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Sociodemographic and Geographic Variation in Awareness of Stroke Signs and Symptoms Among Adults — United States, 2017

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Stroke is the fifth leading cause of death in the United States (*1*). In 2017, on average, a stroke-related death occurred every 3 minutes and 35 seconds in the United States, and stroke is a leading cause of long-term disability (*1*). To prevent mortality or long-term disability, strokes require rapid recognition and early medical intervention (*2*,*3*). Common stroke signs and symptoms include sudden numbness or weakness of the face, arm, or leg, especially on one side; sudden confusion or trouble speaking; sudden trouble seeing in one or both eyes; sudden trouble walking, dizziness, or loss of balance; and a sudden severe headache with no known cause. Recommended action at the first sign of a suspected stroke is to quickly request emergency services (i.e., calling 9-1-1) (*2*). Public education campaigns have emphasized recognizing stroke signs and symptoms and the importance of calling 9-1-1, and stroke knowledge increased 14.7 percentage points from 2009 to 2014 (*4*). However, disparities in stroke awareness have been reported (*4*,*5*). Knowledge of the five signs and symptoms of stroke and the immediate need to call emergency medical services (9-1-1), collectively referred to as "recommended stroke knowledge," was assessed among 26,076 adults aged ≥20 years as part of the 2017 National Health Interview Survey (NHIS). The prevalence of recommended stroke knowledge among U.S. adults was 67.5%. Stroke knowledge differed significantly by race and Hispanic origin ($p<0.001$). The prevalence of recommended stroke knowledge was highest among non-Hispanic White adults (71.3%), followed by non-Hispanic Black adults (64.0%) and Hispanic adults (57.8%). Stroke knowledge also differed significantly by sex, age, education, and urbanicity. After multivariable adjustment, these differences remained significant. Increasing awareness of the signs and symptoms of stroke continues to be a national priority. Estimates from this report can inform public health strategies for increasing awareness of stroke signs and symptoms.

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NHIS is an annual survey of the civilian noninstitutionalized U.S. population. In 2017, NHIS included supplemental content in the sample adult interview that provided a list of five signs and symptoms and asked respondents to identify whether each was a symptom "that someone may be having a stroke." Respondents also were asked to choose "the best thing to do right away" if "you thought someone was having a stroke." One choice was to call 9-1-1.*

The prevalence of knowing each of the five signs and symptoms, to call 9-1-1 for a suspected stroke, and the combination of recommended stroke knowledge was estimated overall and by subgroup. Point estimates and corresponding variances were calculated using SAS-callable SUDAAN (version 11.0; RTI International), accounting for the complex sample design, and weighted to be nationally representative. Satterthwaite-adjusted chi-squared tests were used to assess significant ($p<0.05$) bivariate associations. Logistic regression models (including age, sex, race/ethnicity, education, county urbanicity [large metropolitan area, medium or small metropolitan area, and rural], and region [Northeast, Midwest, South, and West]) were used to generate adjusted prevalence ratios and 95% confidence intervals.

A majority of U.S. adults identified each of the individual signs and symptoms of stroke (Table 1). Prevalence was highest for "numbness of face, arm, leg, or side" (94.4%), "confusion or trouble speaking" (93.6%), and "trouble walking" (90.8%). "Sudden trouble seeing" was identified by 83.5%, and "sudden severe headache" by 76.5%. Awareness of calling 9-1-1 was high (96.3%). Prevalence of recommended stroke knowledge was 67.5%.

Awareness of individual signs and symptoms of stroke and recommended stroke knowledge differed significantly among subgroups (Table 1). The percentage of adults with recommended stroke knowledge ranged from 57.8% among Hispanic adults to 71.3% among non-Hispanic White adults and from 54.8% among adults with less than a high school education to 73.1% among college graduates. After multivariable adjustment, disparities in recommended stroke knowledge persisted by race and Hispanic origin and by education status. Smaller differences in the prevalence of recommended stroke knowledge were noted by sex, age, urbanicity, and region (Table 2).

Discussion

Increasing awareness of signs and symptoms of stroke and the need to call 9-1-1 is vital to enable patients to quickly initiate stroke care and benefit from advances in treatment and systems of care (*6*,*7*). Although knowledge of most signs and symptoms of stroke, and for calling 9-1-1, were high, gaps in knowledge remain. Knowledge varied across geographic and sociodemographic subgroups. Consistent with overall prevalence reported for 2014 (66.2%) (*4*), approximately two thirds (67.5%) of U.S. adult respondents could identify the combination of recommended stroke knowledge in 2017.

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* The choices included "advise them to drive to the hospital," "advise them to call their physician," "call 9-1-1 (or another emergency number)," "call spouse or family member," and "other."

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TABLE 1. Percentages (and standard errors)[*] of adults aged ≥20 years who knew stroke signs and symptoms and appropriate action to take in the event of a stroke, by sociodemographic and geographic characteristics — National Health Interview Survey, United States, 2017

	% (Standard error)							
Characteristic	**Face, arm, leg, side numbness**	**Confusion, trouble speaking**	**Sudden trouble seeing**	**Trouble walking**	**Sudden severe headache**	**Knows all five stroke signs and symptoms**	**Knows to call 9-1-1**	**Knows all five signs and symptoms and to call 9-1-1[§]**
Total	**94.4 (0.22)**	**93.6 (0.25)**	**83.5 (0.34)**	**90.8 (0.26)**	**76.5 (0.37)**	**69.1 (0.42)**	**96.3 (0.16)**	**67.5 (0.43)**
Sex								
Men	93.7 (0.32)	93.0 (0.36)	83.0 (0.48)	90.1 (0.38)	74.3 (0.53)	67.0 (0.60)	96.0 (0.23)	65.3 (0.60)
Women	95.0 (0.25)	94.2 (0.29)	83.9 (0.42)	91.4 (0.33)	78.6 (0.46)	71.2 (0.52)	96.6 (0.21)	69.6 (0.53)
p-value[†]	<0.001	0.005	0.123	0.006	<0.001	<0.001	0.039	<0.001
Age group (yrs)								
20–44	94.4 (0.32)	93.3 (0.39)	84.1 (0.53)	90.3 (0.40)	74.4 (0.57)	67.2 (0.63)	96.9 (0.24)	65.9 (0.63)
45–64	94.8 (0.35)	94.4 (0.35)	84.9 (0.47)	91.6 (0.40)	78.4 (0.57)	71.3 (0.64)	96.5 (0.25)	69.8 (0.65)
≥65	93.6 (0.37)	93.0 (0.38)	80.0 (0.62)	90.3 (0.45)	77.9 (0.66)	69.6 (0.71)	94.9 (0.33)	67.3 (0.74)
p-value	0.087	0.01	<0.001	0.02	<0.001	<0.001	<0.001	<0.001
Race and Hispanic origin								
White, non-Hispanic	96.6 (0.20)	96.5 (0.22)	86.8 (0.34)	93.5 (0.27)	79.0 (0.42)	73.0 (0.47)	96.7 (0.19)	71.3 (0.49)
Black, non-Hispanic	93.0 (0.74)	91.7 (0.90)	81.2 (1.12)	88.6 (0.84)	74.4 (1.18)	65.0 (1.33)	97.1 (0.40)	64.0 (1.34)
Other, non-Hispanic	91.1 (0.79)	88.6 (0.94)	78.5 (1.25)	87.8 (0.94)	71.6 (1.27)	63.5 (1.47)	94.7 (0.71)	61.9 (1.45)
Hispanic	88.0 (0.70)	86.0 (0.80)	74.2 (1.06)	82.7 (0.87)	70.7 (1.12)	59.6 (1.23)	95.2 (0.46)	57.8 (1.25)
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Level of education[¶]								
Less than HS	85.3 (0.94)	82.7 (1.17)	70.3 (1.31)	80.2 (1.06)	67.9 (1.18)	56.7 (1.33)	93.5 (0.59)	54.8 (1.36)
HS or GED	92.9 (0.47)	92.4 (0.45)	79.8 (0.65)	88.7 (0.54)	74.4 (0.71)	65.1 (0.79)	96.0 (0.32)	63.4 (0.81)
Some college	96.3 (0.29)	95.7 (0.36)	85.9 (0.52)	93.2 (0.40)	78.1 (0.62)	71.1 (0.67)	96.9 (0.25)	69.4 (0.68)
College graduate	96.7 (0.23)	96.4 (0.25)	88.4 (0.43)	93.8 (0.34)	79.8 (0.54)	74.5 (0.62)	97.1 (0.22)	73.1 (0.61)
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
County urbanicity								
Large metropolitan counties	93.7 (0.27)	92.7 (0.34)	82.7 (0.43)	89.8 (0.34)	75.2 (0.49)	67.8 (0.54)	96.2 (0.22)	66.1 (0.54)
Medium or small metropolitan counties	95.6 (0.32)	95.2 (0.35)	85.1 (0.59)	92.4 (0.41)	79.2 (0.62)	71.4 (0.78)	96.7 (0.28)	69.9 (0.80)
Rural counties	94.8 (0.84)	94.1 (0.84)	83.2 (1.10)	91.3 (0.93)	76.4 (1.24)	70.2 (1.31)	96.0 (0.47)	68.3 (1.38)
p-value	0.004	<0.001	0.014	<0.001	<0.001	0.002	0.23	0.001
Region								
Northeast	94.9 (0.45)	93.4 (0.55)	83.9 (0.70)	90.2 (0.63)	77.6 (0.91)	70.4 (0.90)	96.3 (0.40)	69.0 (0.90)
Midwest	95.9 (0.33)	95.8 (0.31)	84.9 (0.63)	92.6 (0.48)	75.2 (0.67)	68.5 (0.79)	97.0 (0.30)	67.1 (0.84)
South	93.5 (0.43)	92.7 (0.53)	83.2 (0.60)	90.4 (0.46)	77.3 (0.65)	69.7 (0.75)	96.2 (0.27)	68.0 (0.77)
West	93.9 (0.41)	93.3 (0.45)	82.3 (0.73)	90.1 (0.53)	75.8 (0.80)	67.8 (0.93)	96.0 (0.36)	66.0 (0.92)
p-value	<0.001	<0.001	0.057	0.001	0.088	<0.001	0.153	0.123
Unweighted sample size	26,076	26,076	26,076	26,076	26,076	26,074	26,076	26,073

Abbreviations: GED = general educational development; HS = high school.

[*] Weighted percentages. "Don't know" responses are treated as "no"; "not ascertained and refused" responses are converted to blanks and are not included in the numerators or denominators.

[†] P-values calculated from Satterthwaite-adjusted chi-squared tests.

[§] The combination of knowing all five signs and symptoms of stroke and to call 9-1-1 is referred to as "recommended stroke knowledge."

[¶] Education was missing for 91 adults in the sample; these participants were omitted when education was assessed.

Delays in recognizing stroke signs and symptoms might slow initiation of care. The symptom "sudden severe headache" had the lowest prevalence of awareness. This might be an artifact of its position in the survey questionnaire (the last listed symptom), or because headache is a symptom common to many conditions. Current stroke symptom awareness campaigns might inconsistently emphasize headache; some educational campaigns use incomplete acronyms, such as BE-FAST (balance, eyes, face, arms, speech, time), which does not reference headache.

The Healthy People 2020 goal for awareness of common stroke signs and symptoms (HDS-17) is 59.3% and for calling 9-1-1 is 94.7% (age-adjusted, using NHIS) (*8*). The weighted, but not age-adjusted, prevalence estimates reported here indicate that nationally and regionally, these targets might have been exceeded. However, consistent with previous work, this report demonstrates that awareness varies among some demographic groups (*4,5*). For example, multivariable results indicated that awareness of stroke signs and symptoms decreased with decreasing education. In addition, awareness was less prevalent among other race and Hispanic origin groups than among non-Hispanic White adults.

TABLE 2. Adjusted prevalence ratios (and 95% CI)* of knowledge of stroke signs and symptoms and appropriate action to take in the event of a stroke, among adults aged ≥20 years — National Health Interview Survey, United States, 2017

	Prevalence ratio (95% CI)							
Characteristic	**Face, arm, leg, side numbness**	**Confusion, trouble speaking**	**Sudden trouble seeing**	**Trouble walking**	**Sudden severe headache**	**Knows all five stroke signs and symptoms**	**Knows to call 9-1-1**	**Knows all five signs and symptoms and to call 9-1-1[†]**
Sex								
Men versus women	0.99 (0.98–0.99)	0.99 (0.98–0.99)	0.99 (0.97–1.00)	0.99 (0.98–1.00)	0.95 (0.93–0.96)	0.94 (0.92–0.96)	0.99 (0.99–1.00)	0.94 (0.92–0.96)
Age group (yrs)								
20–44 versus ≥65	1.02 (1.00–1.03)	1.01 (1.00–1.02)	1.06 (1.04–1.08)	1.01 (0.99–1.02)	0.96 (0.94–0.98)	0.98 (0.96–1.01)	1.02 (1.01–1.03)	0.99 (0.97–1.02)
45–64 versus ≥65	1.02 (1.01–1.03)	1.02 (1.01–1.03)	1.07 (1.05–1.09)	1.02 (1.01–1.03)	1.01 (0.99–1.03)	1.03 (1.01–1.06)	1.02 (1.01–1.03)	1.04 (1.02–1.07)
Race and Hispanic origin								
Hispanic versus White, non-Hispanic	0.94 (0.93–0.95)	0.93 (0.91–0.94)	0.89 (0.87–0.92)	0.92 (0.91–0.94)	0.94 (0.91–0.97)	0.88 (0.84–0.91)	0.99 (0.98–1.00)	0.87 (0.83–0.91)
Black versus White, non-Hispanic	0.98 (0.96–0.99)	0.97 (0.95–0.98)	0.95 (0.92–0.97)	0.96 (0.94–0.98)	0.96 (0.92–0.99)	0.91 (0.88–0.95)	1.01 (1.00–1.02)	0.92 (0.88–0.96)
Other versus White, non-Hispanic	0.94 (0.92–0.96)	0.92 (0.90–0.94)	0.90 (0.87–0.93)	0.94 (0.92–0.96)	0.91 (0.88–0.95)	0.87 (0.83–0.91)	0.98 (0.96–0.99)	0.87 (0.83–0.91)
Level of education[§]								
Less than HS versus college degree	0.92 (0.90–0.93)	0.90 (0.88–0.92)	0.84 (0.81–0.87)	0.89 (0.87–0.91)	0.86 (0.83–0.89)	0.79 (0.75–0.83)	0.97 (0.96–0.98)	0.78 (0.74–0.82)
HS or GED versus college degree	0.96 (0.95–0.97)	0.96 (0.95–0.97)	0.91 (0.89–0.93)	0.95 (0.94–0.96)	0.93 (0.91–0.95)	0.88 (0.85–0.90)	0.99 (0.98–1.00)	0.87 (0.84–0.90)
Some college versus college degree	1.00 (0.99–1.00)	0.99 (0.99–1.00)	0.97 (0.96–0.99)	1.00 (0.98–1.01)	0.98 (0.96–1.00)	0.96 (0.93–0.98)	1.00 (0.99–1.00)	0.95 (0.93–0.97)
County urbanicity								
Rural versus large metropolitan	1.01 (0.99–1.03)	1.01 (0.99–1.03)	1.01 (0.98–1.03)	1.01 (0.99–1.03)	1.02 (0.99–1.05)	1.04 (1.00–1.08)	1.00 (0.99–1.01)	1.04 (1.00–1.08)
Medium or small metropolitan versus large metropolitan	1.02 (1.01–1.03)	1.02 (1.01–1.03)	1.02 (1.01–1.04)	1.02 (1.01–1.03)	1.05 (1.03–1.07)	1.05 (1.02–1.08)	1.01 (1.00–1.01)	1.05 (1.02–1.08)
Region								
Northeast versus Midwest	1.00 (0.99–1.01)	0.99 (0.97–1.00)	1.00 (0.98–1.03)	0.98 (0.97–1.00)	1.04 (1.01–1.07)	1.05 (1.01–1.09)	1.00 (0.99–1.01)	1.05 (1.01–1.09)
South versus Midwest	0.99 (0.98–1.00)	0.98 (0.97–1.00)	1.01 (0.99–1.03)	0.99 (0.98–1.01)	1.05 (1.02–1.07)	1.05 (1.02–1.09)	0.99 (0.99–1.00)	1.05 (1.02–1.08)
West versus Midwest	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.01 (0.98–1.03)	1.00 (0.98–1.01)	1.04 (1.01–1.07)	1.04 (1.00–1.08)	0.99 (0.99–1.00)	1.03 (1.00–1.07)
Unweighted sample size	25,985	25,985	25,985	25,985	25,985	25,983	25,985	25,982

Abbreviations: CI = confidence interval; GED = general educational development; HS = high school.

* Models included sex, age, race and Hispanic origin, education, county urbanicity, and region. "Don't know" responses on knowing the signs and symptoms of stroke were treated as no; all not ascertained and refused responses were treated as missing and excluded from these analyses.

[†] The combination of knowing all five signs and symptoms of stroke and to call 9-1-1 is referred to as "recommended stroke knowledge."

[§] Education was missing for 91 adults in the sample; these participants were omitted when education was assessed.

Previous studies have shown that stroke morbidity and mortality vary across populations and communities and disproportionately affect racial and ethnic minorities, persons with less education, and persons living in the Southeast (i.e., the "stroke belt") (*1*). Among some subgroups, stroke mortality might be increasing, and overall, declines in stroke death rates have stalled in most states (*9*). The extent to which an increase in stroke knowledge could affect existing disparities and trends in stroke mortality is unknown.

Improvements in stroke outcomes depend on early recognition and timely initiation of care, as well as medical advances and care coordination. CDC's Paul Coverdell National Acute Stroke Program[†] aims to improve the continuum of care, including emergency services activation. In addition, the U.S. Department of Health and Human Services' Million Hearts[§] initiative aims to prevent 1 million heart attacks and strokes by 2022 through targeted community and health system interventions. The Get With The Guidelines-Stroke[¶] program of the American Heart Association and the American Stroke Association has supported improvements in care, including evidence-based interventions

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[†] https://www.cdc.gov/dhdsp/programs/stroke_registry.htm.

[§] https://millionhearts.hhs.gov/.

[¶] https://www.heart.org/en/professional/quality-improvement/get-with-the-guidelines/get-with-the-guidelines-stroke.

Summary

What is known about this topic?

Awareness of stroke signs and symptoms and the need to call 9-1-1 when those occur can improve stroke outcomes.

What is added by this report?

During 2017, high levels of awareness of individual signs and symptoms of stroke and the need to call 9-1-1 when those occur were reported. However, only two thirds of U.S. adults had the combination of all recommended stroke knowledge, with sociodemographic and geographic variation.

What are the implications for public health practice?

Increasing awareness of the signs and symptoms of stroke continues to be a national priority. Estimates from this report might be used to inform communication strategies that improve awareness and reduce disparities.

such as tissue plasminogen activator (tPA) (*10*). Rapid recognition of stroke signs and symptoms and then immediately calling 9-1-1 increases the potential for ischemic stroke patients to quickly receive tPA, maximizing the health benefit.

The findings in this report are subject to at least five limitations. First, all data were self-reported and subject to recall and social desirability biases. Second, questions did not capture all potential stroke signs and symptoms. Third, close-ended (yes/no) questions might overestimate awareness. Fourth, no established standard is available for determining stroke awareness or how knowledge translates into appropriate action in response to a stroke, overall or across subgroups. Finally, the sample size was large, enabling detection of slight statistical differences, but no clear threshold exists for classifying meaningful differences in stroke knowledge to prompt earlier recognition and more timely care.

Primary prevention is central to promoting cardiovascular health and includes assessment and management of stroke risk factors (*7*). When strokes do occur, recognition of signs and symptoms and then calling 9–1-1 are needed to initiate care quickly to improve outcomes. This report identified overall high awareness of individual signs and symptoms, yet observed lower awareness for certain symptoms. Only approximately two thirds of adults surveyed had the combination of recommended stroke knowledge, and geographic variation and sociodemographic disparities remain. Focused public health efforts, community engagement, innovative strategies to tailor messaging, and continued advances in clinical care and coordination might help address stalled declines in stroke mortality (*9*). Increasing awareness of the signs and symptoms of stroke continues to be a national priority (*6*), and estimates from this report might be used to inform communication strategies.

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Computerized Capability of Office-Based Physicians to Identify Patients Who Need Preventive or Follow-up Care — United States, 2017

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Preventive care or follow-up care have the potential to improve health outcomes, reduce disease in the population, and decrease health care costs in the long-term (*1*). Approximately one half of persons in the United States receive general recommended preventive services (*2*,*3*). Missed physician appointments can hinder the receipt of needed health care (*4*). With electronic health record (EHR) systems able to improve interaction and communication between patients and providers (*5*), electronic reminders are used to decrease missed care. These reminders can improve various types of preventive and follow-up care, such as immunizations (*6*) and cancer screening (*7*); however, computerized capability must exist to make use of these reminders. To examine this capability among U.S. office-based physicians, data from the National Electronic Health Records Survey (NEHRS) for 2017, the most recent data available, were analyzed. An estimated 64.7% of office-based physicians had computerized capability to identify patients who were due for preventive or follow-up care, with 72.9% of primary care physicians and 71.4% of physicians with an EHR system having this capability compared with surgeons (54.8%), nonprimary care physicians (58.5%), and physicians without an EHR system (23.4%). Having an EHR system is associated with the ability to send electronic reminders to increase receipt of preventive or follow-up care, which has been shown to improve patient health outcomes (*8*).

NEHRS is a nationally representative, mixed-mode survey of U.S. office-based physicians that collects information on the adoption, use, and interoperability of EHR systems. Information on physician and practice characteristics is also collected. NEHRS is sponsored by the Office of the National Coordinator for Health Information Technology and conducted by CDC's National Center for Health Statistics (NCHS) annually as a sample survey of nonfederally employed, office-based physicians who are primarily engaged in direct patient care and are located in the 50 U.S. states or the District of Columbia. Physicians with a primary specialty of anesthesiology, pathology, or radiology are excluded. The 2017 NEHRS had a sample of 10,302 physicians and a weighted response rate of 33.6%.* Physicians were identified as having computerized capability to identify patients who are due for preventive or follow-up care if they responded affirmatively to the question, "Does the reporting location use a computerized system to identify patients due for preventive or follow-up care?" Having this computerized capability indicates that the physician's office uses a software program that identifies if a patient is in need of preventive or follow-up care, and if so, has a computer send an alert or reminder to notify the patient that this care is needed (*8*). This capability is distinct from an EHR system, which might contain medical information from all clinicians involved in a patient's care (not just those in a specific office), and all authorized clinicians involved in a patient's care can access the information contained. However, these computerized notifications might be part of some EHR systems.

The percentage of physicians having computerized capability to identify patients due for preventive or follow-up care was estimated for U.S. office-based physicians by selected physician characteristics, including specialty, medical degree, sex, age group in years, currently accepting new patients, and practice characteristics (size, ownership, uses an EHR system, and metropolitan status). The prevalence ratios of physicians having this computerized capability (adjusted for the above-mentioned physician and practice characteristics) were also examined by these characteristics using multivariable logistic regression. The estimates resulting from this regression were used to calculate prevalence ratios according to methods detailed elsewhere (*9*). All estimates meet NCHS standards of reliability for proportions (*10*). Sample weights were used for all analyses, and NEHRS complex sample design was accounted for by using SUDAAN software (version 11.0.1; RTI International). For comparisons of estimates among subgroups, statistical significance ($p<0.05$) was determined by two-tailed significance tests. All reported differences between subgroups were statistically significant.

In 2017, 64.7% of U.S. office-based physicians had the computerized capability to identify patients due for preventive or follow-up care (Table). A higher percentage of primary care physicians (72.9%) had this computerized capability than did surgeons (54.8%) and other nonprimary care physicians (58.5%). Seventy percent of physicians aged 45–54 years had this capability compared with 57.2% of those aged 65–84 years. No differences were found by medical degree, sex, currently accepting new patients, and metropolitan status.

A lesser percentage of physicians in solo practice (53.1%) had this computerized capability than did physicians at practices with

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* A copy of the NEHRS questionnaire is available at https://www.cdc.gov/nchs/data/ahcd/2017_NEHRS_Sample_Card.pdf. Data from the 2017 NEHRS are available at https://www.cdc.gov/rdc/index.htm.

TABLE. Percentages and adjusted prevalence ratios for office-based physicians who have computerized capability to identify patients who are due for preventive or follow-up care, by selected physician and practice characteristics — National Electronic Health Records Survey, 2017

Characteristic	% (95% CI)	aPR (95% CI)
Total	**64.7 (61.5–67.8)**	—
Physician characteristic		
Specialty		
Primary care	72.9[*] (68.6–77.0)	Ref[*]
Surgical care	54.8[†] (47.3–62.0)	0.8[†] (0.7–0.9)
Nonprimary care	58.5[†] (52.5–64.4)	0.8[†] (0.8–0.9)
Medical degree		
Doctor of medicine	64.8 (61.4–68.0)	Ref
Doctor of osteopathic medicine	63.6 (50.7–75.3)	1.0 (0.8–1.2)
Sex		
Female	67.1 (61.4–72.5)	Ref
Male	63.7 (59.8–67.5)	1.0 (0.9–1.1)
Age group (yrs)		
<45	67.2 (60.0–73.9)	Ref
45–54	70.0[§] (64.3–75.4)	1.1 (1.0–1.2)
55–64	63.8 (58.1–69.2)	1.1 (0.9–1.2)
65–84	57.2[§] (49.1–65.0)	1.1 (0.9–1.3)
Currently accepting new patients		
Yes	65.3 (62.1–68.5)	1.1 (0.9–1.3)
No	58.8 (44.3–72.1)	Ref
Practice characteristics		
Size		
Solo practice	53.1[¶] (46.3–59.9)	Ref
2 physicians	70.2[**] (61.9–77.6)	1.1 (0.9–1.3)
3–5 physicians	66.8[**] (60.5–72.7)	1.0 (0.9–1.1)
≥6 physicians	69.6[**] (64.5–74.4)	1.0 (0.9–1.1)
Physician/Physician group ownership		
Yes	61.0[††] (56.8–65.1)	0.9 (0.8–1.0)
No	70.2[††] (65.1–75.0)	Ref
Uses EHR system		
Yes	71.4[††] (68.3–74.4)	2.9[††] (2.0–4.4)
No	23.4[††] (15.3–33.3)	Ref[††]
Metropolitan status		
Metropolitan statistical area (MSA)	64.7 (61.3–67.9)	Ref
Non-MSA	64.8 (54.3–74.3)	1.0 (0.9–1.1)

Abbreviations: aPR = adjusted prevalence ratio; CI = confidence interval; EHR = electronic health record; Ref = referent.

[*] Significant difference compared with surgical care and nonprimary care.

[†] Significant difference compared with primary care.

[§] Significant difference between physicians aged 45–54 and 65–84 years.

[¶] Significant difference compared with 2 physicians, 3–5 physicians, and ≥6 physicians.

[**] Significant difference compared with solo practice.

[††] Significant difference between yes and no.

two physicians (70.2%), three to five physicians (66.8%), and six or more physicians (69.6%). A higher percentage of physicians at practices that were not owned by a physician/physician group (70.2%) had this computerized capability compared with those at practices that were owned by physicians (61.0%). A higher percentage of practices that used an EHR system (71.4%) than did not use an EHR system (23.4%) had this computerized capability.

Summary

What is already known about this topic?

Preventive or follow-up care can improve health outcomes and reduce disease. Missed physician appointments hinder receipt of health care. Electronic reminders can reduce missed appointments.

What is added by this report?

In 2017, 64.7% of U.S. office-based physicians had computerized capability to identify patients due for preventive or follow-up care. A lower percentage of surgeons and nonprimary care physicians had this capability compared with primary care physicians. A higher percentage of physicians whose practice used an electronic health record system had this capability.

What are the implications for public health practice?

These findings highlight physician and practice characteristics associated with capability for computerized identification of patients due for preventive or follow-up care which might inform efforts to increase patient follow-up.

When accounting for physician and practice characteristics simultaneously in a logistic regression model, only few statistically significant differences remained. The proportion of surgeons (adjusted prevalence ratio [aPR] = 0.8; 95% confidence interval [CI] = 0.7-0.9) and other nonprimary care physicians (aPR = 0.8; 95% CI = 0.8-0.9) having the computerized capability to identify patients due for preventive or follow-up care was lower than the proportion of primary care physicians. In addition, the proportion of physicians at practices that used an EHR system was approximately three times greater for having this computerized capability compared with physicians at practices that did not use an EHR system (aPR = 2.9; 95% CI = 2.0–4.4).

Discussion

Results show that the percentage of U.S. office-based physicians with computerized capability to identify patients for preventive or follow-up care is higher among certain physician and practice characteristics, including a physician's specialty, age, practice size, ownership, and use of an EHR system. However, when controlling for these characteristics simultaneously through multivariable analyses, only physician specialty and use of an EHR system had a significant association with this capability: a lower proportion of surgeons and other nonprimary care physicians had this capability than primary care physicians, while a higher proportion of physicians whose practice used an EHR system had this capability compared with physicians at a practice without an EHR system. Because this computerized capability can be included in some EHRs (*8*), this finding might be expected.

The findings in this report are subject to at least three limitations. First, because of the scope, the data analyzed only included nonfederal, office-based physicians, and therefore the ability to examine the computerized capability to identify patients for preventive or follow-up care by physicians in hospitals, jails and prisons, Veterans Affairs medical facilities, or other non-office-based locations could not be determined. Second, only having this computerized capability could be examined, not whether the physician regularly used it, or whether it was effective in getting the patient to make a care appointment. Finally, there might also be additional physician characteristics (e.g., years in practice) and practice characteristics (e.g., daily patient volume) that could be considered but were not available in NEHRS.

Previous research indicates that the use of electronic reminders can increase the likelihood of patients returning for preventive or follow-up care (*6*,*7*). However, before this can occur, a physician must have the capability to identify these patients. Having an EHR system can increase the likelihood a physician has this capability, potentially increasing the potential for patient returns for preventive or follow-up care through use of electronic reminders. This has been shown to improve patient health outcomes (*8*).

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Network Characteristics and Visualization of COVID-19 Outbreak in a Large Detention Facility in the United States — Cook County, Illinois, 2020

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Correctional and detention facilities have been disproportionately affected by coronavirus disease 2019 (COVID-19) because of shared space and movement of staff members and detained persons within facilities (*1*,*2*). During March 1–April 30, 2020, at Cook County Jail in Chicago, Illinois, >900 COVID-19 cases were diagnosed across all 10 housing divisions, representing 13 unique buildings.[†] Movement within the jail was examined through network analyses and visualization, a field that examines elements within a network and the connections between them. This methodology has been used to supplement contact tracing investigations for tuberculosis and to understand how social networks contribute to transmission of sexually transmitted infections (*3*–*5*). Movements and connections of 5,884 persons (3,843 [65%] detained persons and 2,041 [35%] staff members) at the jail during March 1–April 30 were analyzed. A total of 472 (12.3%) COVID-19 cases were identified among detained persons and 198 (9.7%) among staff members. Among 103,701 shared-shift connections among staff members, 1.4% occurred between persons with COVID-19, a percentage that is significantly higher than the expected 0.9% by random occurrence alone ($p<0.001$), suggesting that additional transmission occurred within this group. The observed connections among detained persons with COVID-19 were significantly lower than expected (1.0% versus 1.1%, $p<0.001$) when considering only the housing units in which initial transmission occurred, suggesting that the systematic isolation of persons with COVID-19 is effective at limiting transmission. A network-informed approach can identify likely points of high transmission, allowing for interventions to reduce transmission targeted at these groups or locations, such as by reducing convening of staff members, closing breakrooms, and cessation of contact sports.

All detained persons with data available for at least one bed assignment at Cook County Jail during March 1–April 30, 2020, were identified using records provided by Cook County Sheriff's Office (CCSO), and Cermak Health Services. CCSO staff members who worked at least one shift at the jail during the same period were also included. A case of COVID-19 was defined as detection of SARS-CoV-2 by real-time reverse transcription–polymerase chain reaction (RT-PCR) in a specimen from a detained person, and, among staff members, as reported COVID-19–compatible symptoms or detection of SARS-CoV-2 in specimens by real-time RT-PCR. Detained persons who reported symptoms or who were a close contact of someone with a positive test result were tested; those who were not tested (2,763; 72%) or who received a negative test result (608; 16%) were grouped together for analyses and visualizations. Although staff members were not systematically tested, they were required to report symptoms of COVID-19 or receipt of positive test results immediately to CCSO; staff members reporting positive test results (confirmed case) or symptoms (probable case) were considered to have COVID-19. Staff member test results were confirmed through the Illinois National Notifiable Disease Surveillance System.

Description of Networks

In the person-division networks, divisions represent housing buildings within the jail. Connections occur between persons (detained persons or staff members) and the divisions to which they are assigned, either for housing or a work shift. The number of connections between persons and divisions is calculated based on a value of one for each new bed assignment for detained persons or shifts within a given division for staff members.

To determine whether the number of connections to a given division was associated with a higher proportion of cases among staff members and detained persons, the linear correlation between the proportion of persons meeting the case definition during the study period and the number of connections was compared for each division, representing all persons linked to each division through at least one work shift (staff member) or cell or bed assignment (detained person). The strength of correlation was determined by calculating the correlation coefficients for each line of best fit, with statistical significance assessed at $\alpha = 0.05$.

The person-person networks show persons present at the same location and time based either on shift or bed assignment. To determine whether connections between persons with COVID-19 in both groups were occurring more frequently than expected, the proportion of persons meeting the case definition was used to calculate ratios of observed-to-expected proportions of positive-positive, positive-negative (or not

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[*] These authors contributed equally.

[†] https://www.medrxiv.org/content/10.1101/2020.07.12.20148494v1.

known to be positive), and negative-negative connections, and these ratios were compared using chi-squared tests of independence; significance was assessed at $\alpha = 0.05$.

A joined network of detained persons and staff members was constructed but did not demonstrate clear patterns of clustering or spread. Detained person and staff member networks, displayed separately as unique patterns for each network, were more easily visualized. Data management and analyses were conducted using SAS (version 9.4; SAS Institute) and R (version 3.6.2; The R Foundation) statistical software; visualizations were performed using Gephi (version 0.9.2; The Gephi Consortium). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§]

The average daily census of detained person during March 1–April 30, 2020, was 4,884, with 3,834 (79%) included in the analysis based on availability of cell or bed assignment. Among the 1,080 detained persons tested during the same period, 472 (12.3%) received a positive SARS-CoV-2 test result. CCSO had 2,370 staff members assigned to Cook County Jail on March 1, 2020, most of whom worked on site. During the outbreak, 270 staff members were added, totaling 2,640. Among these, 2,041 (77%) were included in the analysis based on availability of shift and division assignments, 198 (9.7%) of whom had COVID-19; staff members with negative test results could not be identified through available data sources. During the outbreak, interventions were used to limit spread, including cessation of visitation (March 15), suspension of programmatic activities (March 23), conversion of cells to single occupancy, and universal masking for staff members (April 2) and detained persons (April 13).

Person-division networks. Visualization of networks among detained persons and staff members indicates that COVID-19 cases occurred in all jail divisions. The staff member network did not demonstrate a discernable pattern with distribution of persons with COVID-19 throughout divisions (Figure 1). Detained persons with COVID-19 appeared to cluster at division 8/residential treatment unit (RTU) and division 16, both of which were used for medical isolation, and offsite locations (e.g., hospitalizations) (Figure 1).

Person-person networks. Overall, 103,701 shared shift connections occurred among staff members, 1.4% of which were between staff members with COVID-19; this exceeded the expected percentage (0.9%) ($p<0.001$) (Figure 2). Among detained persons, 1,214,462 connections were identified, with 3.2% between two persons with COVID-19, which was also significantly higher than the expected 1.5% ($p<0.001$) (Figure 2). The observed rate decreased to 1.0% when the divisions experiencing the highest clustering related to intentional movement as detained persons with COVID-19 were removed from the network (e.g., to RTU, division 16, or offsite locations). In March, as the number of persons with COVID-19 in the Cook County Jail was increasing, the mean number of interactions between staff members with COVID-19 (377) was significantly higher than that between staff members with negative test results (321) ($p<0.001$). This difference was not statistically significant in April, when the number of persons with COVID-19 in Cook County Jail was declining.

Correlation of Positivity and Number of Connections by Division

Overall, 3,278 connections across all divisions were observed between staff members and divisions, ranging from 80 connections in division 16, to 625 in division 2 (Figure 3). The percentage of staff members with COVID-19 ranged from 2% in division 10 to 13% in RTU. A positive linear relationship was identified between the percentage of staff members with COVID-19 and the number of connections, by division ($r = 0.86$, $p<0.05$). Among detained persons, 6,056 unique connections were calculated (Figure 3). The number of unique connections ranged from 266 in division 4 to 1,037 in division 11, with percentage of detained persons with COVID-19 ranging from 6% in division 4 to 44% in RTU, and 98% in division 16.

Discussion

Network analyses and visualization of a large outbreak of COVID-19 at Cook County Jail demonstrate the complex transmission dynamics that can propagate disease spread, especially in a congregate setting. Connections among persons with COVID-19 occurred more often than expected in staff members and detained persons ($p<0.001$). The observed connections among detained persons with COVID-19 were significantly lower than expected when considering only the housing units in which initial transmission occurred, suggesting the systematic isolation of those with COVID-19 is effective at limiting subsequent transmission. These findings support the importance of rapid detection and isolation of persons with COVID-19 and limitation of movement between divisions as critical elements in reducing spread (*6,7*).

The proportion of connections and number of unique connections by division among staff members with COVID-19 was higher than expected. The correlation between the percentage of staff members with COVID-19 and the number of unique connections by division also demonstrated a strong positive relationship ($p<0.05$). This likely reflects transmission among staff members; however, additional SARS-CoV-2 exposures not

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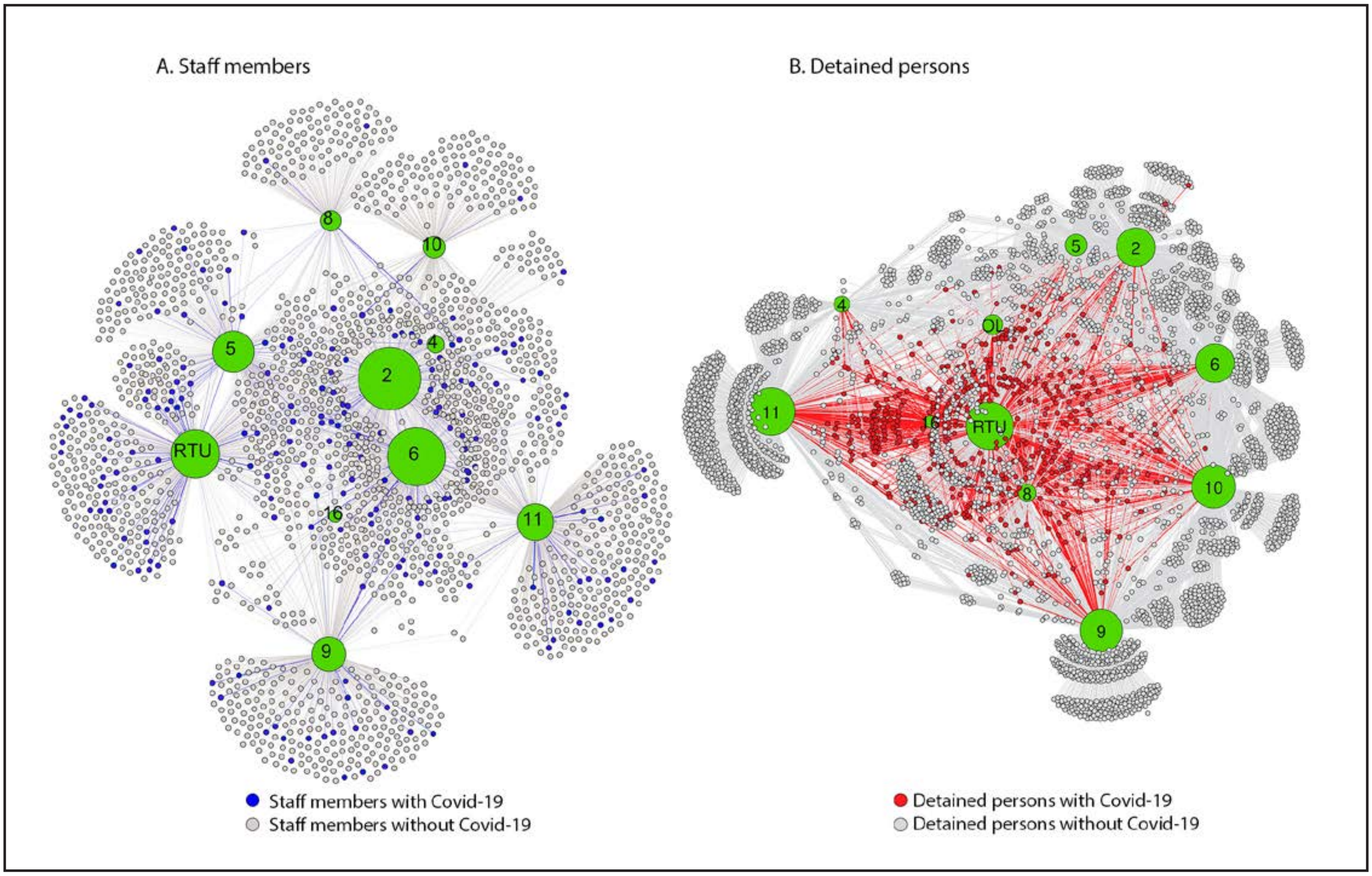
[§] 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

FIGURE 1. Visualization of staff members (A)* and detained persons (B)† epidemiologically linked to an outbreak of COVID-19§ using person-division networks¶ — Cook County Jail, Illinois, March 1–April 30, 2020



Abbreviations: COVID-19 = coronavirus disease 2019; OL = offsite location; RTU = residential treatment unit.

* Staff members–division network includes 1,843 persons who did not have COVID-19 (gray) and 198 with COVID-19 (blue) as reported to the Cook County Sheriff's Office. Lines (connections) are colored according to the same color scheme.

† Detained persons–division network includes 3,371 persons without COVID-19 (gray) and 472 persons with COVID-19 (red). Lines (connections) are colored according to the same color scheme.

§ COVID-19 cases were defined as detection of SARS-CoV-2 (the virus that causes COVID-19) by real-time reverse transcription–polymerase chain reaction (RT-PCR) testing in specimens from detained persons, and among staff members, as reported symptoms or SARS-CoV-2 positive RT-PCR test results.

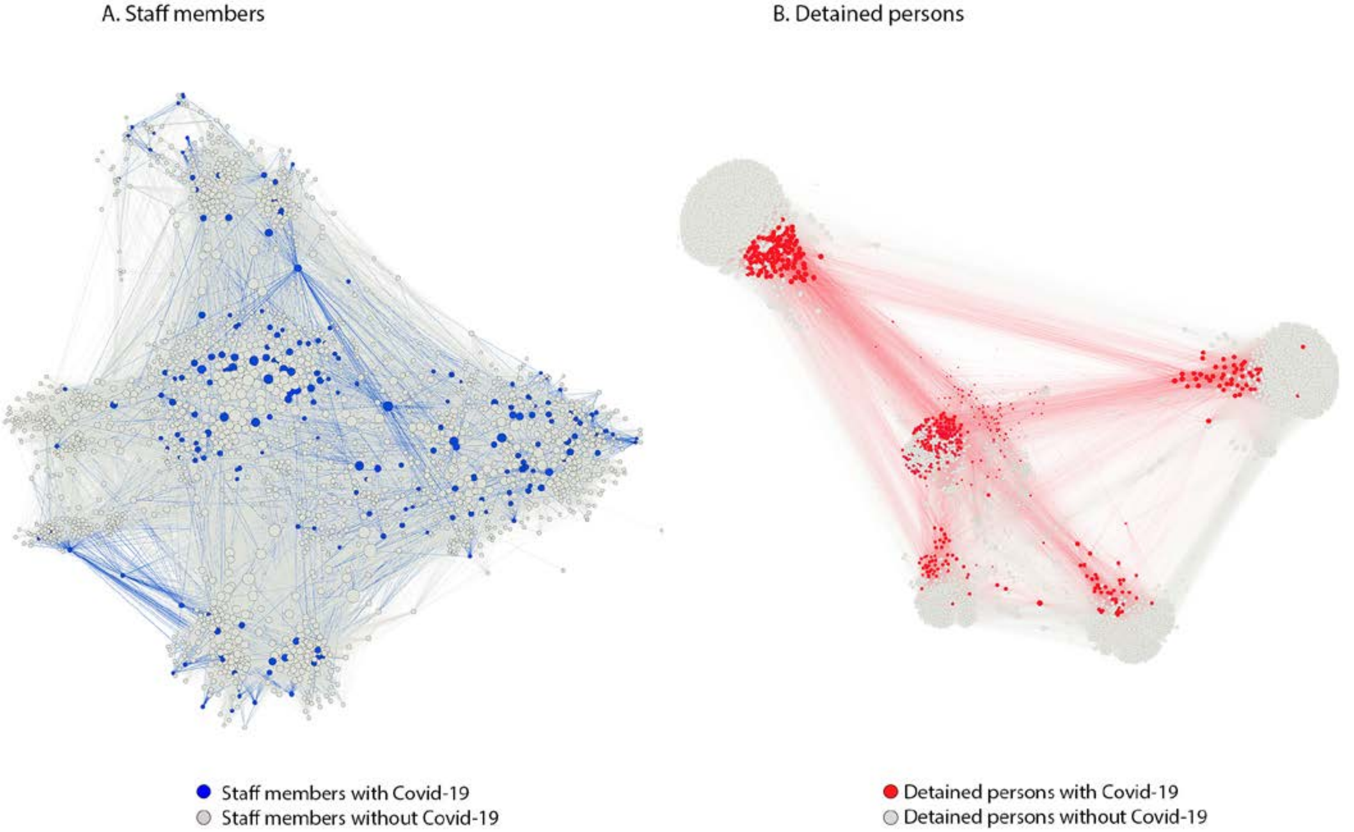
¶ Numbers and letters in large circles within figure represent the individual housing divisions; circle sizes correlate to the number of connections (e.g., a larger circle indicates higher number of connections). Location of division node is not representative of the geographic location of the division on-site at the jail.

recorded in this analysis might also contribute, including staff members returning to their household and community after each work shift. The higher than expected percentage of staff members with COVID-19 reinforces the need for cohorting staff members (i.e., keeping groups together), maintaining consistency in shift assignment locations, and enforcing mask use for source control.

This is the first known report using network analyses and visualization techniques to describe a COVID-19 outbreak in a U.S. correctional or detention facility. Use of network analyses in China revealed disease occurring in clusters (*8*). Another network study estimated and visualized pandemic risk by calculating worldwide connectedness using the newly confirmed COVID-19 case report counts (*9*). These studies demonstrate the capability of a network approach to supplement traditional investigations and provide timely evidence to inform mitigation strategies and policy decisions.

The findings in this report are subject to at least four limitations. First, the networks described in this report were generated by time- and location-based connections among persons, which might not cover other types of disease transmission, such as fomite spread. Second, for this study, data for staff member work shift dates and locations were only available for CCSO staff members with assignments in housing divisions and not for those in functional roles (e.g., transportation or central kitchen), or other non-CCSO staff members on site

FIGURE 2. Visualization of staff members* (A) and detained persons† (B) epidemiologically linked to an outbreak of COVID-19§ using person-person networks — Cook County Jail, Illinois, March 1–April 30, 2020



Abbreviation: COVID-19 = coronavirus disease 2019.

* Staff members–person-person network includes 103,701 connections between 1,843 persons who did not have COVID-19 (gray) and 198 persons with COVID-19 as reported to the Cook County Sheriff's Office (blue). Lines (connections) are colored according to the same color scheme. Observed positive-positive connections were higher than expected (n = 1,420 [1.4%] versus n = 976 [0.9%], p<0.05). Most observed connections were between persons who did not have positive test results (n = 83,813, 80.8%).

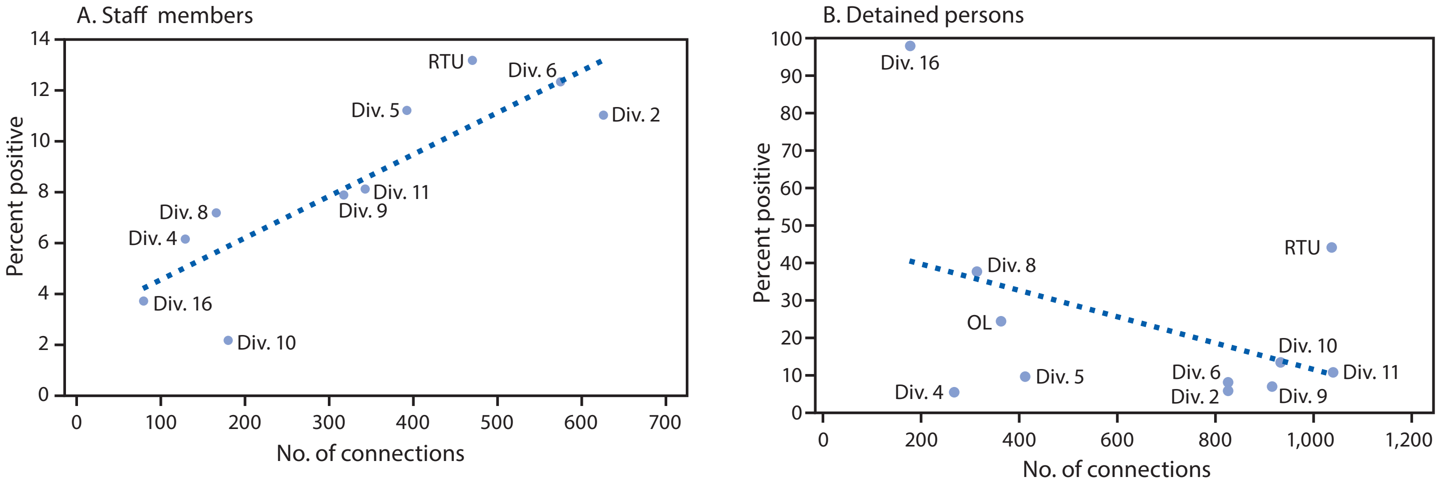
† Detained persons–person-person network includes 1,214,462 connections between 3,371 persons without COVID-19 (gray) and 472 persons with COVID-19 (red). Connections are colored according to the same color scheme. Observed positive-positive connections were higher than expected (n = 39,141 [3.2%] versus n = 18,320 [1.5%], p<0.05). When excluding connections associated with persons in medical isolation or at off-site locations (e.g., residential treatment unit, division 16, and off-site locations, the rate of observed connections is significantly less than expected (n = 11,017 [1.0%] versus n = 12,165 [1.1%], p<0.05). In March, as the number of persons with COVID-19 were increasing, the mean number of interactions between staff members with COVID-19 (n = 377) was significantly higher than that of staff members without COVID-19 (n = 321) [p<0.001]. This difference was not seen in April when cases were declining.

§ COVID-19 cases were defined as detection of SARS-CoV-2 (the virus that causes COVID-19) by real-time reverse transcription–polymerase chain reaction (RT-PCR) testing in specimens from detained persons, and among staff members, as reported symptoms or SARS-CoV-2 positive RT-PCR test results.

(e.g., volunteers, and contractors). Persons not included in the staff member shift data might have interacted with persons in the staff member network. Third, staff members were not systematically tested; thus, this analysis possibly underrepresents the number of staff members with COVID-19 and their connections. In addition, although detained person and staff member networks are displayed separately to more easily visualize the patterns, interactions between these groups likely play an integral role in transmission in a detention facility. Finally, COVID-19 contacts and exposures occurring outside the jail or in the surrounding community, or from staff members with asymptomatic COVID-19, were not assessed in this analysis.

Network analyses and visualizations provide insight into disease spread, illustrating the effectiveness of certain control measures. This study demonstrates the consistent use of cohorting among detained persons and suggests effectiveness of employing this strategy. A network-informed approach can identify likely points of high transmission by demonstrating when transmission is higher than expected, allowing for interventions targeted at these groups or locations (e.g., reducing convening of staff members by closing breakrooms or cessation of contact sports).

FIGURE 3. Correlation[*] between percentage of staff members (A)[†] and detained persons (B)[§] with COVID-19[¶] with number of connections for all divisions — Cook County Jail, Illinois, March 1–April 30, 2020



Abbreviations: COVID-19 = coronavirus disease 2019; OL = offsite location; RTU = residential treatment unit.

[*] Staff members: r = 0.86, p<0.05; detained persons: r = −0.43, p = 0.20.

[†] A total of 3,278 connections were identified for staff members among all divisions with 198 with COVID-19 cases, as reported to the Cook County Sheriff's Office. Connections were defined as having at least one shift in a given division during the study period; division connections are not mutually exclusive, so staff members who worked at least one shift in multiple divisions are represented. r = 0.86, p<0.05.

[§] A total of 6,056 connections were identified for detained persons among all divisions, with 472 COVID-19 cases. Connections were defined as having at least one bed or cell assignment in a given division during the study period; division connections are not mutually exclusive, so detainees with an assignment in more than one division are represented.

[¶] COVID-19 cases were defined as detection of SARS-CoV-2 (the virus that causes COVID-19) by real-time reverse transcription–polymerase chain reaction (RT-PCR) testing specimens from in detained persons, and among staff members, as reported symptoms or SARS-CoV-2 positive RT-PCR test results.

Summary

What is already known about this topic?

Network analyses and visualization can provide information about outbreak transmission dynamics.

What is added by this report?

Analysis of detained person and staff member movements during a COVID-19 outbreak at Cook County Jail in Illinois found fewer connections among detained persons with COVID-19 than expected, suggesting that interventions and medical isolation practices were effective at reducing transmission. Higher than expected connections were identified in staff member networks, suggesting occurrence of additional transmission and areas of focus for transmission interruption.

What are the implications for public health practice?

A network-informed approach can identify likely points of high transmission, enabling targeted interventions to reduce transmission, such as by reducing convening of staff members, closing breakrooms, and cessation of contact sports.

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Transmission of SARS-COV-2 Infections in Households — Tennessee and Wisconsin, April–September 2020

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Improved understanding of transmission of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), within households could aid control measures. However, few studies have systematically characterized the transmission of SARS-CoV-2 in U.S. households (*1*). Previously reported transmission rates vary widely, and data on transmission rates from children are limited. To assess household transmission, a case-ascertained study was conducted in Nashville, Tennessee, and Marshfield, Wisconsin, commencing in April 2020. In this study, index patients were defined as the first household members with COVID-19–compatible symptoms who received a positive SARS-CoV-2 reverse transcription–polymerase chain reaction (RT-PCR) test result, and who lived with at least one other household member. After enrollment, index patients and household members were trained remotely by study staff members to complete symptom diaries and obtain self-collected specimens, nasal swabs only or nasal swabs and saliva samples, daily for 14 days. For this analysis, specimens from the first 7 days were tested for SARS-CoV-2 using CDC RT-PCR protocols.[†] A total of 191 enrolled household contacts of 101 index patients reported having no symptoms on the day of the associated index patient's illness onset, and among these 191 contacts, 102 had SARS-CoV-2 detected in either nasal or saliva specimens during follow-up, for a secondary infection rate of 53% (95% confidence interval [CI] = 46%–60%). Among fourteen households in which the index patient was aged <18 years, the secondary infection rate from index patients aged <12 years was 53% (95% CI = 31%–74%) and from index patients aged 12–17 years was 38% (95% CI = 23%–56%). Approximately 75% of secondary infections were identified within 5 days of the index patient's illness onset, and substantial transmission occurred whether the index patient was an adult or a child. Because household transmission of SARS-CoV-2 is common and can occur rapidly after the index patient's illness onset, persons should self-isolate immediately at the onset of COVID-like symptoms, at the time of testing as a result of a high risk exposure, or at the time of a positive test result, whichever comes first. Concurrent to isolation, all members of the household should wear a mask when in shared spaces in the household.[§]

The data presented in this report are from an ongoing, CDC-supported study of household transmission of SARS-CoV-2 in Nashville, Tennessee and Marshfield, Wisconsin, and include households enrolled during April–September 2020.[¶] Households were eligible if the index patient had symptom onset <7 days before household enrollment and the household included at least one other person who was not symptomatic at the time of the index patient's illness onset and was thus deemed to be at risk. Characteristics of the index patients, household members, and their interactions were ascertained using Research Electronic Data Capture (REDCap),[**] an online application for data collection, or through paper-based surveys. The 7-day secondary infection rate was calculated by dividing the number of laboratory-confirmed SARS-CoV-2 infections identified during the 7-day follow-up period by the number of household members at risk per 100 population.[††] Because saliva samples are considered an emerging diagnostic approach but are not yet standard for SARS-CoV-2 detection (*2*), secondary infection rates were also calculated using positive test results from nasal swab specimens only. To account for household members possibly having been infected when the index case became ill, secondary infections rates were also conservatively calculated excluding household members who had positive test results at enrollment. The study protocol was reviewed and approved by the Vanderbilt University Medical Center's and Marshfield Clinic Research Institute's Institutional Review Board, and was conducted consistent with applicable federal law and CDC policy.[§§]

For this analysis, 101 households (including 101 index patients and 191 household members) were enrolled and completed ≥7 days of follow-up. The median index patient age was 32 years (range = 4–76 years; interquartile range

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[*] These authors contributed equally.

[†] https://www.fda.gov/media/134922/download.

[§] https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/steps-when-sick.html; https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/care-for-someone.html; https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/parents-caregivers.html.

[¶] https://news.vumc.org/2020/06/30/new-study-examines-coronavirus-transmission-within-households/; https://www.marshfieldresearch.org/News/research-institute-to-study-transmission-of-covid-19-in-households.

[**] https://www.project-redcap.org/.

[††] 95% CIs around the estimated secondary infection rates were calculated using the Wilson method.

[§§] 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

[IQR] = 24–48 years); 14 (14%) index patients were aged <18 years, including five aged <12 years and nine aged 12–17 years. Among index patients, 75 (74%) were non-Hispanic White, eight (8%) were non-Hispanic persons of other races, and 18 (18%) were Hispanic or Latino (Table 1). Index patients received testing for SARS-CoV-2 a median of 1 day (IQR = 1–2) after illness onset and were enrolled in the study a median of 4 days (IQR = 2–4) after illness onset.

The median number of household members per bedroom was one (IQR = 0.8–1.3). Seventy (69%) index patients reported spending >4 hours in the same room with one or more household members the day before and 40 (40%) the day after illness onset. Similarly, 40 (40%) of index patients reported sleeping in the same room with one or more household members before illness onset and 30 (30%) after illness onset.

Among all household members, 102 had nasal swabs or saliva specimens in which SARS-CoV-2 was detected by RT-PCR during the first 7 days of follow-up, for a secondary infection rate of 53% (95% CI = 46%–60%) (Table 2). Secondary infection rates based only on nasal swab specimens yielded similar results (47%, 95% CI = 40%–54%). Excluding 54 household members who had SARS-CoV-2 detected in specimens taken at enrollment, the secondary infection rate was 35% (95% CI = 28%–43%).

Forty percent (41 of 102) of infected household members reported symptoms at the time SARS-CoV-2 was first detected by RT-PCR. During 7 days of follow-up, 67% (68 of 102) of infected household members reported symptoms, which began a median of 4 days (IQR = 3–5) after the index patient's illness onset. The rates of symptomatic and asymptomatic laboratory-confirmed SARS-CoV-2 infection among household members was 36% (95% CI = 29%–43%) and 18% (95% CI = 13%–24%), respectively.

Discussion

In this ongoing prospective study that includes systematic and daily follow-up, transmission of SARS-CoV-2 among household members was common, and secondary infection rates were higher than have been previously reported (*1*,*3*–*7*). Secondary infections occurred rapidly, with approximately 75% of infections identified within 5 days of the index patient's illness onset. Secondary infection rates were high across all racial/ethnic groups. Substantial transmission occurred whether the index patient was an adult or a child.

Several studies have reported estimates of household transmission, largely from contact tracing activities, with limited follow-up and testing of household members or delayed enrollment relative to index patient identification (*3*–*5*,*7*). These different approaches to ascertain infections could explain the higher secondary infection rates observed in this study relative to other estimates. In addition, other studies, particularly those conducted abroad, might have found lower secondary infection rates because of rapid isolation of patients in facilities outside households or different adoption of control measures, such as mask use, in the home (*3*–*5*,*7*,*8*).

Because prompt isolation of persons with COVID-19 can reduce household transmission, persons who suspect that they might have COVID-19 should isolate, stay at home, and use a separate bedroom and bathroom if feasible. Isolation should begin before seeking testing and before test results become available because delaying isolation until confirmation of infection could miss an opportunity to reduce transmission to others. Concurrently, all household members, including the index patient, should start wearing a mask in the home, particularly in shared spaces where appropriate distancing is not possible. Close household contacts of the index patient should also self-quarantine, to the extent possible, particularly staying away from those at higher risk of getting severe COVID-19. To complement these measures within the household, a potential approach to reduce SARS-CoV-2 transmission at the community level would involve detecting infections before onset of clinical manifestations; this would require frequent and systematic testing in the community with rapidly available results to enable prompt adoption of preventive measures. The feasibility and practicality of this approach is undergoing extensive discussion (*9*) and study. This ongoing household transmission study will provide critical data regarding the recommended timing and frequency of testing.

TABLE 1. Characteristics of index patients with laboratory-confirmed SARS-CoV-2 infection and household members enrolled in a prospective study of SARS-CoV-2 household transmission — Tennessee and Wisconsin, April–September 2020

Characteristic	No. (%)* Index patients (n = 101)	No. (%)* Household members (n = 191)
Median age, yrs (IQR)	32 (24–48)	28 (14–46)
Age group, yrs		
<12	5 (5)	32 (17)
12–17	9 (9)	30 (16)
18–49	65 (64)	92 (48)
≥50	22 (22)	37 (19)
Male	41 (41)	88 (46)
Race/Ethnicity		
White, non-Hispanic	75 (74)	127 (67)
Other race, non-Hispanic	8 (8)	24 (13)
Hispanic or Latino	18 (18)	40 (21)
Underlying medical condition		
Any	22 (22)	37 (19)
Asthma	12 (12)	24 (13)
Other chronic lung disease	0 (0)	2 (1)
Cardiovascular disease	4 (4)	7 (4)
Diabetes	4 (4)	7 (4)
Chronic renal disease	0 (0)	2 (1)
Immunocompromising condition	2 (2)	3 (2)
Smoking/Vaping†	2 (2)	4 (2)

Abbreviation: IQR = interquartile range.

* Percentages might not sum to 100% because of rounding.

† Data available for 98 index cases and 166 household members.

TABLE 2. Rates of secondary laboratory-confirmed SARS-CoV-2 infections among household members enrolled in a prospective study of SARS-CoV-2 household transmission — Tennessee and Wisconsin, April–September 2020

Characteristic	Laboratory-confirmed SARS-CoV-2 infections/ Household members at risk	Secondary infection rate % (95% CI)*
All household members	102/191	53 (46–60)
Nasal swab–positive tests only	89/191	47 (40–54)
RT-PCR–negative at enrollment	48/137	35 (28–43)
Index patient age group, yrs		
<12	9/17	53 (31–74)
12–17	11/29	38 (23–56)
18–49	64/116	55 (46–64)
≥50	18/29	62 (44–77)
Index patient sex		
Female	66/108	61 (52–70)
Male	36/83	43 (33–54)
Index patient race/ethnicity		
White, non-Hispanic	71/139	51 (43–59)
Other race, non-Hispanic	9/17	53 (31–74)
Hispanic or Latino	22/35	63 (46–77)
Household member age group, yrs		
<12	18/32	57 (39–72)
12–17	14/30	47 (30–64)
18–49	54/92	59 (48–68)
≥50	16/37	43 (29–59)
Household member sex		
Female	52/103	50 (41–60)
Male	50/88	57 (46–67)
Household member race/ethnicity		
White, non-Hispanic	67/127	53 (44–61)
Other race, non-Hispanic	9/24	38 (21–57)
Hispanic or Latino	26/40	65 (50–78)
Household size, no. of persons		
2	26/38	68 (53–81)
3	25/41	61 (46–74)
4	18/40	45 (31–60)
≥5	33/72	46 (35–57)

Abbreviations: CI = confidence interval; RT-PCR = reverse transcription–polymerase chain reaction.

* Secondary infection rate, and 95% CI, estimated over 7 days of follow-up. Enrolled household members who did not report symptoms at time of illness onset in the index case-patient were considered at risk.

An important finding of this study is that fewer than one half of household members with confirmed SARS-CoV-2 infections reported symptoms at the time infection was first detected, and many reported no symptoms throughout 7 days of follow-up, underscoring the potential for transmission from asymptomatic secondary contacts and the importance of quarantine. Persons aware of recent close contact with an infected person, such as a household member, should quarantine in their homes and get tested for SARS-CoV-2.[¶¶]

Summary

What is already known about this topic?

Transmission of SARS-CoV-2 occurs within households; however, transmission estimates vary widely and the data on transmission from children are limited.

What is added by this report?

Findings from a prospective household study with intensive daily observation for ≥7 consecutive days indicate that transmission of SARS-CoV-2 among household members was frequent from either children or adults.

What are the implications for public health practice?

Household transmission of SARS-CoV-2 is common and occurs early after illness onset. Persons should self-isolate immediately at the onset of COVID-like symptoms, at the time of testing as a result of a high risk exposure, or at time of a positive test result, whichever comes first. All household members, including the index case, should wear masks within shared spaces in the household.

The findings in this study are subject to at least four limitations. First, the initial household member who experienced symptoms was considered the index patient, but it is possible that other household members were infected concurrently but developed symptoms at different times or remained asymptomatic. Although households were enrolled rapidly, several infections among household members were already detectable at enrollment, underscoring the rapid spread of infections within households and the challenge inherent in conclusively reconstructing the transmission sequence. Second, although living in the same household might impart a high risk of acquiring infection, some infections might have originated outside the household, leading to higher apparent secondary infection rates. Third, respiratory samples were self-collected; although this might have reduced the sensitivity of detections, studies have reported performance comparable to clinician-collected samples (*10*). Finally, the families in the study might not be representative of the general U.S. population.

These findings suggest that transmission of SARS-CoV-2 within households is high, occurs quickly, and can originate from both children and adults. Prompt adoption of disease control measures, including self-isolating at home, appropriate self-quarantine of household contacts, and all household members wearing a mask in shared spaces, can reduce the probability of household transmission.

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[¶¶] https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/quarantine.html; https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-risk-assesment-hcp.html; https://www.cdc.gov/coronavirus/2019-ncov/community/critical-workers/implementing-safety-practices.html; https://www.cdc.gov/coronavirus/2019-ncov/php/public-health-recommendations.html; https://www.cdc.gov/coronavirus/2019-ncov/hcp/testing-overview.html.

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Birth and Infant Outcomes Following Laboratory-Confirmed SARS-CoV-2 Infection in Pregnancy — SET-NET, 16 Jurisdictions, March 29–October 14, 2020

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Pregnant women with coronavirus disease 2019 (COVID-19) are at increased risk for severe illness and might be at risk for preterm birth (*1–3*). The full impact of infection with SARS-CoV-2, the virus that causes COVID-19, in pregnancy is unknown. Public health jurisdictions report information, including pregnancy status, on confirmed and probable COVID-19 cases to CDC through the National Notifiable Diseases Surveillance System.[*] Through the Surveillance for Emerging Threats to Mothers and Babies Network (SET-NET), 16 jurisdictions collected supplementary information on pregnancy and infant outcomes among 5,252 women with laboratory-confirmed SARS-CoV-2 infection reported during March 29–October 14, 2020. Among 3,912 live births with known gestational age, 12.9% were preterm (<37 weeks), higher than the reported 10.2% among the general U.S. population in 2019 (*4*). Among 610 infants (21.3%) with reported SARS-CoV-2 test results, perinatal infection was infrequent (2.6%) and occurred primarily among infants whose mother had SARS-CoV-2 infection identified within 1 week of delivery. Because the majority of pregnant women with COVID-19 reported thus far experienced infection in the third trimester, ongoing surveillance is needed to assess effects of infections in early pregnancy, as well the longer-term outcomes of exposed infants. These findings can inform neonatal testing recommendations, clinical practice, and public health action and can be used by health care providers to counsel pregnant women on the risks of SARS-CoV-2 infection, including preterm births. Pregnant women and their household members should follow recommended infection prevention measures, including wearing a mask, social distancing, and frequent handwashing when going out or interacting with others or if there is a person within the household who has had exposure to COVID-19.[†]

SET-NET conducts longitudinal surveillance of pregnant women and their infants to understand the effects of emerging and reemerging threats.[§] Supplementary pregnancy-related information is reported for women with SARS-CoV-2 infection (based on detection of SARS-CoV-2 in a clinical specimen by molecular amplification detection testing[¶]) during pregnancy through the day of delivery. As of October 14, 2020, 16 jurisdictions[**] have contributed data. Pregnancy status was ascertained through routine COVID-19 case surveillance or through matching of reported cases with other sources (e.g., vital records, administrative data) to identify or confirm pregnancy status. Data were abstracted using standard forms[††]; sources include routine public health investigations, vital records, laboratory reports, and medical records. Chi-squared tests were performed to test for statistically significant ($p<0.05$) differences in proportion of outcomes between women reported to have symptomatic infection and those reported to have asymptomatic infection using SAS (version 9.4; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§§]

Jurisdictions reported 5,252 pregnant women with SARS-CoV-2 infection. Among these women, 309 (5.9%) were presumed to have ongoing pregnancies (no outcome reported and not past their estimated due date plus 90 days for reporting lag), and 501 (9.5%) did not have pregnancy outcomes reported and were either missing an estimated due date or presumed lost to follow-up. This report focuses on the 4,442 women with known pregnancy outcomes (84.6% of 5,252 women).

The median age of women was 28.9 years, and 46.0% were Hispanic or Latina (Hispanic) ethnicity (Table 1). At least

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[*] https://www.cdc.gov/coronavirus/2019-ncov/php/reporting-pui.html.

[†] https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html; https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/care-for-someone.html#face-covering.

[§] https://assets.researchsquare.com/files/rs-90329/v1/e493691b-542c-47aa-a528-9e1dd9949879.pdf.

[¶] https://wwwn.cdc.gov/nndss/conditions/coronavirus-disease-2019-covid-19/case-definition/2020/.

[**] California (excluding Los Angeles County), Georgia, Houston, Los Angeles County, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York (excluding New York City), North Dakota, Oklahoma, Pennsylvania (excluding Philadelphia), Puerto Rico, Tennessee, and Vermont.

[††] https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/special-populations/pregnancy-data-on-covid-19.html.

[§§] 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

one underlying medical condition was reported for 1,564 (45.1%) women, with prepregnancy obesity (body mass index ≥30 kg/m^2) (35.1%) being the most commonly reported. Most (84.4%) women had infection identified in the third trimester (based on date of first positive test result or symptom onset). Symptom status was known for 2,691 (60.6%) women, 376 (14.0%) of whom were reported to be asymptomatic.

Among 4,527 fetuses and infants, the outcomes comprised 4,495 (99.3%) live births (including 79 sets of twins and one set of triplets), 12 (0.3%) pregnancy losses at <20 weeks' gestation, and 20 (0.4%) losses at ≥20 weeks' gestation (Table 2). Among 3,912 infants with reported gestational age, 506 (12.9%) were preterm, including 149 (3.8%) at <34 weeks and 357 (9.1%) at 34–37 weeks. Frequency of preterm birth did not differ by maternal symptom status (p = 0.62), including among women hospitalized at the time of infection (p = 0.81, Fisher's exact test). Among 3,486 (77.6%) live births with weight, gestational age, and sex reported, 198 (5.7%) were small for gestational age.[¶¶] Twenty-eight (0.6%) infants were reported to have any birth defect; among 23 infants for whom timing of maternal SARS-CoV-2 infection during pregnancy was known, 17 (74%) were born to mothers with infection identified in the third trimester. Nine (0.2%) in-hospital neonatal deaths were reported. Among term infants (≥37 weeks' gestation), 9.3% were admitted to an intensive care unit (ICU); however, reason for admission was often missing.

Information on infant SARS-CoV-2 testing was reported from 13 jurisdictions; among 923 infants with information, 313 (33.9%) were not tested. Among 610 (21.3%) infants for whom molecular test results were reported, 16 (2.6%) results were positive (Table 3), including 14 for whom the timing of the mothers' infection during pregnancy was reported. The percent positivity was 4.3% (14 of 328) among infants born to women with documentation of infection identified ≤14 days before delivery and 0% (0 of 84) among those born to women with documentation of infection identified >14 days before delivery.

Eight of the infants with positive test results were born preterm (26–35 weeks); all were admitted to a neonatal ICU (NICU) without indications reported. Among the eight term infants with positive test results, one was admitted to a NICU for fever and receipt of supplemental oxygen, one had no information on NICU admission, and the remaining six were not admitted to a NICU. No neonatal immunoglobulin M or pregnancy-related specimen (e.g., placental tissue or amniotic fluid) testing was reported; thus, routes of transmission (in utero, peripartum, or postnatal) could not be assessed.

Discussion

In this analysis of COVID-19 SET-NET data from 16 jurisdictions, the proportion of preterm live births among women with SARS-CoV-2 infection during pregnancy (12.9%) was higher than that in the general population in 2019 (10.2%) (*4*), suggesting that pregnant women with SARS-CoV-2 infection might be at risk for preterm delivery. These data are preliminary and describe primarily women with second and third trimester infection, and findings are subject to change pending completion of pregnancy for all women in the cohort and enhanced efforts to improve reporting of gestational age. This finding is consistent with other CDC reports describing higher proportions of preterm births among women hospitalized at the time of SARS-CoV-2 infection (*2*,*3*) and includes outcomes for women hospitalized as well as those not hospitalized at the time of infection (representing a population including persons with less severe illness). Increased frequency of preterm births was also described in a living, systematic review of SARS-CoV-2 infection in pregnancy (*5*). In contrast, a prospective cohort study of 253 infants found no difference in proportion of preterm birth or infant ICU admission between those born to women with positive SARS-CoV-2 test results and those born to women with suspected SARS-CoV-2 but negative test results (*6*), although the difference in findings between these two studies might be attributable to differences in case ascertainment, methodology, data collection, and sample size. Studies comparing pregnant women with and without COVID-19 are needed to assess the actual risk of preterm birth.

Non-Hispanic Black and Hispanic women were disproportionally represented in this surveillance cohort. Racial and ethnic disparities exist for maternal morbidity, mortality, and adverse birth outcomes (*7*–*9*), and the higher incidence and increased severity of COVID-19 among women of color might widen these disparities.[***] Further surveillance efforts, including reporting by additional jurisdictions to improve representativeness, and careful analysis of outcomes by race and ethnicity, will permit more direct and targeted public health action.

Information regarding the frequency and severity of perinatal (potentially including in utero, peripartum, and postnatal) infection is lacking. The American Academy of Pediatrics and CDC recommend testing all infants born to mothers with suspected or confirmed COVID-19.[†††] However, testing results

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[¶¶] Defined as weight <10th percentile for sex and gestational age using the INTERGROWTH-21st online percentile calculator. http://intergrowth21.ndog.ox.ac.uk.

[***] https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/index.html.

[†††] https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/faqs-management-of-infants-born-to-covid-19-mothers/; https://www.cdc.gov/coronavirus/2019-ncov/hcp/caring-for-newborns.html.

TABLE 1. Demographics, underlying medical conditions, and SARS-CoV-2 infection characteristics of pregnant women with known pregnancy outcomes, by symptom status — SET-NET, 16 jurisdictions, March 29–October 14, 2020

	No. of women (%) [Total no. of women with available information]			
	Total	With symptomatic[*] infection	With asymptomatic infection	Unknown symptom status
Characteristic	**N = 4,442 (100.0)**	**N = 2,315 (52.1)**	**N = 376 (8.5)**	**N = 1,751 (39.4)**
Age group, yrs	**[3,097]**	**[1,883]**	**[298]**	**[916]**
Median (IQR)	28.9 (24.4–34.0)	30.0 (24.7–34.0)	28.0 (24.2–33.7)	30.0 (24.2–34.0)
<20	167 (5.4)	97 (5.2)	26 (8.7)	44 (4.8)
20–24	654 (21.1)	390 (20.7)	63 (21.1)	201 (21.9)
25–29	735 (23.7)	454 (24.1)	74 (24.8)	207 (22.6)
30–34	870 (28.1)	530 (28.1)	75 (25.2)	265 (28.9)
35–39	525 (17.0)	326 (17.3)	46 (15.4)	153 (16.7)
≥40	146 (4.7)	86 (4.6)	14 (4.7)	46 (5.0)
Race/Ethnicity	**[3,523]**	**[2,026]**	**[308]**	**[1,189]**
Hispanic or Latina	1,622 (46.0)	876 (43.2)	138 (44.8)	608 (51.1)
Asian, non-Hispanic	122 (3.5)	78 (3.8)	5 (1.6)	39 (3.3)
Black, non-Hispanic	741 (21.0)	410 (20.2)	80 (26.0)	251 (21.1)
White, non-Hispanic	914 (25.9)	592 (29.2)	78 (25.3)	244 (20.5)
Multiple or other race, non-Hispanic	124 (3.5)	70 (3.5)	7 (2.3)	47 (4.0)
Health insurance[†]	**[2,697]**	**[1,363]**	**[289]**	**[1,045]**
Private	1,074 (39.8)	613 (45.0)	124 (42.9)	337 (32.2)
Medicaid	1,442 (53.5)	645 (47.3)	146 (50.5)	651 (62.3)
Other	80 (3.0)	39 (2.9)	10 (3.5)	31 (3.0)
Self-pay/None	101 (3.7)	66 (4.8)	9 (3.1)	26 (2.5)
Underlying medical conditions	**[3,471]**	**[1,998]**	**[322]**	**[1,151]**
Any underlying condition[§]	1,564 (45.1)	902 (45.1)	135 (41.9)	527 (45.8)
Cardiovascular disease	35 (1.0)	31 (1.6)	3 (0.9)	1 (0.1)
Chronic hypertension	55 (1.6)	30 (1.5)	10 (3.1)	15 (1.3)
Chronic lung disease	100 (2.9)	85 (4.3)	10 (3.1)	5 (0.4)
Diabetes mellitus[¶]	74 (2.1)	56 (2.8)	7 (2.2)	11 (1.0)
Immunosuppression	23 (0.7)	16 (0.8)	4 (1.2)	3 (0.3)
Obesity (BMI ≥30 kg/m^2)	1,217 (35.1)	684 (34.2)	97 (30.1)	436 (37.9)
Other[**]	26 (0.7)	22 (1.1)	3 (0.9)	1 (0.1)
Pregnancy related complications[††]	**[2,794]**	**[1,673]**	**[270]**	**[851]**
Pregnancy induced hypertension	211 (7.6)	124 (7.4)	24 (8.9)	63 (7.4)
Gestational diabetes mellitus	228 (8.2)	141 (8.4)	21 (7.8)	66 (7.8)
Trimester of SARS-CoV-2 infection[§§]	**[3,309]**	**[2,031]**	**[295]**	**[983]**
First trimester (<14 wks)	13 (0.4)	11 (0.5)	1 (0.3)	1 (0.1)
Second trimester (14–27 wks)	502 (15.2)	347 (17.1)	24 (8.1)	131 (13.3)
Third trimester (≥28 wks)	2,794 (84.4)	1,673 (82.4)	270 (91.5)	851 (86.6)

Abbreviations: BMI = body mass index; COVID-19 = coronavirus disease 2019.

[*] Inclusive of women reported as symptomatic on the COVID-19 case report form (https://www.cdc.gov/coronavirus/2019-ncov/php/reporting-pui.html) or who had any symptoms reported on the COVID-19 case report form regardless of completion of the symptom status variable.

[†] Latest known insurance during pregnancy or at delivery.

[§] Includes all listed for all women, and gestational diabetes mellitus and pregnancy induced hypertension for women with infection identified in the third trimester. Pregnancy itself is not considered an underlying condition.

[¶] Includes either type 1 or type 2 diabetes, does not include gestational diabetes.

[**] Other conditions include neurologic conditions or disabilities, chronic renal disease, chronic liver disease, psychiatric disorders, and autoimmune disorders.

[††] Among women with SARS-CoV-2 infection in third trimester.

[§§] Calculated as either date of specimen collection for first positive test, or symptom onset if exact date of specimen collection was missing.

were infrequently reported in this cohort. Perinatal infection was uncommon (2.6%) among infants known to have been tested for SARS-CoV-2 and occurred primarily among infants born to women with infection within 1 week of delivery. Among the infants with positive test results, one half were born preterm, which might reflect higher rates of screening in the ICU. These findings also support the growing evidence that although severe COVID-19 does occur in neonates the majority of term neonates experience asymptomatic infection or mild disease[§§§]; however, information on long term outcomes among exposed infants is unknown.

The findings of this report are subject to at least six limitations. First, completeness of variables, particularly those ascertained through interviews or medical record abstraction, varied by

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[§§§] https://www.cdc.gov/coronavirus/2019-ncov/hcp/caring-for-newborns.html.

TABLE 2. Pregnancy and birth outcomes among pregnant women with laboratory-confirmed SARS-CoV-2 infection by symptom status[*] — SET-NET, 16 jurisdictions, March 29–October 14, 2020

	No. of outcomes (%) [Total no. of women with available information]			
	Total	Women with symptomatic infection[†]	Women with asymptomatic infection	Women with no symptom status reported
Characteristic	**N = 4,442**	**N = 2,315 (52.1)**	**N = 376 (8.5)**	**N = 1,751 (39.4)**
Days from first positive RT-PCR test to pregnancy outcome	**[3,278]**	**[2,104]**	**[278]**	**[894]**
Median (IQR)	17.5 (1–58)	23 (3–61)	1 (0–12)	12 (1–58)
Induction of labor	**[3,846]**	**[2,113]**	**[264]**	**[1,469]**
Induced	1,091 (28.4)	593 (28.1)	78 (29.5)	420 (28.6)
Delivery type	**[3,920]**	**[2,145]**	**[285]**	**[1,490]**
Vaginal	2,589 (66.0)	1,403 (65.4)	195 (68.4)	991 (66.5)
Cesarean	1,331 (34.0)	742 (34.6)	90 (31.6)	499 (33.5)
Emergent	110 (39.6)	72 (42.6)	11 (37.9)	27 (33.8)
Non-emergent	168 (60.4)	97 (57.4)	18 (62.1)	53 (66.3)
Pregnancy outcome	**[4,527]** [§]	**[2,372]**	**[384]**	**[1,771]**
Live birth	4,495 (99.3)	2,355 (99.3)	379 (98.7)	1,761 (99.4)
Pregnancy loss	32 (0.7)	17 (0.7)	5 (1.3)	10 (0.6)
Pregnancy loss <20 weeks	12 (0.3)	10 (0.4)	2 (0.5)	0 (0.0)
Pregnancy loss ≥20 weeks	20 (0.4)	7 (0.3)	3 (0.8)	10 (0.6)
Gestational age among live births	**[3,912]**	**[2,137]**	**[287]**	**[1,488]**
Term (≥37 weeks)	3,406 (87.1)	1,840 (86.1)	244 (85.0)	1,322 (88.8)
Preterm (<37 weeks)	506 (12.9)	297 (13.9)	43 (15.0)	166 (11.2)
Late preterm (34–36 weeks)	357 (9.1)	211 (9.9)	28 (9.8)	118 (7.9)
Moderate preterm (32–33 weeks)	50 (1.3)	32 (1.5)	6 (2.1)	12 (0.8)
Very preterm (28–31 weeks)	69 (1.8)	41 (1.9)	6 (2.1)	22 (1.5)
Extremely preterm (<28 weeks)	30 (0.8)	13 (0.6)	3 (1.0)	14 (0.9)
Infant ICU admission among term live births,[¶] n/N (%)	279/2,995 (9.3)	158/1,558 (10.1)	15/173 (8.7)	106/1,264 (8.4)
Birth defects among live births,[**] n/N (%)	28/4,447 (0.6)	18/2,330 (0.8)	2/371 (0.5)	8/1,746 (0.5)

Abbreviations: ICU = intensive care unit; IQR = Interquartile range; RT-PCR = reverse transcription–polymerase chain reaction.

[*] Chi-squared tests of association was performed to compare outcomes between women with symptomatic and asymptomatic infection for induction of delivery, cesarean delivery, pregnancy loss, preterm birth, infant ICU admission, and birth defects and was found to be statistically nonsignificant (p>0.1) for all.

[†] Inclusive of women reported as symptomatic on the COVID-19 case report form (https://www.cdc.gov/coronavirus/2019-ncov/php/reporting-pui.html) or who had any symptoms reported on the COVID-19 case report form regardless of completion of the symptom status variable.

[§] Pregnancy outcomes include 79 sets of twins and one set of triplets; therefore, number exceeds the number of women.

[¶] Among term (≥37 weeks) infants only, reason for admission could include need for isolation of an otherwise asymptomatic infant based on possible SARS-CoV-2 exposure.

[**] Includes congenital heart defects (seven), cleft lip and/or palate (four), chromosomal abnormalities (four), genitourinary (four), gastrointestinal (two), cerebral cysts (one), talipes equinovarus (one), developmental dysplasia of the hip (one), supernumerary digits (one) and five had no birth defects specified. Total exceeds 28 because some infants had multiple birth defects reported.

jurisdiction. Statistical comparisons by maternal symptom status should be interpreted with caution given that symptom status was missing for a substantial proportion. Ongoing efforts to increase matching reported information with existing data sources has improved case ascertainment and completion of critical data elements. Testing and reporting might be more frequent among women with more severe illness or adverse birth outcomes. Second, these data are not nationally representative and include a higher frequency of Hispanic women compared with all women of reproductive age in national case surveillance data (*1*). Third, ascertainment of pregnancy loss depends on linkages to existing data sources (e.g., fetal death reporting), and potential underascertainment of this outcome limits comparison with national estimates. Fourth, few women with first trimester infection and completed pregnancy have been reported to date, limiting ability to evaluate adverse outcomes that might be more likely to be affected by infection earlier in pregnancy, such as birth defects. Fifth, risk factors (e.g., history of previous preterm birth) and clinical details associated with preterm delivery (e.g., spontaneous versus iatrogenic for maternal or fetal indications) were not assessed. Finally, a large proportion of infants had no testing reported. Positive SARS-CoV-2 RT-PCR results are reportable, and this percent positivity is likely an overestimate if negative testing was less often reported. Despite these limitations, this report describes a large population-based cohort with completed pregnancy outcomes and some infant testing.

These data can help to inform and counsel persons who acquire COVID-19 during pregnancy about potential risk to their pregnancy and infants; however, the risks associated with infection early in pregnancy and long-term infant outcomes remain unclear. SET-NET will continue to follow pregnancies affected by SARS-CoV-2 through completion of pregnancy and infants until age 6 months to guide clinical and public health practice.

TABLE 3. Characteristics of laboratory-confirmed infection among infants born to pregnant women with laboratory-confirmed SARS-CoV-2 infection — SET-NET, 13[*] jurisdictions, March 29–October 14, 2020

	No. of infants (%) [Total no. of infants with available information]			
	Total	Not tested or missing data[†]	RT-PCR positive results	RT-PCR negative results
Characteristic	**N = 2,869 (100.0)**	**N = 2,259 (78.7)**	**N = 16 (0.6)[§]**	**N = 594 (20.7)**
Maternal symptom status	**[1,871]**	**[1,475]**	**[13]**	**[383]**
Asymptomatic	231 (12.3)	127 (8.6)	4 (30.8)	100 (26.1)
Symptomatic	1,640 (87.7)	1,348 (91.4)	9 (69.2)	283 (73.9)
Timing of maternal infection[¶]	**[1,851]**	**[1,440]**	**[14]**	**[398]**
≤7 days before delivery	740 (40.0)	456 (31.7)	11 (84.6)	273 (68.6)
8–10 days before delivery	77 (4.2)	56 (3.9)	1 (7.7)	20 (5.0)
>10 days before delivery	1,034 (55.9)	928 (64.4)	1 (7.7)	105 (26.4)
Median (IQR) days from mother's first positive test to delivery	17 (2–53)	28 (3–63)	1 (0–4)	2 (0–12)
Maximum days from mother's first positive test to delivery	191	191	12	132
Gestational age at birth	**[2,692]**	**[2,085]**	**[16]**	**[591]**
Term (≥37 wks)	2,349 (87.3)	1,849 (88.7)	8 (50)	492 (83.2)
Late preterm (34–36 wks)	237 (8.8)	168 (8.1)	3 (18.8)	66 (11.2)
Moderate to very preterm (<34 wks)	106 (3.9)	68 (3.3)	5 (31.3)	33 (5.6)
Infant ICU admission of term infants[**] n/N (%)	**276/2,315 (11.9)**	**202/1,818 (11.1)**	**1/8 (12.5)**	**73/489 (14.9)**

Abbreviations: ICU = intensive care unit; IQR = interquartile range; RT-PCR = reverse transcription–polymerase chain reaction.

[*] Including California [excluding Los Angeles County], Houston, Los Angeles County, Michigan, Minnesota, Nebraska, New Jersey, North Dakota, Oklahoma, Pennsylvania [excluding Philadelphia], Puerto Rico, Tennessee, and Vermont.

[†] A total of 313 (10.9%) live births were reported as not tested during birth hospitalization, the remainder had no testing results reported.

[§] First positive test result occurred on the second day of life for 11 infants, on the third day for four, and on the fourth day for one.

[¶] Defined as either date of specimen collection for first positive test or symptom onset if exact date of collection was missing.

[**] Among term (≥37 weeks) infants only. Reason for admission could include need for isolation of an otherwise asymptomatic infant based on possible SARS-CoV-2 exposure.

Summary

What is already known about this topic?

Pregnant women with SARS-CoV-2 infection are at increased risk for severe illness compared with nonpregnant women. Adverse pregnancy outcomes such as preterm birth and pregnancy loss have been reported.

What is added by this report?

Among 3,912 infants with known gestational age born to women with SARS-CoV-2 infection, 12.9% were preterm (<37 weeks), higher than a national estimate of 10.2%. Among 610 (21.3%) infants with testing results, 2.6% had positive SARS-CoV-2 results, primarily those born to women with infection at delivery.

What are the implications for public health practice?

These findings can inform clinical practice, public health practice, and policy. It is important that providers counsel pregnant women on measures to prevent SARS-CoV-2 infection.

Longer-term investigation into solutions to alleviate underlying inequities in social determinants of health associated with disparities in maternal morbidity, mortality, and adverse pregnancy outcomes, and effectively addressing these inequities, could reduce the prevalence of conditions and experiences that might amplify risks from COVID-19. It is important that health care providers counsel pregnant women that SARS-CoV-2 infection might increase the risk for preterm birth and that infants born to women with infection identified >14 days before delivery might have a lower risk of having test results positive to SARS-CoV-2. Pregnant women and their household members should follow recommended infection prevention measures, including wearing a mask, social distancing, and frequent handwashing when going out or interacting with others. In addition, pregnant women should continue measures to ensure their general health including staying up to date with annual influenza vaccination and continuing prenatal care appointments.

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Update: Characteristics of Symptomatic Women of Reproductive Age with Laboratory-Confirmed SARS-CoV-2 Infection by Pregnancy Status — United States, January 22–October 3, 2020

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Studies suggest that pregnant women might be at increased risk for severe illness associated with coronavirus disease 2019 (COVID-19) (*1*,*2*). This report provides updated information about symptomatic women of reproductive age (15–44 years) with laboratory-confirmed infection with SARS-CoV-2, the virus that causes COVID-19. During January 22–October 3, CDC received reports through national COVID-19 case surveillance or through the National Notifiable Diseases Surveillance System (NNDSS) of 1,300,938 women aged 15–44 years with laboratory results indicative of acute infection with SARS-CoV-2. Data on pregnancy status were available for 461,825 (35.5%) women with laboratory-confirmed infection, 409,462 (88.7%) of whom were symptomatic. Among symptomatic women, 23,434 (5.7%) were reported to be pregnant. After adjusting for age, race/ethnicity, and underlying medical conditions, pregnant women were significantly more likely than were nonpregnant women to be admitted to an intensive care unit (ICU) (10.5 versus 3.9 per 1,000 cases; adjusted risk ratio [aRR] = 3.0; 95% confidence interval [CI] = 2.6–3.4), receive invasive ventilation (2.9 versus 1.1 per 1,000 cases; aRR = 2.9; 95% CI = 2.2–3.8), receive extracorporeal membrane oxygenation (ECMO) (0.7 versus 0.3 per 1,000 cases; aRR = 2.4; 95% CI = 1.5–4.0), and die (1.5 versus 1.2 per 1,000 cases; aRR = 1.7; 95% CI = 1.2–2.4). Stratifying these analyses by age and race/ethnicity highlighted disparities in risk by subgroup. Although the absolute risks for severe outcomes for women were low, pregnant women were at increased risk for severe COVID-19–associated illness. To reduce the risk for severe illness and death from COVID-19, pregnant women should be counseled about the importance of seeking prompt medical care if they have symptoms and measures to prevent SARS-CoV-2 infection should be strongly emphasized for pregnant women and their families during all medical encounters, including prenatal care visits. Understanding COVID-19–associated risks among pregnant women is important for prevention counseling and clinical care and treatment.

Data on laboratory-confirmed and probable COVID-19 cases[†] were electronically reported to CDC using a standardized case report form[§] or NNDSS[¶] as part of COVID-19 surveillance efforts. Data are reported by health departments and can be updated by health departments as new information becomes available. This analysis included cases initially reported to CDC during January 22–October 3, 2020, with data updated as of October 28, 2020. Cases were limited to those in symptomatic women aged 15–44 years in the United States with laboratory-confirmed infection (detection of SARS-CoV-2 RNA in a clinical specimen using a molecular amplification detection test). Information on demographic characteristics, pregnancy status, underlying medical conditions, symptoms, and outcomes was collected. Pregnancy status was ascertained by a pregnancy field on the COVID-19 case report form or through records linked to the Surveillance for Emerging Threats to Mothers and Babies Network (SET-NET) optional COVID-19 module[**,††] (*3*). CDC ascertained symptom status either through a reported symptom status variable (symptomatic, asymptomatic, or unknown) or based on the presence of at least one specific symptom on the case report form. Outcomes with missing data were assumed not to have occurred. Crude and adjusted RRs and 95% CIs were calculated using modified Poisson regression. Overall and stratified risk ratios were adjusted for age (in years), race/ethnicity, and presence of diabetes, cardiovascular disease (including hypertension), and chronic lung disease. SAS (version 9.4; SAS Institute) was used to conduct all analyses. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§§]

During January 22–October 3, a total of 5,003,041 laboratory-confirmed cases of SARS-CoV-2 infection were reported to CDC as part of national COVID-19 case surveillance, including 1,300,938 (26.0%) cases in women

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[*] These authors contributed equally to this report.

[†] https://wwwn.cdc.gov/nndss/conditions/coronavirus-disease-2019-covid-19/case-definition/2020/08/05/.

[§] https://www.cdc.gov/coronavirus/2019-ncov/downloads/pui-form.pdf.

[¶] https://wwwn.cdc.gov/nndss/covid-19-response.html.

[**] https://www.cdc.gov/coronavirus/2019-ncov/downloads/cases-updates/case-report-form-pregnancy-module.pdf.

[††] https://www.researchsquare.com/article/rs-90329/v1.

[§§] 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

aged 15–44 years. Data on pregnancy status were available for 461,825 (35.5%) women aged 15–44 years, 30,415 (6.6%) of whom were pregnant and 431,410 (93.4%) of whom were nonpregnant. Among all women aged 15–44 years with known pregnancy status, 409,462 (88.7%) were symptomatic, including 23,434 pregnant women, accounting for 5.7% of all symptomatic women with laboratory-confirmed COVID-19, and 386,028 nonpregnant women. Pregnant women were more frequently Hispanic/Latina (Hispanic) (29.7%) and less frequently non-Hispanic White (White) (23.5%) compared with nonpregnant women (22.6% Hispanic and 31.7% White). Among all women, cough, headache, muscle aches, and fever were the most frequently reported signs and symptoms; most symptoms were reported less frequently by pregnant women than by nonpregnant women (Table 1).

Compared with nonpregnant women, pregnant women more frequently were admitted to an ICU (10.5 versus 3.9 per 1,000 cases; aRR = 3.0; 95% CI = 2.6–3.4), received invasive ventilation (2.9 versus 1.1 per 1,000 cases; aRR = 2.9; 95% CI = 2.2–3.8) and received ECMO (0.7 versus 0.3 per 1,000 cases; aRR = 2.4; 95% CI = 1.5–4.0). Thirty-four deaths (1.5 per 1,000 cases) were reported among 23,434 symptomatic pregnant women, and 447 (1.2 per 1,000 cases) were reported among 386,028 nonpregnant women, reflecting a 70% increased risk for death associated with pregnancy (aRR = 1.7; 95% CI = 1.2–2.4). Irrespective of pregnancy status, ICU admissions, receipt of invasive ventilation, and death occurred more often among women aged 35–44 years than among those aged 15–24 years (Table 2). Whereas non-Hispanic Black or African American (Black) women made up 14.1% of women included in this analysis, they represented 176 (36.6%) deaths overall, including nine of 34 (26.5%) deaths among pregnant women and 167 of 447 (37.4%) deaths among nonpregnant women.

Increased risk for ICU admission among pregnant women was observed for all strata but was particularly notable among non-Hispanic Asian (Asian) women (aRR = 6.6; 95% CI = 4.0–11.0) and non-Hispanic Native Hawaiian/Pacific Islander women (aRR = 3.7; 95% CI = 1.3–10.1). Risk for receiving invasive ventilation among pregnant women aged 15–24 years was 3.0 times that of nonpregnant women (95% CI = 1.6–5.7), and among pregnant women aged 35–44 years was 3.6 times that of nonpregnant women (95% CI = 2.4–5.4). In addition, among Hispanic women, pregnancy was associated with 2.4 times the risk for death (95% CI = 1.3-4.3) (Table 2).

Discussion

Although the absolute risks for severe COVID-19–associated outcomes among women were low, pregnant women were at significantly higher risk for severe outcomes compared with nonpregnant women. This finding might be related to physiologic changes in pregnancy, including increased heart rate and oxygen consumption, decreased lung capacity, a shift away from cell-mediated immunity, and increased risk for thromboembolic disease (*4*,*5*). Compared with the initial report of these data (*1*), in which increased risk for ICU admissions and invasive ventilation among pregnant women was reported, this analysis includes nearly five times the number of symptomatic women and a higher proportion of women with known pregnancy status (36% versus 28%). Further, to avoid including pregnant women who were tested as part of asymptomatic screening practices at the delivery hospitalization, this analysis was limited to symptomatic women. In this analysis 5.7% of symptomatic women aged 15–44 years with COVID-19 were pregnant, corresponding to the anticipated proportion of 5% of the population at any point in time.[¶¶],[***]

Whereas increased risk for severe disease related to pregnancy was apparent in nearly all stratified analyses, pregnant women aged 35–44 years with COVID-19 were nearly four times as likely to require invasive ventilation and twice as likely to die than were nonpregnant women of the same age. Among symptomatic pregnant women with COVID-19 for whom race/ethnicity was reported, 30% were Hispanic and 24% were White, differing from the overall reported racial/ethnic distribution of women who gave birth in 2019 (24% Hispanic and 51% White).[†††] Pregnant Asian and Native Hawaiian/Pacific Islander women appeared to be at disproportionately greater risk for ICU admission. Hispanic pregnant women of any race not only experienced a disproportionate risk for SARS-CoV-2 infection but also a higher risk for death compared with nonpregnant Hispanic women. Regardless of pregnancy status, non-Hispanic Black women experienced a disproportionate number of deaths relative to their distribution among reported cases. This analysis highlights racial and ethnic disparities in both risk for infection and disease severity among pregnant women, indicating a need to address potential drivers of risk in these populations.

The findings in this report are subject to at least three limitations. First, national case surveillance data for COVID-19 are voluntarily reported to CDC and rely on health care providers and jurisdictional public health agencies to share information

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[¶¶] https://data.census.gov/cedsci/table?q=United%20States&tid=ACSST1Y2019.S0101&hidePreview=false.

[***] https://www.cdc.gov/reproductivehealth/emergency/docs/Geographic-Calculator-for-Pregnant-Women_508.xlsx.

[†††] https://www.cdc.gov/nchs/data/vsrr/vsrr-8-508.pdf.

TABLE 1. Demographic characteristics, signs and symptoms, and underlying medical conditions among symptomatic women of reproductive age with laboratory-confirmed SARS-CoV-2 infection (N = 409,462),[*,†] by pregnancy status — United States, January 22–October 3, 2020

	No. (%) of symptomatic women		
Characteristic	**Pregnant (n = 23,434)**	**Nonpregnant (n = 386,028)**	**Total (N = 409,462)**
Age group, yrs			
15–24	6,463 (27.6)	133,032 (34.5)	139,495 (34.1)
25–34	12,951 (55.3)	131,835 (34.2)	144,786 (35.4)
35–44	4,020 (17.2)	121,161 (31.4)	125,181 (30.6)
Race/Ethnicity[§]			
Hispanic or Latina, any race	6,962 (29.7)	85,618 (22.2)	92,580 (22.6)
AI/AN, non-Hispanic	113 (0.5)	1,652 (0.4)	1,765 (0.4)
Asian, non-Hispanic	560 (2.4)	8,605 (2.2)	9,165 (2.2)
Black, non-Hispanic	3,387 (14.5)	54,185 (14.0)	57,572 (14.1)
NHPI, non-Hispanic	119 (0.5)	1,526 (0.4)	1,645 (0.4)
White, non-Hispanic	5,508 (23.5)	124,305 (32.2)	129,813 (31.7)
Multiple or other race, non-Hispanic	726 (3.1)	12,341 (3.2)	13,067 (3.2)
Signs and symptoms			
Known status of individual signs and symptoms[¶]	10,404	174,198	184,602
Cough	5,230 (50.3)	89,422 (51.3)	94,652 (51.3)
Fever[**]	3,328 (32.0)	68,536 (39.3)	71,864 (38.9)
Muscle aches	3,818 (36.7)	78,725 (45.2)	82,543 (44.7)
Chills	2,537 (24.4)	50,836 (29.2)	53,373 (28.9)
Headache	4,447 (42.7)	95,713 (54.9)	100,160 (54.3)
Shortness of breath	2,692 (25.9)	43,234 (24.8)	45,926 (24.9)
Sore throat	2,955 (28.4)	60,218 (34.6)	63,173 (34.2)
Diarrhea	1,479 (14.2)	38,165 (21.9)	39,644 (21.5)
Nausea or vomiting	2,052 (19.7)	28,999 (16.6)	31,051 (16.8)
Abdominal pain	870 (8.4)	16,123 (9.3)	16,993 (9.2)
Runny nose	1,328 (12.8)	22,750 (13.1)	24,078 (13.0)
New loss of taste or smell[††]	2,234 (21.5)	43,256 (24.8)	45,490 (24.6)
Fatigue	1,404 (13.5)	29,788 (17.1)	31,192 (16.9)
Wheezing	172 (1.7)	3,743 (2.1)	3,915 (2.1)
Chest pain	369 (3.5)	7,079 (4.1)	7,448 (4.0)
Underlying medical conditions			
Known underlying medical condition status[§§]	7,795	160,065	167,860
Diabetes mellitus	427 (5.5)	6,119 (3.8)	6,546 (3.9)
Cardiovascular disease	304 (3.9)	7,703 (4.8)	8,007 (4.8)
Chronic lung disease	506 (6.5)	9,185 (5.7)	9,691 (5.8)
Chronic renal disease	18 (0.2)	680 (0.4)	698 (0.4)
Chronic liver disease	17 (0.2)	350 (0.2)	367 (0.2)
Immunocompromised condition	124 (1.6)	2,496 (1.6)	2,620 (1.6)
Neurologic disorder, neurodevelopmental disorder, or intellectual disability	44 (0.6)	1,097 (0.7)	1,141 (0.7)
Psychiatric disorder	62 (0.8)	1,139 (0.7)	1,201 (0.7)
Autoimmune disorder	26 (0.3)	515 (0.3)	541 (0.3)
Severe obesity[¶¶]	174 (2.2)	1,810 (1.1)	1,984 (1.2)

Abbreviations: AI/AN = American Indian or Alaska Native; NHPI = Native Hawaiian or Other Pacific Islander.

[*] Women with known pregnancy status, representing 52% of 783,072 total cases among symptomatic women aged 15–44 years.

[†] All statistical comparisons were significant at $\alpha < 0.01$, with the exception of the comparison of prevalence of neurologic disorders between pregnant and nonpregnant women ($p = 0.307$).

[§] Race/ethnicity was missing for 6,059 (26%) of symptomatic pregnant women and 97,796 (26%) of symptomatic nonpregnant women.

[¶] Data on individual symptoms were known for 10,404 (44%) of pregnant women and 174,198 (45%) of nonpregnant women. Individual symptoms were considered known if any of the following symptoms were noted as present or absent on the CDC's Human Infection with 2019 Novel Coronavirus Case Report Form: fever (measured >100.4°F [38°C] or subjective), cough, shortness of breath, wheezing, difficulty breathing, chills, rigors, myalgia, rhinorrhea, sore throat, chest pain, nausea or vomiting, abdominal pain, headache, fatigue, diarrhea (three or more loose stools in a 24-hour period), new olfactory or taste disorder, or other symptom not otherwise specified on the form.

[**] Patients were included if they had information for either measured or subjective fever variables and were considered to have a fever if "yes" was indicated for either variable.

[††] New olfactory and taste disorder has only been included on the CDC's Human Infection with 2019 Novel Coronavirus Case Report Form since May 5, 2020. Therefore, data might be underreported for this symptom.

[§§] Status was classified as "known" if any of the following conditions were noted as present or absent on the CDC's Human Infection with 2019 Novel Coronavirus Case Report Form: diabetes mellitus, cardiovascular disease (including hypertension), severe obesity (body mass index ≥40 kg/m^2), chronic renal disease, chronic liver disease, chronic lung disease, immunosuppressive condition, autoimmune condition, neurologic condition (including neurodevelopmental, intellectual, physical, visual, or hearing impairment), psychological/psychiatric condition, and other underlying medical condition not otherwise specified.

[¶¶] Defined as body mass index ≥40 kg/m^2.

TABLE 2. Intensive care unit (ICU) admissions, receipt of invasive ventilation, receipt of extracorporeal membrane oxygenation (ECMO), and deaths among symptomatic women of reproductive age with laboratory-confirmed SARS-CoV-2 (N = 409,462), by pregnancy status, age, race/ethnicity, and underlying health conditions — United States, January 22–October 3, 2020

	No. (per 1,000 cases) of symptomatic women		Risk ratio (95% CI)	
Outcome*/Characteristic	**Pregnant (n = 23,434)**	**Nonpregnant (n = 386,028)**	**Crude[†]**	**Adjusted[†,§]**
ICU admission[¶]				
All	**245 (10.5)**	**1,492 (3.9)**	**2.7 (2.4–3.1)**	**3.0 (2.6–3.4)**
Age group, yrs				
15–24	49 (7.6)	244 (1.8)	4.1 (3.0–5.6)	3.9 (2.8–5.3)
25–34	118 (9.1)	467 (3.5)	2.6 (2.1–3.1)	2.4 (2.0–3.0)
35–44	78 (19.4)	781 (6.4)	3.0 (2.4–3.8)	3.2 (2.5–4.0)
Race/Ethnicity				
Hispanic or Latina	89 (12.8)	429 (5.0)	2.6 (2.0–3.2)	2.8 (2.2–3.5)
AI/AN, non-Hispanic	0 (0)	13 (7.9)	NA	NA
Asian, non-Hispanic	20 (35.7)	52 (6.0)	5.9 (3.6–9.8)	6.6 (4.0–11.0)
Black, non-Hispanic	46 (13.6)	334 (6.2)	2.2 (1.6–3.0)	2.8 (2.0–3.8)
NHPI, non-Hispanic	5 (42.0)	22 (14.4)	2.9 (1.1–7.6)	3.7 (1.3–10.1)
White, non-Hispanic	31 (5.6)	348 (2.8)	2.0 (1.4–2.9)	2.3 (1.6–3.3)
Multiple or other race, non-Hispanic	8 (11.0)	37 (3.0)	3.7 (1.7–7.9)	4.1 (1.9–8.9)
Unknown/Not reported	46 (7.6)	257 (2.6)	2.9 (2.1–3.9)	3.4 (2.5–4.7)
Underlying health conditions				
Diabetes	25 (58.5)	274 (44.8)	1.3 (0.9–1.9)	1.5 (1.0–2.2)
CVD**	13 (42.8)	247 (32.1)	1.3 (0.8–2.3)	1.5 (0.9–2.6)
Chronic lung disease	15 (29.6)	179 (19.5)	1.5 (0.9–2.6)	1.7 (1.0–2.8)
Invasive ventilation[††]				
All	**67 (2.9)**	**412 (1.1)**	**2.7 (2.1–3.5)**	**2.9 (2.2–3.8)**
Age group, yrs				
15–24	11 (1.7)	68 (0.5)	3.3 (1.8–6.3)	3.0 (1.6–5.7)[§§]
25–34	30 (2.3)	123 (0.9)	2.5 (1.7–3.7)	2.5 (1.6–3.7)[§§]
35–44	26 (6.5)	221 (1.8)	3.5 (2.4–5.3)	3.6 (2.4–5.4)
Race/Ethnicity				
Hispanic or Latina	33 (4.7)	143 (1.7)	2.8 (1.9–4.1)	3.0 (2.1–4.5)
AI/AN, non-Hispanic	0 (0)	5 (3.0)	NA	NA
Asian, non-Hispanic	4 (7.1)	19 (2.2)	NA	NA
Black, non-Hispanic	10 (3)	86 (1.6)	1.9 (1.0–3.6)	2.5 (1.3–4.9)
NHPI, non-Hispanic	4 (33.6)	10 (6.6)	NA	NA
White, non-Hispanic	12 (2.2)	102 (0.8)	2.7 (1.5–4.8)	3.0 (1.7–5.6)
Multiple or other race, non-Hispanic	0 (0)	8 (0.6)	NA	NA
Unknown/Not reported	4 (0.7)	39 (0.4)	NA	NA
Underlying health conditions				
Diabetes	10 (23.4)	98 (16.0)	1.5 (0.8–2.8)	1.7 (0.9–3.3)
CVD**	6 (19.7)	82 (10.6)	1.9 (0.8–4.2)	1.9 (0.8–4.5)[¶¶]
Chronic lung disease	4 (7.9)	50 (5.4)	NA	NA
ECMO* **				
All	**17 (0.7)**	**120 (0.3)**	**2.3 (1.4–3.9)**	**2.4 (1.5–4.0)**
Age group,yrs				
15–24	6 (0.9)	31 (0.2)	4.0 (1.7–9.5)	NA[†††]
25–34	7 (0.5)	35 (0.3)	2.0 (0.9–4.6)	2.0 (0.9–4.4)[§§]
35–44	4 (1.0)	54 (0.4)	NA	NA
Race/Ethnicity				
Hispanic or Latina	6 (0.9)	35 (0.4)	2.1 (0.9–5.0)	2.4 (1.0–5.9)
AI/AN, non-Hispanic	0 (0)	1 (0.6)	NA	NA
Asian, non-Hispanic	0 (0)	1 (0.1)	NA	NA
Black, non-Hispanic	5 (1.5)	30 (0.6)	2.7 (1.0–6.9)	2.9 (1.1–7.3)
NHPI, non-Hispanic	0 (0)	2 (1.3)	NA	NA
White, non-Hispanic	4 (0.7)	29 (0.2)	NA	NA
Multiple or other race, non-Hispanic	0 (0)	3 (0.2)	NA	NA
Unknown/Not reported	2 (0.3)	19 (0.2)	NA	NA

See table footnotes on the next page.

TABLE 2. (*Continued*) Intensive care unit (ICU) admissions, receipt of invasive ventilation, receipt of extracorporeal membrane oxygenation (ECMO), and deaths among symptomatic women of reproductive age with laboratory-confirmed SARS-CoV-2 (N = 409,462), by pregnancy status, age, race/ethnicity, and underlying health conditions — United States, January 22–October 3, 2020

	No. (per 1,000 cases) of symptomatic women		Risk ratio (95% CI)	
Outcome[*]/Characteristic	Pregnant (n = 23,434)	Nonpregnant (n = 386,028)	Crude[†]	Adjusted[†,§]
Underlying health conditions				
Diabetes	1 (2.3)	13 (2.1)	NA	NA
CVD[**]	1 (3.3)	20 (2.6)	NA	NA
Chronic lung disease	1 (2.0)	20 (2.2)	NA	NA
Death[§§§]				
All	**34 (1.5)**	**447 (1.2)**	**1.3 (0.9–1.8)**	**1.7 (1.2–2.4)**
Age group, yrs				
15–24	2 (0.3)	40 (0.3)	NA	NA
25–34	15 (1.2)	125 (0.9)	1.2 (0.7–2.1)	1.2 (0.7–2.1)
35–44	17 (4.2)	282 (2.3)	1.8 (1.1–3.0)	2.0 (1.2–3.2)
Race/Ethnicity				
Hispanic or Latina	14 (2.0)	87 (1.0)	2.0 (1.1–3.5)	2.4 (1.3–4.3)
AI/AN, non-Hispanic	0 (0)	5 (3.0)	NA	NA
Asian, non-Hispanic	1 (1.8)	11 (1.3)	NA	NA
Black, non-Hispanic	9 (2.7)	167 (3.1)	0.9 (0.4–1.7)	1.4 (0.7–2.7)
NHPI, non-Hispanic	2 (16.8)	6 (3.9)	NA	NA
White, non-Hispanic	3 (0.5)	83 (0.7)	NA	NA
Multiple or other race, non-Hispanic	0 (0)	12 (1.0)	NA	NA
Unknown/Not reported	5 (0.8)	76 (0.8)	1.1 (0.4–2.6)	1.4 (0.6–3.6)
Underlying health conditions				
Diabetes	6 (14.1)	78 (12.7)	1.1 (0.5–2.5)	1.5 (0.6–3.5)[¶¶¶]
CVD[**]	7 (23.0)	89 (11.6)	2.0 (0.9–4.3)	2.2 (1.0–4.8)[****]
Chronic lung disease	1 (2.0)	37 (4.0)	NA	NA

Abbreviations: AI/AN = American Indian/Alaska Native; CI = confidence interval; CVD = cardiovascular disease; NA = not applicable; NHPI = Native Hawaiian or Other Pacific Islander.

[*] Percentages calculated among total in pregnancy status group.

[†] Crude and adjusted risk ratios were not calculated for cell sizes <5.

[§] Adjusted for age (continuous variable, in years), categorical race/ethnicity variable, and dichotomous indicators for diabetes, cardiovascular disease, and chronic lung disease.

[¶] A total of 17,007 (72.6%) symptomatic pregnant women and 291,539 (75.5%) symptomatic nonpregnant women were missing information on ICU admission status; however, while hospital admission status was not separately analyzed, hospitalization status was missing for 2,393 (10.2%) symptomatic pregnant women and 35,624 (9.2%) of symptomatic nonpregnant women, and no hospital admission was reported for 16,672 (71.1%) pregnant and 337,414 (87.4%) nonpregnant women. Therefore, in the absence of reported hospital admissions, women with missing ICU admission information were assumed to have not been admitted to the ICU.

[**] Cardiovascular disease also accounts for presence of hypertension.

[††] A total of 17,903 (76.4%) pregnant women and 299,413 (77.6%) nonpregnant women were missing information regarding receipt of invasive ventilation and were assumed to have not received it.

[§§] Adjusted for the presence of diabetes, CVD, and chronic lung disease only, and removed race/ethnicity from adjustment set because of model convergence issues.

[¶¶] Adjusted for the presence of diabetes and chronic lung disease and age as a continuous covariate only and removed race/ethnicity from adjustment set because of model convergence issues.

[***] A total of 18,246 (77.9%) pregnant women and 298,608 (77.4%) nonpregnant women were missing information for receipt of ECMO and were assumed to have not received ECMO.

[†††] Model failed to converge even after adjustment for a reduced set of covariates.

[§§§] A total of 5,152 (22.0%) pregnant women and 66,346 (17.2%) nonpregnant women were missing information on death and were assumed to have survived.

[¶¶¶] Adjusted for the presence of CVD and chronic lung disease and age as a continuous variable.

[****] Adjusted for presence of diabetes and chronic lung disease and age as a continuous variable.

for patients who meet standard case definitions. The mechanism used to report cases and the capacity to investigate cases varies across jurisdictions.[§§§] Thus, case information is limited or unavailable for a portion of detected COVID-19 cases, and reported case data might be updated at any time. This analysis was restricted to women with known age; however, pregnancy status was missing for over one half (64.5%) of reported cases, and among those with known pregnancy status, data on race/ethnicity were missing for approximately 25% of cases, and information on symptoms and underlying conditions was missing for approximately one half. Second, when estimating the proportion of cases with severe outcomes, the observational

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[§§§] https://www.cdc.gov/coronavirus/2019-ncov/covid-data/faq-surveillance.html.

Summary

What is already known about this topic?

Limited information suggests that pregnant women with COVID-19 might be at increased risk for severe illness compared with nonpregnant women.

What is added by this report?

In an analysis of approximately 400,000 women aged 15–44 years with symptomatic COVID-19, intensive care unit admission, invasive ventilation, extracorporeal membrane oxygenation, and death were more likely in pregnant women than in nonpregnant women.

What are the implications for public health practice?

Pregnant women should be counseled about the risk for severe COVID-19–associated illness including death; measures to prevent infection with SARS-CoV-2 should be emphasized for pregnant women and their families. These findings can inform clinical practice, risk communication, and medical countermeasure allocation.

data collected through passive surveillance might be subject to reporting bias, wherein preferential ascertainment of severe cases is likely (*6*,*7*); therefore, the frequency of reported outcomes incorporates a denominator of all cases as a conservative estimate. Finally, severe outcomes might require additional time to be ascertained. To account for this, a time lag was incorporated, such that data reported as of October 28, 2020, were used for cases reported as of October 3.

This analysis supports previous findings that pregnancy is associated with increased risk for ICU admission and receipt of invasive ventilation among women of reproductive age with COVID-19 (*1*,*2*). In the current report, an increased risk for receiving ECMO and death was also observed, which are two additional important markers of COVID-19 severity that support previous findings. In comparison to influenza, a recent meta-analysis found no increased risk for ICU admission or death among pregnant women with seasonal influenza (*8*). However, data from previous influenza pandemics, including 2009 H1N1, have shown that pregnant women are at increased risk for severe outcomes including death and the absolute risks for severe outcomes were higher than in this study of COVID-19 during pregnancy (*9*). Longitudinal surveillance and cohort studies among pregnant women with COVID-19, including information about pregnancy outcomes, are necessary to understand the full spectrum of maternal and neonatal outcomes associated with COVID-19 in pregnancy. CDC, in collaboration with health departments, has adapted SET-NET to collect pregnancy-related information and pregnancy and neonatal outcomes among women with COVID-19 during pregnancy[¶¶¶] (*3*).

Understanding the risk posed by SARS-CoV-2 infection in pregnant women can inform clinical practice, risk communication, and medical countermeasure allocation. Pregnant women should be informed of their risk for severe COVID-19–associated illness and the warning signs of severe COVID-19.[****] To minimize the risk for acquiring SARS-CoV-2 infection, pregnant women should limit unnecessary interactions with persons who might have been exposed to or are infected with SARS-CoV-2, including those within their household,[††††] as much as possible.[§§§§] When going out or interacting with others, pregnant women should wear a mask, social distance, avoid persons who are not wearing a mask, and frequently wash their hands. In addition, pregnant women should take measures to ensure their general health, including staying up to date with annual influenza vaccination and prenatal care. Providers who care for pregnant women should be familiar with guidelines for medical management of COVID-19, including considerations for management of COVID-19 in pregnancy.[¶¶¶¶],[*****] Additional data from surveillance and cohort studies on COVID-19 severity during pregnancy are necessary to inform messaging and patient counseling.

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[¶¶¶] https://www.cdc.gov/ncbddd/aboutus/pregnancy/emerging-threats.html.

[****] https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html.

[††††] https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/care-for-someone.html#face-covering.

[§§§§] https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/pregnancy-breastfeeding.html.

[¶¶¶¶] https://www.covid19treatmentguidelines.nih.gov/.

[*****] https://www.acog.org/en/Topics/COVID-19.

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Telework Before Illness Onset Among Symptomatic Adults Aged ≥18 Years With and Without COVID-19 in 11 Outpatient Health Care Facilities — United States, July 2020

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Since March 2020, large-scale efforts to reduce transmission of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), have continued. Mitigation measures to reduce workplace exposures have included work site policies to support flexible work site options, including telework, whereby employees work remotely without commuting to a central place of work.* Opportunities to telework have varied across industries among U.S. jobs where telework options are feasible (*1*). However, little is known about the impact of telework on risk for SARS-CoV-2 infection. A case-control investigation was conducted to compare telework between eligible symptomatic persons who received positive SARS-CoV-2 reverse transcription–polymerase chain reaction (RT-PCR) test results (case-patients, 153) and symptomatic persons with negative test results (control-participants, 161). Eligible participants were identified in outpatient health care facilities during July 2020. Among employed participants who reported on their telework status during the 2 weeks preceding illness onset (248), the percentage who were able to telework on a full- or part-time basis was lower among case-patients (35%; 42 of 120) than among control-participants (53%; 68 of 128) ($p<0.01$). Case-patients were more likely than were control-participants to have reported going exclusively to an office or school setting (adjusted odds ratio [aOR] = 1.8; 95% confidence interval [CI] = 1.2–2.7) in the 2 weeks before illness onset. The association was also observed when further restricting to the 175 participants who reported working in a profession outside the critical infrastructure† (aOR = 2.1; 95% CI = 1.3–3.6). Providing the option to work from home or telework when possible, is an important consideration for reducing the risk for SARS-CoV-2 infection. In industries where telework options are not available, worker safety measures should continue to be scaled up to reduce possible worksite exposures.

This multistate case-control study assessed possible exposures to COVID-19. Methods have been described elsewhere (*2*). In brief, the investigation included symptomatic adults aged ≥18 years who received their first SARS-CoV-2 test at one of 11 Influenza Vaccine Effectiveness in the Critically Ill (IVY) Network outpatient testing or health care centers§ during July 1–29, 2020 (*3*). Laboratory-confirmed case-patients were randomly sampled. Two control-participants were matched based on age, sex, and study location to each case patient, resulting in 615 potential case-patients and 1,212 control-participants. Case-patients and control-participants were contacted 14–23 days after their SARS-CoV-2 test and interviewed to identify participants who were symptomatic and had not been previously tested for SARS-CoV-2. A total of 802 adults (295 case-patients and 507 control-participants) agreed to participate in structured interviews in English or five other languages¶ administered by CDC personnel via telephone with data collected in REDCap software (version 10.3.8; REDCap Consortium) (*4*); 163 adults (9%) declined to participate.

Among these 802 adults contacted, 470 (59%) were ineligible (i.e., were not symptomatic or had a previous SARS-CoV-2 test), and 18 (2%) were excluded because of nonresponse to the telework and work-from-home question. The final analytic sample (314) included 153 (49%) case-patients and 161 (51%) control-participants. An unmatched analysis was performed because of the strict inclusion criteria that resulted in many participants being ineligible for the investigation. This activity was reviewed by CDC and participating sites and conducted consistent with applicable federal law and CDC policy.**

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[*] https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html.

[†] Response options for critical infrastructure jobs included "Healthcare facility (not in a long-term care facility), healthcare facility (long term care facility), large factory setting, correctional or detention facility, and teacher, educator, or camp counselor (i.e., those who worked with persons aged <18 years)."

[§] Baystate Medical Center, Springfield, Massachusetts; Beth Israel Deaconess Medical Center, Boston, Massachusetts; University of Colorado School of Medicine, Aurora, Colorado; Hennepin County Medical Center, Minneapolis, Minnesota; Intermountain Healthcare, Salt Lake City, Utah; Ohio State University Wexner Medical Center, Columbus, Ohio; Wake Forest University Baptist Medical Center, Winston-Salem, North Carolina; Vanderbilt University Medical Center, Nashville, Tennessee; Johns Hopkins Hospital, Baltimore, Maryland; Stanford University Medical Center, Palo Alto, California; University of Washington Medical Center, Seattle, Washington. Participating states include California, Colorado, Maryland, Massachusetts, Minnesota, North Carolina, Ohio, Tennessee, Utah, and Washington.

[¶] Other languages included Arabic, Portuguese, Russian, Spanish, and Vietnamese.

[**] 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

Data collected in this investigation included self-reported demographic characteristics, underlying chronic medical conditions,[††] employment status and location, telework status, close contact (within 6 feet for ≥15 minutes) with a person with known COVID-19, and community exposures (*2*). All questions relating to employment, close contact, and community exposures were asked with reference to the 14 days preceding illness onset. Participants who reported working full-time, part-time, who were self-employed, or who were students were asked additional questions about work, including type of work and telework status.[§§] Descriptive and statistical analyses were performed to assess differences between case-patients and control-participants, as well as between those who reported teleworking and going to an office setting, in terms of demographic characteristics, possible workplace, close contact, and community exposures.

Unconditional logistic regression models, accounting for site-level clustering, were used to estimate odds ratios and 95% CIs for associations between telework status and case-patients and control-participants, adjusting for age, sex, race/ethnicity, and presence of one or more underlying chronic medical conditions (*2*). Analysis was conducted for all participants who reported work and telework status (248) and was then restricted to those working outside the selected critical infrastructure sectors measured (i.e., not in health care, factory, corrections, or education settings) (175). Significance levels were set at $p<0.05$. Statistical analyses were conducted using SAS software (version 9.4; SAS Institute).

Compared with case-patients, control-participants were more likely to be non-Hispanic White ($p<0.01$), have a college degree or higher ($p<0.01$), and report at least one underlying chronic medical condition ($p = 0.02$) (Table 1). In the 14 days before illness onset, 59% of case-patients and 68% of control-participants reported working full-time. Among the 262 participants who reported some form of employment, 36 (30%) case-patients and 37 (27%) control-participants reported workplace or school closures. Three quarters of case-patients (75%) and nearly two thirds of control-participants (66%) worked outside the critical infrastructure. Just over a third of case-patients (35%) reported working from home or teleworking at least part of the time, compared with approximately one half (53%) of control-participants ($p<0.01$).

A total of 110 (35%) participants reported teleworking or working from home at least part of the time, and 138 (44%) reported going into an office or school regularly 2 weeks before illness onset (Table 2). Participants who reported teleworking were more likely to be non-Hispanic White ($p<0.01$), have a college degree or higher ($p<0.01$), have health insurance ($p<0.01$), an income of ≥$75,000 ($p<0.01$), and report close contact with a person with a known COVID-19 case ($p = 0.03$). No significant differences were noted in most community exposures, including shopping, going to a salon, gym, restaurant, or bar/coffee shop or using public transportation, between participants who did and did not report teleworking. However, those who regularly attended work or school were also more likely to attend church or religious gatherings (15; 11%), compared with those who teleworked at least part of the time (three; 3%) ($p = 0.01$).

Among the 248 participants who reported telework status and some form of employment during the 2 weeks before illness onset, case-patients were more likely to have reported exclusively going to an office or school setting (aOR = 1.8, 95% CI = 1.2–2.7) in the 2 weeks before illness onset than were control-participants. The association persisted when the analysis was restricted to the 175 participants who reported working in a profession outside the selected critical infrastructure sectors (aOR = 2.1, 95% CI = 1.3–3.6).

Discussion

This investigation provides evidence of the potential health benefits of teleworking associated with the COVID-19 pandemic. Among participants who reported being employed during the 2 weeks preceding illness onset, the percentage who reported teleworking on a full- or part-time basis was significantly lower among case-patients (35%) than among control-participants (53%). For case-patients and control-participants, the percentage who reported teleworking is higher than national estimates that suggest 26% of U.S. adults were teleworking because of COVID-19 during July 2020 (*5*). Compared with control-participants, case-patients had higher odds of reporting regularly attending work or school. The association persisted when restricting the analysis to those who do not represent critical infrastructure workers measured in the survey. However, these findings highlight socioeconomic differences among participants who did and did not report teleworking before illness onset, with non-White employees and those who earn less money having less opportunity to telework. Sociocultural disparities and unemployment have also been observed in industries where telework options are not feasible (*5*–*7*).

[††] Cardiac condition, hypertension, asthma, chronic obstructive pulmonary disease, immunodeficiency, psychiatric condition, diabetes, and obesity.

[§§] Response options for telework status included "going into an office/school regularly," "working from home/teleworking," or "both." Persons who reported "both" (33) were included among persons who worked from home or teleworked at least part of the time.

TABLE 1. Characteristics of symptomatic adults aged ≥18 years who were outpatients in 11 academic health care facilities and who received positive and negative SARS-CoV-2 test results (314)* — United States, July 1–29, 2020

Characteristic	No. (%)		p-value
	Case-patients (153)	Control-participants (161)	
Age group, yrs			
18–29	44 (28.7)	39 (24.2)	0.23
30–44	46 (30.1)	62 (38.5)	
45–59	45 (29.4)	36 (22.4)	
≥60	18 (11.8)	24 (14.9)	
Sex			
Men	75 (49.0)	72 (44.7)	0.45
Women	78 (51.0)	89 (55.3)	
Race/Ethnicity (missing = 1)			
White, non-Hispanic	92 (60.5)	124 (77.0)	<0.01
Hispanic/Latino	29 (19.1)	12 (7.5)	
Black, non-Hispanic	25 (16.5)	19 (11.8)	
Other, non-Hispanic[†]	6 (3.9)	6 (3.7)	
Education (missing = 4)			
Less than high school	15 (9.9)	3 (1.9)	<0.01
High school degree or some college	60 (39.5)	48 (30.4)	
College degree or more	77 (50.6)	107 (67.7)	
Health insurance coverage (missing = 2)[§]			
No insurance	15 (9.8)	9 (5.7)	0.16
Yes	130 (85.0)	146 (91.8)	
Don't know	8 (5.2)	4 (2.5)	
At least one underlying chronic medical condition[¶] (missing = 1)	**74 (48.4)**	**98 (61.3)**	**0.02**
Type of residence (missing = 1)			
Single family home	107 (69.9)	119 (74.4)	0.41
Apartment	34 (22.2)	34 (21.2)	
Other[**]	12 (7.9)	7 (4.4)	
Household income (US$)			
<25,000	20 (13.1)	10 (6.2)	0.09
25,000–34,000	10 (6.5)	8 (5.0)	
35,000–49,000	16 (10.5)	12 (7.5)	
50,000–74,000	17 (11.1)	25 (15.5)	
≥75,000	64 (41.8)	87 (54.0)	
Don't know/Not sure	15 (9.8)	8 (5.0)	
Refused	11 (7.2)	11 (6.8)	
Employment status 14 days before illness onset			
Work full-time	90 (58.8)	109 (67.7)	0.45
Work part-time	23 (15.0)	18 (11.2)	
Self-employed	8 (5.2)	6 (3.7)	
Student	6 (3.9)	2 (1.2)	
Homemaker	5 (3.3)	4 (2.5)	
Retired	10 (6.6)	14 (8.7)	
Not employed currently/ Unable to work	11 (7.2)	8 (5.0)	
Workplace or school closure because of COVID-19 during illness (256)	**36 (29.8)**	**37 (27.4)**	**0.68**
Place of employment 14 days before illness onset (262)			
Health care facility (not in a long-term care facility)	19 (15.0)	28 (20.8)	0.44
Health care facility (long-term care facility)	1 (0.8)	3 (2.2)	
Large factory setting	4 (3.1)	5 (3.7)	
Correctional or detention facility	0 (0.0)	2 (1.5)	
Teacher, educator, or camp counselor[††]	8 (6.3)	8 (5.9)	
Other[§§]	95 (74.8)	89 (65.9)	
Telework and office or school attendance 14 days before illness onset (248)[¶¶]			
Worked from home or teleworked at least part of the time	42 (35.0)	68 (53.1)	<0.01
Went into an office or school regularly	78 (65.0)	60 (46.9)	

See table footnotes in next column.

TABLE 1. (*Continued*) Characteristics of symptomatic adults aged ≥18 years who were outpatients in 11 academic health care facilities and who received positive and negative SARS-CoV-2 test results (314)* — United States, July 1–29, 2020

[*] Patients were randomly sampled from 11 academic health care systems that are part of the Influenza Vaccine Effectiveness in the Critically Ill (IVY) Network sites (Baystate Medical Center, Springfield, Massachusetts; Beth Israel Deaconess Medical Center, Boston, Massachusetts; University of Colorado School of Medicine, Aurora, Colorado; Hennepin County Medical Center, Minneapolis, Minnesota; Intermountain Healthcare, Salt Lake City, Utah; Ohio State University Wexner Medical Center, Columbus, Ohio; Wake Forest University Baptist Medical Center, Winston-Salem, North Carolina; Vanderbilt University Medical Center, Nashville, Tennessee; Johns Hopkins Hospital, Baltimore, Maryland; Stanford University Medical Center, Palo Alto, California; University of Washington Medical Center, Seattle, Washington). Participating states include California, Colorado, Maryland, Massachusetts, Minnesota, North Carolina, Ohio, Tennessee, Utah, and Washington.

[†] Other race includes responses of Native American/Alaska Native, Asian, Native Hawaiian/other Pacific Islander, and other; these were combined because of small sample sizes.

[§] Insurance status included public, private, or both. No insurance included those who reported having neither private nor public insurance.

[¶] Reported at least one of the following underlying chronic medical conditions: cardiac condition, hypertension, asthma, chronic obstructive pulmonary disease, immunodeficiency, psychiatric condition, diabetes, or obesity.

[**] Other residence included not specified or refused to answer (5), duplex/two-family home (3), trailer/mobile home (3), group home (2), townhome (2), hotel (1), long-term care facility (1), condominium (1), and lived in university fraternity or sorority housing (1).

[††] Including any other field that works with children aged <18 years.

[§§] Other work exposures are those who reported "No, I do not work in any of these fields" among the possible workplace exposures assessed.

[¶¶] Thirteen participants reported "don't know/not sure," and one refused to answer the question. Participants were asked "In the 14 days prior to becoming ill, were you: Going into an office/school regularly; Working from home/teleworking; Both." Response options were dichotomized with those who reported "both" categorized as "Worked from home or teleworked at least part of the time."

TABLE 2. Characteristics of work activity among symptomatic adults aged ≥18 years who reported working in the 14 days before illness onset from 11 academic health care facilities (248) * — United States, July 1–29, 2020

Characteristic	No. (%) Telework and work from home (110)	No. (%) Going into an office or school regularly (138)	p-value
Age group, yrs			
18–29	30 (27.3)	44 (31.9)	0.89
30–44	42 (38.2)	49 (35.5)	
45–59	31 (28.2)	37 (26.8)	
≥60	7 (6.3)	8 (5.8)	
Sex			
Men	48 (43.6)	71 (51.5)	0.22
Women	62 (56.4)	67 (48.5)	
Race/Ethnicity (missing = 1)			
White, non-Hispanic	87 (79.8)	84 (60.9)	<0.01
Hispanic/Latino	6 (5.5)	27 (19.6)	
Black, non-Hispanic	11 (10.1)	22 (15.9)	
Other, non-Hispanic[†]	5 (4.6)	5 (3.6)	
Education (missing = 3)			
Less than high school	1 (0.9)	9 (6.6)	<0.01
High school degree or some college	18 (16.7)	65 (47.4)	
College degree or more	89 (82.4)	63 (46.0)	
Health insurance coverage (missing = 2)[§]			
No insurance	2 (1.8)	17 (12.4)	<0.01
Yes	104 (95.4)	114 (83.2)	
Don't know	3 (2.8)	6 (4.4)	
Household income (US$)			
<25,000	4 (3.6)	18 (13.0)	<0.01
25,000–34,000	5 (4.6)	8 (5.8)	
35,000–49,000	3 (2.7)	16 (11.6)	
50,000–74,000	17 (15.5)	18 (13.0)	
≥75,000	69 (62.7)	64 (46.4)	
Don't know/Not sure	4 (3.6)	9 (6.5)	
Refused	8 (7.3)	5 (3.7)	
Employment status 14 days before illness onset			
Work full-time	85 (77.3)	107 (77.5)	0.12
Work part-time	12 (10.9)	24 (17.4)	
Self-employed	7 (6.4)	5 (3.6)	
Student	6 (5.4)	2 (1.5)	
Place of employment 14 days before illness onset			
Health care facility (not in a long-term care facility)	12 (10.9)	34 (24.6)	<0.01
Health care facility (long-term care facility)	1 (0.9)	3 (2.2)	
Large factory setting	0 (0.0)	6 (4.4)	
Correctional or detention facility	2 (1.8)	0 (0.0)	
Teacher, educator, or camp counselor[¶]	10 (9.1)	5 (3.6)	
Other**	85 (77.3)	90 (65.2)	
Close contact with a person with known COVID-19 (missing = 2)	26 (23.6)	50 (36.8)	0.03
Community exposure 14 days before illness onset[††]			
Shopping (missing = 2)	100 (90.9)	119 (87.5)	0.40
Home, ≤10 persons (missing = 1)	66 (60.0)	68 (49.6)	0.10
Restaurant (missing = 2)	34 (30.9)	51 (37.5)	0.28
Salon (missing = 2)	21 (19.1)	17 (12.5)	0.16
Home, >10 persons (missing = 1)	19 (17.3)	16 (11.7)	0.21
Gym (missing = 2)	13 (11.8)	7 (5.2)	0.06
Public transportation (missing = 2)	5 (4.6)	8 (5.9)	0.64
Bar/Coffee shop (missing = 3)	7 (6.4)	13 (9.6)	0.35
Church/Religious gathering (missing = 2)	3 (2.7)	15 (11.0)	0.01

See table footnotes in next column.

* Participants were asked "In the 14 days prior to becoming ill, were you: Going into an office/school regularly; Working from home/teleworking; Both." Among 262 participants who reported working in the 14 days before illness onset, 13 reported "don't know/not sure," and one refused to answer the question. Response options were dichotomized with those who reported "both" as teleworking or working from home at least part of the time. Patients were randomly sampled from 11 academic health care systems that are part of the Influenza Vaccine Effectiveness in the Critically Ill (IVY) Network sites (Baystate Medical Center, Springfield, Massachusetts; Beth Israel Deaconess Medical Center, Boston, Massachusetts; University of Colorado School of Medicine, Aurora, Colorado; Hennepin County Medical Center, Minneapolis, Minnesota; Intermountain Healthcare, Salt Lake City, Utah; Ohio State University Wexner Medical Center, Columbus, Ohio; Wake Forest University Baptist Medical Center, Winston-Salem, North Carolina; Vanderbilt University Medical Center, Nashville, Tennessee; Johns Hopkins Hospital, Baltimore, Maryland; Stanford University Medical Center, Palo Alto, California; University of Washington Medical Center, Seattle, Washington). Participating states include California, Colorado, Maryland, Massachusetts, Minnesota, North Carolina, Ohio, Tennessee, Utah, and Washington.

[†] Other race includes responses of Native American/Alaska Native, Asian, Native Hawaiian/other Pacific Islander, and other; these were combined because of small sample sizes.

[§] Insurance status included public, private, or both. No insurance included those who reported having neither private nor public insurance.

[¶] Including any other field that works with children aged <18 years.

** Persons who reported "No, I do not work in any of these fields" among the possible workplace exposures assessed.

[††] Participants were asked "In the 14 days before feeling ill about how often did you: 1) Shop for items (groceries, prescriptions, home goods, clothing, etc.); 2) have people visit you inside your home or go inside someone else's home where there were more than 10 people; 3) have people visit you inside your home or go inside someone else's home where there were 10 people or less; 4) go to a restaurant (dine-in, any area designated by the restaurant including patio seating); 5) go to a gym or fitness center; 6) go to a salon or barber (e.g., hair salon, nail salon, etc.); 7) attend church or a religious gathering/place of worship; 8) go to a bar or coffee shop (indoors); and 9) use public transportation (bus, subway, streetcar, train, etc.)." Response options were coded as never versus at least once in the 14 days before illness onset. Participants were asked each question separately and could have responded to multiple community exposure questions.

Most community exposures were not associated with teleworking. Further studies are needed to better characterize the constellation of activities, including possible work and community exposures concomitantly occurring that could increase risk for infection, particularly while asymptomatic transmission occurs.

The findings in this report are subject to at least four limitations. First, persons who participated in this investigation might be systematically different from those who refused or were not eligible for the study, and therefore, might not be representative of the U.S. population. Second, matching was not maintained in this analysis because some potential participants contacted declined to participate in the interview or were ineligible. However, this was accounted for in the analytic approach. Third, unmeasured confounding is possible because different types of telework options were not operationalized, nor were participants asked whether their employer provided a specific alternative work site policy. The question assessing telework status did not differentiate work and school settings, however only eight participants in the sample reported being a student. Further, case-patients and control-participants received testing at outpatient testing centers and cannot be generalized to represent serious illness or persons who used other testing modalities. Finally, symptomatic adults with negative SARS-CoV-2 test results might have been infected with other respiratory viruses and case or control status might be subject to misclassification due to limitations of PCR-based testing (*8*,*9*).

Allowing and encouraging the option to work from home or telework, when possible, is an important consideration for reducing SARS-CoV-2 transmission. Characterizing work from home experiences as well as exploring workplace exposures alongside other community exposures will be critical to understanding the impact of mitigation efforts on COVID-19 incidence. Businesses and employers should promote alternative work site options, such as telework, to support worker and community safety during the COVID-19 pandemic. Within the critical infrastructure and other workplaces where telework options are not possible, worker safety measures should continue to be scaled up by creating a COVID-19 preparedness response plan, implementing essential infection prevention and control measures (e.g., social distancing, wearing masks, provision of personal protective equipment, daily health checks, hand hygiene, sanitation, and disinfection), as well as enhancing policies to protect employees and the community.¶¶

¶¶ https://www.cdc.gov/coronavirus/2019-ncov/community/worker-safety-support/index.html; https://www.osha.gov/Publications/OSHA3990.pdf.

Summary

What is already known about this topic?

Since March 2020, large scale measures to reduce workplace transmission of SARS-CoV-2, including workplace closures and providing telework options, have been implemented.

What is added by this report?

Adults who received positive test results for SARS-CoV-2 infection were more likely to report exclusively going to an office or school setting in the 2 weeks before illness onset, compared with those who tested negative, even among those working in a profession outside of the critical infrastructure.

What are the implications for public health practice?

Businesses and employers should promote alternative work site options, such as teleworking, where possible, to reduce exposures to SARS-CoV-2. Where telework options are not feasible, worker safety measures should continue to be scaled up to reduce possible worksite exposures.

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A SARS-CoV-2 Outbreak Illustrating the Challenges in Limiting the Spread of the Virus — Hopi Tribe, May–June 2020

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On June 3, 2020, a woman aged 73 years (patient A) with symptoms consistent with coronavirus disease 2019 (COVID-19) (*1*) was evaluated at the emergency department of the Hopi Health Care Center (HHCC, an Indian Health Services facility) and received a positive test result for SARS-CoV-2, the virus that causes COVID-19. The patient's symptoms commenced on May 27, and a sibling (patient B) of the patient experienced symptom onset the following day. On May 23, both patients had driven together and spent time in a retail store in Flagstaff, Arizona. Because of their similar exposures, symptom onset dates, and overlapping close contacts, these patients are referred to as co-index patients. The co-index patients had a total of 58 primary (i.e., direct) and secondary contacts (i.e., contacts of a primary contact); among these, 27 (47%) received positive SARS-CoV-2 test results. Four (15%) of the 27 contacts who became ill were household members of co-index patient B, 14 (52%) had attended family gatherings, one was a child who might have transmitted SARS-CoV-2 to six contacts, and eight (30%) were community members. Findings from the outbreak investigation prompted the HHCC and Hopi Tribe leadership to strengthen community education through community health representatives, public health nurses, and radio campaigns. In communities with similar extended family interaction, emphasizing safe ways to stay in touch, along with wearing a mask, frequent hand washing, and physical distancing might help limit the spread of disease.

The Hopi are a Native American tribe and a sovereign nation, primarily residing on the 1.5 million-acre Hopi Reservation in northeastern Arizona (*2*). The Hopi Tribe leadership declared a COVID-19–associated state of emergency on March 17, which was followed by a stay-at-home order March 23 (with projected reopening on June 20). On April 13, HHCC reported its first laboratory-confirmed COVID-19 case in a patient residing on the Hopi Reservation, and cases continued to be diagnosed at low levels through May. However, at the beginning of June, HHCC reported that during the preceding 14 days, the number of new cases had increased sharply, from 1–2 to 10–15 per day (J Hirschman, MD, CDC, personal communication, June 2020).

Investigation and Results

On June 3, a woman aged 73 years (patient A) with symptoms consistent with COVID-19 (*1*) was seen at HHCC emergency department and received a positive SARS-CoV-2 RNA amplification rapid diagnostic test (Abbott ID NOW) (*3*) result. On June 4, HHCC's Community Health Department began contact tracing. Patient A was interviewed to identify symptom onset date and any persons with whom she had close contact* from 2 days before symptom onset on May 27 until the interview date. Contact tracing interviews revealed that a sibling of patient A, aged 67 years, (patient B) experienced symptoms on May 28, 1 day after patient A's symptom onset. Patients A and B reported spending a few hours on May 23, in a large home improvement store in Flagstaff, while wearing masks and reported intermittent mask-wearing† in the 2-hour drive home, and no other passengers were in the car. On May 27, 4 days after returning from Flagstaff, patient A reported headache and continued feeling unwell during the following 4 days (May 28–31). During June 1–2, she experienced worsening headache with fever and shortness of breath and received a positive SARS-CoV-2 test result on June 3. Patient B reported runny nose and sore throat on May 28 and received a positive SARS-CoV-2 test result on June 5. Both patients A and B self-isolated after receiving positive test results, and are considered co-index patients because of their similar exposures, symptom onset dates, and overlapping close contacts.

Primary contacts of co-index patients A and B with laboratory-confirmed COVID-19 test results and secondary contacts (contacts of primary contacts) (*4*) were interviewed by telephone and asked to come to HHCC for testing. Interviews were conducted using a standardized form.§ Close contacts who received positive test results were classified as symptomatic if their symptoms were consistent with COVID-19 (*1*), presymptomatic if they were asymptomatic when tested but experienced

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* Close contact is defined as someone who was within 6 feet of an infected person for at least 15 minutes starting from 2 days before illness onset.

† Intermittent mask wearing was defined as tribal member's acknowledgment of not wearing a mask throughout the duration of close contact.

§ CDC's Human Infection with 2019 Novel Coronavirus Case Report Form (https://www.cdc.gov/coronavirus/2019-ncov/downloads/pui-form.pdf) was used for case investigations. A customized form was used for contact-tracing interviews.

symptoms within 14 days of exposure, or asymptomatic if they never reported any symptoms. These contacts were not retested after they became symptomatic. Symptomatic contacts were tested with Abbott ID NOW and received same-day results; symptomatic contacts with negative test results were retested using real-time reverse transcription–polymerase chain reaction (RT-PCR) (*5*). All contacts who were asymptomatic at the time of investigation were tested with RT-PCR.

Overall, 58 primary and secondary contacts of index patients A and B were identified, 27 (47%) of whom received positive test results for SARS-CoV-2. Among the 29 persons with confirmed COVID-19 (including co-index patients A and B), 22 (76%) were symptomatic and seven were asymptomatic (Figure 1). To describe the sequence of transmission, contacts of patients A and B are denoted by letters and numbers, indicating contact with either or both patients, and the hypothesized sequence of transmission.

Patient A reported working in an office on May 27, her symptom onset date, in close proximity to a colleague (A1.1) for approximately 6 hours (Figure 2). Both patients A and A1.1 reported intermittent mask-wearing in the enclosed office. On June 2, patient A1.1 experienced diarrhea and loss of appetite and, on June 4, received a positive SARS-CoV-2 test result. While patient A1.1 was symptomatic and before being tested, she had contact with 12 persons, including eight household members (A1.1.1–A1.1.8) and four colleagues (A1.1.9–A1.1.12). All 12 contacts of patient A1.1 were tested for SARS-CoV-2, and seven household contacts (all but A1.1.8) received positive test results; all four colleagues received negative test results. After work on May 27, patient A visited a second sibling (patient A2.1).

On the date her symptoms began, May 27, patient A also worked outdoors with patient B and 13 extended family members (A2.1, B1.1–B1.4, and AB1.1–AB1.8[¶]) and then dined with them at an indoor potluck planting dinner,[**] where attendees did not wear masks. On May 30, patients A and B attended a graduation dinner with 23 persons in addition to themselves (B1.1, B1.3–B1.10, and AB2.1–AB2.14). Three persons who attended the planting dinner also attended the graduation dinner (B1.1, B1.3, and B1.4). These three persons, five persons who attended only the graduation dinner (AB2.1, AB2.2, AB2.3, AB2.14, and B1.9), and three who attended only the planting

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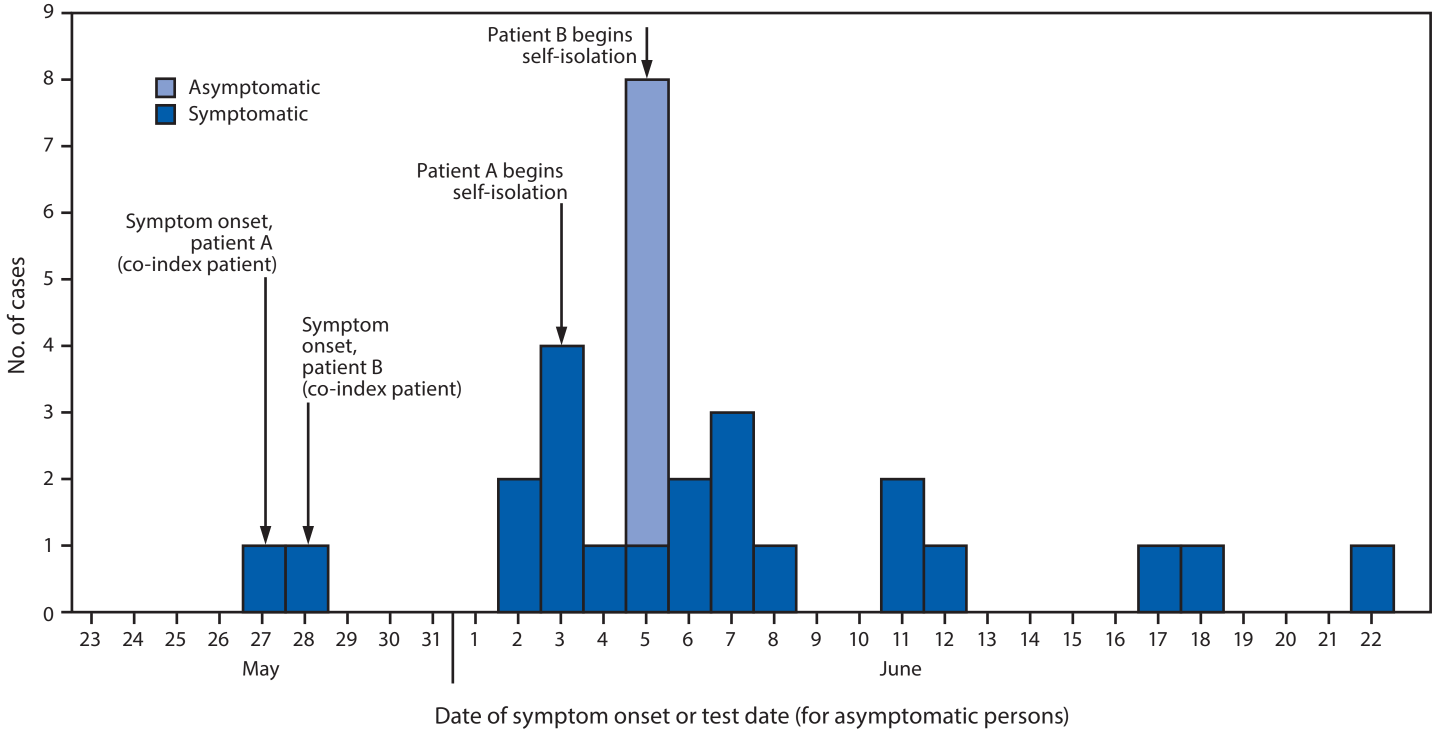
[¶] One person who attended the planting dinner (AB1.2) refused testing and was not included in the study results.

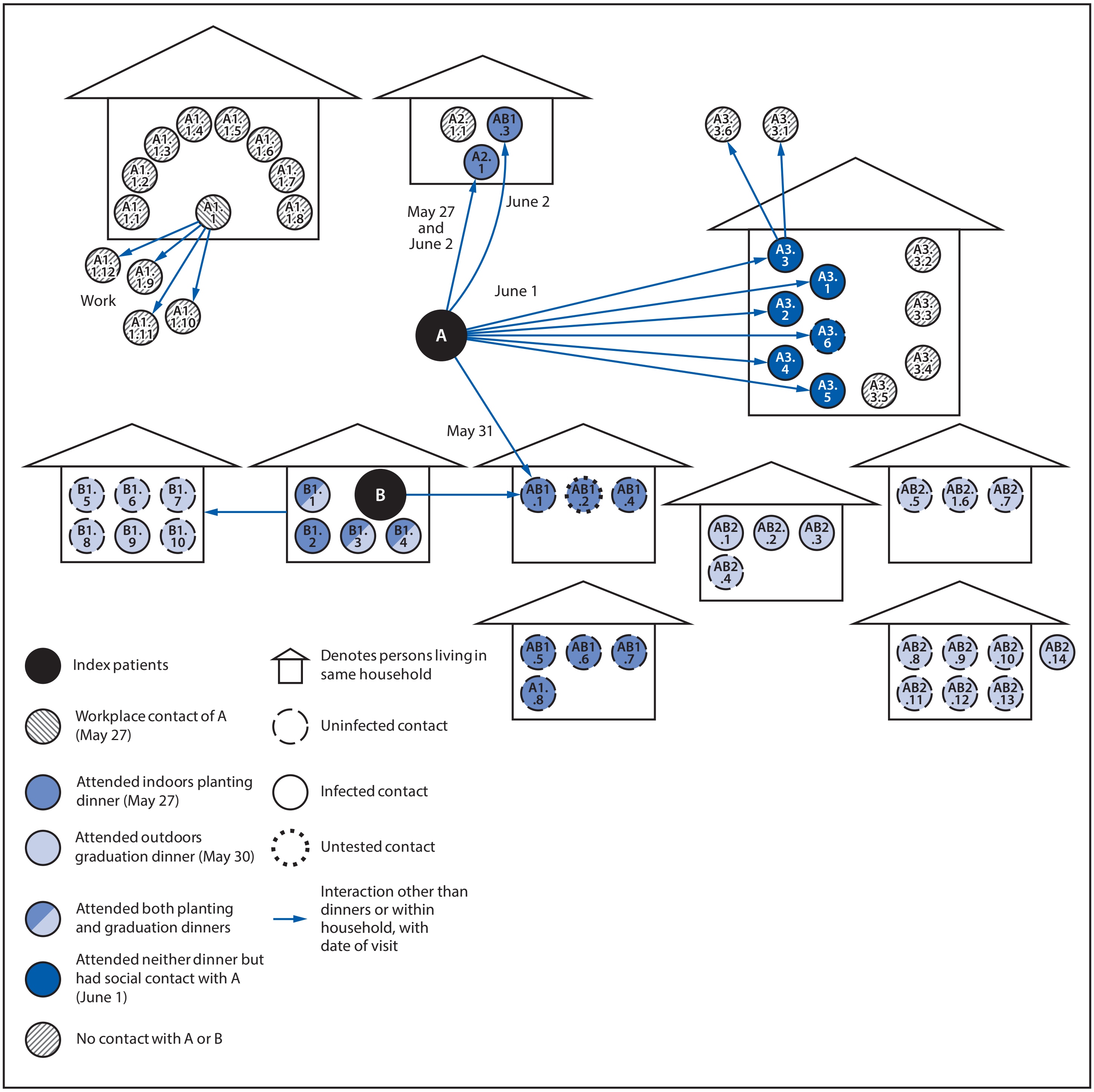
[**] The planting dinner is an activity common among Hopi Tribe members, in which a family member invites immediate and extended members to work together in the crop fields in the morning and then hosts a dinner for those invited later in the evening.

FIGURE 1. Date of symptom onset or test date (for asymptomatic persons) in a cluster of 29 laboratory-confirmed COVID-19 patients — Hopi Tribe, May–June 2020



Abbreviation: COVID-19 = coronavirus disease 2019.

FIGURE 2. Transmission of SARS-CoV-2 among 58 primary and secondary contacts* of co-index patients A and B, resulting in 27 (47%) confirmed cases — Hopi Tribe, May–June 2020



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* Patient AB2.14 lives in another city but is part of the AB2.8–AB2.14 family.

dinner (A2.1, AB1.3, and B1.2) later developed symptoms and received positive SARS-CoV-2 test results. Both dinners took place during the stay-at-home order. On May 31, patients A and B had contact with another family member (AB1.1), for approximately 1 hour, although AB1.1 took a telephone call outside most of that time. AB1.1 received a negative SARS-CoV-2 test result and remained asymptomatic.

On June 1, 4 days after patient A's symptom onset, she was visited for several hours by her daughter (A3.1), son-in-law (A3.2), and four grandchildren (A3.3–A3.6). Later that day, one grandchild (A3.3) played with two friends. On June 2, patient A3.3 developed fever, cough, chills, and difficulty breathing. She was taken to HHCC on June 3 and received a positive SARS-CoV-2 test result. On June 4, all nine household members of A3.3 (A3.1, A3.2, A3.4–A3.6, and A3.3.2–3.3.5) were tested for SARS-CoV-2, and two received positive results, including patient A3.4, who had visited patient A, and patient A3.3.2, who had not. That same day, one of the granddaughter's playmates (A3.3.1) also received a positive test result. No other infections were detected in the playmate's household,[††] and everyone in this household reported consistent mask-wearing, including at home, after patient A3.3.1's symptom onset. Patients A3.4 and A3.3.2 became symptomatic on June 6 and 7, respectively. On June 8, patient A3.1 became symptomatic and received a positive test result on June 10. On June 11, patients A3.2 and A3.5 became symptomatic and received positive test results.

On June 2, patient A's sibling (A2.1) and nephew (AB1.3) visited her for a few hours. They experienced symptoms on June 7 and received positive SARS-CoV-2 test results on June 9. On June 22, A2.1's spouse (A2.1.1) received a positive test result after experiencing symptoms.

Patient B lives with four family members, and six extended family members live next door. From May 28 (symptom onset date) through June 5 (date of laboratory confirmation), patient B had close contact with these 10 family members (B1.1–B1.10), including five (four household and one next door) who later became symptomatic and were confirmed to have COVID-19.

TABLE. Demographic and clinical characteristics of persons with laboratory-confirmed SARS-CoV-2 infection (N = 29) — Hopi Tribe, May–June 2020

Characteristic	No. (%)
Median age (range)	21 (1–79)
Age group (yrs)	
0–19	13 (45)
20–39	8 (28)
40–59	4 (14)
60–79	4 (14)
Sex	
Male	11 (38)
Female	18 (62)
Chronic underlying conditions	
Cardiovascular diseases	3 (10)
Chronic lung disease	2 (7)
Chronic renal disease	1 (3)
Diabetes mellitus	3 (10)
Hyperglycemia	2 (7)
Obesity	7 (24)
Other*	4 (14)
Signs and symptoms	
Abdominal pain	4 (14)
Asymptomatic	7 (24)
Chills	6 (21)
Cough	10 (35)
Diarrhea	5 (17)
Difficulty breathing	4 (14)
Fever	11 (38)
Headache	9 (31)
Malaise	1 (3)
Muscle ache	2 (7)
Runny nose	11 (38)
Sinus congestion	1 (3)
Sore throat	2 (7.0)
Known setting of primary contact[†]	
Graduation reception dinner[§]	8 (30)
Household	4 (14)
Household visits	7(24)
Planting dinner	6 (22)
Work	1 (4)
Laboratory testing results	
Total positive[¶]	**29 (48)**
Symptomatic**	22 (76)
Presymptomatic[††]	4 (14)
Total positive/Total no. tested (attack rate, %)	**29/60 (48)**

* Other includes high cholesterol, impaired glucose tolerance, depressive disorder, dysuria, nuclear sclerosis, proteinuria, and hyperlipidemia.

[†] Both numerator and denominator excluded co-index patients.

[§] Three persons attended both planting dinner and graduation dinner.

[¶] Includes co-index patients A and B.

** Includes presymptomatic.

[††] Developed symptoms after receiving positive test results; patients were not retested after they became symptomatic.

Overall, among 60 extended family and community member contacts, including co-index patients A and B, 29 (48%) persons with confirmed COVID-19 were identified. The median patient age was 21 years (range = 1–79 years) (Table). Among patients with confirmed COVID-19, 13 (45%) had at least one underlying medical condition, including seven (24%) with obesity, three (10%) with diabetes, and three (10%) with cardiovascular disease. Four patients (14%) were presymptomatic, all of whom were aged <20 years, and seven (24%) were asymptomatic, six of whom were aged <30 years. Among 27 contacts with confirmed COVID-19, seven (24%) had visited patient A, four (14%) were household members

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[††] These tertiary contacts are not included in the analysis denominator.

of patient B, one (4%) was a workplace contact, and one was a child who had six close contacts who received positive test results. Two patients went to an emergency department, one patient required critical care, and no deaths occurred. Contact tracing interviews revealed limited understanding of how and when to wear masks, adhere to physical distancing of ≥6 feet, and practice hand hygiene.

Public Health Response

HHCC led the overall response in collaboration with the Hopi Tribe. The Hopi Emergency Response Team, working in collaboration with HHCC public health nurses, coordinated support for housing, food, and other needs during isolation and quarantine and set up a communication team focused on community education and mitigation with messaging regarding recommended mask-wearing, hand hygiene, and physical distancing.

Discussion

In this COVID-19 outbreak among the Hopi, two gatherings of extended family members and workplace exposure likely facilitated transmission of SARS-CoV-2 beyond household contacts into the broader community. Both gatherings included >10 persons and took place while the stay-at-home order was active. A distinctive element of Hopi lifestyle highlighted by this investigation was the frequent social interaction among extended family members, leading to repeated exposure of contacts to patients A and B, both of whom were symptomatic ≥1 week before testing, during which time they socialized in the community. Consistent with other reports, many children and young adults with COVID-19 were asymptomatic or had mild symptoms (*6*,*7*); these patients might not have been identified without universal contact testing. One child exposed six contacts who were later confirmed to have COVID-19, including five household members; although four household members had also visited patient A, the intervals between cases as well as interview findings suggest that the child might have introduced COVID-19 into the household. Approximately one half of the COVID-19 patients identified in this outbreak had chronic underlying conditions.

This investigation highlights a need for prevention strategies focused on enhanced community education related to recognition of COVID-19 symptoms and encouraging consistent mask-wearing. All household members, including the index patient, should wear masks within shared spaces in the household. These strategies, along with self-isolation upon symptom onset, can limit exposures and mitigate transmission. After this investigation, HHCC and the Hopi Tribe increased community messaging in English and in Hopi, using multiple modalities including radio and in-person messaging through community health representatives. Messaging explained that by wearing a mask, practicing physical distancing, washing one's hands frequently, and taking other preventive measures in accordance with CDC guidelines, persons can reduce the risk to themselves and others (*8*,*9*).

The findings in this report are subject to at least three limitations. First, despite intense contact tracing efforts, some tertiary contacts might have been missed. Second, precise determination of exposure dates and classification of contacts as secondary versus tertiary was challenging because of the repeated and overlapping interactions among extended family members. Finally, detailed information on mask wearing and physical distancing practices could not be consistently obtained.

Overall, collaborative efforts and prompt communication between HHCC and the Hopi Tribe proved crucial in containing this outbreak. Lessons learned in this outbreak might also prove useful for other communities with multigenerational households and frequent interactions among extended family members.

Summary

What is already known about this topic?

Large gatherings pose a risk for SARS-CoV-2 transmission.

What is added by this report?

Among 60 immediate and extended family and community members of the Hopi Tribe, 29 (48%) laboratory-confirmed COVID-19 cases occurred; 14% were presymptomatic, and 24% of patients were asymptomatic. The majority of presymptomatic and asymptomatic cases occurred in children and young adults.

What are the implications for public health practice?

Frequent and recurring social interactions among extended family members permitted repeated exposures to infectious persons. In communities with similar extended family interaction, emphasizing safe ways to stay in touch, together with wearing a mask, frequent hand washing, and physical distancing might help limit the spread of disease.

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Community health representatives and public health nurses; the Hopi Tribe; the Hopi Emergency Response Team; frontline workers at Hopi Health Care Center; patients and contacts described in this report.

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Notes from the Field

Development of an Enhanced Community-Focused COVID-19 Surveillance Program — Hopi Tribe, June–July 2020

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The Hopi Tribe, a sovereign nation in northeastern Arizona, includes approximately 7,500 persons within 12 rural villages (*1*). During April 11–June 15, 2020, the Hopi Health Care Center (HHCC, an Indian Health Services facility) reported 136 cases of coronavirus disease 2019 (COVID-19) among Hopi residents; 27 (20%) patients required hospitalization (J Hirschman, MD, CDC, personal communication, June 2020). Contact tracing of Hopi COVID-19 cases identified delayed seeking of care and testing by persons experiencing COVID-19–compatible signs and symptoms*; inconsistent adherence to recommended mitigation measures,† such as mask-wearing and social distancing; and limited knowledge of the roles of testing, isolation, and quarantine procedures§ (*2*). Based on these findings, the Hopi Tribe Department of Health and Human Services (DHHS) collaborated with HHCC to develop a community-focused program to enhance COVID-19 surveillance and deliver systematic health communications to the communities. This report describes the surveillance program and findings from two field tests.¶

The Hopi Tribe DHHS, HHCC, and CDC collaborated to develop methodology and materials for this surveillance program, which aimed to expand upon the Community Health Representative Program. The Hopi Tribe DHHS administers the Community Health Representative Program, which provides health education and patient follow-up through home visits to patients referred by HHCC. Community health representatives are salaried employees with basic clinical training; each manages a caseload of 30–40 patients in one or two villages. For surveillance field tests, community health representatives visited every household in two villages.** At each household, community health representatives screened each member for COVID-19–like signs and symptoms†† and exposures using a standardized form, recommended testing where indicated, and provided education on everyday prevention activities and mitigation of within-household transmission of SARS-CoV-2, the virus that causes COVID-19, using culturally adapted materials.§§ Symptomatic or exposed persons were referred for SARS-CoV-2 testing and management at HHCC. Safety provisions for community health representatives included wearing personal protective equipment, conducting interviews outdoors, maintaining a distance of ≥6 feet from interviewees, and limiting close contact with households reporting confirmed COVID-19 cases (i.e., providing education to well household members from a distance of ≥6 feet but not conducting interviews).

Field tests of the surveillance protocol in two smaller villages were conducted on June 24 in Oraibi and on July 16 in Bacabi (estimated populations 100 and 175, respectively). Five two-person teams, each composed of one community health representative and one volunteer (from the village, Hopi Tribe DHHS, or CDC field team), canvassed each village within 5 hours. In the two villages, 101 households were approached, 78 (77%) of which provided basic information on 259 persons (Table); 141 were screened (age range = 1–91 years, median = 50 years). Two persons who reported mild COVID-19–like symptoms (nasal congestion and runny nose) and two possibly exposed persons were referred for testing. Only the exposed persons sought testing; both received negative test results by reverse transcription–polymerase chain reaction (nasopharyngeal swabs were sent to a commercial laboratory for analysis). One mildly symptomatic person did not permanently reside with the family and was lost to follow-up, and one mildly symptomatic person reported that symptoms were attributable to seasonal allergies. Based on interactions, teams reported that residents of the two villages seemed appreciative of the program and of community health representative presence and were receptive to COVID-19 health education.

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* https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html.

† https://www.cdc.gov/coronavirus/2019-ncov/downloads/php/open-america/community-mitigation-quicklinks.pdf.

§ https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/index.html.

¶ This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy: 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

** These villages were not the site of the outbreak that occurred during May–June 2020 among extended family members.

†† The following signs and symptoms were specifically asked about: fever, chills, body aches, fatigue/extreme tiredness, headache, runny nose, nasal congestion, sore throat, new change/loss in smell or taste, cough, shortness of breath, chest pain, vomiting/nausea, diarrhea, and abdominal pain.

§§ Materials included a laminated booklet with information on how to safely isolate and quarantine in smaller houses that might lack running water; a flyer highlighting important prevention messages such as hand hygiene, mask-wearing, and social distancing; and the Community Health Representative newsletter, which reinforced prevention messages and also provided contact information for resources accessible by tribal members.

TABLE. Numbers of households reached and residents interviewed, by village, in two field tests of house-to-house COVID-19 surveillance and community education* — Hopi Tribe, June–July 2020

	No. (%)		
	Village		
Characteristic	**Oraibi[†]**	**Bacabi[§]**	**Total**
Total no. of households approached	**33**	**68**	**101**
No one home	0 (—)	18 (26)	**18 (18)**
Household declined	1 (3)	4 (6)	**5 (5)**
Household accepted interview	32 (97)	46 (68)	**78 (77)**
Total no. of residents in interviewed households	**103**	**156**	**259**
Persons screened for COVID-19–like signs and symptoms[¶] and exposures	64 (62)	77 (49)	**141 (54)**
Persons declined screening	0 (—)	4 (3)[**]	**4 (2)**
Persons unavailable for screening	39 (38)	75 (48)	**114 (44)**
Persons referred for testing	4 (6)	0 (—)	**4 (2)**

Abbreviation: COVID-19 = coronavirus disease 2019.

[*] Five two-person teams, each composed of one community health representative and one volunteer (from the village, Hopi Tribe Department of Health and Human Services, or CDC field team), canvassed each village within 5 hours.

[†] Canvassed on June 24, 2020.

[§] Canvassed on July 16, 2020.

[¶] Fever, chills, body aches, fatigue/extreme tiredness, headache, runny nose, nasal congestion, sore throat, new change/loss in smell or taste, cough, shortness of breath, chest pain, vomiting/nausea, diarrhea, and abdominal pain.

[**] All four were children whose parents declined screening on their behalf.

In this rural, low-resource setting, house-to-house COVID-19 surveillance and education was feasible, as evidenced by the use of 10 staff members to screen 141 persons in <10 hours, and well-accepted, as indicated by a 5% household refusal rate (Table). Data on reasons for which households declined screening and education were not systematically collected, but involvement of community health representatives, who are known and trusted in the communities, likely increased acceptability of the program. Community health representatives identified a need for increased engagement with village leadership to improve identification of nonvacant houses and availability of household members. Public health guidance about COVID-19 prevention and mitigation strategies was shared with households, including recommendations on when to seek testing, how and when to wear masks and practice social distancing, hand hygiene, and proper isolation and quarantine. Given positive feedback on this program from the communities, community health representatives, HHCC, and the Hopi Tribe leadership, each Hopi village was canvassed at least once during July–October 31, 2020, and resources will be sought to expand the program to canvas villages on a more frequent basis. Additional potential modifications to the program include streamlining the household interview and distributing masks. If the program is expanded, it will be evaluated after 1 year of implementation according to predefined indicators for impact on COVID-19 case detection and community knowledge and practices; precise details of this evaluation plan have not yet been finalized.

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Community health representatives of the Hopi Tribe; community members visited; leadership of both villages; Hopi Tribe leadership.

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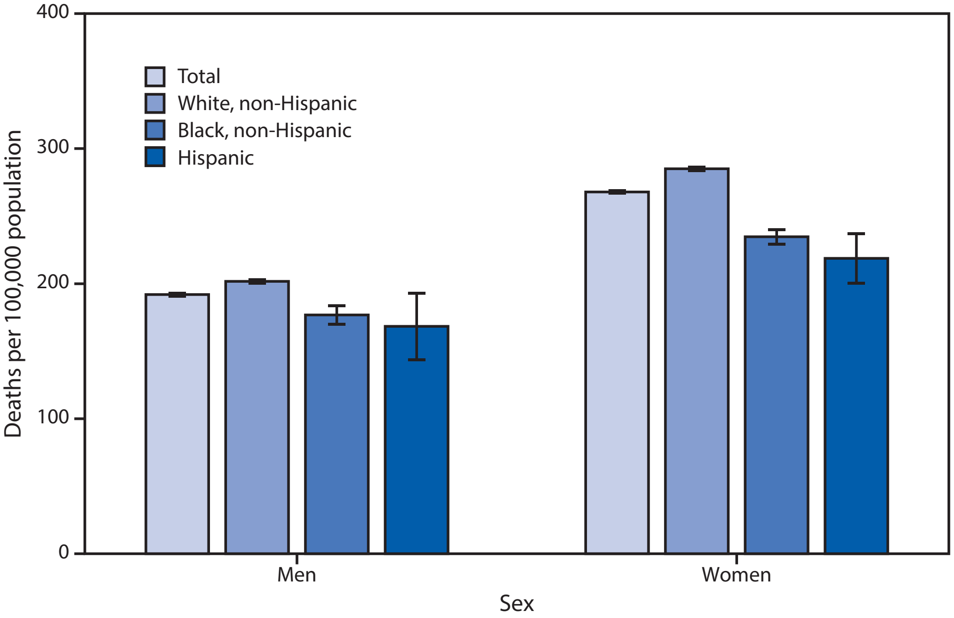
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Death Rates* for Alzheimer Disease[†] Among Adults Aged ≥ 65 Years, by Sex and Race/Hispanic Origin[§] — National Vital Statistics System, 2018



* Deaths per 100,000 population, age adjusted to 2000 U.S. standard population with 95% confidence intervals.

[†] Deaths for Alzheimer disease were identified using *International Classification of Diseases, Tenth Revision* underlying cause of death code G30.

[§] Starting with 2018, estimates for race groups are calculated based on the 1997 Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity and presented for "single" race groups (one race was reported on the death certificate). Before 2018, estimates were calculated according to the 1977 standards. To retain comparability as states transitioned to the new standards, data from states that had transitioned to the 1997 standards were "bridged" back to the 1977 categories through 2017. Single-race estimates for 2018 might not be comparable with bridged-race estimates for earlier years, particularly for the smaller race categories.

In 2018, the age-adjusted death rate for Alzheimer disease among adults aged ≥65 years was higher for women (267.9 deaths per 100,000) than for men (191.9). Among men, non-Hispanic White men had the highest death rate (201.7) compared with non-Hispanic Black (176.8) and Hispanic (168.4) men. Among women, non-Hispanic White women (285.1) had the highest death rate, followed by non-Hispanic Black (234.7) and Hispanic (218.8) women. Compared with men, women had higher age-adjusted death rates from Alzheimer disease in all three race and Hispanic-origin groups.

Source: National Center for Health Statistics, National Vital Statistics System, Mortality Data. https://www.cdc.gov/nchs/deaths.htm.

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