furthermore, cryptosporidiosis rates have historically and consistently been elevated in Chelsea-Clinton, a neighborhood in Manhattan with a higher prevalence of men who have sex with men compared to the rest of NYC (Bureau of Epidemiology Services New York City Department of Health and Mental Hygiene 2017). Therefore, it is hypothesized that cryptosporidiosis is often an infection among men who have sex with men in NYC.

Men who have sex with men are historically at greater risk for cryptosporidiosis, not only because of a higher prevalence of AIDS in this population (Centers for Disease Control and Prevention 2006), but also because of higher risk sexual practices related to oral/anal contact that entail a low risk for HIV transmission but increase the risk for fecal contact (Hellard et al. 2003). In 2021, there were a total of 98 adult men aged 20–59 years who answered questions related to sexual behavior in their cryptosporidiosis incubation period. There were a total of 51 other adults (men aged 18 and 19 years and men aged >59 years as well as all women ≥18 years) who answered the sexual behavior questions during interview. Among men diagnosed with cryptosporidiosis aged 20–59 years, 47% (46/98) reported high-risk sexual practices, compared to 12% (6/51) of all other adult cryptosporidiosis patients ($p<0.001$, Fishers exact test). There are considerable limitations with large amounts of missing data in the sexual behavior questions. However, the data suggest that adult men diagnosed with cryptosporidiosis are likely to report engaging in sexual behaviors that increase the risk of fecal/oral contact.

3. SYNDROMIC SURVEILLANCE AND OUTBREAK DETECTION

The tracking of sentinel populations or surrogate indicators of disease (“syndromic surveillance”) can be useful in assessing gastrointestinal (GI) disease trends in the general population. Such tracking programs provide greater assurance against the possibility that a citywide outbreak would remain undetected. In addition, such programs can play a role in limiting the extent of an outbreak by providing an early indication of a problem so that control measures can be rapidly implemented. There are four systems in place tracking the following data:

1. Hospital emergency department (ED) chief complaint logs to monitor for outbreaks
2. Sales of anti-diarrheal medications: the Anti-Diarrheal Monitoring System (ADM)/over-the-counter medication (OTC) system
3. The number of stool specimens submitted to a participating clinical laboratory for microbiological testing.
4. GI outbreaks in sentinel nursing homes and DOHMH staff assist in the investigation of any identified outbreaks

A description of each system can be found in APPENDIX B.

Throughout 2021, DOHMH received electronic data from all of NYC's 53 EDs, which reported approximately 9,800 visits per day. Additionally, data were received daily from approximately 470 pharmacies in 2021 as part of the ADM/OTC system. The eight nursing homes participating in the Nursing Home Sentinel Surveillance system were contacted by WDRAP team members in 2021 by phone, due to the COVID-19 pandemic.

3.1 Findings: Summary of Syndromic Surveillance Signals

In this report, Figures 5.1–5.3 summarize GI disease signals from NYC's syndromic surveillance systems. Figure 5.1 and Figure 5.2 summarize signals from the Emergency Department system only. Figure 5.3 summarizes signal results from all syndromic surveillance systems operated by DOHMH during 2021. Figures 5.1, 5.2 and 5.3 are included in Section 5 of this report.

Figure 5.1 shows the ratio of daily ED visits for the diarrhea syndrome to all other daily ED visits for syndromes not tracked by ED syndromic surveillance ("other visits") from January 1 to December 31, 2021. The graph also indicates the occurrence of citywide signals and of the spatial residential zip code and hospital signals. There were sustained (i.e.,>1day) diarrheal hospital ED signals in April and December 2021 that were likely related to seasonal gastroenteritis. There were also sustained residential zip code signals at the end of August. There were no citywide diarrheal ED signals in 2021.

Figure 5.2 shows the ratio of daily ED visits for the vomiting syndrome compared to all other daily ED visits for syndromes not tracked by ED syndromic surveillance for 2021.There were several spatial hospital signals grouped in October and November likely related to gastrointestinal viruses. There were no citywide ED signals for vomiting in 2021.

Figure 5.3 shows the timing of signals from all four surveillance systems in 2021. There were no citywide signals in either diarrhea or vomiting from the ED systems and there were no nursing home signals in 2021. However, there were a number of OTC/ADM signals throughout the year, concentrating specifically in July, September and December. The signals for Bismuth sales in July and December were possibly driven by people returning to work in Midtown Manhattan. The signals in September were driven by the opening of a new store. The majority of the OTC/ADM signals were found to be related to promotional sales at the pharmacy chains, specifically for Pepto Bismol®/Bismuth sales. There was no evidence to suggest that the OTC/ADM signals were related to a waterborne disease outbreak. Additionally, there were three signals in the Clinical Laboratory surveillance system throughout the year. All of three signals were only one day in length, which is not suggestive of any sustained signal and supports the conclusion of a lack of a waterborne disease outbreak.

Syndromic surveillance signals alone cannot be used to determine etiologic diagnoses. Also, experience has shown that most signals, especially localized spatial signals in the emergency department system or signals in the laboratory or ADM monitoring systems, may be statistical aberrations and not related to public health events. The systems are therefore used in concert. Given the signals observed during this reporting period were localized, were short duration, and lacked corresponding signals in the other monitoring systems, these were not determined to be related to a waterborne disease outbreak.

In conclusion, during 2021, there were no signals consistent with a waterborne disease outbreak from the four syndromic surveillance systems set up to detect an outbreak related to the water supply. This finding is consistent with all prior years of WDRAP surveillance.

4. INFORMATION SHARING, RESPONSE PLANNING, & SPECIAL PROJECTS

Information pertaining to NYC's Waterborne Disease Risk Assessment Program and related issues are available on both the DEP and DOHMH websites, including results from the City's source water protozoa monitoring program. Documents on the websites include:

DOHMH Webpages:

- *Giardiasis* fact sheet:
  https://www1.nyc.gov/site/doh/health/health-topics/giardiasis.page

- *Cryptosporidiosis* fact sheet:
  http://www1.nyc.gov/site/doh/health/health-topics/cryptosporidiosis.page

- Communicable Disease Surveillance Data:
  https://a816-health.nyc.gov/hdi/epiquery/visualizations?PageType=ts&PopulationSource=CDSD&Topic=1&Subtopic=43

- Diarrheal Infections in Gay Men and Other Men Who Have Sex with Men:
  https://www1.nyc.gov/site/doh/health/health-topics/diarrheal-infections.page

- DOHMH and DEP Waterborne Disease Risk Assessment Program Annual Report Data:
  https://opendata.cityofnewyork.us

DEP Webpages:

- Waterborne Disease Risk Assessment Program's Annual Reports (1997 – current):
  https://www1.nyc.gov/site/dep/water/waterborne-disease-risk-assessment.page

- New York City Drinking Water Supply and Quality Statement (for latest posted report):
  https://www1.nyc.gov/site/dep/about/drinking-water-supply-quality-report.page

- DEP Water Supply Testing Results for Giardia and Cryptosporidium:
  https://data.cityofnewyork.us/Environment/DEP-Cryptosporidium-And-Giardia-Data-Set/x2s6-6d2j

- Additional Information: https://www1.nyc.gov/site/dep/about/document-portal.page

With regard to response planning, NYC has developed an action plan for responding to elevations in levels of Giardia cysts and Cryptosporidium oocysts at a key water supply monitoring location. The initial response plan was developed in 2001. The plan in its current form is known as NYC's "Hillview Reservoir Cryptosporidium and Giardia Action Plan" (CGAP), and the plan is reviewed & updated on an annual basis; it was updated in 2021.

5. ADDITIONAL TABLES AND FIGURES

Table 5.1: Giardiasis, number of cases and annual case rate per 100,000 population (in parentheses) by sex and borough of residence, New York City, 2021.

		Borough of residence				
Sex	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Male	585 (14.9)	235 (30.8)	78 (11.8)	157 (13.1)	101 (9.3)	14 (6.1)
Female	225 (5.2)	61 (7.2)	30 (4.1)	70 (5.2)	54 (4.7)	10 (4.1)
Transgender	1	0	0	1	0	0
Total	811 (9.8)	296 (18.4)	108 (7.7)	228 (9.0)	155 (6.9)	24 (5.0)

Table 5.2: Giardiasis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and sex, New York City, 2021.

	Sex			
Age Group	Total	Male	Female	Transgender
<5 years	48 (9.4)	33 (12.7)	15 (6.0)	0
5–9 years	49 (10.2)	26 (10.5)	23 (9.8)	0
10–19 years	40 (4.6)	23 (5.2)	17 (4.0)	
20–44 years	413 (13.4)	321 (21.4)	(91) (5.8)	1
45–59 years	145 (9.6)	111 (15.4)	34 (4.3)	0
≥ 60 years	116 (6.5)	71 (9.3)	45 (4.4)	0
Total	811 (9.8)	585 (14.9)	225 (5.2)	1

Table 5.3: Giardiasis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and borough of residence, New York City, 2021.

		Borough of residence				
Age Group	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
<5 years	48 (9.4)	4 (5.4)	12 (12.3)	24 (13.4)	8 (6.0)	0
5–9 years	49 (10.2)	3 (4.7)	7 (7.1)	18 (11.0)	18 (14.2)	3 (10.5)
10–19 years	40 (4.6)	10 (8.0)	6 (3.3)	13 (4.7)	10 (4.4)	1 (1.7)
20–44 years	413 (13.4)	177 (25.6)	48 (9.7)	119 (12.3)	56 (7.2)	13 (8.6)
45–59 years	145 (9.6)	60 (21.0)	21 (8.2)	31 (7.2)	31 (7.0)	2 (2.1)
≥ 60 years	116 (6.5)	42 (11.4)	14 (5.2)	23 (4.5)	32 (6.1)	5 (4.4)
Total	811 (9.8)	296 (18.4)	108 (7.7)	228 (9.0)	155 (7.0)	24 (5.0)

Table 5.4: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by sex and borough of residence, New York City, 2021.

		Borough of residence				
Sex	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Male	196 (5.0)	94 (12.3)	40 (6.1)	37 (3.1)	20 (1.9)	5 (2.2)
Female	82 (1.9)	29 (3.4)	22 (3.0)	13 (1.0)	18 (1.6)	0
Total	278 (3.4)	123 (7.6)	62 (4.4)	50 (2.0)	38 (1.7)	5 (1.1)

Table 5.5: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and sex, New York City, 2021.

		Sex	
Age Group	Total	Male	Female
<5 years	19 (3.7)	10 (3.8)	9 (3.6)
5–9 years	5 (1.0)	3 (1.2)	2 (0.8)
10–19 years	22 (2.5)	13 (2.9)	9 (2.1)
20–44 years	169 (5.5)	125 (8.3)	44 (2.8)
45–59 years	44 (2.9)	35 (4.9)	9 (1.1)
≥ 60 years	19 (1.1)	10 (1.3)	9 (0.9)
Total	278 (3.4)	196 (5.0)	82 (1.9)

Table 5.6: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and borough, New York City, 2021.

		Borough of residence				
Age Group	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
<5 years	19 (3.7)	3 (4.0)	9 (9.2)	2 (1.1)	5 (3.8)	0
5–9 years	5 (1.0)	0	4 (4.1)	1 (0.6)	0	0
10–9 years	22 (2.5)	7 (5.6)	6 (3.3)	0	8 (3.5)	1 (1.7)
20–44 years	169 (5.5)	80 (11.6)	31 (6.2)	43 (4.4)	13 (1.7)	2 (1.3)
45–59 years	44 (2.9)	20 (7.0)	11 (4.3)	3 (0.7)	8 (1.8)	2 (2.1)
≥ 60 years	19 (1.1)	13 (3.5)	1 (0.4)	1 (0.2)	4 (0.8)	
Total	278 (3.4)	123 (7.6)	62 (4.4)	50 (2.0)	38 (1.7)	5 (1.1)

Table 5.7: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by race/ethnicity and borough of residence, New York City, 2021.

		Borough of residence				
Race/Ethnicity	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Hispanic	82	25	29	10	18	0
	(3.4)	(6.1)	(3.7)	(2.1)	(2.9)	
White, non-Hispanic	107	68	2	21	12	4
	(4.0)	(9.0)	(1.6)	(2.2)	(2.2)	(1.4)
Black/African American, non-Hispanic	48	12	23	10	2	1
	(2.7)	(6.0)	(5.6)	(1.3)	(0.5)	(2.2)
Asian, non-Hispanic	6	3	2	1	0	0
	(0.5)	(1.5)	(3.4)	(0.3)		
Pacific Islander, Native Hawaiian, American Indian, non-Hispanic	0	0	0	0	0	0
Two or more races, other, non-Hispanic	7	3	0	1	3	0
	(4.6)	(8.7)		(2.0)	(6.4)	
Unknown	28	12	6	7	3	0
Total	278	123	62	50	38	5
	(3.4)	(7.6)	(4.4)	(2.0)	(1.7)	(1.1)

Table 5.8: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by race/ethnicity and age group, New York City, 2021.

		Age group					
Race/Ethnicity	Total	<5 years	5–9 years	10–19 years	20–44 years	45–59 years	≥ 60 years
Hispanic	82	11	3	9	44	11	4
	(3.4)	(6.7)	(1.8)	(2.9)	(4.9)	(2.5)	(1.0)
White, non-Hispanic	107	2	0	3	70	19	13
	(4.0)	(1.4)		(1.3)	(6.9)	(4.2)	(1.9)
Black/African American, non-Hispanic	48	5	1	5	28	9	0
	(2.7)	(4.9)	(1.0)	(2.5)	(4.4)	(2.5)	
Asian, non-Hispanic	6	1	1	1	3	0	0
	(0.5)	(1.3)	(1.4)	(0.9)	(0.6)		
Pacific Islander, Native Hawaiian, American Indian, non-Hispanic	0	0	0	0	0	0	
Two or more races, other, non-Hispanic	7	0	0	0	3	2	2
	(4.6)				(5.3)	(10.2)	(11.4)
Unknown	28	0	0	4	21	3	0
Total	278	19	5	22	169	44	19
	(3.4)	(3.7)	(1.0)	(2.5)	(5.5)	(2.9)	(1.1)

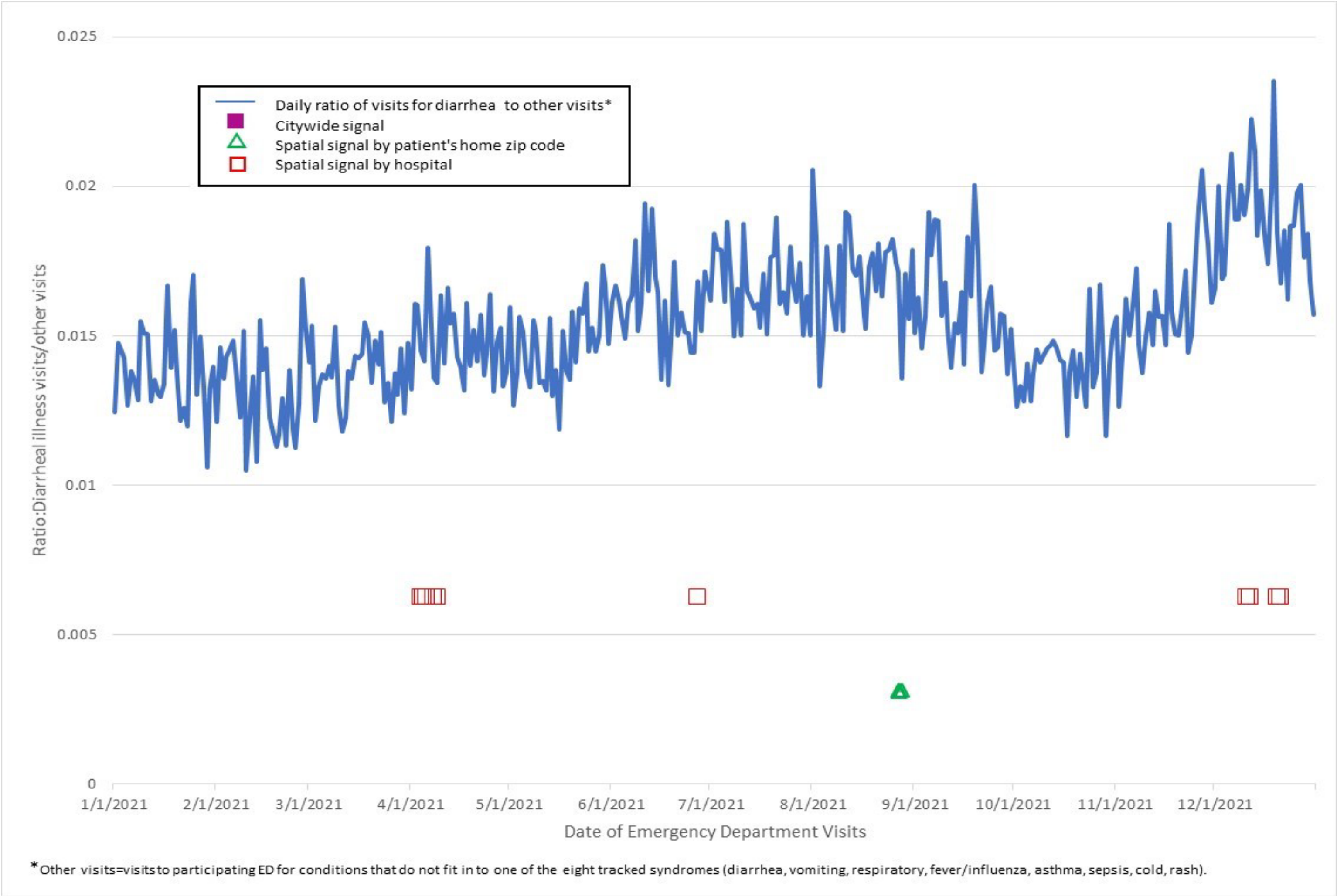

Figure 5.1: Emergency Department Syndromic Surveillance, Trends in visits for the diarrhea syndrome, New York City, January 1, 2021–December 31, 2021.

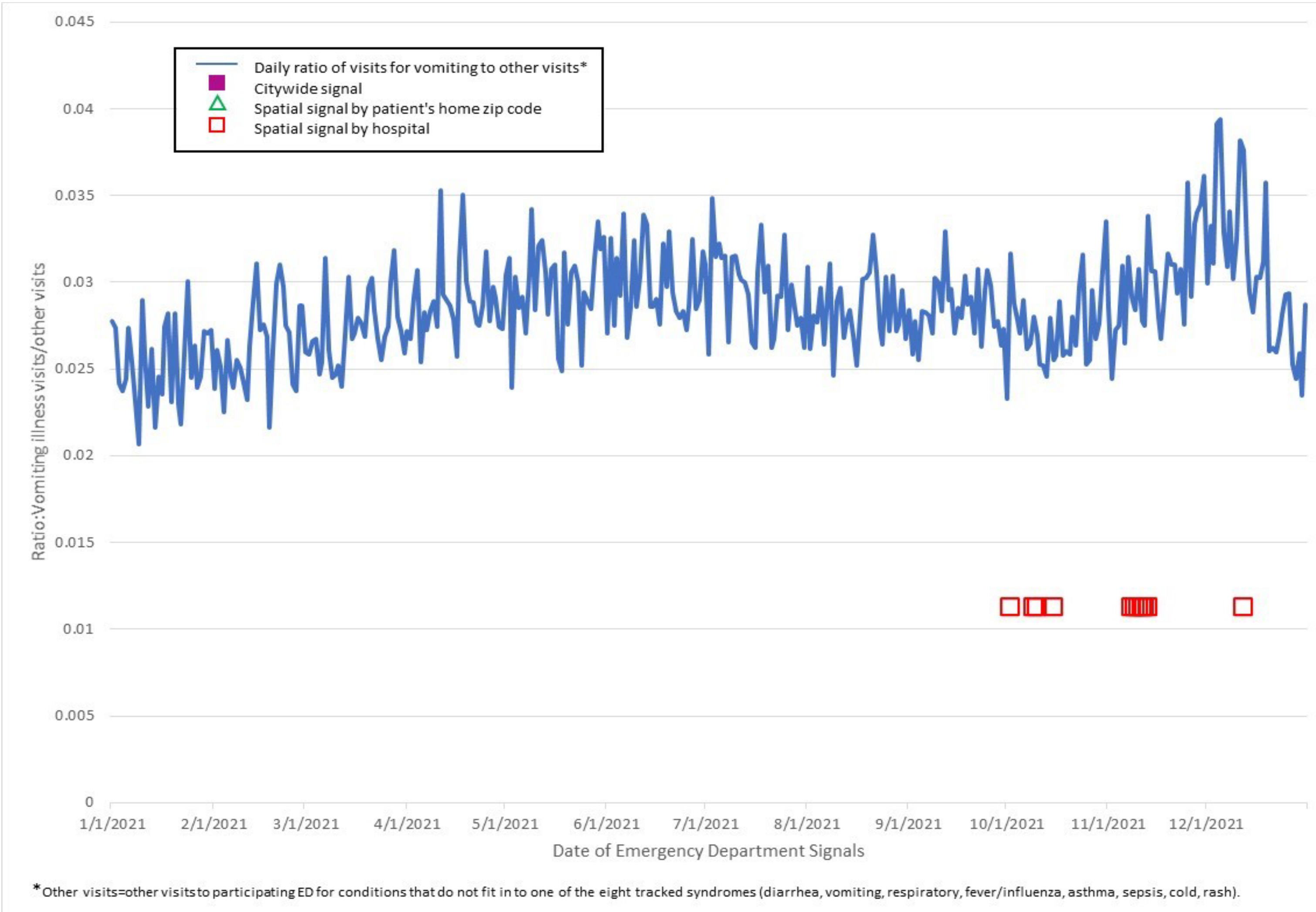

Figure 5.2: Emergency Department Syndromic Surveillance, Trends in visits for the vomiting syndrome, New York City, January 1, 2021–December 31, 2021.

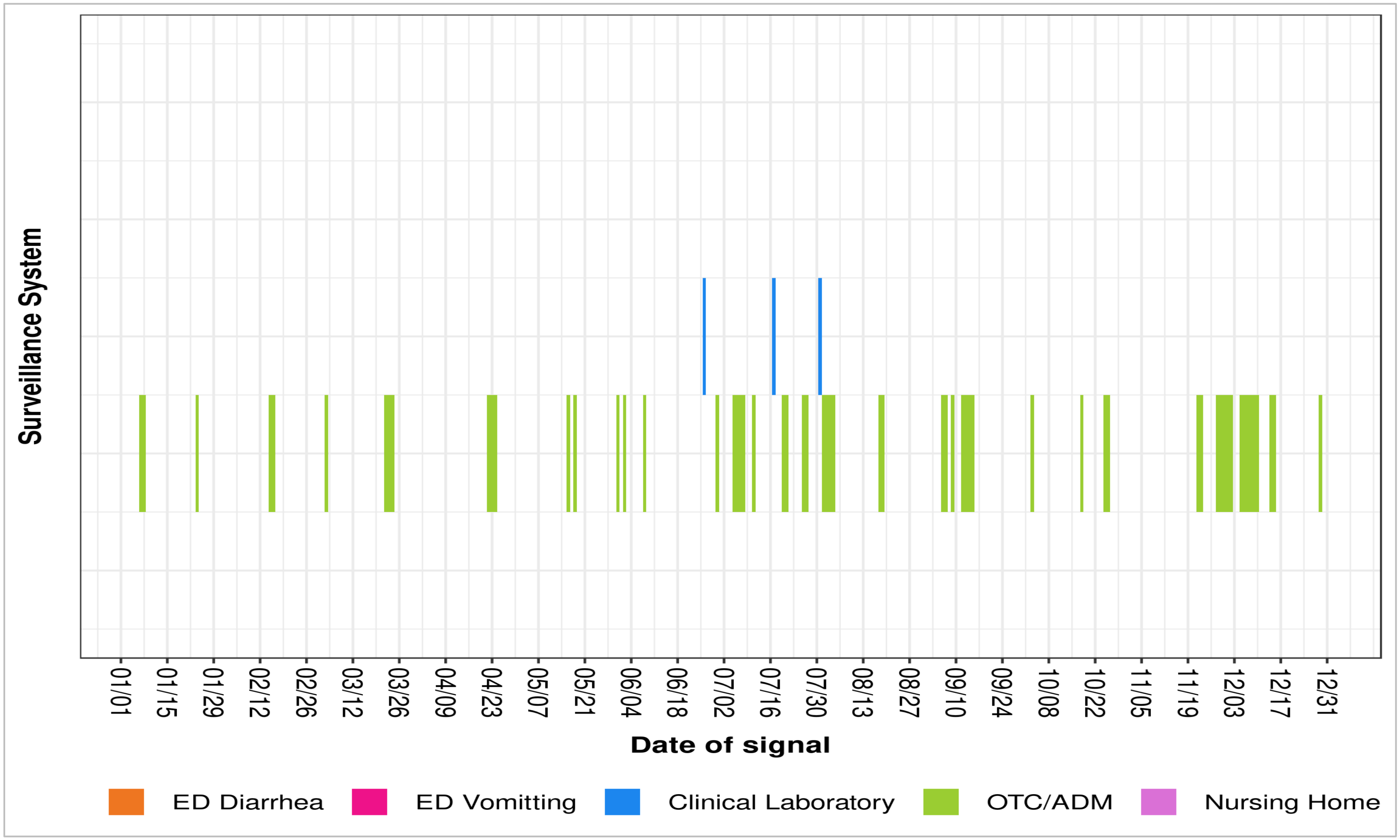

Figure 5.3: Signals for Gastrointestinal Illness, Syndromic Surveillance Systems, New York City, 2021.

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7. APPENDIX A: Information on Calculation of Rates, Case Definitions, and Water Exposure Data Collection

This appendix contains addition details relevant to topics or data addressed in the report. Newly added is a section on drinking water questions from the cryptosporidiosis interview form.

Population denominators

[This paragraph explains procedures for population denominators, relevant to historic and current WDRAP data]
The population denominators used to calculate rates were intercensal population estimates for all years except 2000 and 2010 to 2012. For the years 1994 through 1999, intercensal population estimates per year were used based upon linear interpolation between 1990 and 2000 NYC Census. For the years 2001 through 2009 and 2013 through 2021, intercensal population estimates for each year were used from data produced by DOHMH based on the US Census Bureau Population Estimate Program and housing unit data obtained from the NYC Department of City Planning. For 2010 to 2012, the year 2010 NYC Census data were used (New York City Department of City Planning 2010). Because rates for the years 2001 through 2009 and the rates for the years 2014 through 2021 were calculated for this report using intercensal population estimates, they may differ from previously reported rates based on year 2000 and 2010 NY Census data. Other variations in data between this report and previous reports may be because of factors such as disease reporting delays, correction of errors, and refinements in data processing (for example, the removal of duplicate disease reports). All rates in this report are annual rates. Caution must be exercised when interpreting rates based on very small case numbers.

UHF Zones

For mapping purposes, the United Hospital Fund (UHF) neighborhood of patient residence was used. New York City is divided on the basis of zip code into 42 UHF neighborhoods. Maps illustrating annual case rates by UHF neighborhood are included in this report.

Race-Ethnicity Categories

In this report, race/ethnicity-specific case rates for 2021 are based upon intercensal population estimates and include the race/ethnicity categories used by the US Census Bureau Population Estimate Program. Prior to 2011, there was one race/ethnicity category entitled "Asian, Pacific Islander, American Indian, Alaskan Native, non-Hispanic". Since 2011, separate categories have been used for non-Hispanic Asians, non-Hispanic Pacific Islanders and Native Hawaiians, non-Hispanic American Indian and non-Hispanic of two or more races.

Confirmed and Probable cases

As was first described in the 2012 Annual Report, confirmed and probable cryptosporidiosis cases are now included in the WDRAP reports. Confirmed cases are those in which the laboratory method used has a high positive predictive value (such as light microscopy of stained slide, enzyme immunoassay, polymerase chain reaction, and direct fluorescent antibody test). Probable cases are those in which the laboratory method used has a low positive predictive value (such as the immunochromatographic card/rapid test) or in which the method used for diagnostic testing was not known. The probable case classification for cryptosporidiosis also includes those cases in which laboratory confirmation was not obtained, but the case was epidemiologically linked to a confirmed case and clinical illness was consistent with cryptosporidiosis. DOHMH BCD reports both confirmed and probable cryptosporidiosis cases to the Centers for Disease Control and Prevention through the National Electronic Telecommunications System for Surveillance. BCD interviews all cases. However, if cases are not confirmed at NYS DOH Wadsworth Center then these patients are not considered to be a case and are not included in the final annual count.

Cryptosporidiosis Case Interviews – Drinking Water Consumption Questions

During patient follow up, to determine water drinking habits during their incubation period the following questions are asked:

- Did you (your child) drink any NYC tap water? This includes any NYC municipal water that you may have drank directly from the faucet or which you may have boiled or filtered before drinking, including water used to make tea or coffee that came directly from the tap.
- How many cups of NYC tap water did you (your child) drink on average per day, including directly from the tap, or boiled, or filtered water?
- How many cups of NYC tap water were directly from the tap without being boiled or filtered?
- How many cups of NYC tap water were boiled?
    - How many minutes did you boil NYC tap water?
- How many cups of NYC tap water were filtered? Make of filter and model name and number asked.
- Did you (your child) use unboiled/unfiltered NYC tap water to brush his/her teeth?
- Did you (your child) use unboiled/unfiltered NYC tap water to wash vegetables or fruit?
- Did you (your child) use unboiled/unfiltered NYC tap water to make ice?
- Did you (your child) use unboiled/unfiltered NYC tap water to make juice from concentrate?
- Did you (your child) drink water from a private well? Location asked.
- Did you (your child) drink tap water, or a drink made with tap water when traveling outside of the US?
- Did you (your child) drink municipal water outside NYC, but within the US?
- Did you (your child) drink water from a spring? Location, date and knowledge of other sick person(s) asked.
- Did you (your child) drink water from a pond/lake/river or stream? Location, date and knowledge of other sick person(s) asked.
- Did you (your child) drink commercially bottled water? Brand, amount and location obtained asked.

Note: Some results from patient interviews are available on the NYC DOHMH (Open data) website and are updated yearly.

8. APPENDIX B: Syndromic Surveillance System Descriptions

Hospital Emergency Department (ED) Monitoring

NYC initiated monitoring of hospital ED visits as a public health surveillance system in 2001, and this system has been in operation since that time. Hospitals transmit electronic files hourly containing chief complaint and demographic information for patient visits. Patients are classified into syndrome categories, and daily analyses are conducted to detect any unusual patterns or signals. The two syndromes used to track GI illness are the vomiting syndrome and the diarrhea syndrome. Temporal citywide analyses assess whether the frequency of ED visits for the syndrome has increased in the last seven days compared to the previous 28 days. Clustering is examined by both hospital location and residential zip code. Statistical significance is based on Monte Carlo probability estimates that adjust for the multiple comparisons inherent in examining many candidate clusters each day. The threshold of significance for citywide and spatial signals is set at a recurrence interval of 365 days, indicating a false signal rate of once every 365 days. The most current description of the system is in Lall, et al 2017.

Anti-Diarrheal Medication Monitoring

NYC began tracking anti-diarrheal drug sales as an indicator of GI illness trends in 1995 via a system operated by DEP. Major modifications and enhancements to NYC's anti-diarrheal medication surveillance program have been made over the years, including: utilization of different data sources, initiation and expansion of DEP's ADM program, initiation of DOHMH's OTC program in 2002, and in 2012, the merger of the ADM and the OTC systems. The ADM and OTC systems were merged to simplify the processing and analysis of pharmacy data and combine the strengths of the two systems. The combined OTC/ADM system is operated by DOHMH, and the first full year of operation of the merged system was 2013. DOHMH conducted an evaluation of the impact of the merger of the two systems (final report completed in 2014). In 2015, one ADM pharmacy chain data source dropped out of the program, but two additional pharmacy chains were added. Surveillance with both additional pharmacy chains began in 2016.

In summary, the current system involves tracking of sales of over-the-counter, non-bismuth-containing anti-diarrheal medications and of bismuth subsalicylate medications, searching for citywide as well as local signals. DOHMH Bureau of Communicable Disease (BCD) staff review signals on a daily basis to evaluate whether there are any new or sustained signals at citywide and zip-code levels. If there are sustained signals, BCD staff will perform reviews of reportable GI illness, including norovirus and rotavirus, to attempt to rule out a potential waterborne outbreak. Also, information on product promotions (e.g., price discounts) are considered, as these are known to impact on sales volume).

Clinical Laboratory Monitoring System

The number of stool specimens submitted to clinical laboratories for bacterial and parasitic testing also can be a source of information on GI illness trends in the population. The clinical laboratory monitoring system currently collects data from one large laboratory, designated as Laboratory A in this report. The number of participating laboratories has changed over time, as reported in prior WDRAP reports. Laboratory A transmits data by fax to DOHMH BCD 3–4 times per week, indicating the number of stool specimens examined per day for: (a) bacterial culture and sensitivity, (b) ova and parasites, and (c) *Cryptosporidium*.

The Clinical Laboratory Monitoring results are reviewed upon their receipt. Beginning in 2004, DOHMH implemented a model to establish statistical cut-offs for significant increases in clinical laboratory submissions. The model uses the entire historical dataset from November 1995 for Laboratory A. Sundays and holidays are removed because the laboratories do not test specimens on those days. Linear regression is used to adjust for average day-of-week and day-after-holiday effects as certain days routinely have higher volumes than other days. The cumulative sums (CUSUM) method is applied to a two-week baseline to identify statistically significant aberrations (or signals) in submissions for ova and parasites and for bacterial culture and sensitivity. CUSUM is a quality control method that has been adapted for aberration-detection in public health surveillance. CUSUM is described further in Hutwagner, *et al.* (Hutwagner et al. 1997).

Nursing Home Sentinel Surveillance

The nursing home surveillance system began in 1997. Under the current protocol, when a participating nursing home documents an outbreak of GI illness that is legally reportable to NYSDOH, the nursing home also notifies the WDRAP team at DOHMH. Such an outbreak is defined as onset of diarrhea and/or vomiting involving three or more patients on a single ward/unit within a seven-day period, or more than expected (baseline) number of cases within a single facility. All participating nursing homes have been provided with stool collection kits in advance. When such an outbreak is noted, specimens are to be collected for testing for bacterial culture and sensitivity, ova and parasites, *Cryptosporidium* spp., viruses, and *Clostridium difficile* toxin. Though *C. difficile* is not a waterborne pathogen, *C. difficile* toxin testing was added in 2010 to address a need expressed by infection control practitioners in the nursing homes and was intended to help ensure compliance with the sentinel nursing home protocol.

DOHMH BCD staff facilitates transportation of the specimens to the DOHMH Public Health Laboratory, where culture and sensitivity testing is performed. Specimens designated for ova and parasite tests, *Cryptosporidium* as well as for virus and *C. difficile* toxin testing are sent to NYSDOH Wadsworth Center Laboratory. There are currently eight nursing homes participating in the program. Three are in Manhattan, two are in the Bronx, two are in Queens, and one is in Brooklyn. As feedback for their role in outbreak detection, participating nursing homes are provided with copies of the WDRAP annual report.

All participating nursing homes are visited on an annual basis to help ensure compliance with the program protocol. During the site visits, DOHMH staff members reviewed the rationale for the program and program protocol with nursing administration or infection control staff. In addition, the DOHMH staff members verified that the nursing homes had adequate stool collection supplies on hand.