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Characteristics of People Who Do Not Complete a Public Health Interview: An Assessment of Colorado Enteric Disease Surveillance Data

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Abstract

Objectives: Although enteric disease case interviews are critical for control measures and education, not all case-patients are interviewed. We evaluated systematic differences between people with an enteric disease in Colorado who were and were not interviewed to identify ways to increase response rates and reduce biases in the surveillance data used to guide public health interventions.

Methods: We obtained data from the Colorado Electronic Disease Reporting System from March 1, 2017, through December 31, 2019. Among case-patients not interviewed and interviewed, we used univariate analyses to describe sociodemographic characteristics, timing of contact attempts, and effect of additional funding.

Results: As compared with case-patients who were interviewed, case-patients who were not interviewed were significantly more likely to be aged 18 to 39 years (35.7% vs 31.7%; $P < .001$); identify as male, Hispanic, or Black; be experiencing homelessness or hospitalization; reside in rural/frontier areas or an institution; or live in areas with lower levels of education, life expectancy, and income. Time to first contact attempt was longer for case-patients who were not interviewed than for those who were (mean days from specimen collection to first contact attempt, 9.8 vs 6.8; $P < .001$). Residing in a jurisdiction with additional funding for interviewing was associated with increased interview rates (87.7% vs 68.8%) and timeliness of public health report and first contact attempt (2.3 vs 4.4 days; $P < .001$).

Conclusion: Findings can guide efforts to improve response rates in groups least likely to be interviewed, resulting in reduced biases in surveillance data, better disease mitigation, and increased efficiency in case investigations. Timeliness of case interviews and additional funding to conduct case investigations were factors in increasing response rates.

Keywords

public health, surveillance, case investigation, case interview, foodborne disease, enteric disease, health disparities

Case investigations are a key public health activity. Information collected from people diagnosed with a reportable disease or condition during public health interviews can inform disease control measures and facilitate the dissemination of health education messages to prevent further disease transmission.[1-4] Interviews with people diagnosed with a reportable enteric disease are typically conducted via telephone by investigators at public health agencies using standardized questionnaires that include demographic information, occupation, clinical history, close contacts, and exposures (food, animal, water, and environmental). Enteric disease interviews may identify an ill food worker, health care worker, or childcare worker or attendee, whose illness may result in excluding this person from work or exercising other control measures. Information collected during these interviews can also help identify potential outbreaks, implicated

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food vehicles, and other exposures, enabling public health and regulatory agencies to implement broad control measures. The timeliness of the interview is critical for minimizing recall bias and enacting effective control measures.[5]

Case investigators attempting to interview people with an enteric infection often make multiple contact attempts using various methods, such as telephone, text message, or mailed letters. Despite these efforts, not all people with enteric infections are interviewed. Contact information, including a telephone number, may be missing or incorrect, or the case-patient may not answer despite repeated attempts. Even if the case investigator is successful in contacting case-patients, they may be unwilling or unable to complete the interview. Challenges to completing an interview include contact attempts when the person is unavailable and language barriers. The recent political climate has made some people reluctant to speak with public health officials, a phenomenon exacerbated by the COVID-19 pandemic.[6] While not specific to public health, research studies have noted low response rates among those with low household incomes or education levels, older groups (eg, age >60 y), and racial and ethnic minority populations.[7,8] Systematic differences between those who complete interviews with public health and those who do not have not been studied.

The objective of this study was to describe the sociodemographic characteristics of people with a reportable enteric disease who were not interviewed by public health and compare them with case-patients with a completed interview. A secondary objective was to outline the reasons why case-patients were not interviewed and to evaluate whether public health agency characteristics were associated with an interview (timeliness of case investigation, number of contact attempts, and additional funding). Understanding the characteristics and differences between case-patients with enteric disease who are and are not interviewed by public health officials could help guide efforts to increase response rates and reduce biases in the surveillance data used to guide public health interventions.

Methods

Data Source

We obtained data from the Colorado Department of Public Health and Environment's Colorado Electronic Disease Reporting System (CEDRS)[9] from March 1, 2017, through December 31, 2019, for all people with a laboratory-confirmed or probable diagnosis of the following reportable enteric pathogens: *Campylobacter*, *Cryptosporidium*, *Cyclospora*, Shiga toxin–producing *Escherichia coli*, *Listeria monocytogenes*, nontyphoidal *Salmonella*, *Shigella*, *Vibrio*, and *Yersinia*. We included data from March 2017 onward because that is when fields capturing outcomes for contact attempts were added to CEDRS (completed interview, partial interview, refused interview, scheduled future time for interview, message left/sent, sent email, unable to leave message, contact information not current, information obtained from health care provider office). Because the COVID-19 pandemic affected public health capacity to conduct case investigations and response rates, we included data only through 2019.

Case investigators collect and verify demographic information (age, sex/gender, race, ethnicity, county of residence), date reported to public health, and specimen collection date during case-patient interview or medical record review. Investigators also obtain epidemiologic information from the case-patient interview or medical record review: living environment (person experiencing homelessness, residence in an institution), hospitalization, dates of contact attempts, symptoms (eg, diarrhea, bloody diarrhea, fever), symptom onset date, ill contacts, international travel, industry and occupation, high-risk occupations (food handler, childcare/health care/residential facility worker), food history, and water exposures.

Interview Outcomes

We categorized the outcome of each interview attempt (interviewed, not interviewed) by using the contact attempt outcome fields and an assessment of questionnaire completeness. We used an assessment of questionnaire completeness to account for missing or inconsistent data in the contact attempt outcome fields. We defined case-patients as interviewed if (1) the final contact attempt was documented as "completed interview" or (2) ≥90% of core interview questions were completed. We defined case-patients as not interviewed if the final contact attempt was an outcome other than "completed interview" and <50% of core interview questions were completed. We excluded case-patients who did not meet these definitions (ie, final contact attempt was an outcome other than "completed interview" and 50% to 89% of core interview questions were completed). The 42 core questions evaluated for completeness included symptoms, onset date, ill contacts, international travel, industry and occupation, high-risk occupations, food history, and water exposures. Case investigators did not ask questions about food and water exposures when a case-patient reported international travel. For these case-patients, we evaluated 16 core questions.

Among people not interviewed, we used the contact attempts fields to categorize outcomes as "contacted—partial or refused interview," "not reached" (final contact attempt was message left/sent, sent email, unable to leave message), and "not contacted—contact information not current or no contact attempts documented" (eFigure1 in the supplemental material).

Data Analysis

If a person had multiple enteric infections reported within 14 days, we included only the first reported pathogen event. If infections were reported >14 days apart, we included each

pathogen event. For each case of infection, we evaluated the following characteristics among those interviewed and not interviewed: mean age, age group, sex/gender, race (American Indian or Alaska Native, another race, Asian, Black or African American, multiracial, Native Hawaiian or other Pacific Islander, White), ethnicity (Hispanic or Latino/a, non-Hispanic or non-Latino/a), season reported to public health (spring, March–May; summer, June–August; autumn, September–November; winter, December–February), living environment, hospitalization, and geographic location (rural/frontier or urban, determined by Colorado Rural Health Center designation). Geographic location also included residence in a Foodborne Diseases Active Surveillance Network (FoodNet) catchment county. During this period, FoodNet catchment in Colorado included 7 metropolitan-area counties (Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson) that received additional funding to submit timely and high-quality case investigation data for certain enteric pathogens.

We obtained additional sociodemographic data not available in CEDRS from Colorado EnviroScreen, a publicly available environmental justice mapping tool developed by the Colorado Department of Public Health and Environment and Colorado State University.[10] The tool produces a percentile score (0-100) on population and environmental factors for counties, census tracts, and census block groups in Colorado; the higher the score, the more likely the area is to be affected by environmental health injustice.[10] A county score of 70, for example, means that the score is higher than 70% of all counties in Colorado. We used these scores to identify case-patient counties with a higher proportion of residents (vs the state) with less than a high school education, lower life expectancy, more linguistic isolation, and lower income.

To evaluate timeliness of contact attempts, we measured the intervals between the dates of (1) specimen collection and public health report and (2) public health report and first contact attempt. We excluded from time analyses any interval that was either negative (eg, first contact attempt before specimen collection) or an outlier (>150-day interval).

We used the following tests to compare the characteristics of case-patients with a reportable enteric disease who were not interviewed with the characteristics of case-patients who completed an interview: 2-tailed t tests, Pearson χ^2 test, or Fisher exact test. We set a significance level of .05. We used SAS version 9.4 (SAS Institute, Inc) to conduct all descriptive and univariate analyses. Per the Colorado Multiple Institutional Review Board, this project involved quality improvement and did not involve human subjects research and, therefore, was exempt from full approval and requirements for informed consent.

Results

From March 2017 through December 2019, 8773 cases of infection were reported in Colorado as caused by *Campylobacter*, *Cryptosporidium*, *Cyclospora*, Shiga toxin–producing *E coli*, *Listeria monocytogenes*, *Salmonella*, *Shigella*, *Vibrio*, and *Yersinia*. Of these, we excluded 341 (3.9%) case-patients because interview status was indeterminate. Of the remaining 8432 case-patients, 6659 (79.0%) were interviewed and 1773 (21.0%) were not interviewed (Table 1). Case-patients with Shiga toxin–producing *E coli* were most likely to be interviewed (84.2%), followed by those with *Listeria* and *Salmonella* (82.8% and 82.5%), *Yersinia* (82.3%), *Cyclospora* (80.0%), *Campylobacter* (77.2%), *Shigella* (75.3%), *Cryptosporidium* (71.3%), and *Vibrio* (69.9%).

Sociodemographic Characteristics of Case-Patients

Case-patients not interviewed were older than those interviewed (mean age, 38 vs 36 y; $P = .001$). The proportion of case-patients aged <18 years not interviewed was lower than the proportion interviewed (19.0% vs 24.7%; $P < .001$), and the proportion aged 18 to 39 years not interviewed was higher than the proportion interviewed (35.7% vs 31.7%; $P < .001$) (Table 1). As compared with case-patients who were interviewed, those not interviewed were more likely to identify as male (vs female or another gender; $P < .001$), Hispanic or Latino/a ($P < .001$), or Black or African American ($P = .003$); reside in a rural/frontier area (vs urban area; $P < .001$); be experiencing homelessness (vs not; $P < .001$); reside in an institution (vs not; $P < .001$); or be hospitalized (vs not; $P < .001$). However, we found high missingness and differential missingness between those interviewed and not interviewed. Interview rates were consistent across seasons.

Case-patients not interviewed (vs interviewed) were significantly more likely to reside in counties with a higher proportion of residents (vs the state) with less than a high school education (median [IQR]: 60.9% [37.5%-76.6%] vs 46.9% [26.6%-76.6%]; $P < .001$), a lower life expectancy (64.5% [37.1%-79.0%] vs 58.1% [37.1%-79.0%]; $P = .007$), and a lower income (35.9% [29.7%-43.8%] vs 32.8% [14.1%-42.2%]; $P < .001$) (Figure).

Reasons for No Interview

Of the 1773 case-patients not interviewed, 868 (49.0%) were not able to be reached despite attempts by public health, 636 (35.9%) were never contacted by public health, 132 (7.4%) refused an interview, 104 (5.9%) were partially interviewed, and 33 (1.9%) did not have current contact information (Table 2). Case-patients aged 40 to 59 years and ≥70 years were more likely to refuse an interview than those in other age groups (10.7%-11.5% vs 3.4%-7.2%, respectively). Case-patients aged ≥70 years were more likely than those in other age groups to have a partial interview (8.6% vs 2.4%-6.9%).

Table 1. Sociodemographic characteristics and contact attempts for case-patients with enteric disease who were interviewed and not interviewed, Colorado, March 2017–December 2019[a]

Characteristic	Interviewed[b]	Not interviewed[b]	*P* value[c]
Total case-patients	6659 (79.0)	1773 (21.0)	—
Age, y, mean (SD)	36 (23.3)	38 (22.7)	.001
Age group, y			<.001
<18	1643 (24.7)	336 (19.0)	
18-29	1130 (17.0)	348 (19.6)	
30-39	978 (14.7)	285 (16.1)	
40-49	832 (12.5)	205 (11.6)	
50-59	774 (11.6)	225 (12.7)	
60-69	688 (10.3)	199 (11.2)	
≥70	614 (9.2)	175 (9.9)	
Sex/gender			<.001
Another gender	5 (0.1)	1 (<0.1)	
Female	3400 (51.1)	793 (44.7)	
Male	3254 (48.9)	979 (55.2)	
Ethnicity[d]			<.001
Hispanic or Latino/a	1408 (22.4)	355 (27.7)	
Non-Hispanic or Latino/a	4886 (77.6)	927 (72.3)	
Missing or unknown	365 (5.5)	491 (27.7)	
Race[d]			.003
American Indian or Alaska Native	28 (0.4)	11 (0.8)	
Asian	111 (1.7)	12 (0.9)	
Black or African American	220 (3.5)	68 (5.2)	
Native Hawaiian or Other Pacific Islander	51 (0.8)	5 (0.4)	
White	5443 (85.5)	1112 (84.8)	
Another race[e]	353 (5.6)	75 (5.7)	
Multiracial[f]	158 (2.5)	29 (2.2)	
Missing or unknown	295 (4.4)	461 (26.0)	
Season reported			.17
Spring (March–May)	1350 (20.3)	363 (20.5)	
Summer (June–August)	2547 (38.3)	634 (35.8)	
Fall (September–November)	1837 (27.6)	502 (28.3)	
Winter (December–February)	925 (13.9)	274 (15.5)	
Experiencing homelessness			<.001
Yes	11 (0.2)	13 (0.7)	
No	1728 (26.0)	239 (13.5)	
Missing or unknown	4920 (73.9)	1521 (85.8)	
Living in institution			<.001
Yes	100 (1.5)	35 (2.0)	
No	5355 (80.4)	848 (47.8)	
Missing or unknown	1204 (18.1)	890 (50.2)	
Hospitalized			<.001
Yes	1196 (18.0)	349 (19.7)	
No	5411 (81.3)	940 (53.0)	
Missing or unknown	52 (0.8)	484 (27.3)	
Geographic location			<.001
Rural/frontier	878 (13.2)	565 (31.9)	
Urban	5781 (86.8)	1208 (68.1)	
Resides in a FoodNet catchment area[g]			<.001
Yes	3978 (59.7)	559 (31.5)	
No	2681 (40.3)	1214 (68.5)	
No. of contact attempts, mean (SD)	1.8 (1.2)	3.1 (1.5)	<.001
No. of days, mean (SD)			
Specimen collection to date reported to public health	4.0 (5.6)	5.2 (9.7)	<.001
Date reported to public health to first contact attempt	2.8 (3.3)	4.6 (6.9)	<.001

Abbreviation: FoodNet, Foodborne Diseases Active Surveillance Network.

[a] Data source: Colorado Department of Public Health and Environment's Colorado Electronic Disease Reporting System.[9]

[b] All values are number (column percentage) unless otherwise indicated. Percentages may not sum to 100 because of rounding.

[c] Determined by 2-tailed *t* test (continuous data), Pearson χ^2 test (categorical data), or Fisher exact test (categorical data with ≤20% of expected cell counts <5); $P < .05$ considered significant.

[d] The denominator for race and ethnicity percentages is [total case-patients – missing] for known subgroups and [total case-patients] for missing or unknown subgroups.

[e] Includes case-patients who self-identified as another race not listed on the interview form.

[f] Includes case-patients who self-identified as >1 race.

[g] Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson counties.

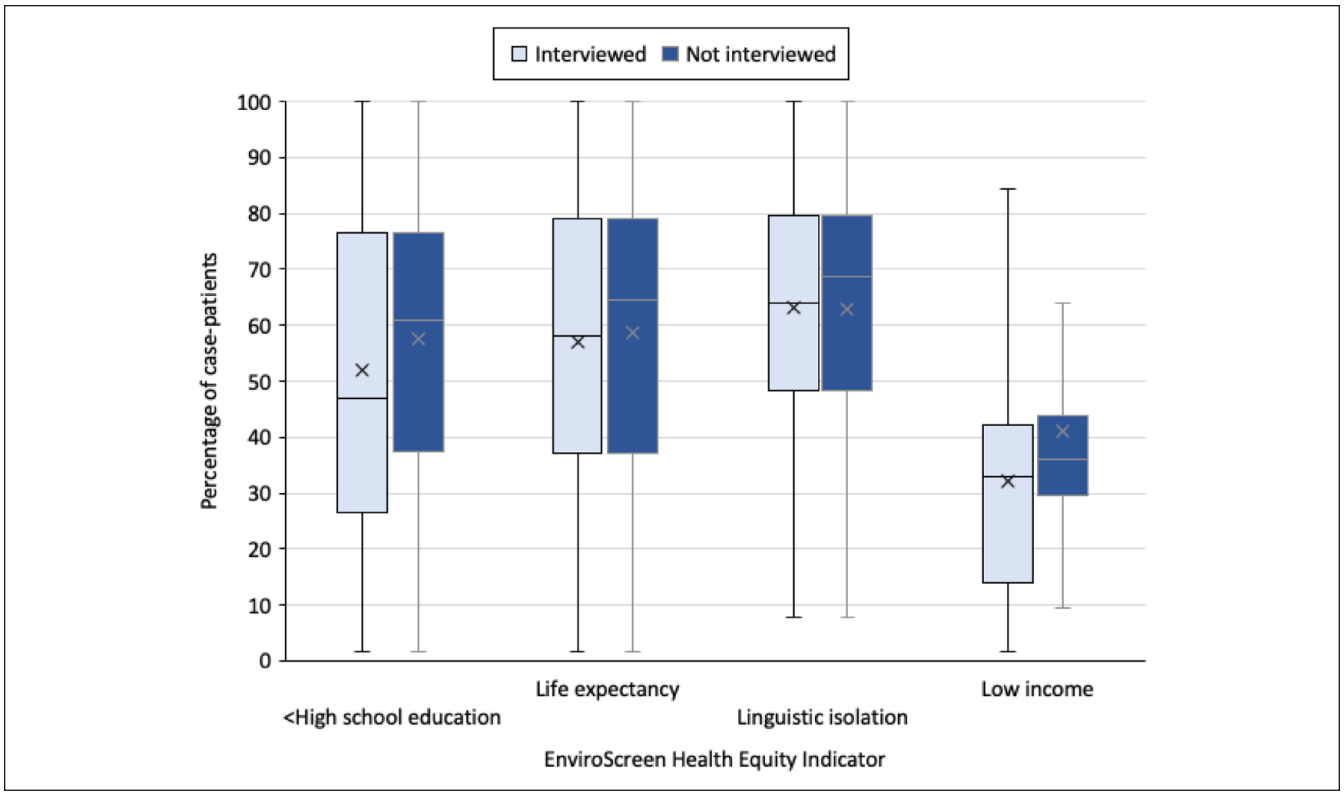

Figure. Sociodemographic characteristics of case-patients with enteric disease interviewed and not interviewed, according to Colorado EnviroScreen health equity indicator scores, Colorado, March 2017–December 2019. Colorado EnviroScreen is an environmental justice mapping tool that is publicly accessible at https://teeo-cdphe.shinyapps.io/COEnviroScreen_English.[10] Box, IQR; line, median; ×, mean; whiskers, range.

A higher percentage of case-patients had no contact attempts in winter months (42.0%) than in other seasons (33.1%-38.3%) (Table 2). No contact attempt was the most common reason for not being interviewed for case-patients living in an institution (54.3%) and rural/frontier locations (45.5%). Not being reached despite attempts by public health officials was the most common reason for not being interviewed for case-patients experiencing homelessness (69.2%), residing in urban areas (52.2%), and residing in FoodNet catchment areas (66.2%).

Time and Number of Contact Attempts

The mean time from specimen collection to public health report was 5.2 days for case-patients not interviewed as compared with 4.0 days for those interviewed ($P < .001$), and public health was slower to contact case-patients not interviewed than interviewed (mean days from report to first contact attempt, 4.6 vs 2.8; $P < .001$) (Table 1). Among case-patients not interviewed, 51.9% had a first contact attempt made within 5 days of specimen collection as compared with 61.4% of those interviewed; 81.6% of case-patients not interviewed had a first contact attempt within 5 days of report to public health as compared with 91.0% of those interviewed.

Interviewing in FoodNet Catchment Areas

Approximately 87.7% of case-patients in FoodNet catchment areas were interviewed as compared with 68.8% of those in non–FoodNet catchment areas (Table 3). In FoodNet counties, age was similar between case-patients not interviewed and interviewed (mean age, 37 y), but in non–FoodNet catchment areas, case-patients not interviewed were older (mean age, 39 vs 36 y; $P < .001$). Other characteristics of case-patients not interviewed or interviewed were similar between FoodNet and non-FoodNet counties. While the number of contact attempts was similar between FoodNet and non-FoodNet counties, the proportion of cases without any documented contact attempt was lower in FoodNet counties (1.3% vs 14.8%; $P < .001$). Public health contacted case-patients in FoodNet counties more quickly than those in non-FoodNet counties (mean days from date reported to first contact attempt, 2.3 vs 4.4; $P < .001$).

Discussion

Case-patients with enteric disease not interviewed by public health differ in important ways from those interviewed, leading to potential biases in data collected for public health action. In our analysis of Colorado enteric disease surveillance data, some people were less likely than others to be

Table 2. Sociodemographic characteristics of case-patients with enteric disease who did not complete an interview, by reason, Colorado, March 2017–December 2019[a]

	Contacted			Not contacted	
Characteristic	**Refused interview**	**Partial interview**	**Not reached**	**Contact information not current**	**No contact attempts**
Total case-patients not interviewed	132 (7.4)	104 (5.9)	868 (49.0)	33 (1.9)	636 (35.9)
Age, mean (SD), y	43 (19.8)	39 (25.5)	37 (21.5)	33 (24.0)	40 (24.2)
Age group, y					
<18	12 (3.6)	23 (6.9)	158 (47.0)	9 (2.7)	134 (39.9)
18-29	24 (6.9)	21 (6.0)	189 (54.3)	7 (2.0)	107 (30.8)
30-39	21 (7.4)	19 (6.7)	158 (55.4)	5 (1.8)	82 (28.8)
40-49	21 (10.2)	5 (2.4)	98 (47.8)	3 (1.5)	78 (38.1)
50-59	26 (11.6)	14 (6.2)	107 (47.6)	1 (0.4)	77 (34.2)
60-69	15 (7.5)	7 (3.5)	86 (43.2)	5 (2.5)	86 (43.2)
≥70	13 (7.4)	15 (8.6)	72 (41.1)	3 (1.7)	72 (41.1)
Sex					
Female	59 (7.4)	52 (6.6)	369 (46.5)	6 (0.8)	307 (38.7)
Male	73 (7.5)	52 (5.3)	499 (51.0)	27 (2.8)	328 (33.5)
Missing or unknown	0	0	0	0	1 (100.0)
Ethnicity					
Hispanic or Latino/a	26 (7.3)	25 (7.0)	185 (52.1)	13 (3.7)	106 (29.9)
Non-Hispanic or Latino/a	64 (6.9)	58 (6.3)	422 (45.5)	12 (1.3)	371 (40.0)
Missing or unknown	42 (8.6)	21 (4.3)	261 (53.2)	8 (1.6)	159 (32.4)
Race					
American Indian or Alaska Native	1 (9.1)	0	5 (45.5)	1 (9.1)	4 (36.4)
Asian	0	2 (16.7)	6 (50.0)	0	4 (33.3)
Black or African American	6 (8.8)	6 (8.8)	38 (55.9)	4 (5.9)	14 (20.6)
Native Hawaiian or other Pacific Islander	0	0	3 (60.0)	1 (20.0)	1 (20.0)
White	76 (6.8)	65 (5.9)	513 (46.1)	14 (1.3)	444 (39.9)
Another race[b]	6 (8.0)	9 (12.0)	39 (52.0)	2 (2.7)	19 (25.3)
Multiracial[c]	5 (17.2)	2 (6.9)	16 (55.2)	1 (3.5)	5 (17.2)
Missing or unknown	38 (8.2)	20 (4.3)	248 (53.8)	10 (2.2)	145 (31.5)
Season reported					
Spring (March–May)	26 (7.2)	15 (4.1)	173 (47.7)	10 (2.8)	139 (38.3)
Summer (June–August)	52 (8.2)	40 (6.3)	315 (49.7)	11 (1.7)	216 (34.1)
Fall (September–November)	41 (8.2)	33 (6.6)	253 (50.4)	9 (1.8)	166 (33.1)
Winter (December–February)	13 (4.7)	16 (5.8)	127 (46.4)	3 (1.1)	115 (42.0)
Experiencing homelessness					
Yes	2 (15.4)	0	9 (69.2)	0	2 (15.4)
No	14 (5.9)	26 (10.9)	129 (54.0)	1 (0.4)	69 (28.9)
Living in institution					
Yes	3 (8.6)	2 (5.7)	10 (28.6)	1 (2.9)	19 (54.3)
No	65 (7.7)	77 (9.1)	409 (48.2)	11 (1.3)	286 (33.7)
Missing or unknown	64 (7.2)	25 (2.8)	449 (50.4)	21 (2.4)	331 (37.2)
Hospitalized					
Yes	27 (7.7)	34 (9.7)	144 (41.3)	11 (3.2)	133 (38.1)
No	66 (7.0)	62 (6.6)	455 (48.4)	11 (1.2)	346 (36.8)
Missing or unknown	39 (8.1)	8 (1.7)	269 (55.6)	11 (2.3)	157 (32.4)
Geographic location					
Rural/frontier	34 (6.0)	25 (4.4)	239 (42.3)	12 (2.1)	259 (45.5)
Urban	98 (8.1)	79 (6.6)	629 (52.2)	21 (1.7)	377 (31.3)
Residing in a FoodNet catchment area[d]					
Yes	64 (11.5)	56 (10.0)	370 (66.2)	8 (1.4)	61 (10.9)
No	68 (5.6)	48 (4.0)	498 (41.0)	25 (2.1)	575 (47.4)

(continued)

Table 2. (continued)

Characteristic	Contacted		Not contacted		
	Refused interview	Partial interview	Not reached	Contact information not current	No contact attempts
EnviroScreen Indicator percentile for counties in which case-patients resided,[e] mean (SD)					
<High school education[f]	66.1 (24.4)	62.7 (24.4)	59.9 (24.7)	64.6 (24.8)	51.0 (24.2)
Life expectancy[g]	65.4 (19.6)	62.0 (22.8)	60.3 (22.9)	62.9 (20.6)	54.5 (24.1)
Linguistic isolation[h]	66.4 (22.0)	70.6 (18.8)	65.3 (21.1)	70.3 (17.2)	57.1 (22.3)
Low income[i]	42.2 (21.4)	38.6 (20.9)	40.0 (21.6)	46.9 (22.1)	41.9 (21.4)

Abbreviation: FoodNet, Foodborne Diseases Active Surveillance Network.
[a] Data source: Colorado Department of Public Health and Environment's Colorado Electronic Disease Reporting System.[9] All values are number (row percentage) unless otherwise indicated; percentages may not sum to 100 because of rounding.
[b] Includes case-patients who self-identified as another race not listed on the interview form.
[c] Includes case-patients who self-identified as >1 race.
[d] Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson counties.
[e] Colorado EnviroScreen is an environmental justice mapping tool that is publicly accessible at https://teeo-cdphe.shinyapps.io/COEnviroScreen_English.[10] The tool produces a percentile score (from 0 to 100) on population and environmental factors for counties, census tracts, and census block groups in Colorado; the higher the score, the more likely the area is to be affected by environmental health injustice.[10] A county score of 70, for example, means that the score is higher than 70% of all counties in Colorado.
[f] Based on the percentage of people in an area with less than a high school education.
[g] Based on the average life expectancy of an area.
[h] Based on the percentage of individuals and households with limited English proficiency or that speak languages other than English at home.
[i] Based on the percentage of people who live at or below twice the federal poverty level.

Table 3. Sociodemographic characteristics and contact attempts for case-patients with enteric disease who were interviewed and not interviewed in FoodNet catchment areas vs non–FoodNet catchment areas, Colorado, March 2017–December 2019[a]

Characteristic	FoodNet catchment area			Non–FoodNet catchment area		
	Interviewed	Not interviewed	Total	Interviewed	Not interviewed	Total
Total case-patients	3978 (87.7)	559 (12.3)	4537 (100.0)	2681 (68.8)	1214 (31.2)	3895 (100.0)
Age, y, mean (SD)[b]	37 (22.9)	37 (21.1)	37 (22.7)	36 (23.8)	39 (23.4)	37 (23.7)
Age group, y[b,c]						
<18	952 (23.9)	92 (16.5)	1044 (23.0)	691 (25.8)	244 (20.1)	935 (24.0)
18-29	660 (16.6)	115 (20.6)	775 (17.1)	470 (17.5)	233 (19.2)	703 (18.1)
30-39	621 (15.6)	122 (21.8)	743 (16.4)	357 (13.3)	163 (13.4)	520 (13.4)
40-49	524 (13.2)	69 (12.3)	593 (13.1)	308 (11.5)	136 (11.2)	444 (11.4)
50-59	468 (11.8)	67 (12.0)	535 (11.8)	306 (11.4)	158 (13.0)	464 (11.9)
60-69	415 (10.4)	50 (8.9)	465 (10.3)	273 (10.2)	149 (12.3)	422 (10.8)
≥70	338 (8.5)	44 (7.9)	382 (8.4)	276 (10.3)	131 (10.8)	407 (10.4)
Sex/gender[b,c]						
Another gender	1 (<0.1)	0	1 (<0.1)	4 (0.1)	1 (0.1)	5 (0.1)
Female	1976 (49.7)	238 (42.6)	2214 (48.8)	1424 (53.1)	555 (45.7)	1979 (50.8)
Male	2001 (50.3)	321 (57.4)	2322 (51.2)	1253 (46.7)	658 (54.2)	1911 (49.1)
Ethnicity[b,c,d]						
Hispanic or Latino/a	853 (22.0)	136 (29.4)	989 (22.8)	555 (23.0)	219 (26.7)	774 (24.0)
Non-Hispanic or Latino/a	3031 (78.0)	327 (70.7)	3358 (77.3)	1855 (77.0)	600 (73.3)	2455 (76.0)
Missing or unknown	94 (2.4)	96 (17.2)	190 (4.2)	271 (10.1)	395 (32.5)	666 (17.1)
Race[b,c,d]						
American Indian/Alaska Native	17 (0.4)	5 (1.0)	22 (0.5)	11 (0.4)	6 (0.7)	17 (0.5)
Asian	98 (2.5)	6 (1.3)	104 (2.4)	13 (0.5)	6 (0.7)	19 (0.6)
Black/African American	197 (5.1)	52 (10.9)	249 (5.7)	23 (0.9)	16 (1.9)	39 (1.2)
Native Hawaiian/other Pacific Islander	45 (1.2)	2 (0.4)	47 (1.1)	6 (0.2)	3 (0.4)	9 (0.3)

(continued)

Table 3. (continued)

Characteristic	FoodNet catchment area			Non–FoodNet catchment area		
	Interviewed	Not interviewed	Total	Interviewed	Not interviewed	Total
White	3174 (81.6)	357 (74.5)	3531 (80.8)	2269 (91.7)	755 (90.6)	3024 (91.4)
Another race[e]	264 (6.8)	40 (8.4)	304 (7.0)	89 (3.6)	35 (4.2)	124 (3.8)
Multiracial[f]	94 (2.4)	17 (3.6)	111 (2.5)	64 (2.6)	12 (1.4)	76 (2.3)
Missing or unknown	89 (2.2)	80 (14.3)	169 (3.7)	206 (7.7)	381 (31.4)	587 (15.1)
Season reported[c]						
Spring (March–May)	832 (20.9)	107 (19.1)	939 (20.7)	518 (19.3)	256 (21.1)	774 (19.9)
Summer (June–August)	1485 (37.3)	178 (31.8)	1663 (36.7)	1062 (39.6)	456 (37.6)	1518 (39.0)
Fall (September–November)	1082 (27.2)	184 (32.9)	1266 (27.9)	755 (28.2)	318 (26.2)	1073 (27.6)
Winter (December–February)	579 (14.6)	90 (16.1)	669 (14.8)	346 (12.9)	184 (15.2)	530 (13.6)
Experiencing homelessness[b,c]						
Yes	9 (0.2)	10 (1.8)	19 (0.4)	2 (0.1)	3 (0.3)	5 (0.1)
No	1096 (27.6)	109 (19.5)	1205 (26.6)	632 (23.6)	130 (10.7)	762 (19.6)
Missing or unknown	2873 (72.2)	440 (78.7)	3313 (73.0)	2047 (76.4)	1081 (89.0)	3128 (80.3)
Living in institution[b,c]						
Yes	67 (1.7)	19 (3.4)	86 (1.9)	33 (1.2)	16 (1.3)	49 (1.3)
No	3530 (88.7)	367 (65.7)	3897 (85.9)	1825 (68.1)	481 (39.6)	2306 (59.2)
Missing or unknown	381 (9.6)	173 (30.9)	554 (12.2)	823 (30.7)	717 (59.1)	1540 (39.5)
Hospitalized[b,c]						
Yes	719 (18.1)	144 (25.8)	863 (19.0)	477 (17.8)	205 (16.9)	682 (17.5)
No	3259 (81.9)	367 (65.7)	3626 (79.9)	2152 (80.3)	573 (47.2)	2725 (70.0)
Missing or unknown	0	48 (8.6)	48 (1.1)	52 (1.9)	436 (35.9)	488 (12.5)
Geographic location[b]						
Rural/frontier	0	0	0	878 (32.8)	569 (46.8)	1447 (37.2)
Urban	3978 (100.0)	559 (100.0)	4537 (100.0)	1803 (67.3)	645 (53.1)	2448 (62.9)
No. of contact attempts, mean (SD)[b,c]	2 (1.2)	4 (1.4)	2.1 (1.4)	2 (1.1)	3 (2.7)	1.9 (1.2)
No contact documented	0	61 (10.9)	61 (1.3)	0	575 (47.4)	575 (14.8)
No. of days, mean (SD)[b,c]						
Specimen collection to date reported to public health	4 (5.9)	6 (12.9)	4.4 (7.4)	4 (4.4)	5 (7.6)	4.1 (5.7)
Date reported to public health to first contact attempt	2 (2.3)	3 (2.8)	2.3 (2.5)	4 (4.5)	6 (8.4)	4.4 (5.6)

Abbreviation: FoodNet, Foodborne Diseases Active Surveillance Network.

[a] Data source: Colorado Department of Public Health and Environment's Colorado Electronic Disease Reporting System.[9] All values are number (column percentage) unless otherwise indicated; percentages may not sum to 100 because of rounding. Catchment areas were Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson counties.

[b] Significantly different ($P < .05$); non–FoodNet catchment area, interviewed vs not interviewed.

[c] Significantly different ($P < .05$); FoodNet catchment area, interviewed vs not interviewed.

[d] The denominator for race and ethnicity percentages is [total case-patients – missing] for known subgroups and [total case-patients] for missing or unknown subgroups.

[e] Includes case-patients who self-identified as another race not listed on the interview form.

[f] Includes case-patients who self-identified as >1 race.

interviewed, including those identifying as Hispanic or Latino/a, identifying as Black or African American, residing in rural/frontier areas, experiencing homelessness, living in an institution, or undergoing hospitalization. Moreover, people not interviewed were more likely than people interviewed to live in areas with lower levels of education, life expectancy, and income. We also found differences by age, with older groups more likely than younger groups to refuse an interview when contacted by public health.

Our findings align with studies that found lower response rates among those with lower household income levels and less education, older groups, and racial and ethnic minority populations.[7,8] Other studies have found lower levels of trust in public health among people identifying as Black or as Hispanic or Latino/a, those with lower income levels, and those living in rural locations,[11,12] which may make case-patients from these populations less willing to complete an interview with public health. In addition to being underrepresented in surveillance, people in these populations may be

hesitant to seek medical care due to negative experiences with health care providers.[13] Public health agencies should focus on equitable community engagement, respectful communication, and data transparency to build collaborative partnerships and trust in these populations.[14] Language may also be a barrier to interviewing if the public health agency is unable to offer the preferred language. More than 25 million people in the United States have limited English proficiency; Spanish, Chinese, Vietnamese, Korean, and Tagalog are the primary languages for 80% of this population.[15] Increased access to and use of cultural navigators, bilingual interviewers, and language line services may help improve response rates.

People who are experiencing homelessness, hospitalized, or living in an institution may be disproportionately affected by enteric disease infection and outbreaks due to living environments and inability to act on recommended control measures (eg, inability to isolate, limited handwashing facilities). Identifying addresses and telephone numbers commonly associated with shelter facilities may help investigators work with organizations to determine whether a person is unsheltered and to connect with the case-patient. Establishing partnerships with local institutions and congregate living facilities may facilitate interviewing residents with enteric infection.

Some of the biases in the sociodemographic characteristics of interviewed case-patients may be due to the interview process. Most contact attempts are made during the day on weekdays, when public health investigators are working. However, these are times when case-patients in younger age groups may be working and unable to answer their telephones. In health surveys, older people who were retired or unemployed were more likely than younger employed people to respond during the day on a weekday, while people who were aged <65 years, had a high school education or higher, had a higher income, were employed, or were from non-White racial groups were more likely to respond after 5 PM and on weekends.[16]

Our study found that some pathogens have higher interview rates than others. This finding could partially be due to case investigation prioritization based on illness severity. Because Colorado participates in FoodCORE (Foodborne Diseases Centers for Outbreak Response Enhancement),[17] case investigators make great effort to contact case-patients with *Salmonella*, Shiga toxin–producing *E coli*, and *Listeria* than case-patients with other pathogens. Although case-patients with *Shigella* are also prioritized, this pathogen had one of the lowest interview rates, possibly because people experiencing homelessness and men who have sex with men may be at higher risk for shigellosis than other groups and may be harder to reach than other populations.[18,19] While it is important to consider characteristics of people unable to be interviewed, characteristics of those with pathogens least likely to be interviewed should also be evaluated.

Targeted interventions to guide educational campaigns and increase response rates among all people with enteric infection need to be explored. The Colorado Department of Public Health and Environment has piloted the use of online surveys in English and Spanish and priming text messages to alert case-patients with enteric disease that they will be receiving a telephone call from public health.[20] Another way to increase response rates could be to use student teams to support enteric disease case investigators and increase the variability of contact attempt timing outside of business hours.[21] Social media messaging by local public health agencies may help educate residents on the importance of speaking to public health and make them more likely to respond to an interview.[22]

Timeliness of laboratory reporting and prompt contact were critical factors in completing an interview. In our study, quicker laboratory reporting and case-patient contact significantly improved response rates. Furthermore, prompt interviewing can decrease recall bias and allow for rapid implementation of local disease control measures and dissemination of health education messages, which can help reduce disease transmission among populations at high risk of infection.[23-25] When compared with non–FoodNet catchment areas, FoodNet catchment areas had higher interview rates, better contact attempt documentation, and faster contact times, indicating that enhanced funding may help increase capacity for enteric disease case investigation. Several studies found that increased funding was associated with better surveillance, interviewing, and investigation and that investments in public health programming can measurably affect foodborne outbreak reporting.[26,27] Participation in FoodCORE demonstrates that targeted efforts can improve the timeliness of enteric disease case interviews and response rates.[5,28]

Limitations

This study was subject to several limitations. First, socioeconomic data are not collected during case interviews, so aggregate county-level health justice data were used to make inferences about case-patients. Second, Colorado has a decentralized public health system, and at the time of the study, the state had 56 local public health agencies responsible for interviewing people with reportable enteric infections. Differences in protocols across agencies may have influenced interview rates and some of our findings. Third, contact attempts fields were added to CEDRS just before the data collection period for this study and may not have immediately or consistently been used by case investigators across the state, which may have affected results. We tried to ensure proper classification of case-patients by also evaluating data completeness in a core set of interview questions, but cases may still have been misclassified. Fourth, critical factors affecting whether a case-patient was interviewed may have been missed because this information was not captured in CEDRS. For example, preferred language, telephone type (home vs mobile), and timing of contact attempts was not

available in CEDRS but may have affected interview completion. Finally, given that the demographic characteristics of FoodNet catchment areas differ from those of non–FoodNet catchment areas (ie, all FoodNet catchment areas are urban), we were unable to directly assess the effect of FoodNet funding on response rates by demographic characteristics.

Conclusions

While interviewing all case-patients is critical for enacting appropriate disease control measures and disseminating health education messages to prevent further disease transmission, results from our study highlight the current biases in Colorado enteric disease surveillance data. Findings from this study can be used to inform public health efforts, resources, and strategies to improve response rates in groups least likely to be interviewed, resulting in reduced health disparities, better local disease mitigation, and increased efficiency in case investigations. Timeliness of case interviews and additional funding to conduct case investigations were shown to be key factors in increasing response rates.

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