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Obesity Prevalence Among Adults Living in Metropolitan and Nonmetropolitan Counties — United States, 2016

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Approximately 46 million persons (14%) in the United States live in nonmetropolitan counties.* Compared with metropolitan residents, nonmetropolitan residents have a higher prevalence of obesity-associated chronic diseases such as diabetes (*1*), coronary heart disease (*1*), and arthritis (*2*). The 2005–2008 National Health and Nutrition Examination Survey (NHANES) found a significantly higher obesity prevalence among adults in nonmetropolitan (39.6%) than in metropolitan (33.4%) counties (*3*). However, this difference has not been examined by state. Therefore, CDC examined state-level 2016 Behavioral Risk Factor Surveillance System (BRFSS) data and found that the prevalence of obesity (body mass index [BMI] ≥30 kg/m^2) was 34.2% among U.S. adults living in nonmetropolitan counties and 28.7% among those living in metropolitan counties (p<0.001). Obesity prevalence was significantly higher among nonmetropolitan county residents than among metropolitan county residents in all U.S. Census regions, with the largest absolute difference in the South (5.6 percentage points) and Northeast (5.4 percentage points). In 24 of 47 states, obesity prevalence was significantly higher among persons in nonmetropolitan counties than among those in metropolitan counties; only in Wyoming was obesity prevalence higher among metropolitan county residents than among nonmetropolitan county residents. Both metropolitan and nonmetropolitan counties can address obesity through a variety of policy and environmental strategies to increase access to healthier foods and opportunities for physical activity (*4*).

BRFSS is a state-based, random-digit–dialed telephone survey of U.S. adults aged ≥18 years, conducted annually by CDC and state and territorial health departments to monitor health conditions and related behaviors.† BRFSS uses multistage, stratified sampling to select a representative sample of the noninstitutionalized adult population in 50 states, the District of Columbia (DC), and selected U.S. territories. In 2016, using combined landline and cell phone data across all states, the median response rate was 47.0%, which was calculated using rates from the American Association of Public Opinion Research.§ Self-reported weight and height were used to calculate BMI (weight [kg]/height [m]^2); obesity was defined as BMI ≥30 kg/m^2.¶ Among 477,665 respondents, 39,186 (8.2%) were excluded, including 36,848 with missing BMI values and 2,338 with implausible BMI values, leaving a final analytic sample of 438,479 adults from 50 states and DC. Unadjusted obesity prevalence is presented overall and

* https://www.ers.usda.gov/webdocs/publications/80894/eib-162.pdf?v=42684.
† https://www.cdc.gov/brfss/annual_data/annual_2016.html.
§ https://www.cdc.gov/brfss/annual_data/2016/pdf/2016-sdqr.pdf.
¶ https://www.nhlbi.nih.gov/files/docs/guidelines/ob_gdlns.pdf.

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by sociodemographic characteristics (age, sex, race/ethnicity, education, income, and employment status), state, and four U.S. Census regions and nine divisions: Northeast region (New England and Middle Atlantic divisions), Midwest region (East North Central and West North Central divisions), South region (South Atlantic, East South Central, and West South Central divisions), and West region (Mountain and Pacific divisions).**

Using 2010 Census data, CDC's National Center for Health Statistics (NCHS) developed an Urban-Rural Classification Scheme for Counties,†† which specified six county types; for this analysis, to ensure sufficient sample size for regional and state-level comparisons, counties were collapsed into two categories: metropolitan (large central metro, large fringe metro, medium metro, and small metro) and nonmetropolitan (micropolitan and noncore). In this analysis, the nonmetropolitan designation was used to classify counties with small populations (<50,000). Rhode Island, New Jersey, Delaware, and DC do not have nonmetropolitan counties; for these jurisdictions, obesity prevalence was calculated for adults living in metropolitan counties only. U.S. territories were excluded because the NCHS classification scheme does not include them. Unadjusted obesity prevalence was stratified by metropolitan and nonmetropolitan status. Differences in obesity prevalence between adults living in metropolitan and nonmetropolitan counties were examined using multivariable logistic regression, controlling for age, sex, and race/ethnicity within levels of the sociodemographic characteristics, states, and Census regions and divisions (statistically significant at $p<0.05$). All analyses accounted for complex survey design and sampling weights.

In 2016, overall obesity prevalence was 29.6% and was highest among persons residing in the South (32.0%) and Midwest (31.4%) regions and the East South Central (35.3%) and West South Central (33.9%) divisions (Table 1). Overall, obesity prevalence was significantly higher among adults living in nonmetropolitan counties (34.2%) than among those living metropolitan counties (28.7%) ($p<0.001$), and the same was found in all Census regions and Census divisions. Among Census regions, the largest difference in obesity prevalence between persons living in nonmetropolitan and metropolitan counties was in the South (5.6 percentage points) and Northeast (5.4 percentage points); among Census divisions, the largest difference in obesity prevalence between nonmetropolitan and metropolitan residents was in the Middle Atlantic division (6.6 percentage points). Obesity prevalence was also significantly higher among nonmetropolitan county residents than among metropolitan county residents for all sociodemographic categories except Hispanics and persons with less than a high school education.

Among adults living in nonmetropolitan counties, obesity prevalence ranged from 20.8% in Colorado to 39.1% in Louisiana; among those living in metropolitan counties, prevalence ranged from 22.5% in Colorado to 36.9% in West Virginia. (Table 2). In 24 (51%) of the 47 states with both

** https://www.census.gov/geo/reference/gtc/gtc_census_divreg.html.
†† https://www.cdc.gov/nchs/data_access/urban_rural.htm.

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TABLE 1. Prevalence of self-reported obesity among adults (aged ≥18 years) by respondent characteristics and metropolitan/nonmetropolitan status — Behavioral Risk Factor Surveillance System, 50 states and the District of Columbia, 2016

Characteristic	No. of respondents	Unadjusted adult obesity prevalence–weighted % (95% CI)*		
		Total	Metropolitan†	Nonmetropolitan†
Total	**438,479**	**29.6 (29.3–29.8)**	**28.7 (28.4–29.0)§**	**34.2 (33.6–34.8)§**
Age group (yrs)¶				
18–24	23,734	17.3 (16.5–18.1)	16.5 (15.6–17.4)§	22.2 (20.3–24.2)§
25–34	42,706	27.2 (26.5–27.9)	26.4 (25.6–27.2)§	32.5 (30.8–34.3)§
35–44	48,951	33.1 (32.3–33.8)	32.0 (31.2–32.9)§	39.6 (38.0–41.2)§
45–54	68,854	35.1 (34.4–35.8)	34.0 (33.2–34.8)§	40.8 (39.4–42.3)§
55–64	96,566	34.2 (33.6–34.8)	33.4 (32.7–34.1)§	38.0 (36.9–39.2)§
≥65	157,668	28.0 (27.5–28.5)	27.5 (26.9–28.1)§	30.1 (29.3–31.0)§
Sex**				
Male	198,440	29.6 (29.2–30.0)	28.8 (28.3–29.2)§	34.4 (33.6–35.2)§
Female	240,000	29.5 (29.1–29.9)	28.7 (28.2–29.1)§	34.0 (33.2–34.8)§
Race/Ethnicity¶,**				
White, non-Hispanic	341,192	28.6 (28.3–28.9)	27.5 (27.2–27.9)§	33.2 (32.6–33.8)§
Black, non-Hispanic	35,091	38.3 (37.4–39.3)	37.7 (36.7–38.7)§	44.2 (41.7–46.7)§
Hispanic, any race	28,666	33.1 (32.1–34.1)	32.9 (31.9–33.9)	36.0 (32.6–39.5)
Other, non-Hispanic	26,954	18.2 (17.3–19.2)	16.8 (15.8–17.8)§	33.2 (31.2–35.3)§
Education¶,**				
<High school	32,325	35.5 (34.5–36.5)	35.4 (34.3–36.6)	35.9 (34.0–37.8)
High school	123,241	32.3 (31.8–32.8)	31.5 (30.9–32.1)§	35.6 (34.7–36.5)§
Some college	120,735	31.0 (30.5–31.5)	30.3 (29.7–30.9)§	34.7 (33.7–35.7)§
College graduate	161,309	22.2 (21.9–22.6)	21.5 (21.1–21.9)§	28.8 (27.9–29.7)§
Annual household income¶,**				
<$25,000	99,244	34.1 (33.5–34.7)	33.4 (32.7–34.2)§	37.1 (35.9–38.2)§
$25,000–49,999	95,553	31.9 (31.3–32.6)	31.1 (30.3–31.8)§	35.9 (34.7–37.1)§
$50,000–74,999	61,211	31.1 (30.3–31.8)	30.2 (29.4–31.1)§	35.4 (34.0–36.8)§
≥$75,000	120,901	25.4 (24.9–25.9)	24.8 (24.3–25.3)§	30.9 (29.8–32.1)§
Employment status¶,**				
Employed	215,226	29.0 (28.6–29.4)	28.2 (27.8–28.6)§	34.1 (33.3–34.9)§
Out of work	17,009	32.9 (31.6–34.3)	32.4 (30.9–34.0)§	35.8 (33.1–38.7)§
Homemaker	22,372	29.0 (27.7–30.3)	28.4 (27.0–29.9)§	32.0 (29.5–34.7)§
Student	11,277	15.2 (14.1–16.3)	14.8 (13.6–16.0)§	18.8 (16.2–21.7)§
Retired	136,638	29.1 (28.5–29.6)	28.6 (28.0–29.2)§	31.2 (30.3–32.2)§
Unable to work	33,534	45.8 (44.8–46.9)	45.5 (44.2–46.8)§	47.1 (45.2–49.1)§
Census region¶,††				
Northeast	88,335	26.9 (26.3–27.5)	26.4 (25.8–27.0)§	31.8 (30.4–33.2)§
Midwest	106,697	31.4 (30.9–31.9)	30.5 (29.9–31.2)§	34.2 (33.3–35.1)§
South	146,919	32.0 (31.5–32.5)	31.0 (30.4–31.6)§	36.6 (35.6–37.6)§
West	96,528	26.0 (25.4–26.6)	25.7 (25.1–26.4)§	28.6 (27.5–29.7)§
Census division¶,††				
New England	43,889	25.4 (24.7–26.1)	25.0 (24.2–25.8)§	28.7 (27.4–30.0)§
Middle Atlantic	44,446	27.4 (26.7–28.2)	26.9 (26.1–27.7)§	33.5 (31.5–35.6)§
East North Central	42,215	31.8 (31.1–32.5)	31.0 (30.2–31.8)§	34.9 (33.5–36.3)§
West North Central	64,482	30.6 (30.0–31.2)	29.3 (28.5–30.1)§	33.3 (32.4–34.2)§
South Atlantic	93,367	29.9 (29.3–30.4)	29.1 (28.5–29.7)§	35.3 (33.9–36.7)§
East South Central	26,587	35.3 (34.4–36.2)	34.5 (33.3–35.6)§	36.9 (35.6–38.1)§
West South Central	26,965	33.9 (32.7–35.2)	33.1 (31.7–34.5)§	37.8 (35.4–40.3)§
Mountain	57,788	26.2 (25.6–26.8)	26.0 (25.3–26.7)§	27.2 (26.3–28.1)§
Pacific	38,740	25.9 (25.0–26.7)	25.6 (24.7–26.4)§	30.3 (28.1–32.6)§

Abbreviation: CI = confidence interval.

* Obesity defined as having a body mass index ≥30 kg/m2 determined by self-reported weight and height.

† Based on National Center for Health Statistics Urban-Rural Classification Scheme for Counties. Metropolitan includes large central metro, large fringe metro, medium metro, and small metro categories. Nonmetropolitan includes micropolitan and noncore categories.

§ Significant difference in the prevalence of obesity between metropolitan and nonmetropolitan areas at the p<0.05 level. Determined using multivariable logistic regression within levels of the sociodemographic and geographic characteristics to control for age, sex, and race/ethnicity.

¶ Significant difference in the prevalence of obesity across levels of the characteristic at the p<0.05 level using Chi-square test.

** Missing data: sex (n = 39; 0.009%), race/ethnicity (n = 6,576; 1.5%), education (n = 869; 0.2%), income (n = 61,570; 14.0%), and employment status (n = 2,423; 0.6%).

†† The United States Census Bureau defines four census regions and nine census divisions: Northeast region (New England and Middle Atlantic divisions), Midwest region (East North Central and West North Central divisions), Southern region (South Atlantic, East South Central, and West South Central divisions), and Western region (Mountain and Pacific divisions).

metropolitan and nonmetropolitan counties, obesity prevalence was significantly higher among adults living in nonmetropolitan counties than among those living in metropolitan counties; in 22 (47%) states, no difference was observed. Wyoming was the only state where obesity prevalence was significantly higher among metropolitan county residents (32.8%) than among nonmetropolitan residents (25.4%; p = 0.002).

Discussion

In this study, obesity prevalence was significantly higher among adults living in nonmetropolitan counties than among those living in metropolitan counties, overall, in all Census regions, all Census divisions, and in approximately half of states with both county types. Across regions and divisions, this disparity in obesity prevalence was highest in the South and Northeast regions and the Middle Atlantic division. With the exception of Hispanics and persons with less than a high school education, the higher obesity prevalence among nonmetropolitan residents was observed in all sociodemographic groups.

These findings are consistent with those previously reported using 2005–2008 NHANES data, which documented higher overall obesity prevalence among adults living in nonmetropolitan versus metropolitan counties of the United States (*3*), and expand the understanding of this health disparity by highlighting differences across states and regions. Research has documented differences between adults living in nonmetropolitan and metropolitan counties in health behaviors and community factors, which could influence obesity risk (*5*–*7*).

TABLE 2. Prevalence of self-reported obesity among adults (aged ≥18 years) by state and metropolitan/nonmetropolitan status — Behavioral Risk Factor Surveillance System, 50 states and the District of Columbia, 2016

Census division†/State	No. of respondents	Unadjusted adult obesity prevalence–weighted % (95% CI)*	
		Metropolitan§	Nonmetropolitan§
New England			
Connecticut	9,960	25.9 (24.7–27.1)	28.1 (22.7–34.2)
Maine	9,554	29.3 (27.3–31.3)	30.9 (29.1–32.7)
Massachusetts	7,480	23.6 (22.2–24.9)	24.4 (16.9–34.0)
New Hampshire	5,888	26.0 (23.8–28.2)	27.6 (25.4–29.9)
Rhode Island	4,936	26.6 (24.9–28.4)	—¶
Vermont	6,071	24.1 (21.3–27.1)**	28.7 (26.9–30.6)**
Middle Atlantic			
New Jersey	6,810	27.4 (25.7–29.1)	—¶
New York	31,269	24.9 (23.9–26.0)**	33.0 (31.6–34.5)**
Pennsylvania	6,367	29.7 (28.1–31.4)**	33.9 (30.4–37.5)**
East North Central			
Illinois	4,518	31.0 (29.2–32.9)**	35.7 (31.0–40.6)**
Indiana	10,319	32.0 (30.6–33.5)	33.9 (31.3–36.7)
Michigan	11,130	31.6 (30.4–32.9)**	36.0 (33.7–38.5)**
Ohio	11,455	30.7 (29.2–32.3)**	34.4 (32.1–36.8)**
Wisconsin	4,793	29.1 (27.0–31.3)**	34.4 (31.6–37.3)**
West North Central			
Iowa	6,645	31.4 (29.4–33.5)	32.7 (30.7–34.8)
Kansas	10,947	29.9 (28.5–31.3)**	33.7 (32.0–35.5)**
Minnesota	15,420	26.5 (25.6–27.5)**	31.7 (30.1–33.2)**
Missouri	6,578	30.5 (28.4–32.6)**	34.9 (32.1–37.9)**
Nebraska	14,173	30.8 (29.1–32.6)**	34.2 (32.9–35.5)**
North Dakota	5,348	30.5 (28.2–32.9)	33.4 (31.2–35.6)
South Dakota	5,371	27.0 (23.9–30.5)**	31.8 (29.2–34.5)**
South Atlantic			
Delaware	3,702	30.7 (28.7–32.8)	—¶
District of Columbia	3,479	22.6 (20.9–24.3)	—¶
Florida	33,186	27.2 (26.1–28.2)**	34.9 (32.6–37.2)**
Georgia	4,884	30.8 (28.9–32.8)	34.0 (30.3–37.9)
Maryland	16,701	29.8 (28.7–30.9)**	35.1 (32.0–38.3)**
North Carolina	5,984	31.1 (29.5–32.9)	34.1 (31.4–37.0)
South Carolina	10,503	31.2 (29.8–32.7)**	37.8 (35.1–40.6)**
Virginia	8,293	27.7 (26.3–29.1)**	36.1 (33.2–39.1)**
West Virginia	6,635	36.9 (35.2–38.7)	38.8 (36.6–41.0)
East South Central			
Alabama	6,526	35.6 (33.8–37.5)	36.0 (33.1–38.9)
Kentucky	9,583	32.1 (30.2–34.0)**	36.9 (34.7–39.2)**
Mississippi	4,821	36.5 (33.4–39.7)	37.9 (35.7–40.1)
Tennessee	5,657	34.3 (32.1–36.6)	36.4 (33.6–39.3)
West South Central			
Arkansas	4,859	35.4 (32.2–38.8)	36.1 (32.6–39.7)
Louisiana	4,868	34.8 (32.5–37.3)	39.1 (34.7–43.7)
Oklahoma	6,449	30.8 (28.8–32.8)**	36.3 (33.9–38.8)**
Texas	10,789	32.9 (31.0–34.8)**	38.7 (34.3–43.2)**
Mountain			
Arizona	10,033	28.8 (27.2–30.4)	33.6 (29.1–38.4)
Colorado	13,637	22.5 (21.5–23.5)	20.8 (19.0–22.8)
Idaho	4,880	26.3 (23.9–28.8)	29.6 (27.0–32.4)
Montana	5,483	25.9 (23.1–29.0)	25.3 (23.3–27.3)
Nevada	3,981	25.1 (23.1–27.3)**	32.1 (28.6–35.9)**
New Mexico	5,531	27.0 (24.7–29.4)**	31.1 (28.7–33.6)**
Utah	10,043	25.4 (24.2–26.7)	24.9 (22.7–27.2)
Wyoming	4,200	32.8 (29.0–36.9)**	25.4 (23.1–27.8)**
Pacific			
Alaska	2,739	30.9 (27.1–35.0)	32.4 (28.8–36.4)
California	10,352	25.0 (24.0–26.1)	24.2 (19.2–30.0)
Hawaii	7,659	23.3 (21.8–24.9)**	26.1 (23.5–28.8)**
Oregon	5,000	27.4 (25.8–29.1)**	35.1 (31.5–38.8)**
Washington	12,990	27.8 (26.8–28.9)**	35.3 (32.3–38.4)**

Abbreviation: CI = confidence interval.

* Obesity defined as having a body mass index ≥30 kg/m2, determined by self-reported weight and height.

† The United States Census Bureau defines nine census divisions within four regions: Northeast region (New England and Middle Atlantic divisions), Midwest region (East North Central and West North Central divisions), Southern region (South Atlantic, East South Central, and West South Central divisions), and Western region (Mountain and Pacific divisions).

§ Based on National Center for Health Statistics Urban-Rural Classification Scheme for Counties. Metropolitan includes large central metro, large fringe metro, medium metro, and small metro categories. Nonmetropolitan includes micropolitan and noncore categories.

¶ Data not available because state does not have counties in the nonmetropolitan classification.

** Significant difference in the prevalence of obesity between metropolitan and nonmetropolitan areas at the p<0.05 level. Within states, differences in obesity prevalence between metropolitan and nonmetropolitan areas were determined using multivariable logistic regression, controlling for age, sex, and race/ethnicity

An analysis of 2013 BRFSS data found that adults living in U.S. nonmetropolitan counties were less physically active and less likely to meet physical activity recommendations than their metropolitan counterparts (*5*). Data from 2011 indicated that across all regions, adults living in rural areas were less likely to have access to healthier food retailers (supermarkets, large grocery stores, and fruit/vegetable specialty stores) than were those living in urban areas (*6*). In addition, several social determinants of health that are risk factors for obesity, such as persistent poverty and food insecurity (*7*), are more prevalent in rural than in urban areas.[§§,¶¶]

In this analysis, the highest obesity prevalence and the greatest disparity in prevalence between persons living in nonmetropolitan and metropolitan counties were in the South Census region. One possible contributing factor is the high rate of persistent poverty in the South, which also is affected by the largest difference in poverty rate between metropolitan and nonmetropolitan county residents.[¶¶]

The findings in this report are subject to at least two limitations. First, data are self-reported, and self-reported weight and height data underestimate BMI values, particularly among persons with a higher BMI (*8*). It is not known whether self-reporting bias is comparable across regions and between metropolitan and nonmetropolitan counties. Second, to ensure sufficient sample size for regional and state-level comparisons, the nonmetropolitan classification was used to designate counties with small populations (<50,000 persons). The literature on rural obesity disparities and prevention strategies uses various methods to define rural areas, some of which might differ in population size from the nonmetropolitan designation used in this paper.

CDC recommends 24 obesity-prevention policy and environmental strategies (*4*). Two systematic reviews summarized the relevance and effectiveness of these strategies in rural areas and identified how these strategies could be adapted for rural settings (*9,10*). One nutrition-related obesity prevention strategy, increasing the availability of healthier food and beverage choices, is challenging to implement in rural areas because of the long distances between food suppliers and retailers and between retailers and consumers, which can influence food cost and the availability of fresh foods. Approaches to overcoming this challenge include strengthening networks between food producers, distributors, and retail food outlets, as well as reducing the distance customers need to travel, for example, by increasing access to nearby farmers' markets (*9*). The 2018 CDC State Indicator Report on Fruits and Vegetables also highlights approaches to increase the purchase, supply, and demand of fruits and vegetables in states and communities across the United States.[***] Other approaches include working with schools and worksites to develop nutrition-related policies and forming strong partnerships with groups such as the Cooperative Extension Service to promote federal food and nutrition assistance program benefits (*9*).

Strategies to increase physical activity in rural areas should take into consideration geographic dispersion, transportation challenges, and limitations on community resources that might not be present in urban areas (*10*). Strategies that have been implemented in rural settings include improving community access to public buildings (e.g., school facilities) after hours for physical activity purposes; improving infrastructure and land use design to support walking and other physical activity (e.g., bicycle paths, paved sidewalks, and outdoor public recreation facilities); promoting existing places for physical activity with improved signage; enhancing physical education in schools; and implementing worksite policies to promote physical activity (*10*). The data in this report can serve as a resource for states seeking to reduce obesity disparities in nonmetropolitan counties through strategies to increase physical activity and healthier eating.

Summary

What is already known about this topic?

National estimates from a decade ago found a higher prevalence of obesity among adults living in nonmetropolitan counties than among those living in metropolitan counties.

What is added by this report?

Analysis of 2016 Behavioral Risk Factor Surveillance System data found a higher obesity prevalence among adults in nonmetropolitan counties than among those in metropolitan counties. The greatest differences in obesity prevalence between nonmetropolitan and metropolitan residents were in the South (5.6 percentage points) and Northeast (5.4 percentage points).

What are the implications for public health practice?

Both nonmetropolitan and metropolitan counties can address obesity through a variety of policy and environmental strategies to increase access to healthier foods and opportunities for physical activity.

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[§§] https://www.ers.usda.gov/webdocs/publications/79761/err-215.pdf?v=42636.

[¶¶] https://www.ers.usda.gov/topics/rural-economy-population/rural-poverty-well-being/.

[***] https://www.cdc.gov/nutrition/data-statistics/2018-state-indicator-report-fruits-vegetables.html.

Conflict of Interest

No conflicts of interest were reported.

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Outbreak of *E. coli* O157:H7 Infections Associated with Exposure to Animal Manure in a Rural Community — Arizona and Utah, June–July 2017

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On June 26, 2017, a hospital in southern Utah notified the Utah Department of Health of Shiga toxin–producing *Escherichia coli* (STEC) O157:H7 infections in two children from a small community on the Arizona-Utah border. Both children developed hemolytic uremic syndrome, characterized by hemolytic anemia, acute kidney failure, and thrombocytopenia and died within a few days of illness onset. Over the next few days, several more STEC-associated illnesses were reported in residents of the community. A joint investigation by local and state health agencies from Arizona and Utah and CDC was initiated to identify the outbreak source and prevent additional cases; a total of 12 cases were identified, including the two children who died. Investigators initially explored multiple potential sources of illness; epidemiologic and environmental information revealed cow manure contact as the likely initial cause of the outbreak, which was followed by subsequent person-to-person transmission. One of the outbreak strains was isolated from bull and horse manure collected from a yard near a community household with two ill children. Local health agencies made recommendations to the public related to both animal contact and hand hygiene to reduce the risk for STEC transmission. Animal or animal manure contact should be considered a potential source of STEC O157:H7 during outbreaks in communities where ruminants are kept near the home.

Epidemiologic Investigation

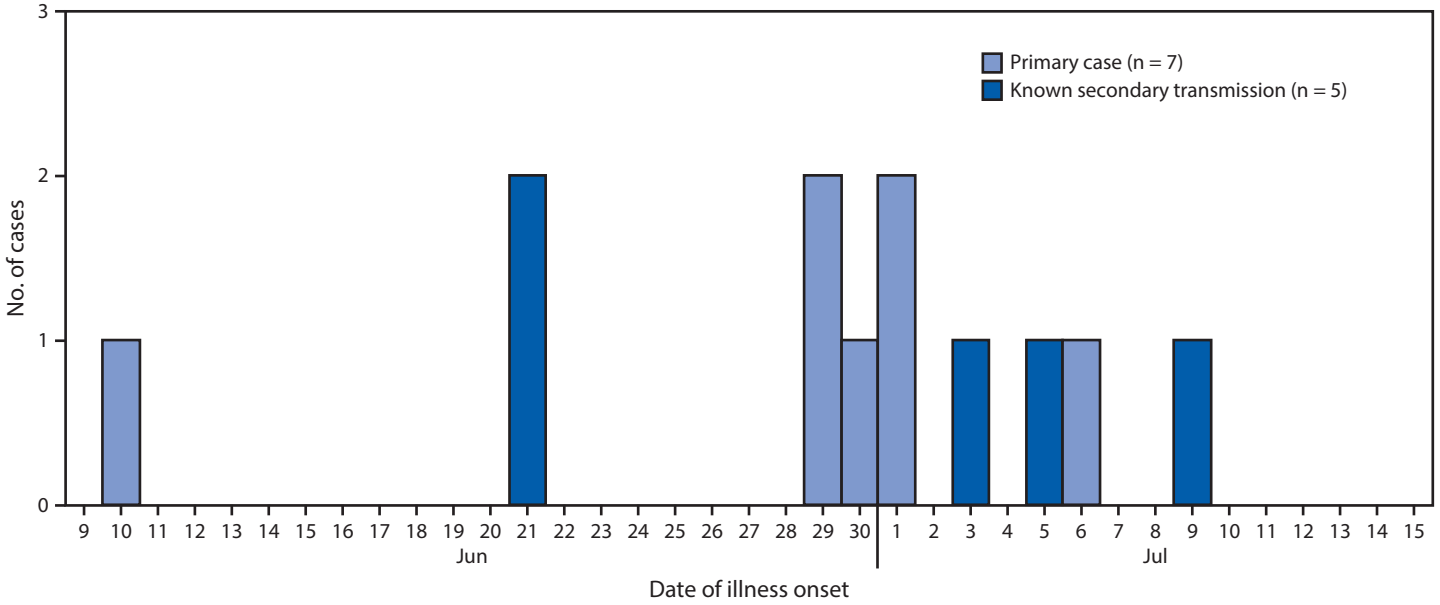
A case of STEC O157:H7 infection was defined as an illness in a resident of the Centennial Park/Colorado City/Hildale community with onset of diarrhea after June 1, 2017, with 1) culture-confirmed STEC O157:H7 with one of three novel pulsed-field gel electrophoresis (PFGE) pattern combinations or 2) physician-diagnosed postdiarrheal hemolytic uremic syndrome. Cases were classified as secondary if contact with another case occurred ≥3 days before illness onset. Local health care facilities identified potential cases via syndromic surveillance and reported them to the Southwest Utah Public Health Department and the Mohave County (Arizona) Health Department. The Southwest Utah Public Health Department created several social media posts advising community residents with diarrhea to see a doctor because local health officials were concerned that adults in this community would not seek health care for themselves.

Twelve cases were identified, including five classified as secondary, from eight separate households. Illness onset dates for the 12 patients ranged from June 10 to July 9, 2017 (Figure 1). The median age of patients was 3 years (range = 1–28 years), and 11 were aged ≤6 years. Five cases occurred in females; nine patients were hospitalized, four had hemolytic uremic syndrome, and two died.

All patients or their guardians were interviewed using a hypothesis-generating questionnaire containing questions about foods eaten, food source locations, travel, recreational water exposure, sources of drinking water, and animal contact during the week before illness onset. All 12 patients or their guardians reported shopping at grocery store A, and guardians of six of seven patients with primary cases reported purchasing ground beef. The prevalence of ground beef consumption was significantly higher than that reported in the Foodborne Diseases Active Surveillance Network Population Survey (FoodNet; https://www.cdc.gov/foodnet/index.html) (86% versus 40%; p = 0.04) (*1*); however, local health officials suspected a higher typical ground beef consumption rate in this community than in the nation overall. Thus, other potential hypotheses were explored in a focus group discussion with five guardians of four ill children. Beef and watermelon consumption, contact with domestic and companion animals, and multiple exposures to recreational water emerged as common exposures.

A 1:3 matched case-control study was designed based on information from the focus group discussion. Guardians of 16 healthy children were recruited through an online survey posted to a closed Facebook group of current and past community residents. The voluntary survey included screening questions to determine their children's eligibility for participation. Community health workers used a focused questionnaire containing questions about consumption of ground beef and fresh produce, as well as all animal contact during the exposure period to interview the guardians of six of seven patients with primary cases and guardians of 16 healthy age-matched controls. Four of six ill children and three of 16 controls reported playing in an area that had animal manure (matched odds ratio = 7.7; 95% confidence interval = 0.8–71.3) (Table).

FIGURE 1. Number of cases of Shiga toxin–producing *Escherichia coli* O157:H7 infection, by date of illness onset — Centennial Park/Colorado City/Hildale community, Arizona and Utah, June–July 2017



Contact tracing identified friendships, working relationships, or familial relationships between persons in all eight households. Illness onset dates were consistent with hypothesized person-to-person contact (Figure 2). The three patients with the earliest illness onset dates (patients A, B, and C), including the two patients who died, lived in the same multifamily household with approximately 40 persons. After the second patient died, the house was voluntarily vacated, and many persons moved within the community. Contact with animal manure was the hypothesized source of the initial illnesses, with further spread via secondary person-to-person transmission.

Laboratory Investigation

Officials from the Utah Department of Health and the Mohave County (Arizona) Health Department collected food, water, animal feed and manure, and environmental samples from various locations in the community. The Utah Public Health Laboratory and Arizona State Public Health Laboratory tested 143 samples for STEC.

A total of 35 samples from grocery store A included ground beef and environmental samples from the meat grinder, meat preparation areas, and meat storage areas. Officials also collected samples of frozen ground beef from households and samples of animal manure from cattle (23), goats (five), horses (17), dogs (11), and other animals (six) in the Centennial Park/Colorado City/Hildale community. Drinking and recreational water samples (12) were collected from surrounding farms and creeks. Stool specimens were obtained from 11 patients.

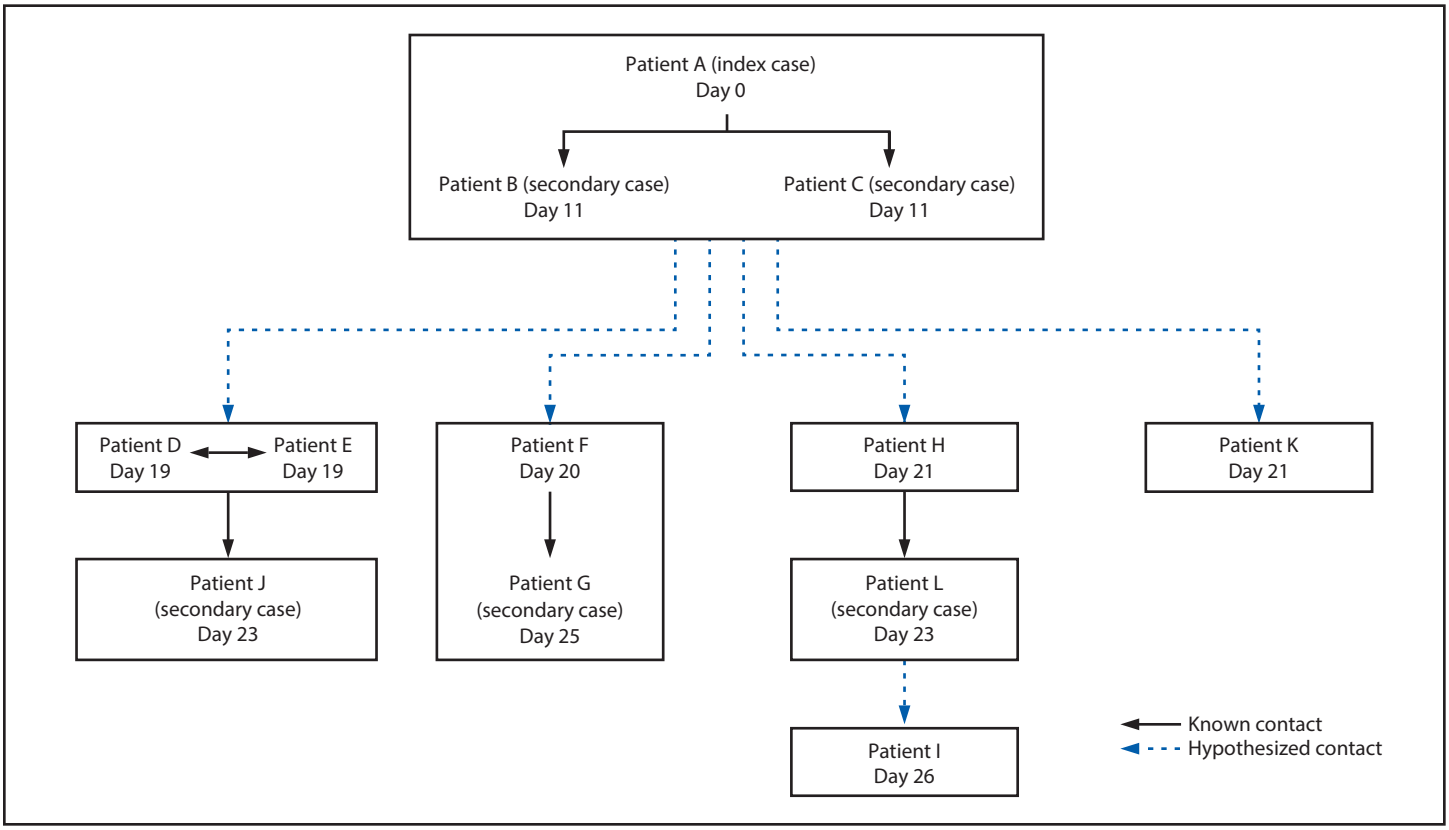
TABLE. Number of exposures to selected food, water, and animals, and matched odds ratios comparing patients with primary cases of Shiga toxin–producing *Escherichia coli* O157:H7 infection (n = 6) with healthy children (n = 16) — Centennial Park/Colorado City/Hildale community, Arizona and Utah, June–July 2017

Exposure	Case-patients no. (%)	Controls no. (%)	Matched odds ratio (95% CI)
Played in area with animal manure	4 (67)	3 (19)	7.7 (0.8–71.3)
Touched cow	2 (33)	1 (6)	5.3 (0.5–58.7)
Dogs wandered on property	4 (80)	7 (44)	4.1 (0.4–38.0)
Drank municipal water	3 (50)	3 (19)	3.1 (0.5–19.3)
Swimming	5 (83)	10 (63)	2.4 (0.3–21.3)
Consumed beef prepared at home	3 (50)	12 (75)	0.3 (0.03–2.8)
Consumed watermelon*	5 (100)	10 (63)	—

Abbreviation: CI = confidence interval.
* Only five of the six case-patients responded to the question on watermelon.

STEC was not isolated from any of the food or environmental samples from grocery store A. However, STEC was isolated from the 11 patient specimens and three animal manure samples (two horses and one bull). All isolates were further characterized by whole genome sequencing. Bioinformatic analysis (*2*) performed at the Utah Public Health Laboratory indicated the 11 clinical isolates, one bull manure isolate, and two horse manure isolates formed a single monophyletic clade with short branch lengths and high statistical support based on bootstrap statistical analysis of 1,000 replicates. This finding indicated that all the isolates were highly related genetically and shared a common molecular evolutionary history. High-quality single-nucleotide polymorphism (hqSNP) analysis performed at CDC (*3*) indicated that the 11 clinical isolates, one bull manure isolate, and two horse manure isolates differed by

FIGURE 2. Number of cases of Shiga toxin–producing *Escherichia coli* O157:57 infection, by type of case and numbered day in the outbreak — Centennial Park/Colorado City/Hildale community, Arizona and Utah, June–July 2017*



* Boxes represent households.

0–4 hqSNPs, suggesting that they were highly related genetically. STEC O157:H7 was not isolated from samples from the source farms or animal feed.

Public Health Response

This multijurisdictional investigation involved daily collaboration among national, state, and local agencies facilitated by an incident command structure. Public communication and educational materials were developed by the Southwest Utah Public Health Department and disseminated by investigation partners, including a public health nurse who was a member of the community. Educational information focused on hygiene related to livestock, safe cooking, increased vigilance for gastrointestinal symptoms, and prevention of secondary transmission. No additional STEC cases with the outbreak strain have been reported from this community since the conclusion of the investigation.

Discussion

In this outbreak, playing in an area with animal manure was associated with illness. The five ill children with the earliest illness onset dates lived in close proximity to one another and the culture-positive animal manure. STEC can be shed intermittently by colonized animals, so additional animals might have carried the outbreak strain despite the lack of isolation from manure. Unlike ruminants, horses are not considered reservoirs for STEC O157:H7 (*4*,*5*). The hypothesis is that the two horses were infected with the outbreak strain while living in proximity to the bull.

This investigation highlights the use of multiple epidemiologic methods, including hypothesis-generating questionnaires, focus group interviewing, a case-control study, and contact tracing in concert with environmental and clinical testing in identifying the source of an outbreak. These methods were used to generate and test hypotheses regarding four modes of disease transmission: person-to-person, food, drinking and recreational water, and animal contact.

This investigation also highlights the importance of communication and outreach efforts to successful, sensitive public health investigations. The inclusion of a local public health nurse in the investigation team enhanced communication and facilitated both the focus group and contact tracing efforts within a community that had been wary of government officials during previous public health interventions.

Summary

What is already known about this topic?

Ruminants can be reservoirs for Shiga toxin–producing *Escherichia coli* (STEC) O157:H7 infections; these infections often cause severe human illness.

What is added by this report?

Twelve cases of STEC O157:H7 infection associated with exposure to animal manure and secondary person-to-person transmission occurred in an Arizona-Utah border community. Bull and horse manure containing the outbreak strain were identified in a yard near that of the first seven patients; contact tracing revealed plausible person-to-person transmission among all patient households.

What are the implications for public health practice?

Hand hygiene is important to reduce the risk for STEC O157:H7 transmission. Contact with animals or animal manure should be considered in outbreak investigations when ruminants are kept near the home.

The findings in this report are subject to at least three limitations. First, this outbreak spread through secondary person-to-person transmission, limiting the number of primary cases available for assessment of exposure frequencies for hypothesis generation. Second, for all methods used to investigate hypotheses, ill children or their guardians were contacted 1–6 weeks after the illness began, which could have resulted in inaccurate recall of food and animal contact. Finally, low health care utilization among members of the adult population might have resulted in unidentified cases. These limitations might have decreased the likelihood of statistically significant epidemiologic findings despite positive identification of the outbreak strain in animal manure.

Based on the epidemiologic and environmental data, it is likely that the initial source of this outbreak was contact with animals or their environments. Certain behaviors in the patients with primary cases might have contributed to initiation of the outbreak, such as lack of awareness of the risk for disease, inadequate hand washing, and hand-to-mouth behaviors. Subsequent person-to-person transmission resulted in a large, severe outbreak that included challenges in identifying the source. Strong multijurisdictional partnerships and a combination of epidemiologic methods were necessary to identify an outbreak source. Promoting adequate sanitation and hand washing practices around animal and manure exposure is critical to prevent future outbreaks.

Conflict of Interest

No conflicts of interest were reported.

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Peer-Delivered Linkage Case Management and Same-Day ART Initiation for Men and Young Persons with HIV Infection — Eswatini, 2015–2017

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To achieve epidemic control of human immunodeficiency virus (HIV) infection, sub-Saharan African countries are striving to diagnose 90% of HIV infections, initiate and retain 90% of HIV-diagnosed persons on antiretroviral therapy (ART), and achieve viral load suppression* for 90% of ART recipients (90-90-90) (*1*). In Eswatini (formerly Swaziland), the country with the world's highest estimated HIV prevalence (27.2%), achieving 90-90-90 depends upon improving access to early ART for men and young adults with HIV infection, two groups with low ART coverage (*1–3*). Although community-based strategies test many men and young adults with HIV infection in Eswatini, fewer than one third of all persons who test positive in community settings enroll in HIV care within 6 months of diagnosis after receiving standard referral services (*4*,*5*). To evaluate the effectiveness of peer-delivered linkage case management† in improving early ART initiation for persons with HIV infection diagnosed in community settings in Eswatini, CDC analyzed data on 651 participants in CommLink, a community-based, mobile HIV-testing, point-of-diagnosis HIV care, and peer-delivered linkage case management demonstration project, and found that after diagnosis, 635 (98%) enrolled in care within a median of 5 days (interquartile range [IQR] = 2–8 days), and 541 (83%) initiated ART within a median of 6 days (IQR = 2–14 days), including 402 (74%) on the day of their first clinic visit (same-day ART). After expanding ART eligibility to all persons with HIV infection on October 1, 2016, 96% of 225 CommLink clients initiated ART, including 87% at their first clinic visit. Compared with women and adult clients aged ≥30 years, similar high proportions of men and persons aged 15–29 years enrolled in HIV care and received same-day ART. To help achieve 90-90-90 by 2020, the United States President's Emergency Plan for AIDS Relief (PEPFAR) is supporting the national scale-up of CommLink in Eswatini and recommending peer-delivered linkage case management as a potential strategy for countries to achieve >90% early enrollment in care and ART initiation after diagnosis of HIV infection (*6*).

CommLink was implemented by two outreach teams, each operating with a van in rural and urban catchment areas in the Hhohho and Manzini regions of Eswatini during June 2015–March 2017 (Figure 1). Each team included two or three HIV-test counselors, three HIV-positive, ART-adherent expert client (peer) counselors, and a nurse. HIV testing was offered to persons encountered at homesteads, worksites, bars, and high-traffic urban locations (e.g., near markets and bus stops). Clients who tested positive and had not received HIV care in the past 90 days were offered point-of-diagnosis HIV care and linkage case management. In modified vans (mobile units) parked at test locations, CommLink nurses provided physical and psychosocial assessment, clinical staging, CD4 count, syndromic treatment for sexually transmitted infections, and a 7-day course of cotrimoxazole (Figure 2). Medical files completed by CommLink nurses were transferred within 48 hours to clinics, health centers, and other referral facilities where clients could receive ART (Figure 1).

Peer counselors provided linkage case management for consenting clients from the time of diagnosis through at least the first return visit for facility-based care after ART initiation. For ART-eligible clients who did not initiate ART or return for their first refill of antiretroviral medication, linkage case management services continued for up to 90 days. Linkage case management comprises the package of services recommended by CDC§ and the World Health Organization (WHO), including 1) peer-delivered counseling and psychosocial support; 2) treatment navigation at referral facilities (escorting to or meeting clients at the referral facility at least once, providing psychosocial support [for the duration of the first clinic visit], and explaining the content, sequence, and locations of HIV clinical, laboratory, and pharmaceutical services); 3) weekly telephone calls and appointment reminders; and 4) two follow-up face-to-face counseling sessions on disclosing HIV status to and HIV testing of partners and family members and on identifying and resolving real and perceived barriers to HIV care (*1*,*7*).

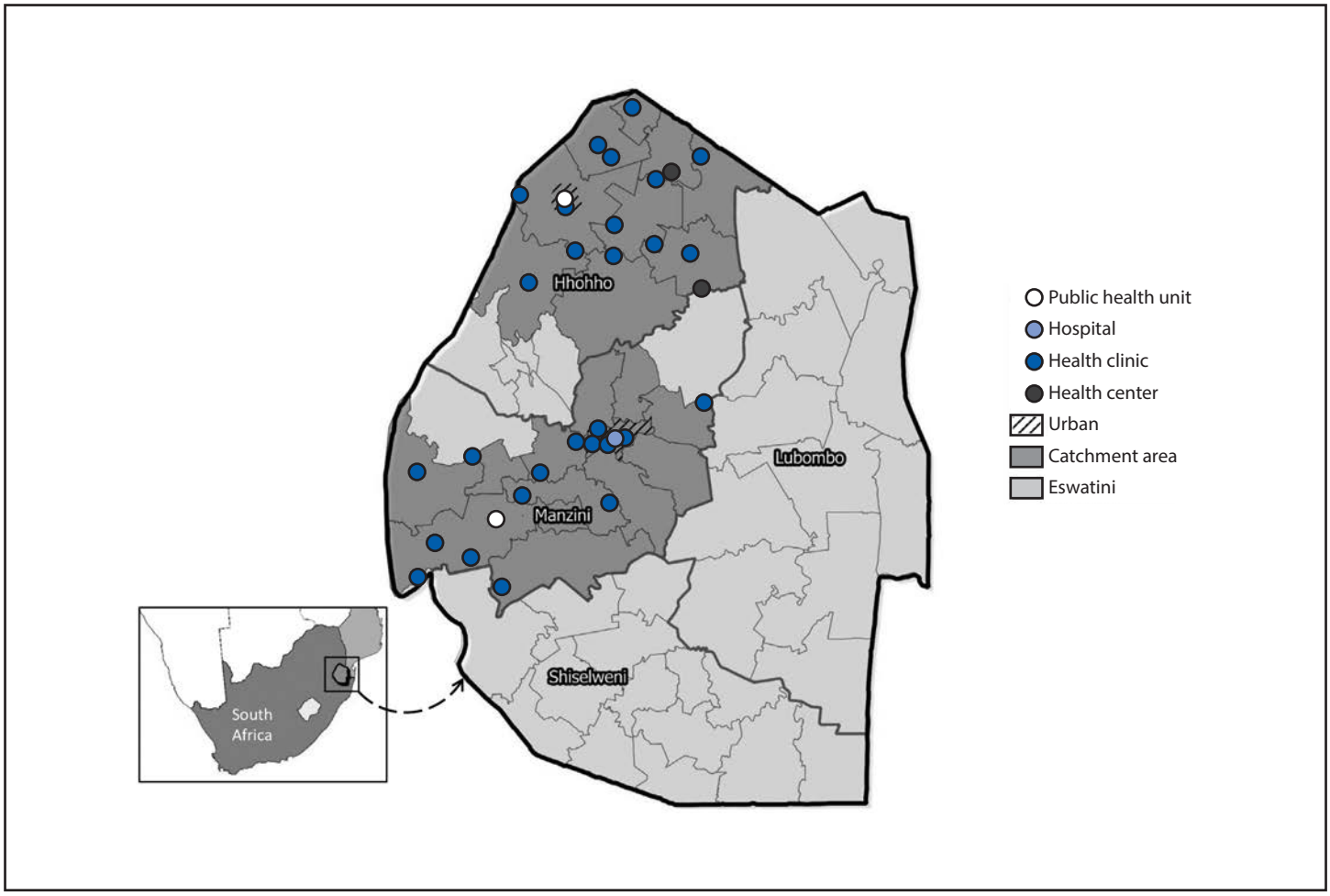
National guidelines for ART eligibility based on CD4 count were expanded twice during the project, resulting in

* HIV RNA concentration below the threshold needed for detection on a viral load assay.

† Linkage case management is a time-limited, multicomponent, client-centered intervention focused on linking persons with HIV infection to medical care and antiretroviral therapy.

§ Cosponsors include the Health Resources and Services Administration, National Institutes of Health, and International Association of Providers of AIDS Care.

FIGURE 1. CommLink* catchment areas and referral HIV-care facilities — Eswatini,† June 2015–March 2017



Abbreviation: HIV = human immunodeficiency virus.
* CommLink is a community-based, mobile HIV-testing, point-of-diagnosis HIV care, and peer-delivered linkage case management demonstration project.
† Formerly Swaziland.

the following three ART-eligibility periods: 1) June 2015–November 2015 (CD4 count <350/μL); 2) December 2015–September 2016 (CD4 count <500/μL); and 3) October 2016–March 2017 (any CD4 count, Test and Start[¶]). At referral facilities, same-day ART patients received a 14-day supply of antiretroviral medications and were instructed to return in 2 weeks to receive their baseline laboratory test results and their first 30-day antiretroviral refill. Information on receipt of facility-based clinical services, including ART, and associated dates of service were abstracted from patient health care cards.

Among 909 persons who tested HIV-positive during CommLink outreach events, 21 (2%) left the event before eligibility screening, and 163 (18%) were either currently in HIV care (90), requested a referral to a facility outside of the catchment area (33), or were ineligible for linkage case management for other reasons, such as residence in another region or country (40). Among 725 eligible persons, 19 (2.6%) were aged <15 years and were excluded from analyses. Of 706 eligible persons aged ≥15 years, 651 (92%) participated in linkage case management and received services for a median of 42 days (IQR = 24–66 days).

Excluding weekly telephone contacts, >90% of clients in all demographic and diagnostic subgroups, including men, persons aged 15–29 years, participants from urban outreach events, and participants who had counselors of a different gender, received linkage case management services (Table). Although proportionally fewer male than female counselors documented weekly telephone contacts with their clients, male counselors contacted 236 (99.6%) of their 237 clients by phone at least three times.

From the date of diagnosis, 635 (98%) clients received HIV care at least once at a referral facility within a median of 5 days (IQR = 2–8 days), and 541 (83%) initiated ART within a

[¶] Provision of ART for all persons living with HIV. http://www.who.int/hiv/pub/arv/arv-2016/en/.

FIGURE 2. CommLink* outreach testing with point-of-diagnosis HIV-care services — Eswatini,† June 2015–March 2017

Abbreviation: HIV = human immunodeficiency virus.
* CommLink is a community-based, mobile HIV-testing, point-of-diagnosis HIV care, and peer-delivered linkage case management demonstration project.
† Formerly Swaziland.

median of 6 days (IQR = 2–14 days), including 402 (74%) on the day of their first clinic visit (Table). As ART eligibility increased from a required CD4 count <350/μL to Test and Start, the percentage of all clients initiated on ART increased from 66% to 96%, the percentage of clients initiated on ART who received same day ART increased from 62% to 87%, and, among 361 clients with newly diagnosed HIV infection, the median CD4 count at ART initiation increased from 313/μL (IQR = 203/μL–422/μL) to 454/μL (IQR = 264/μL–598/μL). Among 402 clients who initiated ART on the day of their first clinic visit, 379 (94%) returned to the facility at least once after ART initiation within a median of 14 days (IQR = 14–15 days).

Nearly all clients enrolled in facility-based HIV care, including men (97%), persons aged 15–29 years (97%), participants from urban (97%) and rural (98%) outreach events, and participants with counselors of the same or different gender (95%–99%). Compared with women and adult clients aged ≥30 years, similar high proportions of men and clients aged 15–29 years received same-day ART and returned to care after same-day ART initiation (Table).

Discussion

Among 651 persons with HIV infection participating in CommLink, a PEPFAR-funded, community-based, mobile HIV-testing, point-of-diagnosis HIV care, and peer-delivered linkage case management demonstration project in Eswatini, nearly all received recommended linkage services, and most enrolled in facility-based HIV care and initiated ART within a few days of the start of these services. During Test and Start, nearly all (96%) CommLink clients initiated ART, most (87%) on the day of their first clinic visit. CommLink findings of near universal early enrollment in HIV care and ART initiation stand in contrast to other studies in Eswatini and elsewhere in sub-Saharan Africa suggesting that only 26%–37% of persons provided standard referral services after HIV diagnosis in community settings enroll early in HIV care, and that many, particularly young adults, delay their enrollment in HIV care for years (*4*,*5*,*8*,*9*).

Early ART initiation after diagnosis is essential to prevent HIV-associated morbidity and mortality and HIV transmission to sexual partners and offspring (*10*). As ART guidelines

TABLE. Use of CommLink* services and enrollment in HIV care and same-day ART initiation outcomes, by client and project characteristics — Eswatini,† June 2015–March 2017§

Characteristic	CommLink clients no. (%)	Mobile HIV care¶ no. (%)	Treatment navigation** no. (%)	Weekly telephone contact†† no. (%)	Counseling sessions§§ no. (%)	Enrolled in HIV care¶¶ no. (%)	Initiated on ART*** no. (%)	Same-day ART††† no. (%)	Same-day ART returned§§§ no. (%)
Total	**651 (100)**	**629 (97)**	**621 (95)**	**553 (85)**	**608 (93)**	**635 (98)**	**541 (83)**	**402 (74)**	**379 (94)**
Sex									
Male	411 (63)	397 (97)	393 (96)	351 (85)	383 (93)	399 (97)	346 (84)	251 (73)	234 (93)
Female	240 (37)	232 (97)	228 (95)	202 (84)	225 (94)	236 (98)	195 (81)	151 (77)	145 (96)
Age group (yrs)									
15–24	91 (14)	86 (95)	84 (92)	74 (81)	84 (92)	89 (98)	72 (79)	50 (69)	48 (96)
25–29	149 (23)	142 (95)	143 (96)	125 (84)	140 (94)	143 (96)	118 (79)	89 (75)	84 (94)
30–34	144 (22)	141 (98)	135 (94)	125 (87)	135 (94)	139 (97)	118 (82)	91 (77)	88 (97)
35–44	169 (26)	166 (98)	163 (96)	144 (85)	160 (95)	167 (99)	145 (86)	110 (76)	100 (91)
≥45	98 (15)	94 (96)	96 (98)	85 (87)	89 (91)	97 (99)	88 (90)	62 (70)	59 (95)
HIV diagnostic status									
New	443 (68)	426 (96)	420 (95)	365 (82)	414 (93)	429 (97)	361 (81)	261 (72)	246 (94)
Prior, out-of-care¶¶¶	208 (32)	203 (98)	201 (97)	188 (90)	194 (93)	206 (99)	180 (87)	141 (78)	133 (94)
ART-eligibility period**									
Jun 2015–Nov 2015 (CD4 <350/μL)	137 (21)	123 (90)	119 (87)	102 (74)	115 (84)	127 (93)	90 (66)	56 (62)	53 (95)
Dec 2015–Sep 2016 (CD4 ≤500/μL)	289 (44)	285 (99)	281 (97)	248 (86)	273 (94)	285 (99)	234 (81)	158 (68)	148 (94)
Oct 2016–Mar 2017 (Test and Start)	225 (35)	221 (98)	221 (98)	203 (90)	220 (98)	223 (99)	217 (96)	188 (87)	178 (95)
Outreach setting									
Urban	346 (53)	340 (98)	329 (95)	289 (84)	323 (93)	337 (97)	275 (79)	186 (68)	176 (95)
Rural	305 (47)	289 (95)	292 (96)	264 (87)	285 (93)	298 (98)	266 (87)	216 (81)	203 (94)
Counselor-client dyads									
Female-male	261 (40)	250 (96)	255 (98)	235 (90)	244 (93)	256 (98)	219 (84)	159 (73)	149 (94)
Female-female	153 (24)	146 (95)	145 (95)	139 (91)	145 (95)	150 (98)	121 (79)	89 (74)	85 (96)
Male-female	87 (13)	86 (99)	83 (95)	63 (72)	80 (92)	86 (99)	74 (85)	62 (84)	60 (97)
Male-male	150 (23)	147 (98)	138 (92)	116 (77)	139 (93)	143 (95)	127 (85)	92 (72)	85 (92)

Abbreviations: ART = antiretroviral therapy; HIV = human immunodeficiency virus; IQR = interquartile range; LCM = linkage case management.

* CommLink is a community-based, mobile HIV-testing, point-of-diagnosis HIV care, and peer-delivered LCM demonstration project.

† Formerly Swaziland.

§ Duration of CommLink services: median interval = 42 days, IQR = 24–66 days.

¶ Includes clinical assessment, CD4+ T-cell count/μL (CD4 count) testing, syndromic treatment for sexually transmitted infections, and cotrimoxazole preventive therapy provided by CommLink nurses at HIV diagnosis.

** Client accompanied by CommLink peer counselor for the duration of at least the first HIV-care facility visit and received psychosocial support and informational counseling on the content and location of HIV clinical, laboratory, and pharmaceutical services.

†† Client spoke with peer counselor, on average, at least once per week for the duration of CommLink services.

§§ Client received initial and at least two follow-up face-to-face counseling sessions focused on the importance of early enrollment in HIV care and ART, disclosure to and HIV testing of partners and family members, and identifying and resolving real and perceived barriers to enrollment or retention in HIV care.

¶¶ Documentation on patient's health care card of receipt of HIV care services at least once at a standing fixed facility (clinic, health center, or hospital). Median interval from HIV diagnosis to enrollment in HIV care = 5 days (IQR = 2–8).

*** ART initiation among patients who met national eligibility guidelines is not provided because of observed variation in ART initiation practices across facilities attributed to 1) a Test and Start study conducted at multiple northern facilities and 2) facility-specific interpretation of expanding national treatment guidelines. Percentages are of all CommLink clients. Median interval from HIV diagnosis to ART initiation = 6 days (IQR = 2–14).

††† Initiated during the first facility visit. Typical practice is to provide a 14-day starter pack of antiretroviral medication. Percentages are of patients initiated on ART.

§§§ Returned for HIV care at the facility at least once after same-day ART initiation; median interval from ART initiation to return visit = 14 days (IQR = 14–15). The return visit was typically to receive baseline test results and the first 30-day antiretroviral medication refill. Percentages are of patients initiated on ART.

¶¶¶ Client reported a prior HIV diagnosis but not having received HIV care in >90 days.

**** Changes in national ART polices based on CD4 count; Test and Start = ART for all HIV-infected persons regardless of CD4 count.

were expanded in Eswatini, both the percentage of CommLink clients initiated on ART and the median CD4 count at ART initiation increased, suggesting programs that integrate community-based HIV testing with recommended linkage and same-day Test and Start services can help reduce late ART initiation and prevalence of advanced HIV disease (*10*).

As recommended by CDC and WHO, CommLink peer-delivered linkage case management services are initiated for all consenting clients at the point of diagnosis (*1*,*7*). Reactive linkage programs (those that require either referral forms or documentation of missed appointments to initiate follow-up) might miss important opportunities to provide timely and effective linkage services (*5*,*9*). As a proactive program, CommLink peer counselors initiate services at the time of diagnosis to build rapport, assess and understand individual circumstances, and use their personal experiences living with

Summary

What is already known about this topic?

Few (26%–37%) persons with human immunodeficiency virus (HIV) infection diagnosed in community settings in sub-Saharan Africa enroll early in care and initiate antiretroviral therapy (ART) when provided standard referral services, particularly men and young adults.

What is added by this report?

Among 651 persons diagnosed with HIV infection in community settings in Eswatini, 98% enrolled in care, and 83% initiated ART within a few days of receiving peer-delivered linkage case management services recommended by CDC and the World Health Organization. After expansion of ART eligibility for all persons with HIV infection, 96% initiated ART.

What are the implications for public health practice?

Providing recommended peer-delivered linkage case management services should be considered as a potential strategy for countries to help achieve >90% early enrollment in care and ART initiation after HIV diagnosis.

HIV infection to help clients cope with their diagnosis, correct misperceptions about HIV and ART, assess and mitigate barriers to HIV care, and ensure that all participants understand how to navigate HIV care. These services might be particularly helpful to groups at high risk for delayed enrollment in HIV care, such as men and young adults.

The findings in this report are subject to at least three limitations. First, clinical outcomes on patient health care cards are subject to documentation and data-abstraction errors. Senior investigator audits of 165 (26%) medical charts of clients enrolled at 12 facilities, however, found that all abstracted enrollment, ART-initiation, and return-visit data were complete and accurate. Second, because cases were closed within 90 days, retention in HIV care among CommLink clients is unknown. However, nearly all same-day ART patients returned to care at least once, suggesting that retention outcomes might be similar to other ART patient cohorts (*1*,*8*). Finally, although CommLink enrollment-in-care findings far exceed those of historical community-based cohorts in Eswatini and elsewhere in sub-Saharan Africa, some of the differences might also be attributed to improvements in decentralized services, Test and Start policies, and HIV care–seeking societal norms (*1*,*8*). However, even when all persons who receive a diagnosis of HIV infection in community settings in sub-Saharan Africa are informed they will receive ART, few (37%) enroll early in care and initiate ART when provided standard referral services alone (*9*).

As a demonstration project providing the package of linkage services that are recommended by CDC and WHO, CommLink achieved near universal early enrollment in HIV care and ART initiation among all participants during Test and Start, including men and young adults, two groups with historically low ART coverage. To help achieve 90-90-90 by 2020, PEPFAR is supporting the national scale-up of CommLink in Eswatini and recommending peer-delivered linkage case management as a potential strategy for countries to achieve >90% early enrollment in care and ART initiation after HIV diagnosis (*6*).

Conflict of Interest

No conflicts of interest were reported.

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Notes from the Field

Carbapenemase-Producing Carbapenem-Resistant Enterobacteriaceae from Less Common Enterobacteriaceae Genera — United States, 2014–2017

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Infections with carbapenemase-producing carbapenem-resistant Enterobacteriaceae (CP-CRE) are associated with high mortality rates (*1*). Carbapenemases encoded on plasmids can move between bacterial strains and have the potential to rapidly increase the proportion of Enterobacteriaceae resistant to carbapenems; as such, CP-CRE have been a particular focus of public health response. Although the Enterobacteriaceae family includes approximately 50 recognized genera, surveillance for CP-CRE has focused on the organisms most associated with clinical infections: *Klebsiella* spp., *Enterobacter* spp., and *Escherichia coli* (*2*,*3*). CRE from other, less commonly encountered genera (hereafter referred to as less common genera) have generally not been targeted for carbapenemase testing, in part, because some of these organisms possess intrinsic resistance to the carbapenem imipenem and others express species-specific chromosomal carbapenemases. However, these organisms can also harbor plasmid-mediated carbapenemases. This report describes CP-CRE from less common genera identified through reference testing at CDC and surveillance at the Minnesota Department of Health (MDH) Public Health Laboratory.

CDC's Clinical and Environmental Microbiology Branch performs molecular testing on submitted CRE to detect *Klebsiella pneumoniae* carbapenemase (KPC), New Delhi metallo-β-lactamase (NDM), Verona integron-mediated metallo-β-lactamase (VIM), active-on-imipenem (IMP), and OXA-48-type carbapenemases. During January 1, 2014–May 25, 2017, CDC identified 1,039 CP-CRE, including 63 (6.1%) from the less common genera. Isolates from the less common genera were submitted by 23 states; Iowa (10; 16%) and Pennsylvania (seven; 11%) contributed the most. KPC-producing *Citrobacter* spp. (27; 42.9%) was the most common organism-mechanism combination identified (Table).

CRE producing a carbapenemase other than KPC are historically uncommon in the United States and often associated with health care exposures outside the United States. Epidemiologic data were available for 20 of 28 patients with non–KPC–CP-CRE from less common genera passively reported to CDC during this period. The median patient age was 62.5 years (range = 2 months to 79 years). Travel history in the year preceding the positive culture was reported for 18 patients; 10 did not travel outside the United States, including five from a single cluster. Six patients were hospitalized outside the United States: three in India, and one each in the Philippines, Romania, and Spain.

The Minnesota Department of Health initiated surveillance for all CRE species in Hennepin and Ramsey counties in 2012 and expanded surveillance statewide on January 1, 2016. Isolates submitted to the MDH Public Health Laboratory are tested for carbapenemases. During January 1, 2014–September 30, 2017, 149 (12%) of 1,241 CRE submitted were carbapenemase-producing; the percentage did not differ between isolates from the more common (*Klebsiella spp.*, *Enterobacter spp.*, and *E. coli*) and the less common genera. Among the 149 CP-CRE isolates, all were from unique patients, and 20 (13.4%) were from less common genera. The most common organism and mechanism combinations among the less common genera were IMP-producing *Providencia rettgeri* (seven; 35%) and KPC-producing *Citrobacter freundii* (six; 30%) (Table).

Epidemiologic data were available for the 20 Minnesota patients with CP-CRE from the less common genera; no clusters were identified. The median patient age was 56.5 years (range = 14–75 years), and 15 (75%) patients were hospitalized at the time of culture collection. Two patients were hospitalized internationally (one each in Kenya and Kuwait) in the year before their positive culture.

Less common Enterobacteriaceae genera appear to be a small but potentially important subset of CP-CRE; however, estimates of the true proportion of CP-CRE from these less common genera are limited by the lack of systematic testing. Of note, many of the carbapenemases in the less common CRE genera were not KPC. These were frequently identified in patients who did not report travel outside the United States in the year preceding their positive culture, indicating domestic acquisition. Clinicians should be aware that CRE from the less common genera can harbor carbapenemases and consider requesting carbapenemase testing from state public health laboratories to guide infection control practices and prevent further spread of these resistance mechanisms. CRE surveillance that includes a broader range of Enterobacteriaceae genera is being piloted in 10 states and will be critical for better understanding the potential impact of these less common genera on the spread of carbapenemases.

TABLE. Carbapenemase-producing carbapenem-resistant Enterobacteriaceae by species and mechanism, among organisms other than *Klebsiella spp.*, *Enterobacter spp.*, and *E. coli* tested at CDC, January 1, 2014–May 25, 2017, and the Minnesota Department of Health (MDH) Public Health Laboratory, January 1, 2014–September 10, 2017*

	Mechanism					
Laboratory (period)/Organism	**KPC**	**IMP**	**NDM**	**OXA-48 type**	**VIM**	**Total**
CDC (January 1, 2014–May 25, 2017)†						
***Citrobacter*§**	27	0	1	0	1	**29**
Citrobacter freundii	22	0	1	0	1	**24**
Citrobacter koseri	2	0	0	0	0	**2**
Citrobacter braakii	1	0	0	0	0	**1**
Citrobacter farmeri	1	0	0	0	0	**1**
***Morganella*§**	0	1	2	0	0	**3**
Morganella morganii	0	1	1	0	0	**2**
Proteus mirabilis	6	2	2	0	1	**11**
***Providencia*§**	1	8	1	0	0	**10**
Providencia rettgeri	0	6	0	0	0	**6**
Providencia stuartii	1	1	1	0	0	**3**
***Raoultella*§**	4	0	0	0	1	**5**
Raoultella ornithinolytica	1	0	0	0	0	**1**
Serratia	4	0	0	0	1	5
Serratia marcescens	3	0	0	0	1	**4**
Serratia ureilytica	1	0	0	0	0	**1**
Total, CDC	**42**	**11**	**6**	**0**	**4**	**63**
MDH Public Health Laboratory (January 1, 2014–September 10, 2017)						
Citrobacter freundii	6	0	1	0	0	**7**
Providencia rettgeri	0	7	1	0	0	**8**
Serratia marcescens	1	0	0	0	1	**2**
Raoultella planticola	1	0	0	0	0	**1**
Raoultella ornithinolytica	0	0	0	1	0	**1**
Leclercia adecarboxylata	1	0	0	0	0	**1**
Total, MDH Public Health Laboratory	**9**	**7**	**2**	**1**	**1**	**20**

Abbreviations: CP-CRE = carbapenemase-producing carbapenem-resistant Enterobacteriaceae; IMP = active-on-imipenem; KPC = *Klebsiella pneumoniae* carbapenemase; NDM = New Delhi metallo-β-lactamase; VIM = Verona integron-mediated metallo-β-lactamase.

* Two IMP-producing *Providencia rettgeri* and one VIM-producing *Serratia marcescens* from Minnesota are included in both the CDC and MDH Public Health Laboratory sections of the table.

† Limited to isolates submitted to CDC for confirmatory testing; not all passively reported CP-CRE patients had isolates submitted.

§ One KPC-producing *Citrobacter*, one NDM-producing *Morganella*, one IMP-producing *Providencia*, three KPC-producing *Raoultella,* and one VIM-producing *Raoultella* were not identified to species level.

Conflict of Interest

A patent is pending for the real-time polymerase chain reaction test for the detection of IMP genes; however, none of the authors is a submitter of the patent. No other conflicts of interest were reported.

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Notes from the Field

Contact Investigation for an Infant with Congenital Tuberculosis Infection — North Carolina, 2016

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In November 2016, hospital A notified the North Carolina Division of Public Health (NCDPH) that annual tuberculosis screening of neonatal intensive care unit (NICU) staff members identified six health care staff members with newly positive tuberculin skin tests (TSTs). All six staff members had cared for an infant in whom a diagnosis of congenital tuberculosis was made after death. NCDPH worked with county health departments and hospital A to conduct a contact investigation.

The infant was born at hospital A in July 2016 at 25 weeks' gestational age to a mother originally from a country with high tuberculosis prevalence. After delivery, the mother developed respiratory distress that required intubation; a bronchoalveolar lavage (BAL) specimen was negative for acid-fast bacilli. The infant was admitted to the NICU with fever and respiratory failure, supported by high-frequency oscillatory ventilation, and died after 17 days. One month after delivery, *Mycobacterium tuberculosis* was isolated from a culture of the mother's BAL specimen. A contact investigation around the mother at the time of diagnosis identified no positive TST test results among health care staff members. Microscopic examination of the stored placenta revealed acid-fast bacilli. During investigation, medical records obtained from fertility treatment 2 years earlier at a hospital in another state indicated that the mother had granulomatous salpingitis on histopathology, consistent with genitourinary tuberculosis; delivery and NICU staff members were unaware of the mother's medical history. No contact investigation had been performed around the infant before this investigation.

A contact was defined as a person who treated or spent time in the open NICU with the index infant. Health care staff members and volunteers identified as contacts were screened with TSTs; tests with induration ≥5 mm was considered a positive result. Persons with a history of positive TST results were screened for tuberculosis symptoms by clinical examination. For NICU patients identified as contacts, NCDPH recommended a TST and interferon-gamma release assay (IGRA), clinical evaluation including a chest radiograph, preemptive treatment with 9 months of isoniazid, and clinical monitoring until age 2 years. Preemptive treatment was recommended because of concerns about false negative results among infants, who are at increased risk for developing active tuberculosis (*1*–*4*). NICU visitors identified as contacts were evaluated with IGRAs.

In total, 132 of 135 (98%) health care staff members were evaluated; seven (5%), including the original six NICU staff members identified through annual tuberculosis screening, had a newly positive TST result (induration range = 10–20 mm), and all had performed at least one aerosol-generating procedure (e.g., intubation or open suctioning) on the index infant. None of the staff members with positive TSTs had been exposed to the mother or reported other known exposures. All 29 NICU volunteers were notified of their exposure; 15 (52%) were screened for tuberculosis infection at hospital A, and all were negative.

Among 23 NICU visitors tested, one (4%) had a positive IGRA. This visitor reported no other risk factors for tuberculosis infection and had spent multiple hours per day during 11 days sitting with an infant adjacent to the index infant. All adults who tested positive for tuberculosis infection received latent tuberculosis treatment through local health departments.

Twenty-six infants were present in the NICU during the index infant's hospitalization. Families of 25 infants (96%) were notified; one family could not be located. Clinical assessment was performed on 22 (85%) infants, including 16 who received a TST and IGRA, three who received only IGRA, and three who received only TST. None had a positive screening test or evidence of active disease. Eighteen (82%) of the 22 infants began preemptive latent tuberculosis treatment, and four (18%) entered clinical monitoring without treatment.

Annual TST screening of health care staff members prompted an investigation that revealed likely transmission of tuberculosis from an infant with congenital infection to seven NICU staff members and one visitor. Factors that might have contributed to this transmission event include congenital infection, which is associated with high bacterial load, multiple aerosol-generating procedures, and respiratory support using a high-frequency oscillatory ventilator with unfiltered exhaust (*5*).

Congenital tuberculosis is rare (*1*,*6*); however, transmission from infants with congenital infection to health care workers has been documented (*1*,*5*,*7*). Transmission to visitors or other patients has not previously been documented except by exposure to contaminated medical devices (*1*,*2*,*5*). Patients and visitors were considered contacts here because of evidence of transmission to multiple health care staff members and aerosol-generating procedures performed in the NICU.

Tuberculosis has been associated with infertility, particularly in high-prevalence countries. Early detection and treatment

of latent and active tuberculosis infections among pregnant women and those seeking to become pregnant can prevent transmission to their infants. Medical providers should also consider a thorough evaluation for tuberculosis among infants born to mothers who have epidemiologic risk factors for tuberculosis and a compatible clinical presentation. Even if tuberculosis is not suspected, routine use of control measures (e.g., closed suctioning and filtering air exhaust ports from ventilators) might be considered to reduce the potential for exposure. Finally, when exposure cannot be prevented, adherence to contact investigation guidelines is important (*8*) to rapidly identify and evaluate contacts, including visitors who shared airspace with an infant with congenital tuberculosis infection during a prolonged period or during aerosol-generating procedures.

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Conflict of Interest

No conflicts of interest were reported.

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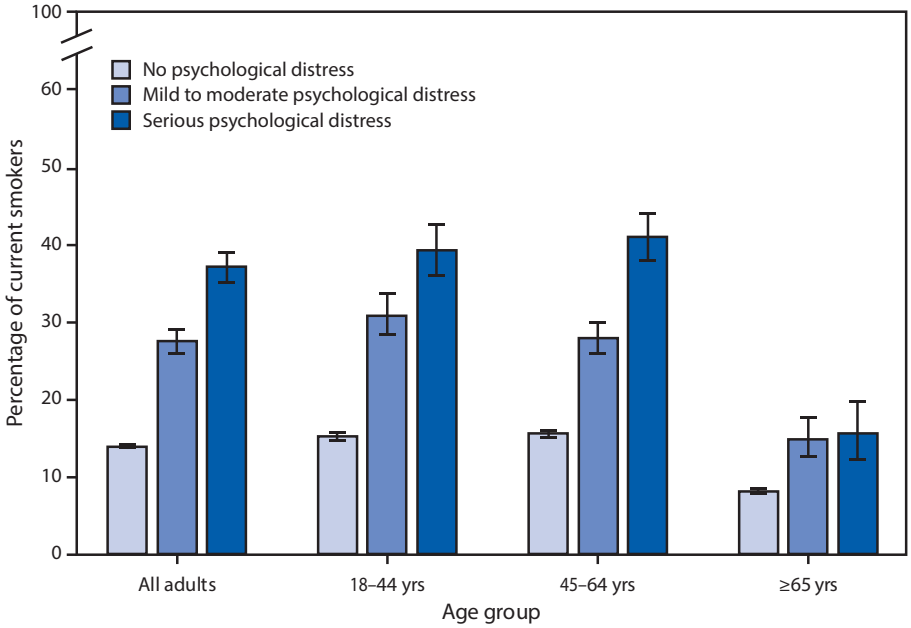
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults Aged ≥18 Years With or Without Psychological Distress† Who Were Current Smokers,§ by Age Group and Level of Distress — National Health Interview Survey,¶ 2014–2016



* With 95% confidence intervals indicated with error bars.
† Level of psychological distress is based on responses to the questions, "During the past 30 days, how often did you feel: 1) so sad that nothing could cheer you up, 2) nervous, 3) restless or fidgety, 4) hopeless, 5) that everything was an effort, or 6) worthless?" Response categories were: all (4), most (3), some (2), a little (1) and none (0) of the time. Response codes 0–4 for the six items were combined to yield a point value on a 0–24 point scale. A value of 13 or more was used to define serious psychological distress. A value of 8–12 was used to define mild to moderate psychological distress.
§ Adults were asked if they had smoked at least 100 cigarettes in their lifetime and, if yes, whether they currently smoked cigarettes every day, some days, or not at all. Those who smoked every day or some days were classified as current cigarette smokers.
¶ Estimates are based on household interviews of a sample of the noninstitutionalized U.S. civilian population aged ≥18 years and are derived from the National Health Interview Survey Sample Adult component.

During 2014–2016, 37.2% of adults aged ≥18 years with serious psychological distress were current smokers, followed by 27.6% of those with mild to moderate psychological distress and 14.0% of those with no psychological distress. Among adults aged 18–44 and 45–64 years, the percentage of adults who were current smokers increased with the level of psychological distress. Among adults aged ≥65 years, the percentage who were current smokers was less among adults with no psychological distress than among adults with mild to moderate or serious psychological distress.

Source: National Health Interview Survey, 2014–2016. https://www.cdc.gov/nchs/nhis/index.htm.

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