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Estimated County-Level Prevalence of Selected Underlying Medical Conditions Associated with Increased Risk for Severe COVID-19 Illness — United States, 2018

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Risk for severe coronavirus disease 2019 (COVID-19)–associated illness (illness requiring hospitalization, intensive care unit [ICU] admission, mechanical ventilation, or resulting in death) increases with increasing age as well as presence of underlying medical conditions that have shown strong and consistent evidence, including chronic obstructive pulmonary disease, cardiovascular disease, diabetes, chronic kidney disease, and obesity (*1–4*). Identifying and describing the prevalence of these conditions at the local level can help guide decision-making and efforts to prevent or control severe COVID-19–associated illness. Below state-level estimates, there is a lack of standardized publicly available data on underlying medical conditions that increase the risk for severe COVID-19–associated illness. A small area estimation approach was used to estimate county-level prevalence of selected conditions associated with severe COVID-19 disease among U.S. adults aged ≥18 years (*5,6*) using self-reported data from the 2018 Behavioral Risk Factor Surveillance System (BRFSS) and U.S. Census population data. The median prevalence of any underlying medical condition in residents among 3,142 counties in all 50 states and the District of Columbia (DC) was 47.2% (range = 22.0%–66.2%); counties with the highest prevalence were concentrated in the Southeast and Appalachian region. Whereas the estimated number of persons with any underlying medical condition was higher in population-dense metropolitan areas, overall prevalence was higher in rural nonmetropolitan areas. These data can provide important local-level information about the estimated number and proportion of persons with certain underlying medical conditions to help guide decisions regarding additional resource investment, and mitigation and prevention measures to slow the spread of COVID-19.

BRFSS is an annual, random-digit–dialed landline and mobile telephone survey of noninstitutionalized U.S. adults aged ≥18 years in all 50 states, DC, and U.S. territories. BRFSS collects self-reported information on selected health behaviors and conditions. Overall, 437,500 persons participated in the 2018 BRFSS survey, with a median weighted response rate of 49.9%.*

* https://www.cdc.gov/brfss/index.html.

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The underlying medical conditions included in these prevalence estimates were selected using the subset of the list of conditions with the strongest and most consistent evidence[†] of association with higher risk for severe COVID-19–associated illness on CDC's website as of June 25, 2020 (*2*) and for which questions on the BRFSS aligned. These included chronic obstructive pulmonary disease (COPD), heart conditions, diabetes mellitus, chronic kidney disease (CKD), and obesity (defined as body mass index [BMI] of ≥30 kg per m^2). Conditions from the list of those with mixed and limited evidence[§] of association with increased risk for severe COVID-19 illness were not included (*2*). An analysis of U.S. COVID-19 patient surveillance data found that hospitalizations were six times higher, ICU admissions five times higher, and deaths 12 times higher among patients with underlying medical conditions, compared with those without (*4*); however, that analysis included a narrower definition of obesity (BMI ≥40 kg per m^2), and some, but not all conditions in both the strongest and most consistent evidence and mixed and limited evidence lists.

BRFSS respondents were classified as having an underlying medical condition if they answered "yes" to any of the following questions: "Have you ever been told by a doctor, nurse, or other health professional that you have COPD, emphysema, or chronic bronchitis; heart disease (angina or coronary heart disease, heart attack, or myocardial infarction); diabetes; or chronic kidney disease?" Respondent-reported height and weight were used to calculate BMI; respondents with BMI ≥30 kg per m^2 were considered to have obesity. A created variable captured persons having any of these conditions.

Nationwide estimates of underlying medical conditions were weighted to adjust for survey design. For county-level prevalence, estimates of each and of any condition were generated using a multilevel regression and poststratification approach (*5*) for 3,142 counties in all 50 states and DC. This approach has been validated in comparison with direct BRFSS survey estimates and local surveys for multiple chronic disease measures at state and county levels (*5*,*6*). Briefly, a multilevel regression model was constructed for each outcome using individual-level age,[¶] gender, race/ethnicity,[**] and educational-level[††] data

[†] Conditions with consistent evidence of increased risk for severe COVID-19–associated illness from multiple small studies or a strong association from a large study.

[§] Conditions for which multiple studies have reached different conclusions about risk associated with that condition. Those with limited evidence are those for which consistent evidence has been reported from a small number of studies. https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/evidence-table.html.

[¶] Age was categorized into 13 age groups at 5-year intervals for ages ≥18 years.

[**] Race/ethnicity was categorized as non-Hispanic white, non-Hispanic African American, non-Hispanic American Indian or Alaska Native, non-Hispanic Asian, non-Hispanic Native Hawaiian/other Pacific Islander, other single non-Hispanic race, two or more non-Hispanic race groups, and Hispanic.

[††] Education was categorized as less than high school, high school graduate, some college or technical school, or college graduate.

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from the 2018 BRFSS, and data on county-level percentage of the adult population living at <150% of the poverty level from the 2014–2018 American Community Survey (ACS), a survey sent to about 3.5 million addresses each month that asks about topics not included on the decennial census, including education and employment. The model parameters were applied to 2018 Census county-level population estimates by age, gender, and race/ethnicity to calculate the predicted probability of each outcome. Because the U.S. Census Bureau does not provide county-level population data for education level by age, sex, and race/ethnicity, a bootstrapping approach[§§] was used to impute it. The estimated prevalence was obtained by multiplying the probability by the total population by county. Model-based estimates for any condition were validated by comparing them with the weighted direct survey estimates from counties with sample size ≥500 (213) in BRFSS; the Pearson correlation coefficient was 0.89. The county-level estimates of having any underlying medical condition were categorized into six county urban/rural classifications using CDC's National Center for Health Statistics definitions (large central metro/city, large fringe metro/suburb, medium metro, small metro, micropolitan, noncore/rural) (*7*). The overall weighted direct survey estimates were conducted using SUDAAN (version 11; RTI International), and other analyses were conducted using SAS (version 9.4; SAS Institute).

The nationwide prevalence of any of the five underlying medical conditions among adults aged ≥18 years was 40.7% (95% confidence interval [CI] = 40.4%–41.0%) (Table 1). The overall weighted prevalences of these conditions were 30.9% (obesity), 11.4% (diabetes), 6.9% (COPD), 6.8% (heart disease), and 3.1% (CKD).

Among 3,142 counties, the median estimated (modeled) county prevalence of any underlying medical condition was 47.2% (range = 22.0%–66.2%); obesity, 35.4% (range = 15.2%–49.9%); diabetes, 12.8% (range = 6.1%–25.6%); COPD, 8.9% (range = 3.5%–19.9%); heart disease, 8.6% (range = 3.5%–15.1%); and CKD, 3.4% (range = 1.8%–6.2%) (Table 1).

Counties with the highest prevalences of any condition were concentrated in Southeastern states, particularly in Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Tennessee, and West Virginia, as well as some counties in Oklahoma, South Dakota, Texas, and northern Michigan, among others (Figure) (Supplementary Table, https://stacks.cdc.gov/view/cdc/90519). The estimated number of adults with any condition generally followed the population distribution, with higher estimated numbers of persons with any underlying medical conditions in more highly populated areas.

The estimated median prevalence of any condition generally increased with increasing rurality, ranging from 39.4% in large central metro counties to 48.8% in noncore counties (Table 2); the estimated median number of persons with any underlying condition ranged from 4,300 in noncore counties to 301,744 in large central metro counties.

Discussion

Three recent studies have reported that underlying medical conditions are highly prevalent among U.S. COVID-19 patients requiring hospitalization and ICU admission (*3*,*4*,*8*). In this report, the median county prevalence of any of five underlying medical conditions that increase the risk for severe COVID-19–associated illness was 47.2%, and prevalences were higher in counties in the southeastern United States and in more rural counties. These county level estimates can be used together with data on hospitalizations, ICU admissions, and ventilator use among COVID-19 patients with underlying conditions when planning for mitigation efforts and additional resource investment, including hospital beds, staffing, ventilators, and other medical supplies that might be needed

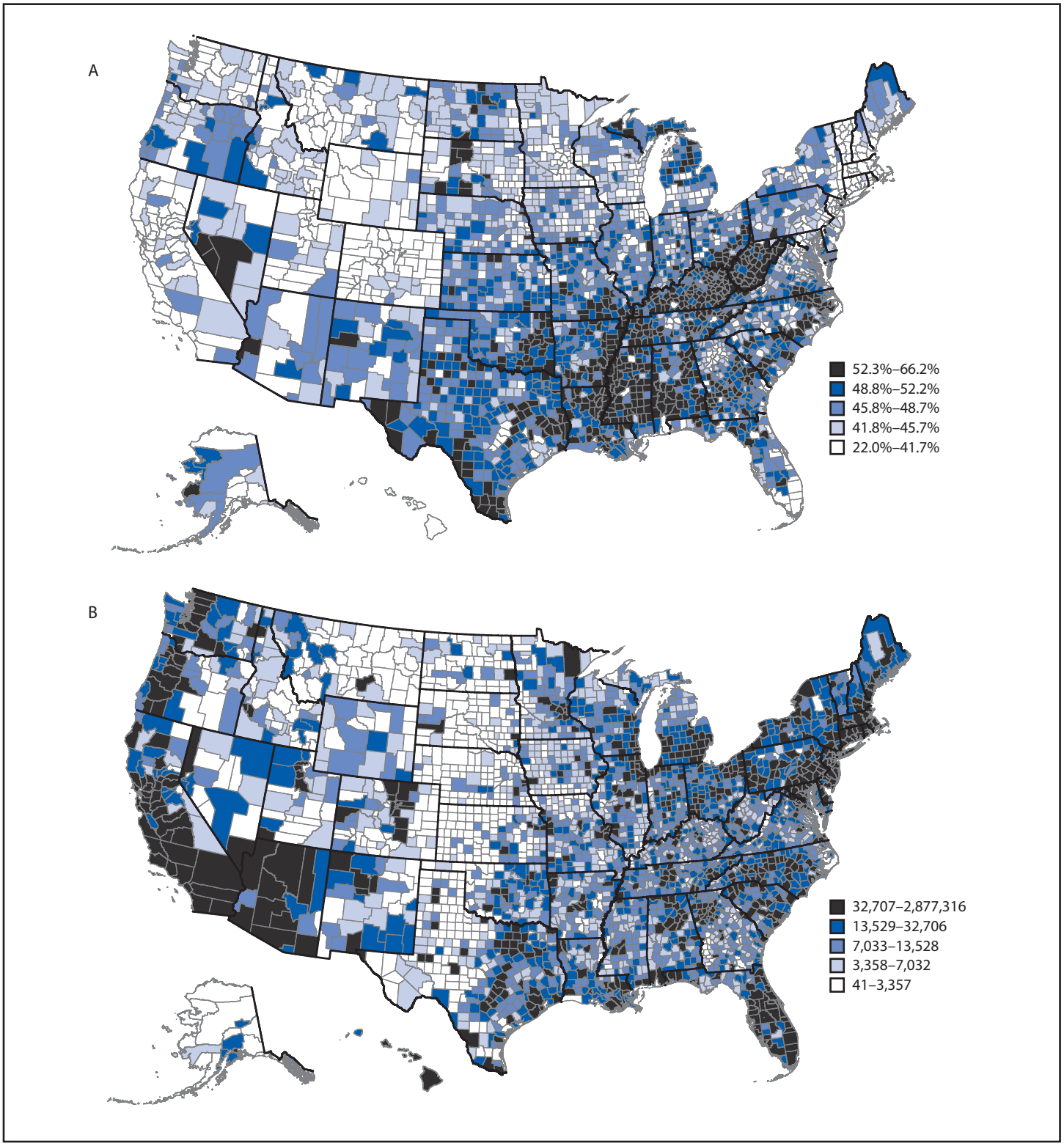
[§§] https://ww2.amstat.org/meetings/jsm/2016/onlineprogram/AbstractDetails.cfm?abstractid=319359.

TABLE 1. Nationwide and model-based county-level (n = 3,142) estimates of prevalence and number of adults aged ≥18 years with selected underlying medical conditions that might increase risk for severe COVID-19–associated illness — United States, 2018

Selected underlying medical condition*	Nationwide prevalence[†] % (95% CI)	Median county prevalence[§] % (range)	Median county no. of adults[†] (range)
Any	40.7 (40.4, 41.0)	47.2 (22.0–66.2)	9,743 (41–2,877,316)
Obesity (BMI ≥30 kg/m^2)	30.9 (30.6, 31.2)	35.4 (15.2– 49.9)	7,174 (25–2,097,906)
Diabetes mellitus	11.4 (11.2, 11.6)	12.8 (6.1–25.6)	2,742 (11–952,335)
COPD	6.9 (6.7, 7.0)	8.9 (3.5–19.9)	1,962 (7–434, 075)
Heart disease	6.8 (6.7, 7.0)	8.6 (3.5–15.1)	1, 811 (7–434,790)
Chronic kidney disease	3.1 (3.0, 3.3)	3.4 (1.8–6.2)	717 (3–237,766)

Abbreviations: BMI = body mass index; CI = confidence interval; COPD = chronic obstructive pulmonary disease; COVID-19 = coronavirus disease 2019.
* Diabetes mellitus includes both type 1 and type 2 diabetes. COPD includes emphysema and chronic bronchitis. Heart disease includes angina or coronary heart disease, and heart attack or myocardial infarction.
† Weighted direct estimates from the Behavioral Risk Factor Surveillance System, 2018.
§ Prevalence and number of adults estimated for 3,142 counties using a multilevel regression and poststratification approach applied to 2018 Behavioral Risk Factor Surveillance System data.

FIGURE. Model-based estimates of U.S. prevalence (A) and number (B) of adults aged ≥18 years with any selected underlying medical condition,* by county — United States, 2018



* Selected underlying conditions include chronic obstructive pulmonary disease, emphysema, or chronic bronchitis; heart disease (angina or coronary heart disease, heart attack, or myocardial infarction); diabetes; chronic kidney disease; or obesity (body mass index ≥30 kg/m^2).

TABLE 2. Model-based estimates of prevalence and number of persons aged ≥18 years with any select underlying medical condition, by urban/rural county classification — United States, 2018

County classification*	No. of counties	Median county prevalence % (range)	Median county no. of persons (range)
Metropolitan			
Large central metro†	68	39.4 (23.9–48.1)	301,744 (43,770–2,877,316)
Large fringe metro§	368	43.9 (26.4–56.9)	34,221 (1,611–725,284)
Medium metro¶	372	45.5 (22.0–61.7)	33,687 (659–332,209)
Small metro**	358	45.8 (27.8–62.2)	26,683 (41–87,153)
Nonmetropolitan			
Micropolitan††	641	47.8 (24.3–64.6)	13,979 (176–59,820)
Noncore§§	1,335	48.8 (26.8–66.2)	4,300 (47–29,469)

* Based on 2013 Urban-Rural Classification Scheme for Counties from the National Center for Health Statistics, CDC.
† Large central metro counties in metropolitan statistical areas (MSAs) of 1 million population that 1) contain the entire population of the largest principal city of the MSA, or 2) are completely contained within the largest principal city of the MSA, or 3) contain ≥250,000 residents of any principal city in the MSA.
§ Large fringe metro counties in MSA of ≥1 million population that do not qualify as large central.
¶ Medium metro counties in MSA of 250,000–999,999 population.
** Small metro counties are counties in MSAs of <250,000 population.
†† Micropolitan counties in MSAs.
§§ Noncore counties not in MSAs.

to treat persons with underlying medical conditions, should they become ill with COVID-19.

The percentage of the population (prevalence) and the estimated numbers of adults with underlying medical conditions provide information for planning and have implications for health care resource utilization. Areas with comparatively lower prevalences but large populations, such as metropolitan areas, might still have large numbers of persons with underlying medical conditions at increased risk for severe COVID-19 illness. Conversely, areas with smaller populations but a comparatively higher prevalence of persons with underlying medical conditions might also have substantial need for additional resources to treat severe COVID-19 illness. Health care in rural counties is often underresourced,¶¶ and rural communities might have limited access to adequate care, which could further increase risk for poor COVID-19–associated outcomes. Prevalence estimates help highlight counties with a higher relative need for resources, whereas estimates of numbers of persons with underlying medical conditions help identify overall need by county; both can help decision-makers predict resource needs and develop resource allocation plans.

¶¶ https://www.aha.org/system/files/2019-02/rural-report-2019.pdf.

Summary

What is already known about this topic?

Older adults and those with chronic obstructive pulmonary disease, heart disease, diabetes, chronic kidney disease, and obesity are at higher risk for severe COVID-19–associated illness.

What is added by this report?

The median model-based estimate of the prevalence of any of five underlying medical conditions associated with increased risk for severe COVID-19–associated illness among U.S. adults was 47.2% among 3,142 U.S. counties. The estimated number of persons with these conditions followed population distributions, but prevalence was higher in more rural counties.

What are the implications for public health practice?

The findings can help local decision-makers identify areas at higher risk for severe COVID-19 illness in their jurisdictions and guide resource allocation and implementation of community mitigation strategies.

The findings in this report are subject to at least five limitations. First, estimates were based on BRFSS data and subject to survey biases such as nonresponse, social desirability, and recall and knowledge of having a particular condition. Second, BRFSS data do not include all underlying medical conditions that might increase risk for severe COVID-19 illness, such as sickle cell disease, or information on organ transplant or disease severity. Third, some of the underlying medical conditions included in BRFSS might not exactly capture those conditions with the strongest and most consistent evidence such as specific heart conditions (e.g., cardiomyopathies and heart failure) or specific type of diabetes. Further, because COVID-19 is a novel disease and information regarding risk factors for severe illness is evolving, additional underlying medical conditions might be added in the future (as an example, cancer was added to the list after these analyses were conducted). Fourth, BRFSS data are collected for noninstitutionalized civilian persons and exclude populations that might be particularly vulnerable to severe COVID-19 illness, including those living in long-term care facilities and incarcerated populations, and might therefore not be representative for those groups. Finally, these estimates might be imprecise because of the multilevel regression modeling process and county-level population estimation.

These findings can be used by state and local decision-makers to help identify areas at higher risk for severe COVID-19–associated illness because of underlying medical conditions and guide resource allocation and implementation of prevention and mitigation strategies. Future analyses could include weighting the contribution of each underlying medical condition according to the risk for severe COVID-19–associated outcomes, as well as identifying and

incorporating other aspects of vulnerability to both infection and severe outcomes to better estimate the number of persons at increased risk for COVID-19. These findings highlight the prevalence of underlying medical conditions at the local (county) level that are important causes of morbidity and mortality on their own and increase risk for severe COVID-19–associated illness. These findings also emphasize the importance of prevention efforts to reduce the prevalence of these underlying medical conditions and their risk factors such as smoking, unhealthy diet, and lack of physical activity.

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Identification of Substance-Exposed Newborns and Neonatal Abstinence Syndrome Using ICD-10-CM — 15 Hospitals, Massachusetts, 2017

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Opioid use disorder and neonatal abstinence syndrome (NAS) increased in Massachusetts from 1999 to 2013 (*1*,*2*). In response, in 2016, the state passed a law requiring birth hospitals to report the number of newborns who were exposed to controlled substances to the Massachusetts Department of Public Health (MDPH)* by mandating monthly reporting of *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) diagnostic codes related to maternal dependence on opioids (F11.20) or benzodiazepines (F13.20) and to newborns affected by maternal use of drugs of addiction (P04.49) or experiencing withdrawal symptoms from maternal drugs of addiction (P96.1) separately.† MDPH uses these same codes for monthly, real-time crude estimates of NAS and uses P96.1 alone for official NAS state reporting.§ MDPH requested CDC's assistance in evaluating the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of either maternal or newborn codes to identify substance-exposed newborns, and of newborn exposure codes (both exposure [P04.49] or withdrawal [P96.1]) and the newborn code for withdrawal alone (P96.1) to identify infants with NAS cases related to three exposure scenarios: 1) opioids, 2) opioids or benzodiazepines, and 3) any controlled substance. Confirmed diagnoses of substance exposure and NAS abstracted from linked clinical records for 1,123 infants born in 2017 and their birth mothers were considered the diagnostic standard and were compared against hospital-reported ICD-10-CM codes. For identifying substance-exposed newborns across the three exposure scenarios, the newborn exposure codes had higher sensitivity (range = 31%–61%) than did maternal drug dependence codes (range = 16%–41%), but both sets of codes had high PPV (≥74%). For identifying NAS, for all exposure scenarios, the sensitivity for either newborn code (P04.49 or P96.1) was ≥92% and the PPV was ≥64%; for P96.1 alone the sensitivity was ≥79% and the PPV was ≥92% for all scenarios. Whereas ICD-10-CM codes are effective for NAS surveillance in Massachusetts, they should be applied cautiously for substance-exposed newborn surveillance. Surveillance for substance-exposed newborns using ICD-10-CM codes might be improved by increasing the use of validated substance-use screening tools and standardized facility protocols and improving communication between patients and maternal health and infant health care providers.

The evaluation examined the validity of using ICD-10-CM codes to estimate the prevalence of substance-exposed newborns and NAS in Massachusetts among 15 hospitals identified by MDPH from among 41 Massachusetts birthing hospitals.¶ During the planning and development of protocols and methods, the most recent year for which data were complete was 2017; the evaluation was conducted in the first quarter of 2019. All 33,431 live-born infants in 2017 from the identified hospitals were linked to their mother's record and were categorized into three mutually exclusive groups: 1) infants or their mothers assigned specific maternal or newborn ICD-10-CM codes (related to maternal drug dependence or newborn exposure or withdrawal) as reported to MDPH by hospitals, regardless of risk factors**; 2) mother-infant pairs with risk factors associated with an increased likelihood of

* https://malegislature.gov/Laws/SessionLaws/Acts/2016/Chapter52.

† The following are definitions of the ICD-10-CM diagnostic codes required for reporting by Massachusetts: F11.20 = opioid dependence, uncomplicated; F13.20 = sedative, hypnotic, or anxiolytic dependence, uncomplicated; P04.49 = newborn affected by maternal use of other drugs of addiction [besides unspecified drugs of addiction, cocaine and hallucinogens]; and P96.1 = neonatal withdrawal symptoms from maternal use of drugs of addiction.

§ Massachusetts has two statewide NAS surveillance systems. One uses ICD-10-CM codes P96.1 or P04.49 to provide rapid, crude estimates of NAS for monthly facility-based NAS reporting. Because NAS is more likely to be diagnosed in cases that require pharmacologic intervention, MDPH includes P04.49 in addition to P96.1. The second system uses ICD-10-CM code P96.1 (and its equivalent, *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) code 779.5) to identify NAS cases by linking hospital discharge data to birth certificate data in the Pregnancy to Early Life Longitudinal (PELL) data system. These codes are automatically recorded in the PELL data system, which provides cleaned, reliable data that include quality of care indicators and covariates to assess health disparities. https://www.mass.gov/guides/neonatal-abstinence-syndrome-dashboard#-explore-the-nas-data-dashboard-.

¶ Five of 46 birthing hospitals in Massachusetts were excluded because they had <300 births. The remaining 41 were stratified with a quasirandom design by the six Massachusetts Executive Office of Health and Human Services Regions (West, Central, Northeast, Metro, Southeast, and Metro-North), and further stratified by prevalence of substance-exposed newborns below or at or above the mean (three per 100 live births) as reported in 2017 in Massachusetts. Fifteen hospitals were randomly selected from these 12 strata, based on the total number of hospitals in each stratum. One hospital was substituted to ensure representation by teaching status and hospital system.

** The specific diagnostic codes included infants who were assigned P96.1 or P04.49 during their birth hospitalization or infants whose birth mothers were assigned F11.20 or F13.20 during pregnancy based on hospital reporting to MDPH.

substance use during pregnancy (*3*–*5*) but without the specified ICD-10-CM codes[††]; and 3) infants not in the first two groups. A total of 1,129 infant-mother pairs were selected using stratified sampling from within those three groups at each hospital; infants in the first group (those with specific ICD-10-CM codes assigned) were oversampled to increase the probability of identifying false positives.[§§]

The validity (sensitivity, specificity, PPV, and NPV) of the following ICD-10-CM code combinations to assess substance-exposed newborns were calculated: 1) those related to maternal dependence on opioids (F11.20) or benzodiazepines (F13.20) and 2) those related to newborns affected by maternal drug exposure (P04.49) or experiencing withdrawal from drug exposure (P96.1). To identify NAS, the validity of codes P04.49 or P96.1 and P96.1 alone were assessed. Analyses conducted using P96.1 alone included infants from 12 of the 15 hospitals (69.5% of the weighted sample) that reported individual ICD-10-CM codes to MDPH. Substance-exposed newborns and NAS that were confirmed using abstracted clinical record data served as the diagnostic standard. Identification of substance-exposed newborns was confirmed using either a documented history of maternal substance use during pregnancy or laboratory confirmation[¶¶] of maternal drug use or fetal exposure to selected controlled substances within the 30 days preceding delivery.[***] Three substance exposure scenarios were assessed: 1) exposure to opioids, 2) exposure to opioids or benzodiazepines, and 3) exposure to opioids, benzodiazepines, barbiturates, amphetamines, cocaine, hallucinogens, or marijuana (i.e., any controlled substance). Infants were confirmed as having NAS if 1) newborn substance exposure was confirmed and a Finnegan or modified Finnegan score (a system used to quantify and diagnose NAS) was ≥8 (*6*) or 2) if diagnosis of NAS was officially documented in the infant's medical record.[†††] The final sample was weighted to represent the total number of births from each of the three groups at each selected hospital. Multiparous births were adjusted to account for nonindependence between related infants. Prevalence of characteristics of the total sample and both substance-exposed and nonexposed newborns and 95% confidence intervals were calculated. Analyses were conducted using SAS (version 9.4; SAS Institute).

Records for 1,123 mother-infant pairs were abstracted; six infants were excluded because there was insufficient information in the clinical chart to confirm that the birth mother and infant were linked correctly. The data included information from four complete sets of twins and 33 other infants who constituted one member of multiparous births. Most infants were born at term (92%) and weighed >2,500 g at birth (91%) (Table 1). Approximately one third of mothers were aged 30–34 years (36%) and nearly one half (47%) were non-Hispanic white. Across all exposure scenarios for substance-exposed newborns, the sensitivity of newborn exposure codes (P04.49 or P96.1) was ≥14 percentage higher (range = 31%–61%) than were maternal drug dependence codes (F11.20 or F13.20) (range = 16%–41%) (Table 2). Sensitivity for identifying substance-exposed newborns was highest in the exposure to opioids only scenario when evaluating maternal and newborn codes. The PPV for both the newborn exposure codes and maternal drug dependence codes was high for substance-exposed newborns (≥74%) across all exposure scenarios. Evaluating NAS for all exposure scenarios, the sensitivity of P04.49 (exposure) or P96.1 (withdrawal) (≥92%) was higher than that for P96.1 alone (≥79%). The PPV for P04.49 or P96.1 was lower (64%–65%) than that of P96.1 alone (≥92%). All ICD-10-CM code combinations had high specificity and NPV (≥94%) for all exposure scenarios for substance-exposed newborns and NAS.

Discussion

ICD-10-CM codes can be used to monitor the prevalence of several conditions, including substance-exposed newborns and NAS. Evaluating the sensitivity and PPV of these codes can inform how well they identify actual cases. The MDPH surveillance system reports selected maternal drug dependence codes and newborn exposure codes for monitoring substance-exposed newborns separately, and this analysis found the newborn exposure codes to have higher (although still low to moderate) sensitivity than do maternal drug dependence codes within each substance exposure scenario; specificity for both types of codes was consistently high.

[††] Risk factors were based upon previously published analyses and included birth mother's age <34 years at birth event, birth mother's insurance through Medicaid, or infant length of stay ≥5 days.

[§§] The aim was to oversample from group 1 and from group 2 to increase the likelihood of identifying false-positives and false-negatives, respectively. The initial goal was to capture a final unweighted sample comprising 40% of infant-mother pairs in group 1, 50% in group 2, and 10% in group 3. The final unweighted sample (the 1,123 records abstracted) comprised 462 (41.1%), 549 (48.9%), and 112 (10.0%) infants-mother pairs in groups 1, 2 and 3, respectively. Among the 33,431 infants at the 15 hospitals, 59.5%, 1.9%, and 2.1% of infants from groups 1, 2, and 3, respectively, were included in the sample. Because the sample had approximately 2% of all infants in groups 2 and 3, but 59.5% of the infants in group 1, infant-mother pairs in group 1 only were oversampled.

[¶¶] Maternal urine toxicology laboratory testing results 30 days before through 2 days after delivery were assessed to ascertain substance use 30 days before and up to delivery; metabolites of the substances of interest remain detectable in urine 2 days after their use. https://ncsacw.samhsa.gov/files/IA_Drug_Testing_Bench_Card_508.pdf.

[***] Recorded substance use was not limited to illicit use. Drugs used for delivery were not included as substance exposures.

[†††] In the sample, only Finnegan or modified Finnegan scores were identified in clinical charts. Two infants were assessed using Eat, Sleep, Console (https://www.nature.com/articles/s41372-020-0733-y), but results were not documented in the clinical record.

TABLE 1. Weighted characteristics of mother-infant pairs included in the study population as a percentage of the total sample, substance-exposed newborns, and non–substance-exposed newborns* — 15 Massachusetts hospitals, 2017

Characteristic	Newborns % (95% CI)		
	Total sample, unweighted N = 1,123	Substance-exposed, unweighted n = 470	Non–substance-exposed, unweighted n = 653
Maternal age group (yrs)			
<20	3.5 (2.0–5.0)	6.0 (0.0–13.1)	3.3 (1.8–4.9)
20–24	10.9 (8.4–13.4)	24.5 (12.8–36.3)	9.9 (7.5–12.4)
25–29	25.8 (22.5–29.2)	23.9 (14.6–33.3)	26.0 (22.4–29.5)
30–34	36.3 (32.6–40.0)	30.4 (18.5–42.3)	36.7 (32.8–40.6)
≥35	23.5 (20.0–26.9)	15.1 (4.2–26.0)	24.1 (20.4–27.7)
Maternal race and ethnicity†			
White, non-Hispanic	47.1 (43.1–51.0)	54.6 (41.4–67.7)	46.5 (42.4–50.6)
Hispanic	19.4 (16.2–22.5)	21.1 (9.6–32.6)	19.3 (16.0–22.5)
Black, non-Hispanic	7.5 (5.6–9.4)	6.4 (0.0–13.7)	7.6 (5.6–9.6)
Asian, non-Hispanic	7.1 (5.1–9.0)	2.3 (0.0–6.6)	7.4 (5.4–9.5)
Other	2.7 (1.4–4.0)	1.0 (0.3–1.6)	2.8 (1.4–4.2)
Unknown/Missing	16.3 (13.4–19.1)	14.6 (5.4–23.8)	16.4 (13.4–19.4)
Infant sex			
Male	50.7 (46.8–54.7)	57.8 (45.0–70.6)	50.2 (46.1–54.4)
Infant gestational age at birth (wks)			
<34	2.7 (1.4–3.9)	3.5 (0.5–6.6)	2.6 (1.3–3.9)
34–36	5.4 (3.7–7.0)	9.6 (2.7–16.6)	5.1 (3.4–6.8)
≥37 (term)	92.0 (89.9–94.0)	86.8 (79.3–94.4)	92.3 (90.2–94.4)
Infant birthweight (grams)			
500–1,499	1.4 (0.5–2.3)	1.0 (0.4–1.7)	1.4 (0.4–2.3)
1,500–2,499	7.2 (5.2–9.2)	12.6 (5.2–20.0)	6.8 (4.8–8.8)
≥2,500	91.4 (89.3–93.6)	86.4 (78.9–93.8)	91.8 (89.6–94.0)
Multiple live births			
Singleton	97.3 (96.1–98.5)	98.4 (97.6–99.3)	97.2 (95.9–98.5)
Multiples	2.7 (1.5–3.9)	1.6 (0.7–2.4)	2.8 (1.5–4.1)
Highest Finnegan NAS score§,¶			
Mean (range)	—	9.5 (2–28)	NR**
Length of hospital stay (days)			
Mean (range)	4.2 (0–155)	10.2 (0–155)	3.8 (0–142)
Median	1.8	2.3	1.8

Abbreviations: CI = confidence interval; NAS = neonatal abstinence syndrome; NR = not reported.

* Missing included if >5%.

† If more than two races were chosen, the maternal race and ethnicity were identified as other; if Hispanic ethnicity was unknown or if race was unknown, the maternal race and ethnicity was labeled as unknown/missing.

§ A scored assessment of the most common signs of neonatal abstinence syndrome.

¶ Only 2.1% of the weighted total sample had reported Finnegan scores.

** Not reported because number was <5.

These data demonstrate opportunities for improvement in identifying substance-exposed newborns. Implementing universal maternal screening protocols with validated screening tools to help identify maternal drug use, executing standardized facility protocols around screening and assessing newborns for substance exposure, and improving communication between patients and maternal and infant health care providers might lead to improvement in identifying substance-exposed newborns (*7*), which could lead to more accurate assignment of ICD-10-CM codes.[§§§] Sensitivity of ICD-10-CM codes was consistently highest when evaluating substance-exposed newborns with opioid exposure only, even though the ICD-10-CM codes aren't specific to only opioids. Efforts by providers and medical coders to assign appropriate ICD-10-CM codes for nonopioid exposure could increase ICD-10-CM code sensitivity for nonopioid substances.

State surveillance definitions of NAS vary widely across the United States (*8*). Most states use only P96.1 (withdrawal) for identifying NAS because P04.49 is primarily used to identify substance-exposed newborns (*8*). A recent Tennessee study using ICD-10-CM codes found a high PPV (98%) for P96.1 to identify NAS caused by opioids (*9*), consistent with the findings (92%) of this evaluation. In Massachusetts, codes for exposure (P04.49) or withdrawal (P96.1) might yield the most

[§§§] https://www.samhsa.gov/sites/default/files/topics/specific_populations/protecting-our-infants-act-report-congress-2017.pdf.

TABLE 2. Sensitivity, specificity, positive predictive value, and negative predictive value of reported *International Classification of Diseases, Tenth Edition, Clinical Modification* (ICD-10-CM) codes compared with confirmed cases of substance-exposed newborns and infants with neonatal abstinence syndrome caused by in utero exposures to various substance groups, by type of controlled substance — 15 Massachusetts hospitals, 2017

		Substance-exposed newborns and infants with NAS, % (95% CI)*		
ICD-10-CM code	Validation measure	Opioids	Opioids or benzodiazepines	Opioids, benzodiazepines, barbiturates, marijuana, amphetamines, cocaine, or hallucinogens
Substance-exposed newborns				
F11.20 or F13.20†	Sensitivity	41.4 (28.1–54.8)	30.9 (20.7–41.0)	16.3 (11.6–21.0)
	Specificity	100.0 (100.0–100.0)	100.0 (100.0–100.0)	100.0 (100.0–100.0)
	PPV	98.6 (96.9–100.0)	98.9 (97.3–100.0)	98.9 (97.3–100.0)
	NPV	98.5 (97.6–99.3)	97.5 (96.4–98.6)	94.4 (92.7–96.1)
P04.49 or P96.1†	Sensitivity	60.5 (41.7–79.3)	45.7 (31.2–60.2)	30.9 (22.5–39.2)
	Specificity	99.4 (99.3–99.5)	99.5 (99.3–99.6)	99.9 (99.9–100.0)
	PPV	73.9 (69.6–78.3)	75.2 (70.9–79.5)	96.0 (94.1–98.0)
	NPV	98.9 (98.1–99.8)	98.1 (96.9–99.2)	95.3 (93.6–97.0)
Infants with neonatal abstinence syndrome				
P04.49 or P96.1†	Sensitivity	92.1 (88.8–95.5)	92.2 (88.9–95.5)	92.3 (89.0–95.5)
	Specificity	99.2 (99.1–99.4)	99.2 (99.1–99.4)	99.2 (99.1–99.4)
	PPV	63.9 (59.1–68.6)	64.3 (59.6–69.1)	65.0 (60.3–69.7)
	NPV	99.9 (99.8–99.9)	99.9 (99.8–99.9)	99.9 (99.8–99.9)
P96.1†,§	Sensitivity	80.2 (74.3–86.1)	79.8 (73.9–85.7)	79.4 (73.5–85.3)
	Specificity	99.9 (99.8–99.9)	99.9 (99.8–99.9)	99.9 (99.8–99.9)
	PPV	91.7 (87.9–95.5)	92.0 (88.3–95.7)	92.3 (88.6–96.0)
	NPV	99.7 (99.6–99.8)	99.7 (99.6–99.8)	99.7 (99.6–99.8)

Abbreviations: CI = confidence interval; NAS = neonatal abstinence syndrome; NPV = negative predictive value; PPV = positive predictive value.
* Percentages use weighted data.
† F11.20: opioid dependence, uncomplicated; F13.20: sedative, hypnotic, or anxiolytic dependence, uncomplicated; P04.49: newborn affected by maternal use of other drugs of addiction; and P96.1: neonatal withdrawal symptoms from maternal use of drugs of addiction.
§ Weighted data from 12 of 15 selected hospitals that reported individual ICD-10-CM diagnostic codes (representing 69.5% of total weighted sample).

Summary

What is already known about the topic?

Massachusetts uses independent combinations of *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) diagnostic codes to surveil substance-exposed newborns and neonatal abstinence syndrome (NAS), but the ability of these codes to identify substance-exposed newborns and NAS is unknown.

What is added by this report?

Whereas ICD-10-CM codes performed relatively well for surveillance of NAS in the sample for this study (sensitivity range = 79%–92%, positive predictive value range = 64%–92%), surveillance for substance-exposed newborns using ICD-10-CM codes missed more cases (sensitivity range = 16%–61%).

What are the implications for public health practice?

In Massachusetts, ICD-10-CM codes are effective for NAS surveillance but should be applied cautiously for surveillance of substance-exposed newborns.

sensitive estimates for identifying infants with NAS, but P96.1 alone better identifies infants who indeed have NAS because of its higher PPV; however, PPV varies by population prevalence.

Using exposure (P04.49) in addition to withdrawal (P96.1) codes might be more sensitive for identifying NAS than using P96.1 alone because P04.49 might identify newborns exhibiting signs of NAS who have not received a diagnosis of withdrawal (P96.1) by providers. Because these codes provide different information, they should be selected based on the surveillance purpose. In Massachusetts, many hospitals have programs to support mothers with substance use disorder and infants with a diagnosis of NAS (*10*). Identifying infants with NAS in real time is important for linking families to these programs and evaluating their impact; therefore, a more sensitive NAS surveillance system could help ensure that all families that might potentially benefit from the programs are linked to them. However, a code with higher PPV will better identify newborns who genuinely have NAS and might be more accurate for tracking state estimates. In contrast to findings assessing ICD-10-CM codes to identify substance-exposed newborns, the sensitivity of ICD-10-CM codes for identifying NAS was similar across all three exposure scenarios. Although NAS is a more general term for neonatal withdrawal that can include nonopioid exposures (e.g., benzodiazepines), evidence suggests that the recent increases in NAS are primarily from in utero exposure to opioids, either alone or in combination with other substances; in this analysis, nearly all (98%) of the newborns with NAS were exposed to opioids.

The findings in this report are subject to at least four limitations. First, because of stigma and legal implications, disclosure of maternal use of controlled substances and NAS diagnosis might be underreported by patients and clinical providers, resulting in reporting bias and leading to underreporting in the clinical records used as the standard.¶¶¶ However, multiple sources of information were used to determine controlled substance use and exposure, including any notation of Finnegan score and available laboratory results (urine, meconium, and blood) to increase sensitivity of ascertainment. Second, the current ICD-10-CM used to monitor substance-exposed newborns might affect coding because the maternal dependence codes are specific to opioids and benzodiazepines only, but the newborn substance exposure codes do not specify distinct substances. Third, accuracy and consistency of coding might vary by facility. Finally, results are only generalizable to the 15 selected Massachusetts hospitals. Data were limited by the exclusion of small birthing facilities, and, because some facilities did not report P96.1 separately from P04.49, three of 15 hospitals were excluded when evaluating ICD-10-CM code P96.1 alone, resulting in a total of 12 for analysis.

This evaluation contributes to understanding the use of ICD-10-CM codes for assessing the public health prevalence of substance-exposed newborns and NAS in Massachusetts. Considering the exposures of interest and the purpose of surveillance, public health organizations, including MDPH, might effectively conduct surveillance for NAS using ICD-10-CM codes. Surveillance for substance-exposed newborns using ICD-10-CM codes in Massachusetts should be undertaken with caution at this time but might be improved by increasing the use of validated substance-use screening tools and standardized facility protocols and improving communication between patients and maternal health and infant health care providers.

¶¶¶ https://www.guttmacher.org/state-policy/explore/substance-use-during-pregnancy.

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Evaluation of Online Risk Assessment To Identify Rabies Exposures Among Health Care Workers — Utah, 2019

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On November 7, 2018, the Utah Department of Health (UDOH) reported the first confirmed human rabies death in the state since 1944 (*1*). The case occurred in a person who had been treated over a period of 19 days at four health care facilities and an emergency medical transport service across three counties and two states. Human rabies is preventable through preexposure or postexposure vaccination but is invariably fatal upon symptom onset. Timely identification of persons who might have been exposed to rabies virus is therefore crucial to administer postexposure prophylaxis (PEP). Because of the large number of health care workers who had been involved in the patient's care, a standardized online risk assessment survey was developed by UDOH based on Advisory Committee on Immunization Practices recommendations (*2*). This online tool was evaluated for accuracy, acceptability, and administrative obligation by reviewing the results from the tool and conducting focus group discussions and a follow-up survey. Among 90 health care workers initially identified by the online risk assessment as being potentially exposed to infectious material, 74 were classified as exposed. All 74 health care workers received PEP following consultation with occupational health staff members, indicating a positive predictive value of the assessment tool of 82%. In a follow-up survey, 42 (76%) of the 55 respondents reported that they were satisfied with the assessment process. In focus group discussions, participants suggested that the survey could be improved by providing additional information about rabies exposures because many of them were unfamiliar with human-to-human rabies transmission. This evaluation highlighted the importance of adopting clear communication strategies, demonstrated the benefits of using an online risk assessment during a mass rabies exposure, and provided specific feedback for CDC to improve resources available for states and health care facilities after mass rabies exposures.

Human-to-human transmission of rabies virus has only been confirmed among organ and tissue transplant recipients; however, because rabies virus has been isolated from tears, saliva, and nervous tissues of rabies patients, the possibility cannot be excluded (*2*). Because of the rarity of rabies and initial nonspecific signs and symptoms, patients with rabies sometimes have prolonged interactions with health care workers before diagnosis, which can result in multiple instances of exposure to potentially infectious materials. In such events, thorough risk assessments for potential rabies virus exposure, usually conducted by public health practitioners, are necessary to determine the need for PEP. Innovative methods that efficiently assess exposure risk and appropriately recommend PEP could improve the efficiency of health systems.

Within 48 hours of the 2018 Utah rabies case diagnosis, UDOH activated an Incident Command System and distributed the online risk assessment tool to infection prevention teams at four health care facilities and an emergency medical transport service. The infection prevention teams worked with supervisors to identify health care workers who might have been exposed, e-mailed them the risk assessment, and monitored completion of the assessment over the next 3 weeks.

The risk assessment tool (Supplementary material; https://stacks.cdc.gov/view/cdc/90520) was developed using Research Electronic Data Capture (REDCap) (*3*). The survey included questions about direct contact with certain infectious materials (cerebrospinal fluid [CSF], nervous tissue, saliva, respiratory secretions, or tears), and contact of infectious materials with mucous membranes (eyes, nose, and mouth) or broken skin (e.g., abrasion or cuts). Health care workers were asked whether they were involved in endotracheal intubation, tracheal tube maintenance, or oral care, and whether they were wearing appropriate personal protective equipment (PPE) or had direct contact with infectious materials during the procedure. An automated risk algorithm embedded in the online assessment provided recommendation for PEP if respondents reported any direct mucous membrane or broken skin contact with infectious materials. Health care workers were referred to occupational health staff members for in-person assessments if the algorithm determined that PEP was recommended or if further assessment was indicated (i.e., if health care workers reported additional exposures or concerns). The outcome of the online risk assessment was analyzed to assess the types and frequencies of exposures and determine the positive predictive value of the risk algorithm.

To understand knowledge gaps about human rabies among health care workers and to evaluate the acceptability of the online risk assessment, UDOH and CDC conducted focus group discussions with employees and infection prevention teams from the health care systems where the patient was hospitalized. Based on the results obtained from the focus groups, UDOH and CDC developed an online satisfaction survey in REDCap, which was sent to health care workers who completed the online risk

assessment. Respondents were asked to rank their familiarity with rabies, level of concern, and satisfaction with the risk assessment process using a Likert scale and open-ended answers. Descriptive statistics were calculated using STATA software (version 14.0; StataCorp). This investigation was determined by CDC to be public health surveillance.*

The online risk assessment was completed by 242 health care workers in four facilities and one emergency medical service. The algorithm initially recommended 80 health care workers for PEP and 10 for additional follow-up with occupational health staff members. Among these 90 persons for whom a potential exposure could not be ruled out, 74 were classified as having been exposed and received PEP following consultation with occupational health, indicating a positive predictive value of the assessment tool of 82%. No rabies deaths were reported among health care workers more than 12 months after the event.

Among all 242 respondents, 140 (58%) reported no exposures, 74 (31%) reported performing procedures that could have placed them at risk for an exposure (e.g., intubation, oral care, needlestick), and 28 (12%) reported having had direct contact with infectious material not involving a medical procedure (e.g., CSF, tears, neural tissue, saliva, or respiratory secretions) (Figure); some respondents had multiple exposures and other exposure types such as laboratory exposures or other concerns not addressed in the survey. Among the 74 health care workers who performed tracheal or oral care (including intubation), 67 (91%) reported not wearing PPE to cover their eyes, nose, and mouth. Of these, 25 (37%) reported direct contact with respiratory secretions.

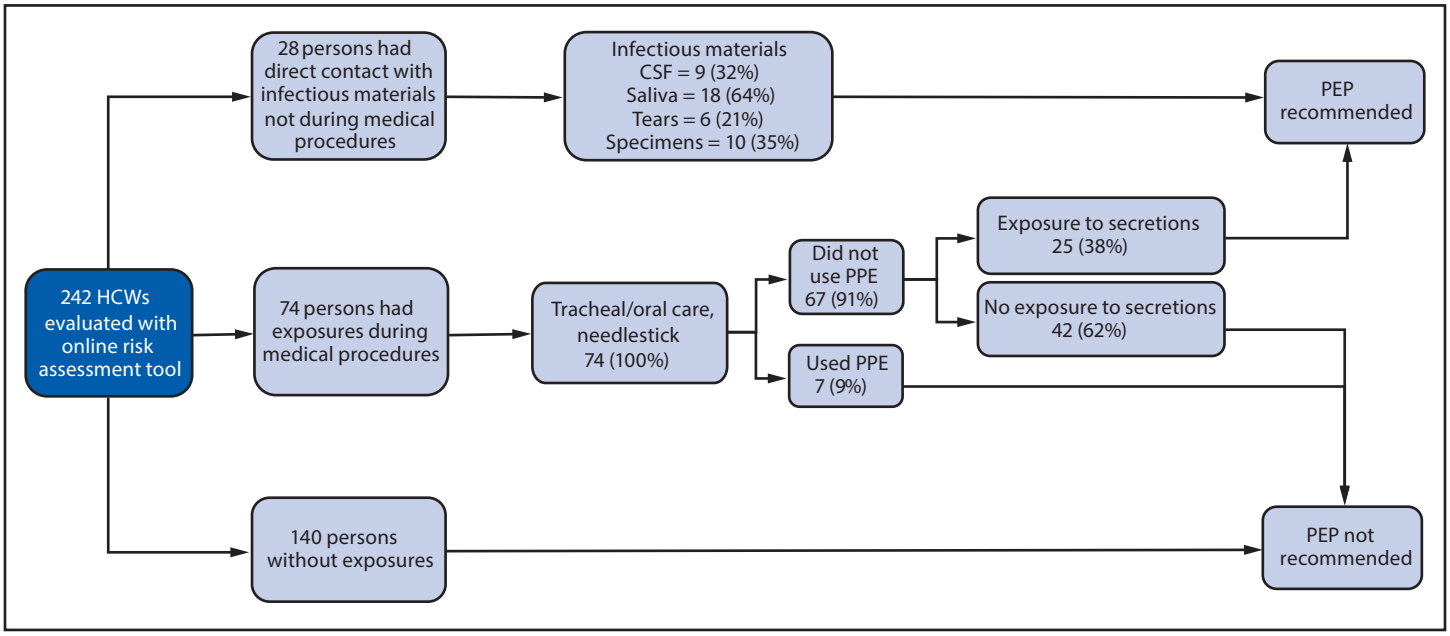
Among the 242 health care workers who completed the online risk assessment, 55 (23%) also responded to the follow-up satisfaction survey. Among those respondents, 35 (64%) indicated that they were not very familiar with rabies infection prevention or routes of exposure. Of the 55, 28 (51%) reported high levels of personal concern about exposures at the time of the patient's rabies diagnosis. Unfamiliarity with rabies among some health care workers was also identified during focus group discussions. Health care workers reported being unfamiliar with clinical signs and transmission of human rabies and recommended use of PPE to prevent exposures.† This resulted in anxiety among health care workers, illustrated by statements such as "I did not kiss my husband for 2 weeks" and "I slept on the sofa [out of fear of infecting my family]."

Health care workers reported initially receiving delayed and conflicting information about rabies transmission from their supervisors, the occupational health clinic, and Internet sources. Online resources about human-to-human transmission specific to hospital settings were reportedly difficult to

* U.S. Department of Health and Human Services, Title 45 Code of Federal Regulations 46, Protection of Human Subjects.

† https://www.cdc.gov/infectioncontrol/guidelines/isolation/index.html.

FIGURE. Health care worker exposures to potentially infectious materials* from a case of human rabies, by type of exposure, and postexposure prophylaxis recommendations based on an online risk assessment — Utah, 2019



Abbreviations: CSF = cerebrospinal fluid; HCWs = health care workers; PEP = postexposure prophylaxis; PPE = personal protective equipment.
* Laboratory specimen exposures included tears, respiratory secretions, saliva, CSF, and neural tissue; categories for the type of exposure were not mutually exclusive and do not show all possible exposure categories.

find. Administrators explained that it took approximately 1 week to develop and distribute informational materials, a delay that exacerbated anxiety among health care workers.

Of the 55 respondents to the satisfaction survey, 42 (76%) were satisfied with the online risk assessment, and 48 (87%) recommended that it be used in future situations. Some reasons against using the risk assessment included unclear guidance concerning what constituted a rabies exposure, unclear and lengthy questions, concerns about the accuracy of the automated PEP algorithm, and insufficiently tailored questions for certain professions (e.g., laboratorians and housekeeping staff members). These concerns were also expressed during focus group discussions. Respondents suggested that the risk assessment should be used only as a screening tool, which would refer persons with elevated exposure risk to their health care providers for in-person assessments.

Discussion

This evaluation found that the online risk assessment identified health care workers with potential exposures and was helpful and recommended by users for future use. However, the process could be improved by tailoring questions to specific audiences, clarifying exposure assessment questions, and including background information on rabies. Timely distribution of clear information in line with established risk communication principles could improve the process and alleviate health care worker anxiety (*4*). These findings suggest that an online risk assessment could be used to rapidly rule out nonexposures, while allowing thorough in-person assessment and counseling of potentially exposed persons.

In addition, this evaluation revealed suboptimal use of PPE among health care workers. Approximately 90% of health care workers who performed high-risk procedures reported not wearing adequate PPE while caring for a patient with encephalitis of unknown origin. Standard infection control precautions are sufficient to protect against most exposures to pathogens causing encephalitis (including rabies), and although the precautions are recommended while caring for all patients in a hospital setting, low adherence continues to be reported (*5*).

The findings in this report are subject to at least two limitations. First, because an additional qualitative risk assessment was performed by the occupational health clinic for workers who were considered exposed based on the online risk assessment result, it was not possible to ascertain whether the final PEP determination came from the online assessment. Second, the follow-up satisfaction survey was subject to recall and nonresponse bias because the survey was completed 5 months after the exposure window and only 55 of 242 health care workers responded.

Summary

What is already known about the topic?

Human rabies cases are rare; however, exposure assessments to determine the need for postexposure prophylaxis (PEP) are time- and resource-consuming.

What is added by this report?

An online risk assessment tool was used following potential exposure to rabies virus in Utah. Among 90 health care workers identified by the tool as being potentially exposed to infectious material, 74 who were classified as exposed received PEP, after consultation with the occupational health staff, indicating a positive predictive value of 82%. In a follow-up survey, 42 (76%) of 55 participants reported satisfaction with the assessment process.

What are the implications for public health practice?

Online exposure assessment tools could substantially reduce the administration and financial obligation on health systems in events requiring numerous risk assessments; based on this evaluation, CDC is improving available tools for states in other mass rabies exposures.

Although rabies is rare in the United States, during the last 5 years, an average of 177 health care workers underwent an exposure risk assessment for every hospitalized human rabies patient (*6*–*9*) (Poxvirus and Rabies Branch, CDC, unpublished data). Because clinicians are recommended to consult with public health officials for nonroutine exposures, the workload placed on health departments by rabies exposures in health care settings is far greater than might be expected for a rare disease (*2*). Providing an online assessment reduced the need for in-person consultations from 242 to approximately 90, a 63% reduction. Because each human rabies death costs an estimated $191,000 in terms of staff member hours and PEP-associated costs, an online risk assessment could reduce administrative and financial costs (*10*). Since this evaluation, CDC has been improving tools available to states after mass rabies exposures and developing clearer content tailored for health care workers on human-to-human exposure risk in health care settings. Online tools that could be used in other events requiring numerous risk assessments appear to be an acceptable method to accurately assess exposure risk if they provide clear information on exposure and transmission pathways.

Acknowledgments

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Morbidity and Mortality Weekly Report

Population Point Prevalence of SARS-CoV-2 Infection Based on a Statewide Random Sample — Indiana, April 25–29, 2020

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Population prevalence of persons infected with SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), varies by subpopulation and locality. U.S. studies of SARS-CoV-2 infection have examined infections in nonrandom samples (*1*) or seroprevalence in specific populations* (*2*), which are limited in their generalizability and cannot be used to accurately calculate infection-fatality rates. During April 25–29, 2020, Indiana conducted statewide random sample testing of persons aged ≥12 years to assess prevalence of active infection and presence of antibodies to SARS-CoV-2; additional nonrandom sampling was conducted in racial and ethnic minority communities to better understand the impact of the virus in certain racial and ethnic minority populations. Estimates were adjusted for nonresponse to reflect state demographics using an iterative proportional fitting method. Among 3,658 noninstitutionalized participants in the random sample survey, the estimated statewide point prevalence of active SARS-CoV-2 infection confirmed by reverse transcription–polymerase chain reaction (RT-PCR) testing was 1.74% (95% confidence interval [CI] = 1.10–2.54); 44.2% of these persons reported no symptoms during the 2 weeks before testing. The prevalence of immunoglobulin G (IgG) seropositivity, indicating past infection, was 1.09% (95% CI = 0.76–1.45). The overall prevalence of current and previous infections of SARS-CoV-2 in Indiana was 2.79% (95% CI = 2.02–3.70). In the random sample, higher overall prevalences were observed among Hispanics and those who reported having a household contact who had previously been told by a health care provider that they had COVID-19. By late April, an estimated 187,802 Indiana residents were currently or previously infected with SARS-CoV-2 (9.6 times higher than the number of confirmed cases [17,792]) (*3*), and 1,099 residents died (infection-fatality ratio = 0.58%). The number of reported cases represents only a fraction of the estimated total number of infections. Given the large number of persons who remain susceptible in Indiana, adherence to evidence-based public health mitigation and containment measures (e.g., social distancing, consistent and correct use of face coverings, and hand hygiene) is needed to reduce surge in hospitalizations and prevent morbidity and mortality from COVID-19.

The study population was randomly selected from a list of Indiana residents derived from tax returns, including filers and dependents. State databases were cross-checked for recent contact information, and institutionalized and deceased persons were removed. Stratified random sampling was conducted among all persons aged ≥12 years using Indiana's 10 public health preparedness districts as sampling strata. After the study was announced, 15,495 participants were contacted by the state health department via postcard, text message, e-mail, or telephone, depending on available contact information. The number of participants were determined by assuming prevalences ranging from 0.5% to 15% and a margin of error of 1 percentage point. Consenting participants were able to select a testing time, by phone or online, at one of 68 statewide sites and complete a research intake form that included questions about their reasons for participating, demographic characteristics (e.g., age, sex, race, and ethnicity), number of children aged <18 years living in the household, highest level of education achieved, general health status, use of tobacco or vaping products, COVID-19–compatible symptoms† during the past 2 weeks (asked at time of registration and prompted to update if they experienced any new symptoms at testing site check-in), and whether the participant or any household member had received a provider diagnosis of COVID-19. The study was deemed a public health surveillance activity by the Indiana University Institutional Review Board and was exempted from human subjects review.

Logistical support at testing locations was coordinated by the state health department with support from other state agencies, the Indiana National Guard, and private organizations. During April 25–29, personnel used swabs to collect nasopharyngeal specimens for RT-PCR testing to detect the presence of SARS-CoV-2 and 2–3 mL samples of blood by venipuncture for antibody testing using a chemiluminescent microparticle immunoassay for detection of SARS-CoV-2 IgG. Participants could access results and explanations of their test results online within 3 days of testing and were linked to additional resources as needed.

* https://www.medrxiv.org/content/10.1101/2020.04.14.20062463v2.

† Fever, cough, shortness of breath, chest pain, muscle aches, chills, tiredness or fatigue, sore throat, runny nose, headache, diarrhea, vomiting, loss of sense of smell, and loss of sense of taste.

Because racial and ethnic minority populations responded at lower rates in the sample (Table 1), civic leaders were enlisted to establish 2 days of nonrandom testing (May 2–3) hosted at Indianapolis locations in two racial/ethnic minority populations. Doing so was motivated by the need to understand the impact of the virus in populations that have been disproportionately affected by the COVID-19 pandemic and been shown to have higher proportions of essential workers, who might therefore continue to be at elevated risk for infection (*4*). An additional motivation was to compare results of random and nonrandom samples as a way to inform the limitations of nonrandom sampling occurring in the United States. Clergy and community leaders helped mobilize community members by increasing trust and engagement with the testing program. Because some participants in the nonrandom testing group might have chosen to participate because of concerns that they might be infected, possibly resulting in selection bias; findings from the nonrandom testing are reported separately.

Population prevalence estimates were calculated for persons who were currently or previously infected with SARS-CoV-2. Persons with positive results for both tests (16 in random sample and 100 in nonrandom sample) were classified as currently infected. Persons were classified as asymptomatic if they indicated that they had no symptoms on the checklist during the 2 weeks before testing. To adjust for nonresponse, data were weighted for age, race (dichotomized as white or nonwhite), and Hispanic ethnicity. Data for each person who received testing were then reweighted according to the proportions of these three factors in each of the 10 sampling strata, as determined by U.S. Census population estimates. Sampling was performed using R software (version 4.0.0; The R Foundation). Analyses were performed using SAS (version 9.4; SAS Institute), and bootstrapping methods were used to obtain point estimates, p-values, and CIs.

The nonrandom sample was analyzed separately. To account for clustering effects resulting from members of the same household being tested, which did not apply to the random sample, estimates were obtained using generalized estimating equations assuming a binomial distribution for the presence of current infection and antibodies. Analyses were performed using R software.

Among 15,495 randomly selected persons, 3,658 (23.6%) participated, 3,629 (99.2%) of whom had at least one test result available (Table 1). Overall, approximately 55% of participants were female, 92% were white, and 98% were non-Hispanic. Approximately one third each were aged <40 years, 40–59 years, and ≥60 years. Statewide, 1.74% of persons (unweighted n = 47) had a positive RT-PCR test result (95% CI = 1.10%–2.54%), and 1.01% (95% CI = 0.76%–1.45%) (unweighted n = 38) had samples that were seropositive, resulting in an estimated overall population SARS-CoV-2 prevalence of active or current infection in Indiana of 2.79% (95% CI = 2.02%–3.70%). The overall prevalence was significantly higher among Hispanics (8.3%) than among non-Hispanics (2.3%) (p = 0.03). Participants who reported having a current household member who had previously been told by a provider that they had COVID-19 had a higher overall prevalence (33.6% versus 2.2%; p = 0.004).

Among all participants with positive RT-PCR results, 44.2% reported no symptoms during the 2 weeks before testing. Among these persons, no differences by demographic characteristics were identified. However, a higher but nonsignificant percentage of males reported being asymptomatic (60.3%) than did females (24.5%; p = 0.056) at the time of testing.

The nonrandom sample group included 898 persons (Table 2). In this more racially and ethnically diverse group, 22.8% of participants had a positive RT-PCR test result, indicating active infection, and an additional 5.8% were seropositive. Among those with active infection, 20.2% reported being asymptomatic.

Discussion

The results of this large statewide population prevalence study, in a state with a population of 6.73 million,[§] indicate that an estimated 187,802 Indiana residents were infected with SARS-CoV-2 from the start of the pandemic through April 29, 2020, a population prevalence of 2.8%. The finding that more persons had samples that tested positive for SARS-CoV-2 by RT-PCR, indicating an active infection, than for SARS-CoV-2 antibodies suggests that Indiana was in the early stage of the pandemic when the study was conducted. In late April, a total of 17,792 COVID-19 cases had been confirmed using conventional testing strategies (*3*), and were reported in the state, including 1,099 COVID-19–associated deaths. Based on the estimated total number of infections, the estimated infection-fatality rate was 0.58%, or approximately six times the 0.1% mortality rate for influenza (*5*). This fatality rate is lower than the infection-fatality rate of 1.3 observed on a cruise ship (*2*) but consistent with an extrapolated infection-fatality rate in China of 0.66% derived from a nonrandom sample of persons repatriated to their countries from China after the outbreak (*6*).

Because of the higher prevalence and smaller percentage of asymptomatic persons in the nonrandom sample, those estimates (and estimates from nonrandom samples from other states) might be subject to selection bias and are therefore not as representative as are estimates from random samples. The Indiana estimates of seroprevalence might be more comparable with the seroprevalence from a county-based random sample study in Los Angeles, California, that reported a seroprevalence

[§] https://www.census.gov/quickfacts/IN.

TABLE 1. Estimated point prevalence* of current or past infection with SARS-CoV-2, by demographic characteristics and urbanicity — Indiana, April 25–29, 2020

Characteristic (no. with information)	Random sample size, no. (%)	Expected sample size,† no.	SARS-CoV-2 positive by RT–PCR for current infection (N = 3,605) % (95% CI)	Asymptomatic (among RT-PCR positive results) %	SARS-CoV-2 positive by IgG for past infection§ (N = 3,518) % (95% CI)	Total population prevalence¶ (valid test result: N = 3,632) % (95% CI)
Totals	**3,658**	**N/A**	**1.74 (1.1–2.5)**	**44.2**	**1.09 (0.8–1.5)**	**2.79 (2.0–3.7)**
Sex (3,651)						
Female	1,995 (55)	1,850	1.42 (0.8–2.2)	24.7	1.02 (0.5–1.6)	2.41 (1.6–3.3)
Male	1,656 (45)	1,801	2.13 (0.9–3.9)	60.2	1.18 (0.7–1.9)	3.26 (1.9–5.0)
Race (3,658)						
White	3,373 (92)	3,180	1.47 (1.0–2.1)	40.3	1.02 (0.6–1.5)	2.70 (1.7–3.3)
Nonwhite	281 (8)	479	3.39 (0.6–7.9)	54.8	1.54 (0.4–3.1)	4.83 (1.7–9.5)
Hispanic origin (3,658)						
Hispanic	80 (2)	259	6.85 (1.2–15.2)	56.9	1.49 (0.3–4.9)	8.32 (2.7–15.8)**
Non-Hispanic	3,578 (98)	3,399	1.28 (0.9–1.7)	38.1	1.06 (0.7–1.5)	2.29 (1.9–2.7)**
Urbanicity (3,658)††						
Urban††	2,323 (63)	2,303	1.72 (0.8–3.0)	47.3	1.04 (0.6–1.5)	2.72 (1.6–4.0)
Rural/Mixed	910 (25)	874	2.05 (1.0–3.2)	34.6	1.24 (0.5–2.1)	3.23 (2.1–4.8)
Rural	425 (12)	480	1.20 (0.3–2.3)	54.5	1.08 (0.3–2.5)	2.25 (0.8–4.0)
Age group (yrs) (3,658)						
<40	1,017 (28)	1,928	1.71 (0.9–2.7)	34.5	1.39 (0.7–2.2)	3.05 (1.9–4.3)
40–59	1,328 (36)	922	2.09 (1.0–3.5)	47.8	1.08 (0.5–1.8)	3.14 (1.9–5.0)
≥60	1,313 (36)	808	0.92 (0.4–1.5)	45.4	0.77 (0.3–1.3)	1.65 (1.0–2.4)
Ever told by a doctor respondent had positive test result for SARS-CoV-2 (3,658)						
Yes	53	N/A	24.4 (2.7–49.0)**	N/A	16.8 (4.0–34.5)**	40.9 (15.4–63.8)**
No	3,605	N/A	1.3 (1.0–2.0)**	N/A	0.8 (0.6–1.2)**	2.2 (1.6–3.0)**
Ever told by a doctor that household member had positive test result for SARS-CoV-2 (3,629)						
Yes	50	N/A	29.4 (3.8–53.1)**	N/A	6.0 (0.9–14.0)	33.6 (10.9–59.0)**
No	3,608	N/A	1.3 (0.8–1.8)**	N/A	1.0 (0.7–1.4)	2.2 (1.7–2.9)**

Abbreviations: CI = confidence interval; IgG = immunoglobulin G; N/A = not applicable; RT-PCR = reverse transcription–polymerase chain reaction.
* Point estimates and CIs were produced by bootstrap methods.
† Based on U.S. Census population estimates.
§ Based on presence of antibodies without evidence of current infection.
¶ Evidence of current or previous infection.
** p<0.05 based on a resampling test using bootstrap methods.
†† Purdue Rural Indiana Classification System (https://pcrd.purdue.edu/ruralindianastats/geographic-classifications.php#table1).

of 4.7% in mid-April 2020 (*2*), which is higher than this statewide seropositivity rate.

Participants with a household member who had received a diagnosis of COVID-19 were 15 times more likely to have had positive test results for SARS CoV-2 than were those who did not. This, along with the relatively low observed statewide prevalence, suggests that social distancing efforts (e.g., stay-at-home orders) that were in effect during March 24–May 3, 2020, likely minimized community spread. Because these policies have been shown to be effective (*7*), in the absence of a vaccine, they constitute important approaches for prevention of transmission. These findings also underscore the importance of assuring effective protection of household members when patients with COVID-19 undergo home isolation.

Racial minorities in the nonrandom sample and Hispanics in the random sample experienced higher prevalences than did whites and non-Hispanics, suggesting the need for communication strategies tailored to the culture and languages of local communities, as well as more testing and contact tracing resources to prevent additional infections in these groups. Such initiatives should involve local community leaders who can help mobilize persons to participate despite a potential mistrust of government within these communities (*8*). The significantly higher observed prevalence in minority communities might have been due in part to social conditions that increased transmission opportunities, including minorities being disproportionately represented among essential workers.

The findings in this report are subject to at least five limitations. First, the main sample was randomly selected but achieved a low response rate of 23.6%, although standard practices were followed to adjust for nonresponse. However, respondents might have been subject to response bias, which could have resulted in underestimates or overestimates. Second, limitations in the tests themselves or the testing procedures might have caused inaccurate results. Whereas the laboratory-based negative percent agreement was 100% for all tests, the

TABLE 2. Estimated point prevalence of current or past infection with SARS-CoV-2, by demographic characteristics — nonrandom sample, Indiana, May 2–3, 2020

Characteristic*	Total nonrandom sample size, no. (%)	% SARS-CoV-2 positive by RT-PCR for current infection (N = 898)	% Asymptomatic (among RT-PCR positive results)	% SARS-CoV-2 positive by IgG for past infection† (N = 889)	% Total population prevalence§ (valid test result: N = 898)	p value¶
Total	**898**	**22.8**	**20.2**	**5.8**	**28.6**	—
Sex						
Female	523 (58.2)	21.7	22.6	6.0	27.7	0.369
Male	375 (41.8)	24.2	17.4	5.5	29.7	
Race						
White	208 (23.1)	19.5	24.6	4.7	24.2	<0.001
Black	295 (32.9)	9.0	35.6	6.8	15.8	
Other (including multiracial)	395 (44.0)	36.9	14.4	5.7	42.5	
Hispanic origin						
Hispanic	396 (44.1)	37.6	17.6	7.0	44.7	<0.001
Non-Hispanic	502 (55.9)	13.0	20.7	4.9	17.9	
Age group (yrs)						
<20	77 (8.6)	31.0	30.0	7.5	38.5	<0.001
20–39	277 (30.8)	29.3	13.0	6.5	35.8	
40–59	369 (41.1)	24.9	20.5	5.2	30.1	
60–79	169 (18.8)	6.9	37.7	5.0	11.9	
≥80	6 (0.7)	0	0	16.8	16.8	
Ever told by a doctor respondent had positive test result for SARS-CoV-2						
Yes	55 (6.1)	39.2	13.8	14.1	53.3	0.002
No	843 (93.9)	21.6	20.8	5.2	26.9	
Ever told by a doctor that household member had positive test result for SARS-CoV-2						
Yes	97 (10.8)	46.1	16.1	11.0	57.1	<0.001
No	801 (89.2)	20.2	20.8	5.2	25.4	

Abbreviations: IgG = immunoglobulin G; RT-PCR = reverse transcription–polymerase chain reaction.
* Data are adjusted for clustering within home address.
† Determined by presence of antibodies without evidence of current infection.
§ Evidence of current or previous infection.
¶ P-values compare group differences for overall population prevalence.

positive percent agreement¶ was 90% for one RT-PCR test and 100% for the others. Samples from participants tested in the early stages of infection or poor sampling technique could have caused false-negative results. The antibody test has an estimated 100% sensitivity 14 days after symptom onset in SARS-CoV-2–infected persons and a specificity of 99.6%, which could have caused some false-positive results. Third, in the nonrandom sample, self-selection by potentially more symptomatic persons might have contributed to the higher overall prevalence of current and previous infections and lower prevalence of asymptomatic infections. Population-based prevalence estimates from nonrandom samples should be interpreted with caution; however, focused nonrandom sampling among groups at higher risk for infection can provide data to enhance public health mitigation and containment strategies. Fourth, the study was conducted in Indiana at one point in time and therefore is not generalizable to other states and times. Finally, the study excludes persons who did not file state tax returns, those who were institutionalized, and children aged <12 years.

This study does, however, provide context for the importance of random sample studies in statewide populations. Policymakers need to have generalizable population estimates of SARS-CoV-2 prevalence to establish baseline prevalence rates and to understand the groups most at risk for infection. The uninfected majority of state residents represents the minimum number of persons who are susceptible to the virus because it remains to be determined whether those previously infected are susceptible to reinfection. Given the large number of persons who remain susceptible in Indiana, adherence to evidence-based public health mitigation and containment measures (e.g., social distancing, consistent and correct use of face coverings, and hand hygiene) continues to be needed to reduce surge in hospitalizations and prevent morbidity and mortality from COVID-19.

¶ Statistical guidance on reporting results from studies evaluating diagnostic tests states that when a new test is evaluated by a comparison with a nonreference standard, unbiased estimates of sensitivity and specificity cannot be calculated. The estimates are called positive percent agreement and negative percent agreement, reflecting that the estimates are not of accuracy but of agreement of the new test with the nonreference standard. (https://www.fda.gov/media/71147/download).

Summary

What is already known about this topic?

No state has conducted a random sample study to determine the population prevalence of SARS-CoV-2 infection at a given point in time.

What is added by this report?

In a random sample of Indiana residents aged ≥12 years, the estimated prevalence of current or previous SARS-CoV-2 infection in late April 2020 was 2.79%. Among persons with active infection, 44% reported no symptoms.

What are the implications for public health practice?

The number of reported cases represents an estimated one of 10 infections. Given that many persons in Indiana remain susceptible, adherence to evidence-based public health mitigation measures (e.g., social distancing, consistent and correct use of face coverings, and hand hygiene) is needed to reduce surge in hospitalizations and prevent morbidity and mortality from COVID-19.

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Estimated Community Seroprevalence of SARS-CoV-2 Antibodies — Two Georgia Counties, April 28–May 3, 2020

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Transmission of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), is ongoing in many communities throughout the United States. Although case-based and syndromic surveillance are critical for monitoring the pandemic, these systems rely on persons obtaining testing or reporting a COVID-19–like illness. Using serologic tests to detect the presence of SARS-CoV-2 antibodies is an adjunctive strategy that estimates the prevalence of past infection in a population. During April 28–May 3, 2020, coinciding with the end of a statewide shelter-in-place order, CDC and the Georgia Department of Public Health conducted a serologic survey in DeKalb and Fulton counties in metropolitan Atlanta to estimate SARS-CoV-2 seroprevalence in the population. A two-stage cluster sampling design was used to randomly select 30 census blocks in each county, with a target of seven participating households per census block. Weighted estimates were calculated to account for the probability of selection and adjusted for age group, sex, and race/ethnicity. A total of 394 households and 696 persons participated and had a serology result; 19 (2.7%) of 696 persons had SARS-CoV-2 antibodies detected. The estimated weighted seroprevalence across these two metropolitan Atlanta counties was 2.5% (95% confidence interval [CI] = 1.4–4.5). Non-Hispanic black participants more commonly had SARS-CoV-2 antibodies than did participants of other racial/ethnic groups (p<0.01). Among persons with SARS-CoV-2 antibodies, 13 (weighted % = 49.9; 95% CI = 24.4–75.5) reported a COVID-19–compatible illness,* six (weighted % = 28.2; 95% CI = 11.9–53.3) sought medical care for a COVID-19–compatible illness, and five (weighted % = 15.7; 95% CI = 5.1–39.4) had been tested for SARS-CoV-2 infection, demonstrating that many of these infections would not have been identified through case-based or syndromic surveillance. The relatively low seroprevalence estimate in this report indicates that most persons in the catchment area had not been infected with SARS-CoV-2 at the time of the survey. Continued preventive measures, including social distancing, consistent and correct use of face coverings, and hand hygiene, remain critical in controlling community spread of SARS-CoV-2.

DeKalb and Fulton counties had the highest numbers of reported COVID-19 cases among Georgia counties at the time of survey initiation (approximately 1,900 and 2,700, respectively). A two-stage cluster sampling design, stratified by county, was used to target a representative sample of 420 households.† Within each county, 30 census blocks were randomly selected with probability proportional to number of occupied households (per 2010 U.S. Census) without replacement. Selection of the census blocks was performed using the Community Assessment for Public Health Emergency Response Geographic Information System Toolbox.§ Within each census block, systematic sampling was used to select seven households for participation; a centroid starting location was defined and every n^{th} household (defined as number of households in the cluster divided by seven) was approached for participation.

The survey was conducted during April 28–May 3, overlapping partially with the Georgia shelter-in-place order for all residents (April 3–30). A household was defined as a living space shared by one or more persons, excluding correctional facilities, long-term care facilities, dormitories, or other institutional settings. Unoccupied buildings were excluded. If a household declined participation, did not respond to an initial door knock, or could not be enrolled for another reason,¶ an adjacent household was selected. All household members who

* An illness was categorized as one compatible with COVID-19 if symptoms met the Council of State and Territorial Epidemiologists (CSTE) clinical criteria in the case definition, including 1) cough, shortness of breath, or difficulty breathing or 2) two or more other symptoms (fever [measured or subjective], chills, rigors, myalgia, headache, sore throat, new olfactory and taste disorders). https://cdn.ymaws.com/www.cste.org/resource/resmgr/2020ps/interim-20-id-01_covid-19.pdf.

† Sample size calculations were performed assuming a seroprevalence of 1%, a margin of error of 0.9%, and a design effect of 1.6 to account for the survey design and intra-cluster correlation.

§ https://www.cdc.gov/nceh/casper/sampling-methodology.htm.

¶ Included circumstances such as 1) only a minor at home or awake; 2) a language barrier (Spanish as the main language in a household was not considered a language barrier because materials were translated into Spanish, and Spanish-speaking interviewers were available); 3) an inaccessible household; and 4) a potential security concern.

spent an average of ≥2 nights per week in the home were invited to participate. A blood sample for serology was required from at least one household member for household enrollment. A standardized questionnaire was administered to participants, assessing household and demographic characteristics, chronic medical conditions, recent illnesses and associated symptoms, previous testing for SARS-CoV-2, and potential exposures.

This investigation was determined by CDC and the Georgia Department of Public Health to be public health surveillance.** Participants or their parent or guardian provided written consent. Individual test results were returned to participants who indicated that they would like to receive them. After the survey was completed, CDC and the Georgia Department of Public Health participated in a community outreach event to address community questions and concerns about the survey.

Phlebotomists used standard venipuncture technique to collect blood in households from consenting participants. Blood was collected in K2-EDTA tubes and transported to a CDC laboratory certified under the Clinical Laboratory Improvement Amendments of 1988 (CLIA), where plasma was separated into aliquots in Nalgene cryogenic vials. One aliquot was heat-treated at 56°C (132.8°F) for 10 minutes, and then tested using the qualitative VITROS anti-SARS-CoV-2 total antibody in vitro diagnostic test on the automated VITROS 3600 Immunodiagnostic System (Ortho Clinical Diagnostics).†† Verification of the assay performance characteristics was performed by the CDC testing laboratory (sensitivity = 93.2%, specificity = 99.0%, accuracy = 96.8%, reproducibility = 100.0%, and serum/plasma equivalency = 95.6%).

The age, sex, and racial/ethnic distributions of participants were compared with those of the catchment area population using one-way chi-squared goodness-of-fit tests. Initial weights were computed as the inverse of the probability of selection and adjusted using a raking algorithm so that the marginal distribution of age group, sex, and race/ethnicity of the sample closely agreed with population estimates from the U.S. Census Bureau (*1*,*2*). Crude values and population estimates (weighted proportions) are reported for describing the survey participants. Characteristics of participants with (seropositive) and without (seronegative) presence of SARS-CoV-2 antibodies were compared using a score test for independence that performs well even with sparse data (*3*). Wilson's interval was used for computing 95% CIs (*4*,*5*). Analysis was conducted using SAS (version 9.4; SAS Institute).

Among 1,675 households approached, 397 (23.7%) were enrolled, attaining 94.5% of the targeted 420 households.§§ All 60 census blocks were represented, with an average of 6.6 (range = 2–7) households enrolled per census block. Participating households had a total of 1,122 household members (median household size = two; range = 1–11); 708 persons provided a blood sample for serology, and 696 (98.3%) persons from 394 (99.2%) households had a serology result.¶¶ Compared with census data for the counties, participants were less frequently children aged <18 years and more likely to be non-Hispanic white (Table 1).

Overall, 19 (2.7%) of 696 participants, representing 15 (3.8%) of 394 households in 14 census blocks, were seropositive. The weighted seroprevalence in the total catchment area was 2.5% (95% CI = 1.4–4.5). Among age groups, seroprevalence estimates were highest among adults aged 18–64 years; no children were seropositive (Table 2). Among racial/ethnic groups, the highest estimated seroprevalence (5.2%; 95% CI = 2.9–9.1) was among non-Hispanic black participants, which was significantly higher than that among all other racial/ethnic groups combined (p<0.01).

Two participants from separate households reported a previously confirmed SARS-CoV-2 infection; both were seropositive (Table 3). A COVID-19–compatible illness during 2020 was reported by 229 (weighted % = 33.3; 95% CI = 27.6–39.6) seronegative participants and 13 (weighted % = 49.9; 95% CI = 24.4–75.5) seropositive participants (p = 0.31). Among seropositive persons, none had been hospitalized, six (weighted % = 28.2; 95% CI = 11.9–53.3) had sought medical care for a COVID-19–compatible illness, and five (weighted % = 15.7; 95% CI = 5.1–39.4) had been previously tested for SARS-CoV-2 infection.

Among seropositive participants, two had known contact with a person with COVID-19. Work in a health care setting, although not necessarily as a direct care provider, was reported by five (weighted % = 19.9; 95% CI = 7.2–44.6) seropositive participants, and 56 (weighted % = 8.4; 95% CI = 5.3–13.1) seronegative participants (p = 0.28). Living in a multi-unit dwelling (two or more units per building) was reported for six (weighted % = 52.0; 95% CI = 26.5–76.5) seropositive participants and 175 (weighted % = 27.2; 95% CI = 17.5–39.7) seronegative participants (p = 0.20).

** US Department of Health and Human Services, Title 45 Code of Federal Regulations 46, Protection of Human Subjects.

†† This test was authorized by the Food and Drug Administration for emergency use only. Method verification was completed at CDC in a CLIA-certified diagnostic reference laboratory. Test results were automatically calculated on the VITROS Immunodiagnostic System by dividing the Signal for the test sample to Cutoff (S/C). Specimens with S/C <1.0 are interpreted as nonreactive for anti-SARS-CoV-2 total. Specimens with S/C ≥1.0 are interpreted as reactive for anti-SARS-CoV-2 total.

§§ Of 1,675 approached households, 34.4% refused, 37.8% had no response, and 4.0% requested a return visit at another time that was not completed.

¶¶ Samples for 12 participants could not be tested because of insufficient volume or hemolysis; these participants and a resultant three households were excluded (i.e., no household member had a test result).

TABLE 1. Unweighted demographic characteristics of survey participants with a SARS-CoV-2 serology test result, compared with 2018 postcensal estimates for the overall catchment area — DeKalb and Fulton counties, Georgia, April 28–May 3, 2020

Characteristic	No. (%) Participants (N = 696)	No. (%) Catchment area* (N = 1,806,672)	p value†
Gender			0.241
Male	317 (45.6)	866,297 (47.9)	
Female	377 (54.2)	940,375 (52.1)	
Other§	2 (0.3)	0 (—)	
Age group (yrs)			<0.001
0–17	48 (6.9)	404,349 (22.4)	
18–49	347 (49.9)	860,956 (47.6)	
50–64	189 (27.2)	324,517 (18.0)	
≥65	112 (16.1)	216,850 (12.0)	
Race/Ethnicity			<0.001
White, non-Hispanic	329 (47.3)	634,436 (35.1)	
Black, non-Hispanic	266 (38.2)	854,544 (47.3)	
Hispanic	44 (6.3)	141,394 (7.8)	
Asian/Pacific Islander, non-Hispanic	29 (4.2)	128,981 (7.1)	
Multiple race/Other/Unknown	28 (4.0)	47,317 (2.6)	

Source: National Center for Health Statistics. Vintage 2018 postcensal estimates. https://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm#Vintage2018.
* DeKalb County and Fulton County combined; 2018 postcensal estimates.
† One-way chi-squared goodness-of-fit tests comparing sample with catchment area demographics.
§ Excluded when testing against the distribution of the catchment area.

Discussion

A door-to-door household survey conducted in two counties in metropolitan Atlanta during April 28–May 3, 2020, found an estimated 2.5% seroprevalence of SARS-CoV-2 antibodies. This suggests that most of the population had not been infected with SARS-CoV-2 at the time of the survey, which occurred at the end of the statewide shelter-in-place order. Few U.S. studies are available for comparison; those available used different methods and estimated seroprevalence during April at 1.8% in Boise, Idaho; 4.7% in Los Angeles, California; and 14.0% in New York (including New York City) (*6*–*8*).

In this metropolitan Atlanta survey, an estimated one half of seropositive persons recalled having had a COVID-19–compatible illness, approximately one third sought medical care for the illness, and even fewer had a test for SARS-CoV-2 infection. These findings highlight that many SARS-CoV-2 infections would have been missed by case-based surveillance, which requires receiving medical care in the health care system or a test for SARS-CoV-2, and by syndromic surveillance, which relies on symptomatic illness. As testing practices change during the course of the pandemic, this pattern, reflecting findings at the end of April, might also change.

SARS-CoV-2 seropositivity was associated with non-Hispanic black race/ethnicity in this survey. Although the number of seropositive persons in the survey are small for

TABLE 2. Demographic characteristics of participants with and without SARS-CoV-2 antibodies and estimated seroprevalence — DeKalb and Fulton counties, Georgia, April 28–May 3, 2020

Characteristic	Participants with SARS-CoV-2 antibodies (N = 19) No.	Weighted proportion,* % (95% CI)	Participants without SARS-CoV-2 antibodies (N = 677) No.	Weighted proportion,* % (95% CI)	Estimated seroprevalence (95% CI)
Total	**19**	**100**	**677**	**100**	**2.5 (1.4–4.5)**
Sex					
Male	8	50.1 (25.6–74.7)	309	47.8 (43.3–52.2)	2.6 (1.1–6.3)
Female	11	49.9 (25.3–74.4)	366	52.0 (47.6–56.5)	2.4 (1.1–5.1)
Other	0	0 (—)	2	0.2 (0.0–0.9)	—
Age group (yrs)					
0–17	0	0 (—)	48	22.8 (16.7–30.3)	—
18–49	12	61.6 (35.2–82.6)	335	47.4 (40.8–54.1)	3.3 (1.6–6.4)
50–64	6	35.2 (14.8–62.8)	183	17.5 (14.5–21.1)	4.9 (1.8–12.9)
≥65	1	3.2 (0.4–21.8)	111	12.3 (9.4–15.8)	0.7 (0.1–4.5)
Race/Ethnicity					
White, non-Hispanic	2	4.6 (0.7–23.7)	327	37.2 (27.8–47.7)	0.3 (0.1–1.7)
Black, non-Hispanic	16	93.5 (73.8–98.7)	250	44.2 (33.8–55.1)	5.2 (2.9–9.1)
Hispanic	0	0 (—)	44	7.7 (4.2–13.5)	—
Asian/Pacific Islander, non-Hispanic	0	0 (—)	29	6.9 (2.5–17.6)	—
Multiple race/Other/Unknown	1	1.9 (0.2–19.8)	27	4.0 (2.1–7.5)	1.2 (0.1–14.1)

Abbreviation: CI = confidence interval.
* Weights were computed as the inverse of the probability of selection and adjusted so that the marginal distribution of age group, sex, and race/ethnicity of the sample closely agreed with population estimates; presented as column percentages.

TABLE 3. Characteristics and exposures of participants with and without SARS-CoV-2 antibodies — DeKalb and Fulton counties, Georgia, April 28–May 3, 2020

Characteristic	Participants with SARS-CoV-2 antibodies (N = 19)		Participants without SARS-CoV-2 antibodies (N = 671)*	
	No.	Weighted proportion,† % (95% CI)	No.	Weighted proportion,† % (95% CI)
Illness history during 2020				
COVID-19–compatible illness§	13	49.9 (24.4–75.5)	229	33.3 (27.6–39.6)
Any illness with cough or shortness of breath	10	31.1 (13.8–55.9)	188	26.2 (21.2–32.0)
Any illness with fever/feeling feverish	12	47.9 (23.3–73.6)	147	21.7 (16.7–27.6)
Any illness with loss of taste or smell	8	28.4 (12.4–52.7)	38	8.2 (4.9–13.5)
Sought medical care for illness¶	6	28.2 (11.9–53.3)	117	16.3 (12.1–21.6)
Hospitalized because of illness	0	0 (—)	5	0.9 (0.4–2.2)
Missed work or school because of illness	10	42.4 (20.1–68.2)	121	19.7 (15.1–25.4)
Previous test for SARS-CoV-2				
None	14	84.3 (60.6–94.9)	643	97.1 (95.4–98.2)
Positive result	2	7.0 (1.5–27.0)	0	0 (—)
Negative result	1	4.4 (0.7–23.5)	23	2.6 (1.6–4.3)
Unknown result**	2	4.3 (0.7–23.3)	5	0.3 (0.1–1.1)
Medical history				
Any chronic condition††	7	20.3 (8.1–42.5)	309	39.8 (34.0–45.8)
Chronic lung disease	1	1.5 (0.1–19.2)	86	14.0 (10.8–18.0)
Cardiovascular disease	5	15.5 (5.4–37.2)	167	18.5 (14.9–22.7)
Chronic kidney disease	0	0 (—)	8	1.1 (0.4–3.0)
Liver disease	0	0 (—)	8	0.6 (0.2–1.5)
Diabetes mellitus§§	2	5.3 (0.9–24.6)	61	7.2 (5.2–10.0)
Autoimmune/Rheumatologic condition	2	5.9 (1.2–25.6)	27	2.8 (1.8–4.3)
Immunocompromising condition or therapy	0	0 (—)	46	5.1 (3.6–7.2)
Neurologic condition	0	0 (—)	18	2.8 (1.7–4.7)
Seasonal allergies	10	43.3 (21.8–67.7)	404	59.7 (52.7–66.3)
Pregnant or postpartum¶¶	0	0 (—)	9	1.4 (0.5–3.5)
Known exposures to ill persons				
Contact with ≥1 person with confirmed COVID-19	2	7.8 (1.8–28.0)	30	6.5 (3.8–10.9)
Cared for person with confirmed COVID-19	2	7.8 (1.8–28.0)	12	2.5 (1.2–5.3)
Contact with ≥1 person with respiratory symptoms (not known confirmed COVID-19)	5	20.9 (7.3–46.9)	139	21.9 (17.3–27.2)
Travel during 2020				
International travel (outside of the United States)	2	9.8 (2.6–30.5)	81	11.1 (7.2–16.7)
Domestic travel (outside of Georgia)	4	24.3 (9.2–50.5)	254	32.4 (26.7–38.8)
Work setting				
Attend or work in a school or daycare***	6	21.7 (8.9–44.1)	188	38.8 (31.3–47.0)
Work in a health care setting***	5	19.9 (7.2–44.6)	56	8.4 (5.3–13.1)
Outpatient or urgent care clinic	3	10.0 (2.4–33.3)	17	2.1 (1.2–3.8)
Hospital or emergency department	2	10.0 (2.7–30.9)	13	1.3 (0.6–2.4)
Long-term care or assisted living facility	0	0 (—)	3	0.9 (0.2–3.3)
>1 setting	0	0 (—)	4	0.4 (0.1–1.2)
Other†††	0	0 (—)	19	3.8 (1.9–7.5)

See table footnotes on the next page.

assessing differences between seronegative and seropositive persons, this finding is congruent with other data indicating that non-Hispanic blacks have been disproportionally affected by the COVID-19 pandemic (*9*). A multitude of factors might play a role in this disparity (e.g., social determinants of health, including factors related to housing, economic stability, and work circumstances). In general, black persons have increased likelihood of exposure through work in frontline industries and are more likely to live in housing structures with higher population density (*10*).

Many aspects of the immune response to SARS-CoV-2 infection are unknown. Understanding rates of seroconversion among asymptomatic persons, the duration of detectable circulating antibodies in relation to illness severity, and the potential impact of host factors (e.g., age and underlying medical conditions) on seroconversion are essential for interpreting SARS-CoV-2 seroprevalence data. It is also unknown whether antibodies, as detected by commonly available serologic assays, confer immunity, a critical factor in understanding the implications of seroprevalence estimates.

TABLE 3. (*Continued*) Characteristics and exposures of participants with and without SARS-CoV-2 antibodies — DeKalb and Fulton counties, Georgia, April 28–May 3, 2020

Characteristic	Participants with SARS-CoV-2 antibodies (N = 19)		Participants without SARS-CoV-2 antibodies (N = 671)*	
	No.	Weighted proportion,† % (95% CI)	No.	Weighted proportion,† % (95% CI)
Work industry (participants aged ≥18 years)§§§				
Utilities/Construction/Manufacturing	0	0 (—)	42	4.7 (3.2–6.7)
Warehouse/Shipping/Parcel delivery	2	19.6 (5.2–52.0)	9	0.8 (0.4–1.8)
Restaurants/Bars/Food services/Accommodation	1	10.7 (2.1–39.9)	23	3.4 (2.1–5.4)
Retail/Grocery stores	0	0 (—)	19	2.0 (1.2–3.4)
Transportation	0	0 (—)	14	1.5 (0.8–2.7)
Education/Child day care	0	0 (—)	48	6.3 (4.6–8.6)
Health care¶¶¶	6	37.6 (15.6–66.1)	53	7.4 (4.7–11.4)
Barber shop/Beauty salon/Personal services	1	3.9 (0.6–22.8)	9	1.0 (0.5–2.1)
Finance/Banking/Insurance and real estate/Rental/Leasing	0	0 (—)	34	3.8 (2.6–5.6)
Professional/Scientific/Technical services	0	0 (—)	47	7.1 (4.5–11.0)
Public administration	2	4.7 (0.8–23.9)	22	2.5 (1.5–4.1)
Religious organizations	1	2.9 (0.3–21.4)	5	0.3 (0.1–1.1)
Student	2	5.0 (0.9–24.3)	14	1.6 (0.9–2.9)
Other industry	0	0 (—)	53	6.4 (4.6–8.7)
Retired or unemployed	3	7.5 (1.7–27.6)	154	18.8 (14.7–23.8)
Insufficient information to classify	1	8.0 (1.6–32.6)	78	9.6 (6.7–13.5)
Dwelling type				
Single unit (including townhouses)	13	48.0 (23.5–73.5)	489	71.9 (59.4–81.7)
Multiunit (≥2 housing units per building)	6	52.0 (26.5–76.5)	175	27.2 (17.5–39.7)

Abbreviations: CI = confidence interval; COVID-19 = coronavirus disease 2019; CSTE = Council of State and Territorial Epidemiologists.

* Denominator = six of the 677 seronegative participants had missing data.

† Weights were computed as the inverse of the probability of selection and adjusted so that the marginal distribution of age group, sex, and race/ethnicity of the sample closely agreed with population estimates; column percentages are presented.

§ Based on clinical criteria in the CSTE COVID-19 case definition. (https://cdn.ymaws.com/www.cste.org/resource/resmgr/2020ps/interim-20-id-01_covid-19.pdf).

¶ Went to a doctor, clinic, emergency department, saw a doctor remotely through telemedicine because of the illness, or was hospitalized overnight for the illness.

** Includes test result still pending at the time of the survey.

†† Some persons reported more than one chronic condition; chronic conditions included chronic lung disease, cardiovascular diseases, chronic kidney disease, liver disease, diabetes mellitus, autoimmune or rheumatologic condition, immunocompromising condition or therapy, and neurologic condition.

§§ Includes reports of prediabetes.

¶¶ Postpartum defined as up to 6 weeks after childbirth.

*** Since January 2020 but not necessarily at the time of the survey.

††† Additional settings reported included functional medicine, physical therapy clinic, support office/building, mental health clinic, research administration, emergency medical technician, plasma donation center, home health care, federal OSHA clinic, research clinic, volunteer at a hospital, technician-phone interviews, dietician office, school nurse, dentist office, community clinic, and pharmaceutical representative.

§§§ Work information collected in a free text field was coded based on the Census Industry and Occupation Classification System. The codes were then combined into broad industry categories based on National Health Interview Survey simple and detailed recode categories. https://www.cdc.gov/niosh/topics/coding/analyze.html.

¶¶¶ One seropositive participant worked in health care but not in a health care setting (reported full-time telework in 2020).

The findings in this report are subject to at least six limitations. First, the sampling frame was derived from 2010 census data and did not reflect subsequent changes in housing and occupancy. Second, participation was voluntary, and the overall participation rate of approached households was low. The effect of nonresponse bias on the seroprevalence estimates is unknown; many factors might have influenced a person's willingness to participate, including the likelihood of being at home during the shelter-in-place order, mistrust of a door-to-door survey among community members, and the probability that the person was seropositive, all of which might affect the survey's representativeness. Active community engagement beginning at the design of the survey is an important component to gain trust and potentially improve participation. Third, racial and ethnic minority populations and children aged <18 years were underrepresented; the lack of seropositivity among persons aged <18 years might have biased the final seroprevalence estimate toward zero. Fourth, the survey was powered to determine an overall seroprevalence estimate and not for subgroup analyses. The number of seropositive participants was low, resulting in wide CIs for weighted proportions. Fifth, all serologic assays have associated error that can result in false-positive or false-negative results. Particularly, false-positive results are of concern when the overall population seroprevalence is low. The accuracy and precision of the final seroprevalence estimate is affected by both test and sampling error. Finally, case numbers in the Georgia counties where this survey was conducted have increased substantially since the survey was conducted; therefore, the seroprevalence

reported here does not represent the seroprevalence at the time of publication.

Community-level seroprevalence estimates can complement case-based and syndromic surveillance as a tool to understand local transmission and the extent of past infection in a population. The relatively low seroprevalence estimate in this report suggests that most persons in the catchment area had not been infected with SARS-CoV-2 by the end of April. Continued mitigation measures to prevent infection, including social distancing, consistent and correct use of face coverings, and hand hygiene, remain essential to controlling the spread of SARS-CoV-2 in the community.

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Summary

What is already known about this topic?

SARS-CoV-2 infection in persons who are asymptomatic or not tested might not be recognized by case-based and syndromic surveillance; therefore, the population prevalence of past infection might be unknown.

What is added by this report?

A community seroprevalence survey, conducted in two counties in metropolitan Atlanta during April 28–May 3, using a two-stage cluster sampling design and serologic testing, estimated that 2.5% of the population had antibodies to SARS-CoV-2.

What are the implications for public health practice?

Serologic surveillance can complement case-based and syndromic surveillance. At the time of this survey, most of the two-county population had not been previously infected with SARS-CoV-2, highlighting the importance of continued mitigation measures to prevent infection, including social distancing, consistent and correct use of face coverings, and hand hygiene.

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Notes from the Field

Effects of the COVID-19 Response on Tuberculosis Prevention and Control Efforts — United States, March–April 2020

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CDC's Division of Tuberculosis Elimination (DTBE) funds 61 state, local, and territorial tuberculosis programs in the United States through the TB Elimination and Laboratory cooperative agreement. Recipients report data to CDC on indicators that measure progress toward TB elimination and performance of essential TB program activities. After the first U.S. case of coronavirus disease 2019 (COVID-19) was reported on January 20, 2020 (*1*), CDC project officers were informed by these grantees that program personnel (including those positions funded through the CDC cooperative agreement and state or local budgets) would be deployed for their jurisdictions' COVID-19 response.

In April 2020, as part of routine monitoring, CDC project officers communicated with 50 of the 61 (82%) grantees to estimate the effect of COVID-19 deployments on essential TB activities. Eleven (18%) programs were not reached because of deployments among project officers and recipients. CDC project officers characterized the effect as 1) no impact (no changes in staffing assignments or TB program activities), 2) partial impact (<50% of personnel time dedicated to COVID-19 response or some changes made to program activity, but activity still being performed), or 3) high impact (50%–100% of personnel time dedicated to COVID-19 response or major changes made to program activity or activity not being performed at the time of the program's response) (Table).

Among the 50 programs, 60%–72% were experiencing partial or high impact on staffing capacity for 1) cooperative agreement and fiscal management, 2) clinical consultation or clinic service delivery, 3) outreach and field services (e.g., contact tracing and directly observed therapy), 4) surveillance and case reporting, and 5) training and program evaluation.

Changes in staffing capacity were assessed separately from changes in essential activities. For example, if staffing capacity had been reduced, nondeployed staff members could still have assumed additional, high-priority duties, such as ensuring patient care.

Partial or high impact on indicators measuring essential TB control activities was reported by 52% of jurisdictions for diagnosis and treatment of persons with TB disease, 68% for diagnosis and treatment of persons with latent TB infection, 64% for contact investigations for infectious TB, 74% for targeted testing and treatment of latent TB infection among populations at risk, and 58% for case reporting and other surveillance activities (genotype or cluster monitoring and data analysis). In addition, 74% of the TB programs reported reduced program evaluation, and 94% reported reduced education and training efforts.

The National TB Controllers Association (NTCA), which represents all state, local, and territorial programs, observed similar effects. NTCA convenes monthly webinars for members to discuss emerging problems and share best practices. By March, webinar participation was declining because of deployments. To obtain moment-in-time impressions of how the response was affecting TB activities, NTCA queried participants using a series of real-time text questions and tallied responses to each question. In the March 18 and April 9, 2020, webinars, >90% of 43 (March) and 38 (April) responses indicated that TB programs had deployed personnel to their jurisdictions' COVID-19 response. TB program personnel possess skills that health departments needed for the response. For example, among 72 responses in April, 26% were providing expertise in contact tracing, 21% in infection control, 17% in clinical care and treatment, and 14% in monitoring patients in home isolation.

Responses to polling questions indicated that capacity for essential TB activities declined between March and April. For example, during the April webinar, the percentage of responses regarding less time for interviewing patients doubled over responses to the same question in March (22% of 115 responses in April, compared with 10% of 110 responses in March), and 15% indicated challenges in obtaining TB medications, up from 7% in March. Transfer of TB resources for COVID-19 use (including personal protective equipment, housing, hospital beds, and isolation rooms) was indicated by 12% of responses in April, up from 7% in March.

These observations suggest that the COVID-19 response is diverting resources from essential TB elimination activities. Effects of reduced capacity on outcomes (e.g., increases in TB incidence or lower completion of treatment rates) will become clearer after provisional surveillance data, including number of U.S. TB cases reported during 2020, are published in early 2021. CDC is monitoring state capacity for reporting TB cases and will document gaps in reporting associated with the COVID-19 response. However, signals of reduced capacity are concerning. Incomplete contact investigations and delays in diagnosis of TB disease are associated with outbreaks of TB disease (*2*), and sustained weakening of TB programs was

TABLE. Effect of COVID-19 response on CDC tuberculosis (TB) elimination and laboratory program performance indicators, by level of impact — 50 U.S. jurisdictions,* April 2020

Performance indicator	No. (%)			
	No impact†	Partial impact§	High impact¶	Partial§ or high¶ impact
Program staffing for cooperative agreement and fiscal management	18 (36)	16 (32)	15 (30)	**31 (62)**
Program staffing for clinical consultation or clinic service delivery	17 (34)	21 (42)	12 (24)	**33 (66)**
Program staffing for outreach and field services (e.g., directly observed therapy or contact investigations)	16 (32)	16 (32)	14 (28)	**30 (60)**
Program staffing for surveillance and case reporting	14 (28)	24 (48)	12 (24)	**36 (72)**
Program staffing for training and program evaluation	15 (30)	13 (26)	21 (42)	**34 (68)**
Diagnosis and treatment of persons with TB disease	23 (46)	22 (44)	4 (8)	**26 (52)**
Diagnosis and treatment of persons with LTBI	15 (30)	25 (50)	9 (18)	**34 (68)**
Contact investigations for infectious TB cases	17 (34)	23 (46)	9 (18)	**32 (64)**
Targeted testing and treatment of LTBI among populations at risk	12 (24)	22 (44)	15 (30)	**37 (74)**
Case reporting and other surveillance activities (e.g., genotype or cluster monitoring and data analysis)	20 (40)	24 (48)	5 (10)	**29 (58)**
Program evaluation activities (e.g., cohort review)	10 (20)	20 (40)	17 (34)	**37 (74)**
Education and training activities	2 (4)	22 (44)	25 (50)	**47 (94)**

Abbreviations: COVID-19 = coronavirus disease 2019; LTBI = latent TB infection.
* Reported by 50 of 61 CDC-funded TB program recipients to CDC project officers. Number and row percent might total <50 (100%) as a result of missing responses. Eleven programs could not be reached because of deployments among the eight CDC project officers or in the TB programs.
† No changes in staffing assignments or TB program activities.
§ <50% of personnel time dedicated to COVID-19 response or some changes made to program activity, but activity is still being performed.
¶ 50%–100% of personnel time dedicated to COVID-19 response or major changes made to program activity or activity was not being performed at the time of the program's response.

recognized as a cause of the TB resurgence in the late 1980s and early 1990s (*3*).

The COVID-19 response has affected multiple sectors of public health, recommended preventive screening, and clinical care. The United States will need to address the backlog of population health services that have been delayed or not done while public health resources are focused on COVID-19. The U.S. domestic TB elimination program is one example. If essential TB program activities are not sustained, gains made in reducing U.S. TB cases will be at risk. CDC has published guidance regarding non–COVID-19 public health activities that require physical interaction with clients.* CDC will support grantees by providing technical assistance or outbreak response, when requested. NTCA will continue to communicate with members and share best practices for averting a resurgence of TB.

* https://www.cdc.gov/coronavirus/2019-ncov/hcp/non-covid-19-client-interaction.html.

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Notes from the Field

Characteristics of Tetrahydrocannabinol–Containing E-cigarette, or Vaping, Products Used by Adults — Illinois, September–October 2019

Livia Navon, MS[1,2]; Isaac Ghinai, MBBS[1,3]; Jennifer Layden, MD, PhD[4]

As of February 18, 2020, 2,807 patients hospitalized with e-cigarette, or vaping, product use–associated lung injury (EVALI) had been reported to CDC (*1*). Nationwide, and in Illinois, approximately 80% of EVALI patients reported use of tetrahydrocannabinol (THC)-containing e-cigarette, or vaping, products (*2*,*3*). The recent EVALI outbreak highlighted the limited availability of data on the characteristics of THC-containing e-cigarette, or vaping, products used in the United States.

During the EVALI outbreak, the Illinois Department of Public Health (IDPH) developed an online public survey targeting Illinois adults aged ≥18 years who used any e-cigarette, or vaping, products (*4*). The survey included questions about e-cigarette, or vaping, product use in the past 3 months, including types of substances used (e.g., nicotine, THC), product brand names (respondents could list up to 10 products), types of devices used (e.g., tank models, dab rigs), and product forms (e.g., oils, solids). The public survey link was available on the IDPH website during September 17–October 8, 2019, and was publicized by IDPH, the news media, and local health departments.

Overall, 4,527 survey responses were received from residents of all 102 Illinois counties; 939 (21%) respondents reported use of THC-containing e-cigarette, or vaping, products during the past 3 months; the median age of these respondents was 34 years (range = 18–77 years). Among THC-containing product users, 501 (53%) provided the brand names of products they had used in the past 3 months. These 501 respondents reported using 732 THC-containing products with 220 different brand names. Fifty-eight brands (26%) were reported by more than one respondent and accounted for 78% (570 of 732) of products reported, with the remaining 162 brand names each reported by only one respondent. Dank Vapes, a class of illicit THC-containing products sold under the same brand name but with no obvious centralized production or distribution, was the most commonly reported brand name (151 of 732 products; 21%) followed by Cresco* (59 of 732; 8%) (Figure). Products available through the Illinois Medical Cannabis Patient Program accounted for 23% of reported products (169 of 732 products); survey respondents aged ≥35 years reported 63% (106 of 169) of these legally available products.

Overall, 638 (68%) THC-containing product users reported which product form they used. Among these 638 respondents, 501 (79%) reported using prefilled, oil-containing cartridges, and 47 (7%) reported using THC-containing oil not in prefilled cartridges. Use of solids, such as dabs or waxes, was reported by 124 (19%) respondents, and use of marijuana plant material in e-cigarette, or vaping, devices was reported by 21 (3%) respondents. Fourteen percent of respondents (92 of 638) reported using more than one product form. Among the 695 THC-containing product users who provided e-cigarette, or vaping, device information, 244 (35%) reported using more than one type of device.

Although these data are from a convenience sample, these findings highlight the diversity of available THC-containing e-cigarette, or vaping, products. Most consumers of these products reported using prefilled, oil-containing cartridges; however, use of multiple product forms and device types was reported. Product brands used likely vary across jurisdictions and the corresponding regulatory environments for THC-containing products. Dank Vapes, the brand most frequently reported by survey respondents, was also the brand most frequently reported by EVALI patients in Illinois and nationally (*2*,*3*). To reduce the risk of EVALI, people should not use THC-containing e-cigarette, or vaping, products, particularly from informal sources such as friends, family, or in-person or online dealers (*1*).

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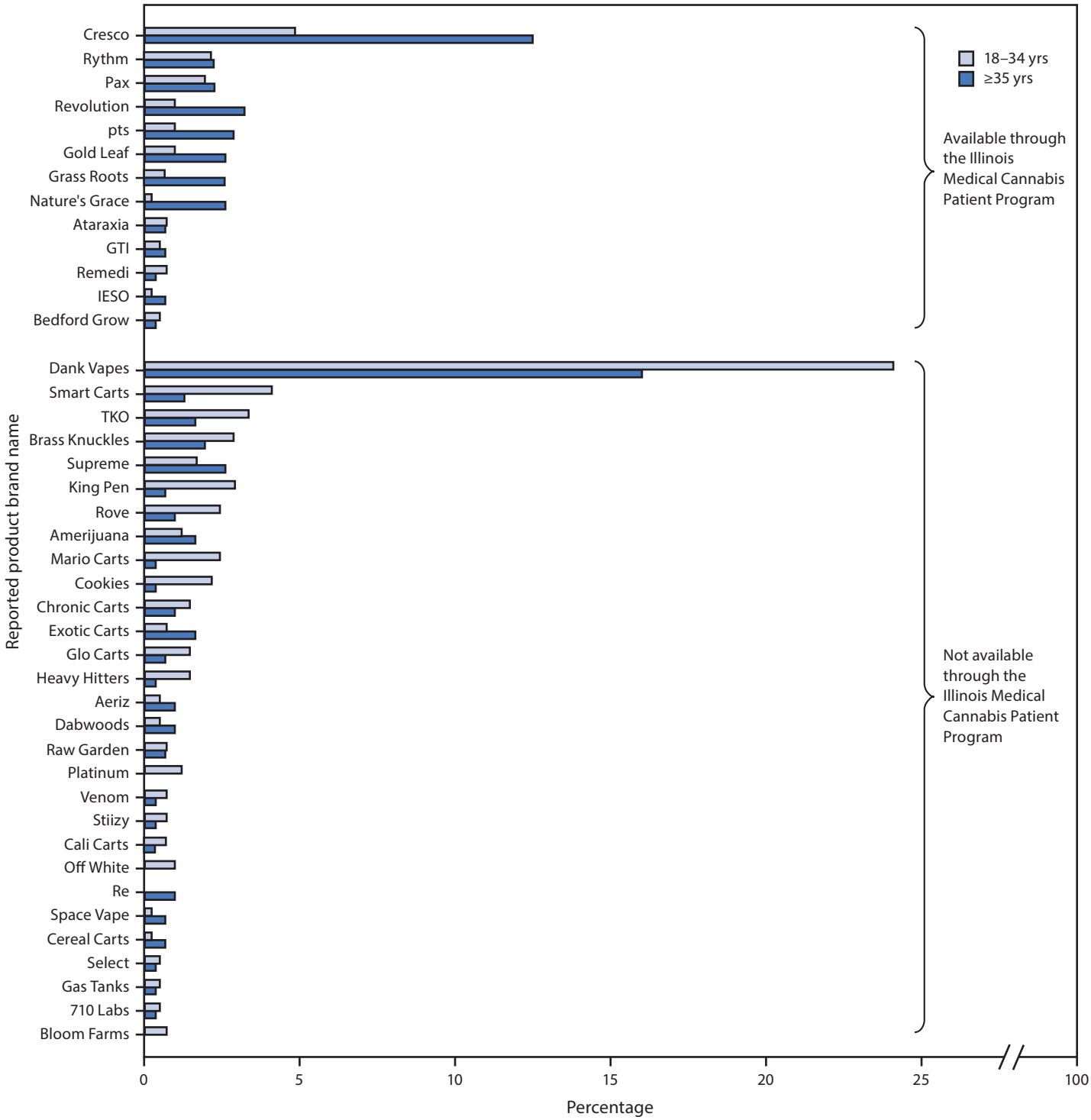
* Cresco is a product brand available legally through the Illinois Medical Cannabis Patient Program. A full list of products licensed through the Program is available at: https://www2.illinois.gov/sites/agr/Plants/MCPP/Pages/default.aspx.

FIGURE. Most frequently reported tetrahydrocannabinol (THC)-containing e-cigarette, or vaping, product brand names* as a percentage of all named products, by age group† and by Illinois Medical Cannabis Patient Program availability§ among a convenience sample of adult e-cigarette, or vaping, product users — Illinois, September–October 2019



* Brand names reported by at least three survey respondents are displayed.

† Survey respondents aged 18–34 years reported 419 products with brand names; survey respondents aged ≥35 years reported 313 products with brand names. Percentages for each age group were calculated using these denominators.

§ A full list of products licensed through the Illinois Medical Cannabis Patient Program is available at https://www2.illinois.gov/sites/agr/Plants/MCPP/Pages/default.aspx. At the time of the survey, products not available through the Illinois Medical Cannabis Patient Program were likely obtained through informal sources such as friends, family, in-person or online dealers, or from in-person purchases in jurisdictions with legalized adult-use cannabis sales. In Illinois, legal sale of adult-use cannabis products from licensed dispensaries began on January 1, 2020.

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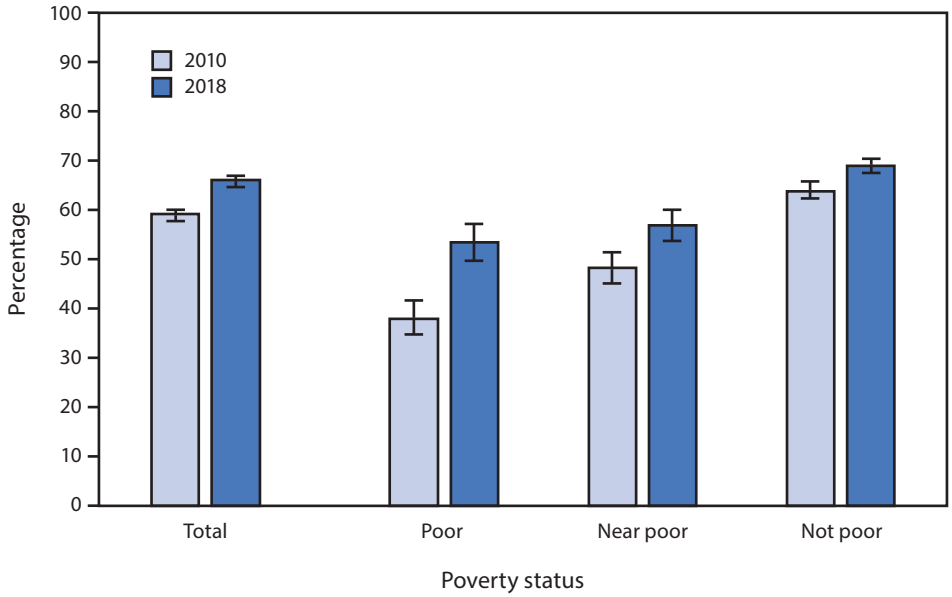
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults Aged 50–75 Years Who Received Colorectal Cancer Screening,† by Poverty Status§ and Year — National Health Interview Survey, United States, 2010 and 2018¶



* With 95% confidence intervals indicated with error bars.
† Based on survey questions that included reports of home fecal occult blood test (FOBT) in the past year, sigmoidoscopy procedure in the past 5 years with FOBT in the past 3 years, or colonoscopy in the past 10 years. These procedures constituted the 2008 U.S. Preventive Services Task Force (USPSTF) screening recommendations for colorectal cancer. Estimates of colorectal cancer screening are consistent with the 2008 USPSTF recommendations and do not incorporate the new colorectal test types discussed in the more recent 2016 USPSTF screening recommendations (https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/colorectal-cancer-screening).
§ Poverty status is determined by family income and family size using the U.S. Census Bureau's poverty thresholds (https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html). "Poor" persons are defined as those with incomes below the poverty threshold, "near poor" persons have incomes of 100% to <200% of the poverty threshold, and "not poor" persons have incomes of ≥200% of the poverty threshold.
¶ Estimates are based on household interviews of a sample of the noninstitutionalized U.S. civilian population.

The percentage of adults aged 50–75 years who received colorectal cancer tests or procedures increased from 58.7% in 2010 to 65.5% in 2018. The percentage increased from 2010 to 2018 in all income groups: from 37.9% to 53.1% among poor, 47.9% to 56.7% among near poor, and 63.6% to 68.7% among not poor adults. In both 2010 and 2018, the percentage of adults who received colorectal cancer screening was lowest among poor and highest among not poor adults.

Source: National Health Interview Survey, 2010 and 2018. https://www.cdc.gov/nchs/nhis.htm.

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