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Imputed State-Level Prevalence of Achieving Goals To Prevent Complications of Diabetes in Adults with Self-Reported Diabetes — United States, 2017–2018

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Diabetes increases the risk for developing cardiovascular, neurologic, kidney, eye, and other complications. Diabetes and related complications also pose a huge economic cost to society: in 2017, the estimated total economic cost of diagnosed diabetes was $327 billion in the United States (*1*). Diabetes complications can be prevented or delayed through the management of blood glucose (measured by hemoglobin A1C), blood pressure (BP), and non–high-density lipoprotein cholesterol (non-HDL–C) levels, and by avoiding smoking; these are collectively known as the ABCS goals (hemoglobin A1C, Blood pressure, Cholesterol, Smoking) (*2–5*). Assessments of achieving ABCS goals among adults with diabetes are available at the national level (*4*,*6*); however, studies that assess state-level prevalence of meeting ABCS goals have been lacking. This report provides imputed state-level proportions of adults with self-reported diabetes meeting ABCS goals in each of the 50 U.S. states and the District of Columbia (DC). State-level estimates were created by raking and multiple imputation methods (*7*,*8*) using data from the 2009–2018 National Health and Nutrition Examination Survey (NHANES), 2017–2018 American Community Survey (ACS), and 2017–2018 Behavioral Risk Factor Surveillance System (BRFSS). Among U.S. adults with diabetes, an estimated 26.4% met combined ABCS goals, and 75.4%, 70.4%, 55.8%, and 86.0% met A1C <8%, BP <140/90 mmHg, non-HDL–C <130 mg/dL and nonsmoking goals, respectively. Public health departments could use these data in their planning efforts to achieve ABCS goal levels and reduce diabetes-related complications at the state level.

This analysis included adults aged ≥20 years who reported having received a diagnosis of diabetes (excluding gestational diabetes) from a health care provider. This report defined ABCS goals as A1C <8%,* BP<140/90 mmHg, non-HDL–C <130 mg/dL, and being a nonsmoker (*4*). Nonsmokers were

* The American Diabetes Association recommends an A1C goal for many nonpregnant adults of <7%, and a less stringent A1C goal of <8% is recommended for persons with other medical conditions and limited life expectancy. https://care.diabetesjournals.org/content/diacare/suppl/2018/12/17/42.Supplement_1.DC1/DC_42_S1_2019_UPDATED.pdf.

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defined as those who provided negative responses to questions about smoking (≥100 cigarettes in their lifetime and being a current smoker at the time of the survey). To estimate state-level prevalence, the raking method[†] was first used to adjust BRFSS weights to the ACS on age, sex, race, health insurance status, education, and income to reflect the state population characteristics (*7*). Multiple imputation methods were used (*8*) to predict the values of A1C, BP, and non-HDL–C for adults with self-reported diabetes in the weight-adjusted BRFSS data.[§] Variables common to both NHANES and BRFSS were used as predictors (i.e., age, sex, race, health insurance status, education, income, body mass index category, and health status).[¶] Prevalence was estimated by averaging the estimates from all imputed data sets,[**] and standard errors were pooled by combining the within-imputation variance and the between-imputation variance (*8*). For the nonsmoking goal, the state-level prevalence was estimated directly from weight-adjusted BRFSS data. The national prevalence of each of the ABCS goals was a direct estimate from 2015–2018 NHANES. For prevalence of achieving ABCS goals, 90% confidence intervals (CIs) were calculated to help illuminate meaningful differences while reflecting the uncertainty inherent in these modeled estimates. Analyses were conducted using SAS software (version 9.4; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[††]

Among adults with self-reported diabetes, 26.4% met combined ABCS goals nationally, and state-level estimates ranged from 22.3% to 28.2% (Table). The lowest prevalence was in Wisconsin, and the highest was in Utah. Most of the states varied within the 90% CI of the national prevalence.

For each ABCS goal, nationally, 75.4% met the A1C goal (<8%), 70.4% met the BP goal (<140/90 mmHg), 55.8% met the non-HDL–C goal (<130 mg/dL), and 86.0% met the nonsmoking goal. Among adults with diabetes who attained the A1C goal, the lowest prevalence was 73.7% (Texas), and the highest prevalence (77.2%) was in Alaska; all were within the 90% CI of the national estimate. The lowest prevalence of meeting the BP goal was 62.8% in DC, and the highest (74.8%) was in Alaska. The lowest prevalence of achieving the non-HDL–C goal was 52.8% in Wisconsin, and the

† Raking method was used repeatedly by year and by the state to adjust 2017–2018 BRFSS weights to the 2017–2018 ACS. https://journals.sagepub.com/doi/pdf/10.1177/1536867X1401400104.

§ 2009–2018 NHANES was used for conducting multiple imputations.

¶ The study imputed the values of A1C in BRFSS based on the A1C information in NHANES and the shared predictors in NHANES and BRFSS. Similarly, values of BP and non-HDL–C were imputed based on the shared predictors in both data sets and the BP and non-HDL–C information respectively in NHANES.

** The multiple imputation method generated multiple data sets. Each imputed data set was then analyzed individually, and the final result was obtained by combining the results obtained from all the imputed data sets.

†† 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.

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TABLE. Estimated prevalence* of achieving hemoglobin A1C, blood pressure, cholesterol, and avoiding smoking (ABCS) goals among adults with self-reported diabetes — United States, 2017–2018

Area	Prevalence, % (90% CI)				
	ABCS goals†	A1C <8%	BP <140/90 mmHg	Non-HDL–C <130 mg/dL	Nonsmoking
Nationwide§	**26.4 (22.5–30.3)**	**75.4 (72.7–78.1)**	**70.4 (67.4–73.4)**	**55.8 (51.7–59.9)**	**86.0 (83.6–88.4)**
Alabama	24.5 (21.2–27.7)	75.4 (72.7–78.1)	69.0 (65.9–72.0)	57.9 (53.7–62.1)	85.5 (83.8–87.2)
Alaska	25.4 (18.5–32.4)	77.2 (71.2–83.2)	74.8 (68.3–81.3)	54.4 (47.6–61.1)	87.4 (84.4–90.5)
Arizona	24.2 (21.3–27.2)	74.8 (71.3–78.4)	70.9 (67.7–74.1)	54.7 (51.0–58.4)	87.6 (85.9–89.4)
Arkansas	24.1 (20.8–27.5)	75.1 (71.5–78.8)	70.5 (67.0–74.0)	56.4 (51.2–61.6)	84.1 (81.9–86.3)
California	25.0 (21.8–28.2)	74.6 (71.5–77.8)	71.4 (68.0–74.8)	54.6 (50.2–59.0)	91.0 (89.1–92.8)
Colorado	26.1 (22.5–29.7)	76.8 (73.7–79.9)	72.4 (68.7–76.1)	56.4 (52.9–59.9)	87.9 (86.1–89.6)
Connecticut	24.8 (21.4–28.1)	75.9 (72.8–78.9)	69.6 (66.1–73.1)	56.3 (51.7–60.9)	87.2 (85.4–89.0)
Delaware	24.1 (20.2–28.1)	75.6 (71.6–79.6)	68.4 (64.6–72.2)	56.8 (51.6–61.9)	88.9 (86.9–90.8)
District of Columbia	23.3 (19.6–27.1)	75.1 (70.4–79.8)	62.8 (58.4–67.1)	62.8 (58.0–67.6)	84.4 (81.8–87.0)
Florida	25.0 (21.4–28.6)	75.8 (72.0–79.5)	68.2 (64.7–71.7)	55.6 (51.9–59.3)	89.2 (87.3–91.1)
Georgia	24.5 (21.3–27.7)	74.6 (71.0–78.2)	69.3 (66.2–72.3)	57.5 (54.0–61.0)	87.0 (85.1–89.0)
Hawaii	24.8 (21.2–28.5)	75.1 (71.7–78.4)	69.5 (65.3–73.7)	54.1 (48.8–59.5)	88.4 (86.3–90.5)
Idaho	25.5 (21.1–29.9)	76.3 (72.2–80.3)	72.1 (67.7–76.6)	55.4 (49.5–61.2)	87.7 (85.5–90.0)
Illinois	25.0 (20.9–29.1)	75.3 (71.7–78.8)	70.1 (66.7–73.5)	56.1 (52.0–60.2)	87.9 (85.9–90.0)
Indiana	23.8 (21.6–26.0)	76.3 (73.7–78.9)	70.3 (68.0–72.6)	55.9 (52.4–59.5)	83.6 (82.0–85.2)
Iowa	23.7 (21.0–26.5)	75.8 (72.1–79.5)	69.6 (66.6–72.5)	53.9 (50.9–56.8)	87.2 (85.7–88.7)
Kansas	24.3 (22.0–26.6)	75.6 (73.4–77.7)	71.1 (68.8–73.4)	55.6 (52.1–59.0)	86.2 (84.8–87.5)
Kentucky	24.3 (21.3–27.2)	75.3 (72.1–78.5)	71.2 (68.2–74.3)	57.3 (54.2–60.4)	80.9 (78.8–83.1)
Louisiana	24.5 (20.2–28.8)	75.4 (72.0–78.8)	69.0 (65.4–72.7)	59.2 (53.7–64.6)	85.1 (82.6–87.5)
Maine	25.3 (21.7–29.0)	75.8 (73.1–78.5)	71.3 (68.7–73.9)	56.1 (51.3–60.8)	85.8 (83.9–87.7)
Maryland	26.5 (23.8–29.3)	76.4 (73.2–79.7)	70.1 (67.3–72.9)	58.2 (55.1–61.3)	88.5 (86.8–90.2)
Massachusetts	26.2 (21.9–30.4)	76.3 (72.3–80.2)	71.3 (67.3–75.3)	56.3 (50.3–62.2)	87.5 (85.0–90.0)
Michigan	24.6 (22.2–27.1)	76.1 (72.5–79.8)	69.6 (66.6–72.6)	56.2 (53.2–59.3)	86.3 (84.8–87.8)
Minnesota	25.6 (23.2–28.1)	76.3 (73.9–78.6)	71.2 (68.8–73.7)	56.1 (52.8–59.5)	87.6 (86.3–89.0)
Mississippi	23.5 (20.6–26.4)	74.5 (71.6–77.3)	66.8 (63.3–70.2)	58.7 (55.3–62.1)	84.3 (82.4–86.1)
Missouri	24.7 (20.1–29.3)	75.8 (72.8–78.8)	71.6 (68.1–75.2)	56.7 (52.4–61.0)	83.0 (80.8–85.2)
Montana	25.2 (20.9–29.5)	76.0 (72.2–79.8)	70.6 (65.9–75.4)	54.3 (49.6–59.0)	87.5 (85.4–89.7)
Nebraska	25.5 (22.4–28.6)	76.1 (73.7–78.6)	71.0 (67.9–74.2)	55.1 (51.5–58.7)	89.3 (88.0–90.6)
Nevada	23.2 (17.6–28.8)	75.1 (69.7–80.5)	69.2 (64.4–74.0)	55.9 (48.9–62.9)	85.9 (82.5–89.4)
New Hampshire	26.9 (22.4–31.4)	76.2 (71.1–81.3)	72.0 (68.0–75.9)	55.9 (51.3–60.6)	89.2 (87.3–91.1)
New Jersey	26.2 (21.1–31.3)	76.2 (71.7–80.7)	70.1 (65.4–74.8)	55.3 (50.8–59.9)	88.4 (85.9–91.0)
New Mexico	24.6 (21.1–28.1)	73.9 (69.9–77.8)	71.3 (67.5–75.2)	54.8 (49.7–59.9)	86.4 (84.5–88.4)
New York	23.5 (20.5–26.5)	74.6 (71.1–78.0)	69.6 (66.5–72.8)	55.8 (52.0–59.7)	88.4 (87.0–89.8)
North Carolina	24.6 (20.4–28.7)	76.0 (72.2–79.8)	69.2 (65.4–73.1)	57.5 (53.0–62.1)	84.1 (81.1–87.1)
North Dakota	23.7 (21.1–26.3)	75.9 (72.1–79.7)	71.6 (68.4–74.8)	55.1 (51.2–58.9)	82.4 (79.7–85.0)
Ohio	24.6 (22.1–27.1)	76.0 (73.8–78.1)	69.9 (67.4–72.4)	55.8 (52.7–59.0)	84.7 (83.1–86.3)
Oklahoma	24.8 (21.8–27.8)	75.7 (72.9–78.5)	72.0 (68.7–75.4)	54.6 (50.7–58.5)	85.4 (83.6–87.3)
Oregon	24.8 (21.3–28.3)	76.1 (71.8–80.4)	72.6 (68.1–77.1)	54.9 (50.7–59.2)	84.2 (81.3–87.0)
Pennsylvania	25.3 (21.7–28.9)	76.0 (72.2–79.7)	70.3 (66.5–74.1)	56.6 (51.4–61.9)	85.4 (83.3–87.5)
Rhode Island	25.2 (21.1–29.2)	75.9 (72.1–79.7)	70.5 (66.8–74.1)	55.3 (50.4–60.3)	87.7 (85.5–89.8)
South Carolina	24.6 (22.3–26.9)	74.9 (72.3–77.4)	67.9 (65.7–70.1)	58.4 (55.9–60.9)	85.2 (83.5–86.9)
South Dakota	24.5 (20.1–28.8)	76.2 (71.4–81.0)	70.0 (65.2–74.8)	55.3 (49.0–61.6)	84.0 (80.3–87.7)
Tennessee	22.5 (18.6–26.4)	74.9 (71.5–78.4)	69.8 (66.1–73.5)	56.7 (52.8–60.5)	79.3 (76.7–81.9)
Texas	23.5 (19.4–27.6)	73.7 (69.3–78.0)	70.1 (63.9–76.3)	54.9 (49.8–60.0)	88.4 (85.6–91.1)
Utah	28.2 (25.1–31.3)	76.0 (72.3–79.6)	73.6 (70.1–77.1)	54.7 (50.6–58.8)	91.8 (90.3–93.4)
Vermont	25.4 (21.8–29.1)	75.6 (71.8–79.3)	71.2 (67.3–75.2)	57.1 (52.7–61.6)	86.0 (83.4–88.7)
Virginia	25.5 (22.2–28.8)	75.7 (72.1–79.3)	69.3 (65.9–72.7)	56.6 (53.3–60.0)	87.3 (85.7–88.8)
Washington	26.1 (23.8–28.3)	76.2 (73.8–78.6)	72.8 (70.2–75.4)	54.7 (51.9–57.5)	89.4 (88.1–90.8)
West Virginia	24.0 (20.6–27.5)	75.1 (72.2–78.1)	73.5 (70.5–76.5)	56.2 (52.5–59.9)	80.7 (78.8–82.6)
Wisconsin	22.3 (18.2–26.3)	76.0 (72.2–79.8)	70.1 (65.7–74.4)	52.8 (47.4–58.2)	85.5 (83.0–88.1)
Wyoming	24.0 (19.9–28.1)	75.0 (69.6–80.4)	72.6 (69.3–76.0)	53.2 (48.9–57.6)	86.1 (83.7–88.5)

Abbreviations: A1C = hemoglobin A1C; BP = blood pressure; ABCS = hemoglobin A1C, blood pressure, cholesterol, and avoiding smoking; ACS = American Community Survey; BRFSS = Behavioral Risk Factor Surveillance System; CI = confidence interval; NHANES = National Health and Nutrition Examination Survey; non-HDL–C = non-high-density lipoprotein cholesterol.

* State-level estimates of A1C, BP, and non-HDL–C were created by raking and multiple imputation methods using data from 2009–2018 NHANES, 2017–2018 ACS, and 2017–2018 BRFSS; state-level estimates of nonsmoking were made directly from weight-adjusted BRFSS data, and the raking method was first used to adjust 2017–2018 BRFSS weights to the 2017–2018 ACS.

† ABCS goals were defined as A1C <8%, BP <140/90 mmHg, non-HDL–C <130 mg/dL, and avoiding smoking.

§ National average prevalence of each goal was a direct estimate from 2015–2018 NHANES.

¶ Some state-level estimates were below or above the 90% CI of the national prevalence. ABCS goals: Wisconsin; BP goal: Alaska, District of Columbia, Mississippi, Utah, and West Virginia; non-HDL–C goal: District of Columbia; nonsmoking goal: California, Delaware, Florida, Kentucky, Maryland, Missouri, Nebraska, New Hampshire, North Dakota, Tennessee, Utah, Washington, and West Virginia.

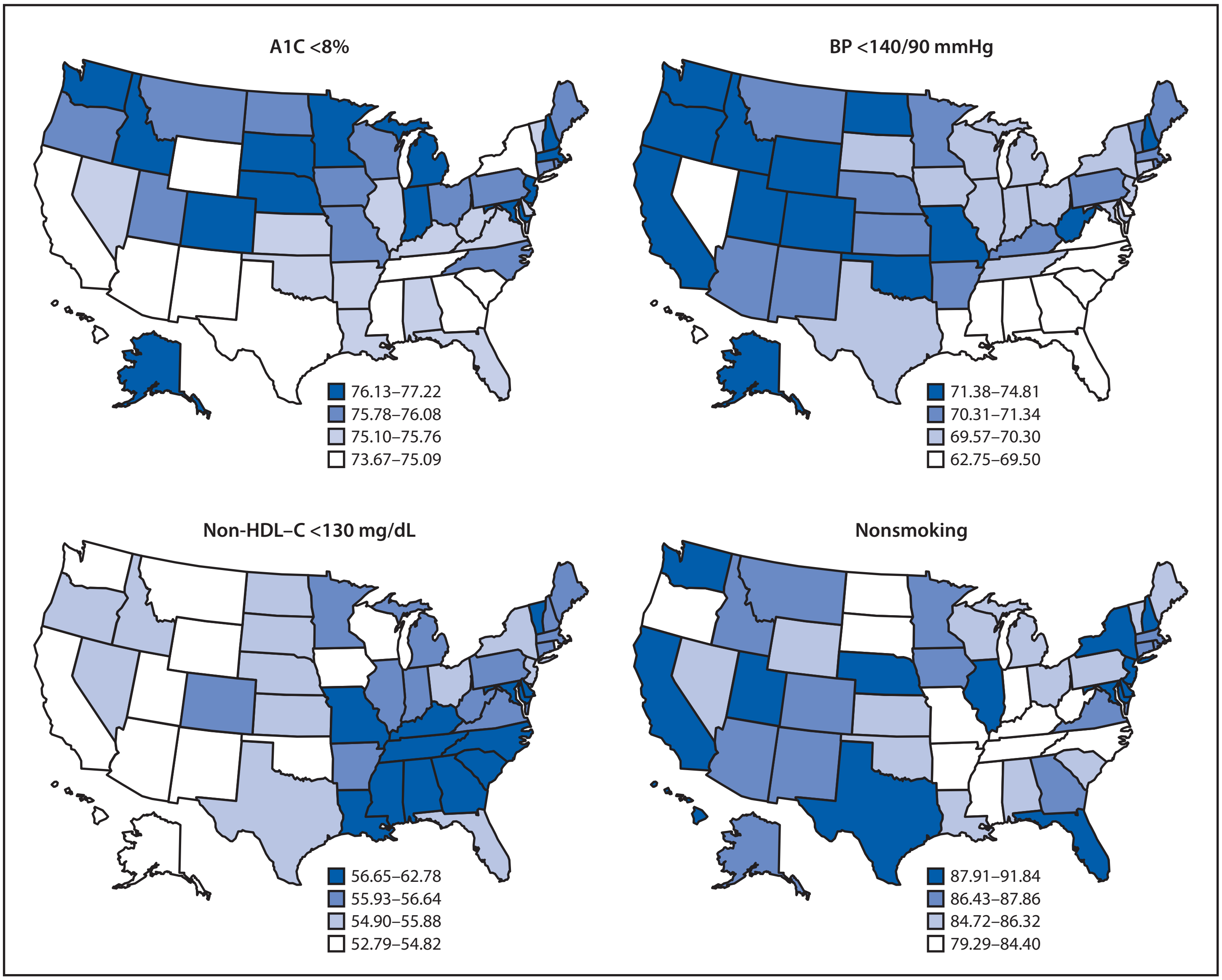
highest was 62.8% in DC. The prevalence in DC was above the 90% CI of national prevalence. The lowest prevalence of achieving the nonsmoking goal (79.3%) was in Tennessee, and the highest (91.8%) was in Utah. When comparing the individual goals (Figure), the prevalence of achieving the nonsmoking goal was the highest, and that of achieving the non-HDL–C goal was the lowest. In addition, there was a relatively larger variation among states in achieving the nonsmoking goal than other goals.

Discussion

This is the first study to estimate the state-level prevalence of achieving ABCS goals to prevent complications of diabetes among adults with self-reported diabetes for all 50 U.S. states and DC. The study identified some states where achievements of the ABCS goals are relatively higher or lower.

Previous studies looked at the achievement of ABCS goals among persons with diabetes at the national level. One analysis using the 2007–2012 NHANES data found that among

FIGURE. Estimated prevalence* of achieving individual goals of ABCS† among adults with self-reported diabetes — United States, 2017–2018



Abbreviations: A1C = hemoglobin A1C; ABCS = hemoglobin A1C, blood pressure, cholesterol, and avoiding smoking; BP= blood pressure; non-HDL–C= non-high-density lipoprotein cholesterol.

* The percentage intervals for the quantile cutoffs vary because of variations in the distribution of goal achievement.

† ABCS goals were defined as A1C <8%, BP <140/90 mmHg, non-HDL–C <130 mg/dL, and avoiding smoking (current smokers were defined as those who had ≥100 cigarettes in their lifetime and were a smoker at the time of the survey).

Summary

What is already known about this topic?

Effective management of hemoglobin A1C, blood pressure, cholesterol, and avoiding smoking (ABCS) is important in preventing complications from diabetes. Little information on state-level prevalence in achieving ABCS goals is available.

What is added by this report?

During 2017–2018, the proportion of U.S. adults with self-reported diabetes who met ABCS goals was suboptimal. Only 26.4% met all the ABCS goals, 75.4% met the A1C goal, 70.4% met the blood pressure goal, 55.8% met the cholesterol goal, and 86.0% were current nonsmokers.

What are the implications for public health practice?

These estimates provide data that public health departments could use in their planning efforts to achieve ABCS goals and thus reduce diabetes-related complications at the state level.

adults with diagnosed diabetes, 21.3% met all ABCS goals, and 63.7% met the goal for A1C, 65.5% for BP <140/80 mmHg, 56.6% for low-density lipoprotein cholesterol <100 mg/dL, and 80.6% for nonsmoking (*6*). The results of the National Diabetes Statistics Report showed that during 2013–2016, 19.2% of adults aged ≥18 years with diagnosed diabetes met goals for A1C <7.0%, BP <140/90 mmHg, non-HDL–C <130 mg/dL, and nonsmoking; 36.4% met goals of A1C <8.0%, BP <140/90 mmHg, non-HDL–C <160 mg/dL, and nonsmoking (*4*).

Achieving goals for ABCS can reduce the risks for diabetes complications. An analysis from the UK Prospective Diabetes Study suggested that among persons with type 2 diabetes, an intensive blood glucose control regimen reduced A1C levels by 11% over 10 years and reduced the risk for microvascular complications by 25% (*3*). In addition, accumulating evidence has shown that reducing BP and cholesterol levels and avoiding smoking help decrease the incidence of cardiovascular complications among persons with diabetes (*5*).

Some potential factors, such as access to health care and the difference in individual sociodemographic factors, might explain the variation in the achievement of ABCS goals. One study found that lack of health care coverage and low use of health care services were associated with poor management of diabetes (*9*). Another study suggested that persons with higher socioeconomic status were more likely to manage diabetes more effectively (*10*).

The findings in this report are subject to at least four limitations. First, the study sample did not include institutionalized adults, who might achieve different levels of reaching ABCS goals than do noninstitutionalized adults. Second, self-reported diabetes status and other variables might be subject to diagnosis, recall, and social desirability bias. Third, the methods applied cannot ensure that all bias was reduced; state-level estimates for A1C, BP, and non-HDL–C levels might be less precise than they would be if these variables had been measured directly, rather than relying on the multiple imputation method. Finally, possible reasons underlying state variation in the prevalence of meeting ABCS goals were not examined.

Despite increased recognition of the importance of effectively managing risk factors among adults with diabetes, the prevalence of meeting ABCS goals to reduce complications of diabetes is still suboptimal. CDC has been working closely with states to address the burden of diabetes. For example, the Diabetes State Burden Toolkit (https://nccd.cdc.gov/Toolkit/DiabetesBurden) provides estimates of the health and economic impact of diabetes by state. In addition, CDC funds state health departments to support programs to help reduce diabetes complications (e.g., Improving the Health of Americans Through Prevention and Management of Diabetes, Heart Disease, and Stroke [DP18–1815]).[§§] Tracking state-level progress of ABCS levels might help identify gaps in diabetes care. There is a trade-off because direct measurement at the state level is more precise than is imputation but is more costly, whereas imputation is more practical but does not consider variation related to diabetes management programs or policies in states. Nonetheless, public health departments could use these data in their planning efforts to achieve ABCS goal levels and reduce diabetes-related complications at the state level.

§§ https://www.cdc.gov/diabetes/programs/stateandlocal/funded-programs/dp18-1815.html.

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COVID-19 Outbreak in an Amish Community — Ohio, May 2020

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In the United States, outbreaks of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), were initially reported in densely populated urban areas (*1*); however, outbreaks have since been reported in rural communities (*2*,*3*). Rural residents might be at higher risk for severe COVID-19–associated illness because, on average, they are older, have higher prevalences of underlying medical conditions, and have more limited access to health care services.* In May, after a cluster of seven COVID-19 cases was identified in a rural Ohio Amish community, access to testing was increased. Among 30 additional residents tested by real-time reverse transcription–polymerase chain reaction (RT-PCR; TaqPath COVID-19 Combo Kit),† 23 (77%) received positive test results for SARS-CoV-2. Rapid and sustained transmission of SARS-CoV-2 was associated with multiple social gatherings. Informant interviews revealed that community members were concerned about having to follow critical mitigation strategies, including social distancing§ and mask wearing.¶ To help reduce the ongoing transmission risk in a community, state and county health department staff members and community leaders need to work together to develop, deliver, and promote culturally responsive health education messages to prevent SARS-CoV-2 transmission and ensure that access to testing services is timely and convenient. Understanding the dynamics of close-knit communities is crucial to reducing SARS-CoV-2 transmission.

Investigation and Findings

On May 9 and May 11, 2020, respectively, a husband and wife in an Amish community in Wayne County, Ohio, experienced COVID-19–related symptoms. Both had nasopharyngeal samples tested and SARS-CoV-2 infection confirmed by receipt of positive RT-PCR results on May 14. The husband, who had a history of chronic obstructive pulmonary disease, participated in church services on May 2 and 3. He was hospitalized on May 15 with fever, cough, and shortness of breath, and received a diagnosis of COVID-19–related pneumonia; he was discharged on May 17. Another adult family member, with cancer, became symptomatic May 16, received a positive SARS-CoV-2 test result May 18, and died May 21. During May 13–19, four additional symptomatic community members received positive test results. After these initial seven cases were identified, community leaders contacted Wayne County Health Department (WCHD) to report that numerous other community members had symptoms** consistent with COVID-19. As a result, WCHD, with support from the Ohio Department of Health and a community bishop, organized a testing clinic at an Amish community school on May 20, where nasopharyngeal swabs were collected for RT-PCR testing. The testing clinic was publicized by the bishop and other community leaders; anyone could attend and receive testing.

CDC and Ohio health department investigators conducted 11 key informant interviews with community leaders and members. Some interviewees might have had COVID-19, but for reasons of confidentiality, interviewee names were not recorded. Consequently, interviews were not linked to cases. One interview was conducted at the testing clinic; 10 additional interviews, using snowball sampling (*4*), were conducted over the following 10 days. All invited participants orally consented to be interviewed. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.†† Interviews took 1 hour to complete and included open-ended questions to identify knowledge gaps related to COVID-19 prevention, transmission, and testing, and to understand attitudes, practices, facilitators of, and barriers to implementing strategies to decrease transmission. All interview notes were handwritten and reviewed by two interviewers. Theme saturation, a research term defined as the point "when a researcher begins to hear the same comments again and again" (*5*), was reached through iterative review and analysis. The following 10 themes were identified: 1) COVID-19 knowledge, including the spread of SARS-CoV-2; 2) myths and misinformation; 3) facilitators of and barriers to following COVID-19 prevention strategies at home, at work, and in the community; 4) use of traditional communication (e.g., newspapers) for information sharing; 5) access to testing; 6) means of transportation; 7) community cohesion;

* https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/other-at-risk-populations/rural-communities.html#why-higher-risk.

† https://www.fda.gov/media/136112/download.

§ https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html.

¶ https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/diy-cloth-face-coverings.html.

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

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

8) selflessness; 9) strong work ethic; and 10) individual and community responsibility.

At the May 20 testing clinic and during the interviews, community members reported six social gatherings during the preceding 2 weeks, including a prechurch service[§§] (May 2), church services (May 3, 10, and 17), a wedding (May 12), and a funeral (May 16) (Figure). Among 30 community members who had nasopharyngeal swabs collected at the testing clinic, 23 (77%) received positive SARS-CoV-2 test results. All community members with positive results reported multiple COVID-19–related signs and symptoms. The earliest symptom onset date was May 7, 5 days after a prechurch service and 4 days after a church service. On May 27, one person was hospitalized with fever and shortness of breath, received a diagnosis of COVID-19–associated pneumonia, and was discharged on May 30.

Among the 30 persons with laboratory-confirmed COVID-19, the mean age was 46 years (range = 12–86 years), and 21 (70%) were male. Eight of those persons reported having underlying medical conditions (Table). Symptoms most commonly reported included fatigue, headache, cough, myalgias, and chills. Among the 30 persons, none had traveled recently, and 24 (80%) at the time of testing reported contact with a person who was sick, usually at a social or religious event.

[§§] Prechurch services are meetings of men of the church district to discuss the planning of upcoming services, including where and when it will be held, the message of the service, and needs of specific community members.

Summary

What is already known about this topic?

COVID-19 cases have been increasing in rural U.S. communities. Social gatherings can facilitate exposure to and transmission of SARS-CoV-2.

What is added by this report?

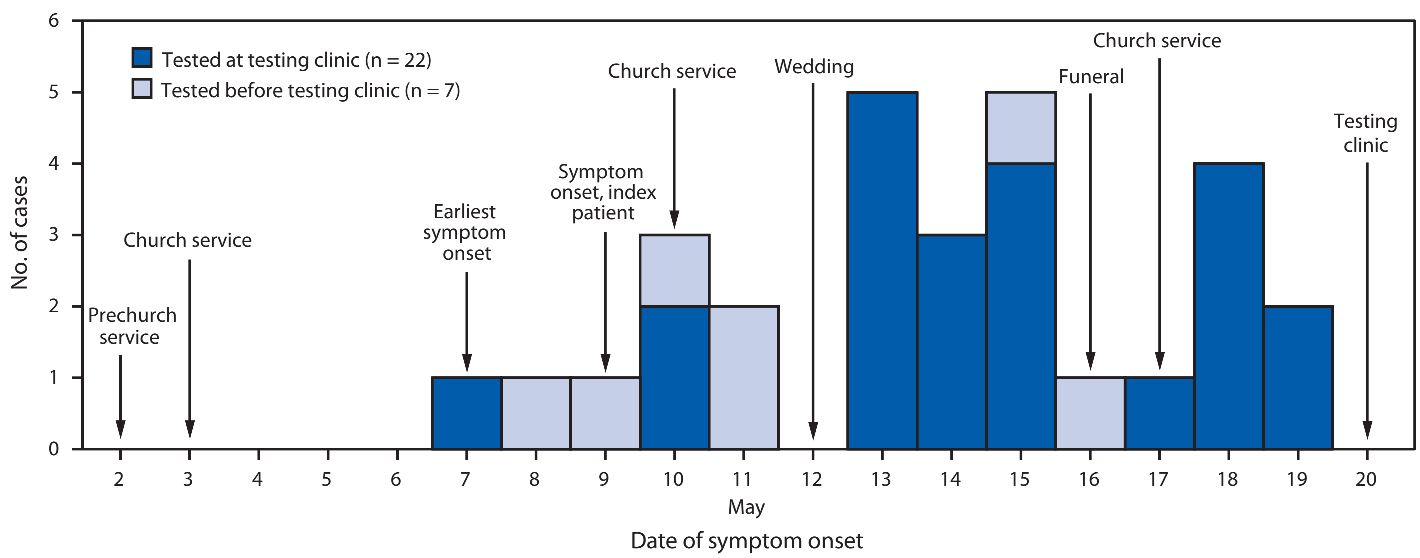
Social gatherings, important in Amish communities, likely contributed to rapid transmission of SARS-CoV-2 in a rural Ohio Amish community. Some community members were concerned about having to follow critical mitigation strategies, including social distancing and mask wearing.

What are the implications for public health practice?

COVID-19 outbreaks in communities where social gatherings are common might be prevented by fostering collaborations and trust between the community and local health departments, sharing culturally and linguistically responsive health messages that emphasize protecting family and community members through established communication networks, and ensuring timely and convenient access to testing.

Most interviewees accurately reported knowledge about transmission and prevention measures, including that SARS-CoV-2 spreads through "coughing, sneezing" and can be prevented by "handwashing, social distancing, and staying at home." However, several interviewees reported misconceptions that mask wearing might cause harm ("people wearing them all day long at work and getting a headache and not feeling well"), and that vitamins and herbs can help prevent

FIGURE. Date of symptom onset among 30* persons in an Amish community who received positive SARS-CoV-2 test results, and dates of social gatherings in that community — Ohio, May 2–20, 2020



* Date of symptom onset missing for one patient tested at the testing clinic.

TABLE. Clinical characteristics of 30 persons with laboratory-confirmed COVID-19 in a rural Amish community — Ohio, May 2–20, 2020

Characteristic	No. (%)
Signs and symptoms	
Fatigue	24 (80)
Headache	21 (70)
Cough	17 (57)
Myalgias	17 (57)
Chills	16 (53)
Sore throat	15 (50)
Loss of taste or smell	14 (47)
Runny nose	12 (40)
Fever	11 (37)
Nausea or vomiting	9 (30)
Shortness of breath	7 (23)
Diarrhea	5 (17)
Underlying medical conditions	**8 (27)**
Cardiovascular disease/Hypertension	4 (13)
Diabetes	3 (10)
Immunocompromise	2 (7)
Chronic lung disease	1 (3)
Contact with a person with COVID-19 symptoms	**24 (80)**
Recent travel history	**0 (—)**
Hospitalized	**3 (10)**
Deaths	**1 (3)**

Abbreviation: COVID-19 = coronavirus disease 2019.

SARS-CoV-2 infection. Several barriers to use of mitigation strategies were described, including having limited access to updated and trusted guidance ("access to health care is not an issue…access to good information is the problem"); lack of social or cultural acceptability of wearing masks ("the need to wear a mask has never been a part of this community"); and hesitancy around proper and consistent social distancing because of cultural practices and acceptability of the term ("fellowship is as important to us as worship," "call it physical distancing…social distancing has the connotation of social isolation"). Interviewees also stressed the convenience and timing of testing clinics ("transport is a challenge because we need to hire a driver; testing clinic today made it easy" and "testing clinics should be coordinated with the communities").

Discussion

The Amish in Wayne County are part of the Greater Holmes County Area Settlement, which has the largest population of Amish in Ohio (36,955 in 2020).¶¶ Traditionally, the Amish limit engagement with the government, the non-Amish health care system, and modern medicine, except in acute events that affect the wider community, such as a 2014 measles outbreak in an Ohio Amish community (*6*), and prefer an herbal or natural approach to well-being (*7*).

The high SARS-CoV-2 positivity rates from the May 20 testing clinic and findings from the interviews highlighted the extent and probable reasons for community transmission and served to increase participants' awareness of COVID-19. After the testing clinic, an additional 39 persons from the community received tests by June 28, after experiencing COVID-19–compatible symptoms or having close contact with a person with COVID-19. Among the 39 persons whose specimens were tested, 25 (67%) received positive test results, suggesting ongoing community transmission.

Amish communities emphasize strong social connections and communal activities (*7*). The importance of religious and social gatherings and communal fellowship among the Amish has challenged efforts to prevent infection during the COVID-19 pandemic. Six religious and social gatherings were reported in this community; such gatherings have been shown to lead to SARS-CoV-2 outbreaks (*8*). To help limit transmission within other Amish communities, public health officials recommended five strategies to local health departments. First, health departments should continue to build trusting relationships with Amish community institutions and leaders. Second, health education materials should be provided through local networks. The Amish rarely use electronic communication; however, well-established Amish media networks (newspapers and radio stations), local Amish steering committees (serving as liaisons to various government levels), and Amish- and non-Amish–owned businesses with Amish employees can help share COVID-19 prevention messages. Third, messages using culturally acceptable language emphasizing protection of family and community might help persuade community members to apply these strategies. Fourth, access to testing services needs to be timely and convenient, with active support from community leaders. Fifth, health departments and the community should continually share information and concerns about mitigation strategies and barriers to their use. Establishing points of contact within communities might allow health department staff members to promptly share updated or new information.

The findings in this report are subject to at least three limitations. First, the Amish community in which the outbreak occurred has diverse cultural practices and traditions. Some of the more traditional community members might have been reluctant to participate in the testing clinic, resulting in lower than expected turnout. Second, interviews were conducted from a convenience sample; therefore, findings might not be generalizable to this community or to other Amish communities. Finally, estimating COVID-19 attack rates among Amish communities is challenging. Amish communities are organized by church districts consisting of 20–40 families. Establishing

¶¶ https://groups.etown.edu/amishstudies/files/2020/10/Amish_Pop_by_state_and_county_2020.pdf.

the number of members in a specific community is difficult because members of one church district participate in other church districts' religious and social gatherings, often based upon family ties.

Despite limited resources, strengthening collaboration between and across health departments and communities might help overcome cultural barriers. Although Amish communities might be experiencing challenges with preventing and mitigating SARS-CoV-2 transmission, leveraging Amish cultural beliefs of communal responsibility could help limit the spread of SARS-CoV-2.

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Mental Health–Related Emergency Department Visits Among Children Aged <18 Years During the COVID-19 Pandemic — United States, January 1–October 17, 2020

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Published reports suggest that the coronavirus disease 2019 (COVID-19) pandemic has had a negative effect on children's mental health (*1*,*2*). Emergency departments (EDs) are often the first point of care for children experiencing mental health emergencies, particularly when other services are inaccessible or unavailable (*3*). During March 29–April 25, 2020, when widespread shelter-in-place orders were in effect, ED visits for persons of all ages declined 42% compared with the same period in 2019; during this time, ED visits for injury and non-COVID-19–related diagnoses decreased, while ED visits for psychosocial factors increased (*4*). To assess changes in mental health–related ED visits among U.S. children aged <18 years, data from CDC's National Syndromic Surveillance Program (NSSP) from January 1 through October 17, 2020, were compared with those collected during the same period in 2019. During weeks 1–11 (January 1–March 15, 2020), the average reported number of children's mental health–related ED visits overall was higher in 2020 than in 2019, whereas the proportion of children's mental health–related visits was similar. Beginning in week 12 (March 16) the number of mental health–related ED visits among children decreased 43% concurrent with the widespread implementation of COVID-19 mitigation measures; simultaneously, the proportion of mental health–related ED visits increased sharply beginning in mid-March 2020 (week 12) and continued into October (week 42) with increases of 24% among children aged 5–11 years and 31% among adolescents aged 12–17 years, compared with the same period in 2019. The increased proportion of children's mental health–related ED visits during March–October 2020 might be artefactually inflated as a consequence of the substantial decrease in overall ED visits during the same period and variation in the number of EDs reporting to NSSP. However, these findings provide initial insight into children's mental health in the context of the COVID-19 pandemic and highlight the importance of continued monitoring of children's mental health throughout the pandemic, ensuring access to care during public health crises, and improving healthy coping strategies and resiliency among children and families.

CDC analyzed NSSP ED visit data, which include a subset of hospitals in 47 states representing approximately 73% of U.S. ED visits.* Mental health–related ED visits among children aged <18 years was a composite variable derived from the mental health syndrome query of the NSSP data for conditions likely to result in ED visits during and after disaster events (e.g., stress, anxiety, acute posttraumatic stress disorder, and panic).† Weekly numbers of mental health–related ED visits and proportions of mental health–related ED visits (per 100,000 pediatric ED visits§) were computed overall, stratified by age group (0–4, 5–11, and 12–17 years) and sex, and compared descriptively with the corresponding weekly numbers and proportions for 2019. Numbers and proportions of visits were compared during calendar weeks 1–11 (January 1–March 14, 2020) and weeks 12–42 (March 15–October 17, 2020) (before and after a distinct decrease in overall ED visits reported beginning in week 12 in 2020)¶ (*4*). Analyses are descriptive and statistical comparisons were not performed.

The number of children's mental health–related ED visits decreased sharply from mid-March 2020 (week 12, March 15–21) through early April (week 15, April 5–11) and then increased steadily through October 2020. (Figure 1). During the same time, the overall proportion of reported children's ED visits for mental health–related concerns increased and remained higher through the end of the reporting period

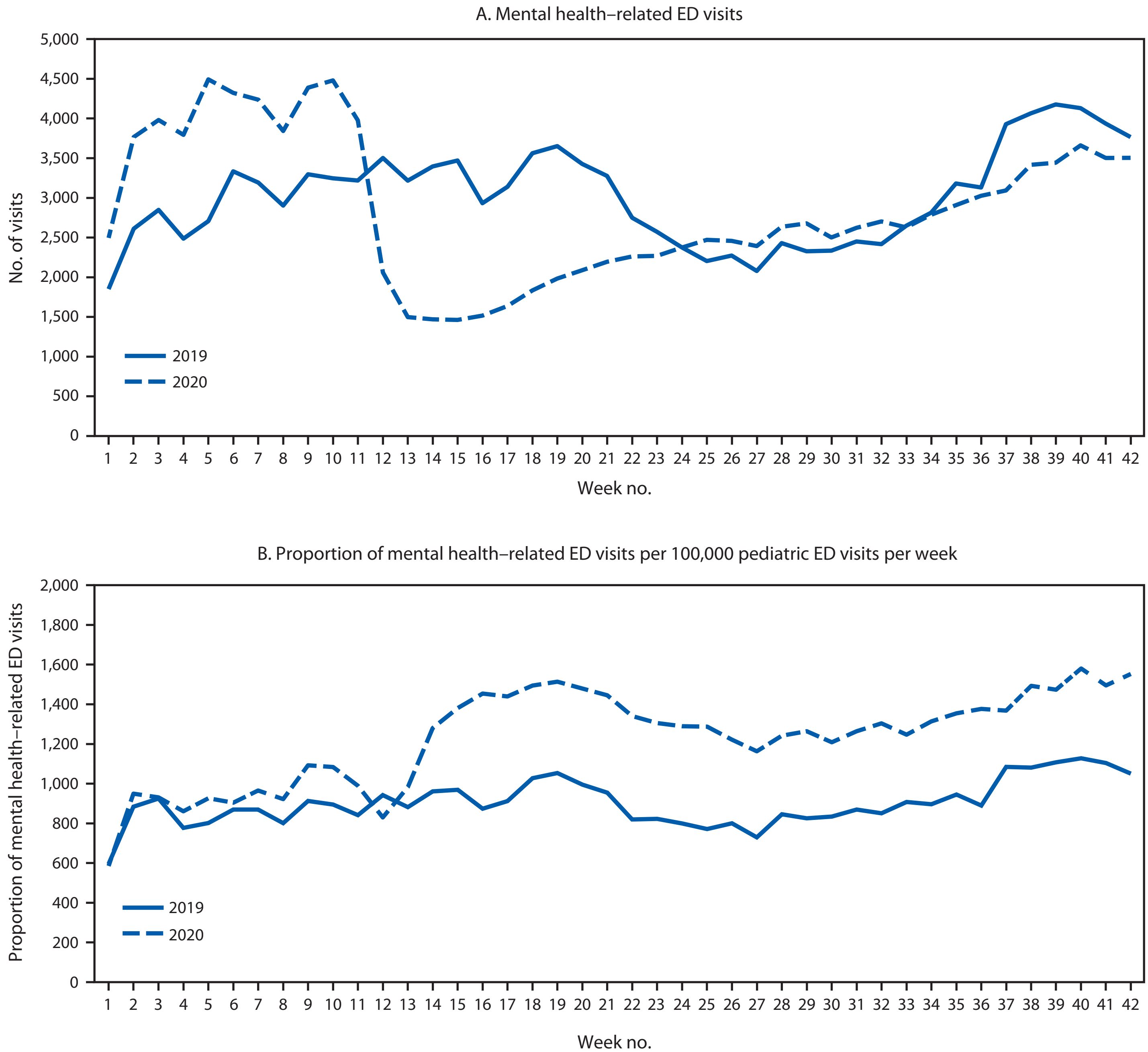
* The National Syndromic Surveillance Program (NSSP) is a network developed and maintained by CDC, state and local health departments, and academic and private sector health partners to collect electronic health data in real time. NSSP includes ED visit data from a subset of hospitals in 47 states (all but Hawaii, South Dakota, and Wyoming). https://www.cdc.gov/nssp/participation-coverage-map.html; https://www.cdc.gov/nssp/calculations-for-coverage.html.

† Mental health–related ED visits were defined using the NSSP Syndrome Definition (SD) Subcommittee community-developed syndrome definition for mental health conditions likely to increase in emergency department frequency during and after natural or human-caused disaster events. This syndrome definition attempts to leverage only mental health conditions and presentations that showed increases in visit frequency after select disasters in the United States. There are no disaster-related terms inherent to this query. The query has been added to NSSP BioSense Platform Electronic Surveillance System for the Early Notification of Community-based Epidemics as a Chief Complaint and Discharge Diagnosis category. https://knowledgerepository.syndromicsurveillance.org/disaster-related-mental-health-v1-syndrome-definition-subcommittee.

§ Average proportion of ED visits for children's mental health = (average number of ED visits for children's mental health/average total number of ED visits for the same age or sex population [e.g., children aged <18 years]) x 100,000.

¶ To decrease the effect of differential reporting, this analysis was restricted to only include hospitals sending diagnosis codes at patient discharge that are >75% complete and informative, with <20% standard deviation in their values over the previous 2 years.

FIGURE 1. Weekly number of emergency department (ED) mental health–related visits (A) and proportion of (B) children's mental health–related ED visits per total ED visits* among children aged <18 years — National Syndromic Surveillance Program, United States, January–October 2019 and 2020



* Proportion of mental health–related ED visits = number of ED visits for children's mental health/total number of pediatric ED visits x 100,000.

in 2020 than that in 2019 (Figure 1). The proportion of mental health–related ED visits among children increased 66%, from 1,094 per 100,000 during April 14–21, 2019 to 1,820 per 100,000 during April 12–18, 2020 (Supplementary Figure 1, https://stacks.cdc.gov/view/cdc/96609). Although the average reported number of children's mental health–related ED visits overall was 25% higher during weeks 1–11 in 2020 (342,740) than during the corresponding period in 2019 (274,736), the proportion of children's mental health–related visits during the same time was similar (1,162 per 100,000 in 2020 versus 1,044 per 100,000 in 2019). (Table). During weeks 12–42, 2020 (mid-March–October) however, average weekly reported numbers of total ED visits by children were 43% lower (149,055), compared with those during 2019 (262,714), whereas the

TABLE. Average number and proportions* of emergency department (ED) visits and mental health–related ED visits† among children aged <18 years — National Syndromic Surveillance Program (NSSP), United States, 2019–2020

Surveillance period/indicators	2019				2020			
	Age group, yrs				Age group, yrs			
	All <18	0–4	5–11	12–17	All <18	0–4	5–11	12–17
Weeks 1–42§								
Average weekly total ED visits	265,863	110,002	81,133	74,728	199,782	78,742	59,660	61,380
Average weekly mental health–related ED visits	3,025	80	625	2,320	2,872	54	522	2,296
Mental health–related ED visits per 100,000 visits	1,130	73	762	3,084	1,539	75	919	3,863
Weeks 1–11¶								
Average weekly total ED visits	274,736	118,926	83,924	71,886	342,740	143,789	107,049	91,902
Average weekly mental health–related ED visits	2,876	82	594	2,200	3,974	80	821	3,073
Mental health–related ED visits per 100,000 visits	1,044	69	707	30,45	1,162	56	769	3,333
Weeks 12–42**								
Average weekly total ED visits	262,714	106,835	80,143	75,736	149,055	55,661	42,844	50,550
Average weekly mental health–related ED visits	3,078	79	635	2,363	2,481	45	416	2,020
Mental health–related ED visits per 100,000 visits	1,161	75	782	3,098	1,673	81	972	4,051

* Average proportion of ED visits for children's mental health = (average number of ED visits for children's mental health/average total number of ED visits for the same age or sex population [e.g., children aged 18 years]) x 100,000. All numbers have been rounded to the nearest whole number.

† Mental health–related ED visits were defined using NSSP's Syndrome Definition (SD) Subcommittee community-developed syndrome definition for mental health conditions likely to increase in ED frequency during and after natural or human-caused disaster events. This syndrome definition attempts to leverage only mental health conditions and presentations that showed increases in visit frequency after select disasters in the United States. There are no disaster-related terms inherent to this query. The query has been added to NSSP BioSense Platform Electronic Surveillance System for the Early Notification of Community-based Epidemics as a Chief Complaint and Discharge Diagnosis category. https://knowledgerepository.syndromicsurveillance.org/disaster-related-mental-health-v1-syndrome-definition-subcommittee.

§ Weeks 1–42 in 2019 correspond to December 30, 2018–October 19, 2019; weeks 1–42 in 2020 correspond to December 29, 2019–October 17, 2020.

¶ Weeks 1–11 in 2019 correspond to December 30, 2018–March 16, 2019; weeks 1–11 in 2020 correspond to December 29, 2019–March 14, 2020.

** Weeks 12–42 in 2019 correspond to March 17–October 19, 2019; weeks 12–42 in 2020 correspond to March 15–October 17, 2020.

average proportion of children's mental health–related ED visits was approximately 44% higher in 2020 (1,673 per 100,000) than that in 2019 (1,161 per 100,000).

Adolescents aged 12–17 years accounted for the largest proportion of children's mental health–related ED visits during 2019 and 2020 (Figure 2). During weeks 12–42, 2020, the proportion of mental health–related visits for children aged 5–11 years and adolescents aged 12–17 years increased approximately 24% and 31%, respectively compared with those in 2019; the proportion of mental health–related visits for children aged 0–4 years remained similar in 2020. (Table.) The highest weekly proportion of mental health–related ED visits occurred during October for children aged 5–11 years (week 42; 1,177 per 100,000) and during April (week 16) for adolescents aged 12–17 years (4,758 per 100,000) (Figure 2).

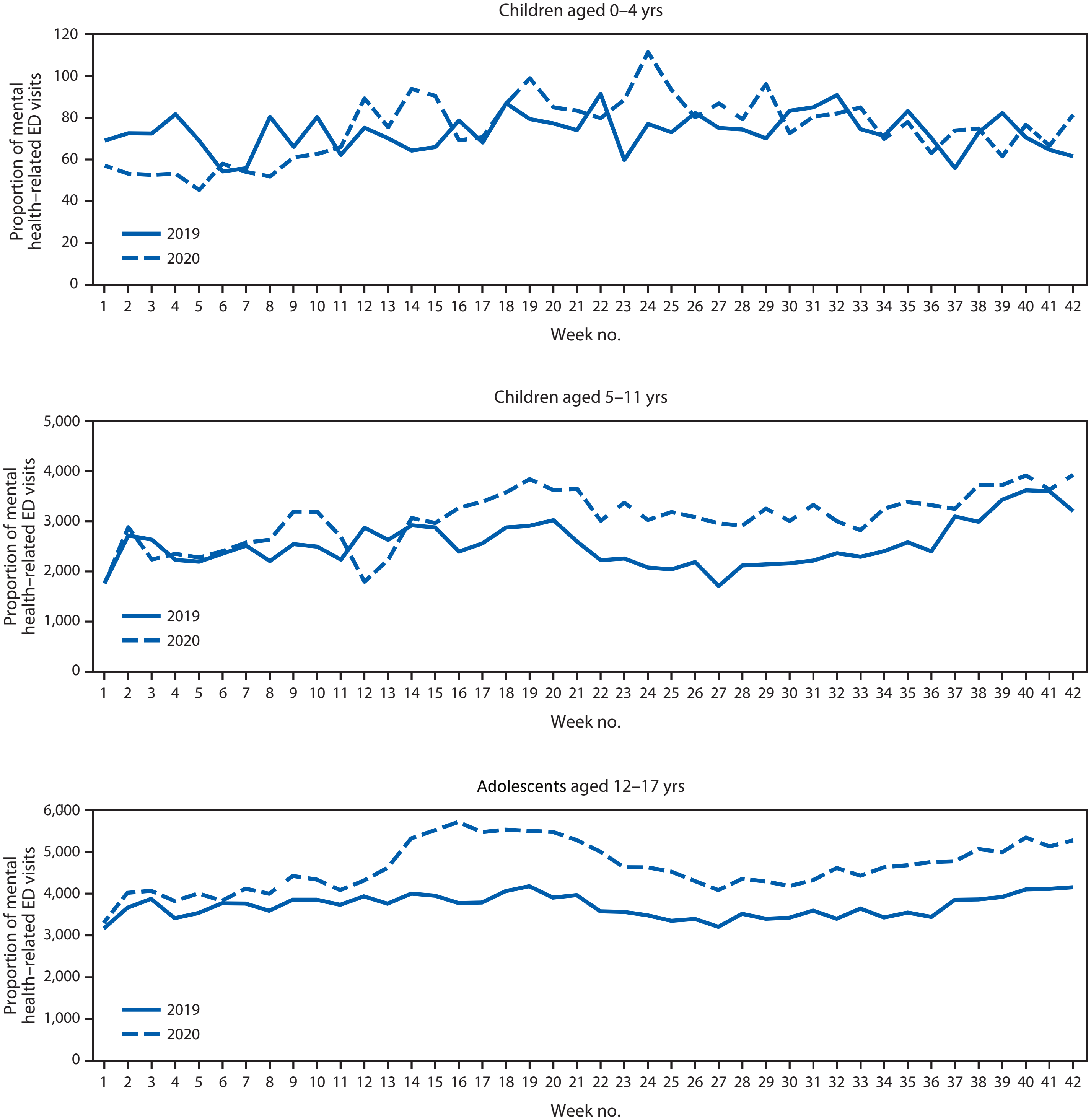
During 2019 and 2020, the proportion of mental health–related ED visits was higher among females aged <18 years than it was among males (Supplementary Figure 2, https://stacks.cdc.gov/view/cdc/96610). Similar patterns of increasing proportions of mental health–related ED visits were observed in 2020 for males and females, with increases beginning mid-March and continuing through October.

Discussion

Substantial declines in the overall reported numbers of children's mental health–related ED visits occurred in 2020 during mid-March to early May, coincident with the widespread implementation of community mitigation measures** enacted to prevent COVID-19 transmission (e.g., school closures and restrictions to nonemergent care) and decreases in overall ED visits for the same period (*4*). A previous report found the mean weekly number of ED visits for children aged <14 years declined approximately 70% during March 29–April 25, 2020, relative to the corresponding period in 2019 (*4*). Further, the mean number of weekly ED visits for persons of all ages decreased significantly for asthma (–10%), otitis media (–65%), and sprain- and strain-related injuries (–39%), and mean weekly ED visits for psychosocial factors increased 69% (*4*). This report demonstrates that, whereas the overall number of children's mental health–related ED visits decreased, the proportion of all ED visits for children's mental health–related concerns increased, reaching levels substantially higher beginning in late-March to

** https://www.whitehouse.gov/wp-content/uploads/2020/03/03.16.20_coronavirus-guidance_8.5x11_315PM.pdf; https://www.cdc.gov/coronavirus/2019-ncov/community/community-mitigation.html.

FIGURE 2. Weekly proportion of mental health–related emergency department (ED) visits* per total ED visits among children aged <18 years, by age group — National Syndromic Surveillance Program, United States, January–October 2019 and 2020



* Proportion of mental health–related ED visits = number of ED visits for children's mental health/total number of pediatric ED visits x 100,000.

October 2020 than those during the same period during 2019. Describing both the number and the proportion of mental health–related ED visits provides crucial context for these findings and suggests that children's mental health warranted sufficient concern to visit EDs during a time when nonemergent ED visits were discouraged.

Many children receive mental health services through clinical and community agencies, including schools (*5*). The increase in the proportion of ED visits for children's mental health concerns might reflect increased pandemic-related stress and unintended consequences of mitigation measures, which reduced or modified access to children's mental health services (*2*), and could result in increased reliance on ED services for both routine and crisis treatment (*3*). However, the magnitude of the increase should be interpreted carefully because it might also reflect the large decrease in the number and proportion of other types of ED visits (e.g., asthma, otitis media, and musculoskeletal injuries) (*4*) and variation in the number of EDs reporting to NSSP.

Adolescents aged 12–17 years accounted for the highest proportion of mental health–related ED visits in both 2019 and 2020, followed by children aged 5–11 years. Many mental disorders commence in childhood, and mental health concerns in these age groups might be exacerbated by stress related to the pandemic and abrupt disruptions to daily life associated with mitigation efforts, including anxiety about illness, social isolation, and interrupted connectedness to school (*5*). The majority of EDs lack adequate capacity to treat pediatric mental health concerns (*6*), potentially increasing demand on systems already stressed by the COVID-19 pandemic. These findings demonstrate continued need for mental health care for children during the pandemic and highlight the importance of expanding mental health services, such as telemental health and technology-based solutions (e.g., mobile mental health applications) (*5*,*7*).

The findings in this report are subject to at least three limitations. First, the proportions presented should be interpreted with caution because of variations affecting the denominators used to calculate proportions. Children's mental health–related ED visits constitute a small percentage of all pediatric ED visits (1.1% in 2019 and 1.4% in 2020), increasing susceptibility of rates to decreases in ED visits during the pandemic. In addition, NSSP ED participation can vary over time; however, analyzing number of visits and proportion of total ED visits provides context for observed variation. Second, NSSP data are not nationally representative; these findings might not be generalizable beyond those EDs participating in NSSP. Further, usable information on race and ethnicity was not available in the NSSP data. Finally, these data are subject to under- and overestimation. Variation in reporting and coding practices can influence the number and proportion of mental health–related visits observed. ED visits represent unique events, not individual persons, and as such, might reflect multiple visits for one person. The definition of mental health focuses on symptoms and conditions (e.g., stress, anxiety) that might increase after a disaster in the United States and might not reflect all mental health–related ED visits. Still, these data likely underestimate the actual number of mental health–related health care visits because many mental health visits occur outside of EDs.

Summary

What is already known about this topic?

Emergency departments (EDs) are often the first point of care for children's mental health emergencies. U.S. ED visits for persons of all ages declined during the early COVID-19 pandemic (March–April 2020).

What is added by this report?

Beginning in April 2020, the proportion of children's mental health–related ED visits among all pediatric ED visits increased and remained elevated through October. Compared with 2019, the proportion of mental health–related visits for children aged 5–11 and 12–17 years increased approximately 24%. and 31%, respectively.

What are the implications for public health practice?

Monitoring indicators of children's mental health, promoting coping and resilience, and expanding access to services to support children's mental health are critical during the COVID-19 pandemic.

Children's mental health during public health emergencies can have both short- and long-term consequences to their overall health and well-being (*8*). This report provides timely surveillance data concerning children's mental health in the context of the COVID-19 pandemic. Ongoing collection of a broad range of children's mental health data outside the ED is needed to monitor the impact of COVID-19 and the effects of public health emergencies on children's mental health. Ensuring availability of and access to developmentally appropriate mental health services for children outside the in-person ED setting will be important as communities adjust mitigation strategies (*3*). Implementation of technology-based, remote mental health services and prevention activities to enhance healthy coping and resilience in children might effectively support their well-being throughout response and recovery periods (*5*,*7*). CDC supports efforts to promote the emotional well-being of children and families and provides developmentally appropriate resources for families to reduce stressors that might contribute to children's mental health–related ED visits[††] (*9*).

[††] https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/parental-resource-kit/.

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Risk Assessment and Management of COVID-19 Among Travelers Arriving at Designated U.S. Airports, January 17–September 13, 2020

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In January 2020, with support from the U.S. Department of Homeland Security (DHS), CDC instituted an enhanced entry risk assessment and management (screening) program for air passengers arriving from certain countries with widespread, sustained transmission of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19). The objectives of the screening program were to reduce the importation of COVID-19 cases into the United States and slow subsequent spread within states. Screening aimed to identify travelers with COVID-19–like illness or who had a known exposure to a person with COVID-19 and separate them from others. Screening also aimed to inform all screened travelers about self-monitoring and other recommendations to prevent disease spread and obtain their contact information to share with public health authorities in destination states. CDC delegated postarrival management of crew members to airline occupational health programs by issuing joint guidance with the Federal Aviation Administration.* During January 17–September 13, 2020, a total of 766,044 travelers were screened, 298 (0.04%) of whom met criteria for public health assessment; 35 (0.005%) were tested for SARS-CoV-2, and nine (0.001%) had a positive test result. CDC shared contact information with states for approximately 68% of screened travelers because of data collection challenges and some states' opting out of receiving data. The low case detection rate of this resource-intensive program highlighted the need for fundamental change in the U.S. border health strategy. Because SARS-CoV-2 infection and transmission can occur in the absence of symptoms and because the symptoms of COVID-19 are nonspecific, symptom-based screening programs are ineffective for case detection. Since the screening program ended on September 14, 2020, efforts to reduce COVID-19 importation have focused on enhancing communications with travelers to promote recommended preventive measures, reinforcing mechanisms to refer overtly ill travelers to CDC, and enhancing public health response capacity at ports of entry. More efficient collection of contact information for international air passengers before arrival and real-time transfer of data to U.S. health departments would facilitate timely postarrival public health management, including contact tracing, when indicated. Incorporating health attestations, predeparture and postarrival testing, and a period of limited movement after higher-risk travel, might reduce risk for transmission during travel and translocation of SARS-CoV-2 between geographic areas and help guide more individualized postarrival recommendations.

On January 17, 2020, entry screening of air passengers arriving from Wuhan, Hubei Province, China, the epicenter of the COVID-19 outbreak at the time, began at three U.S. airports (Los Angeles International Airport, California; San Francisco International Airport, California; and John F. Kennedy International Airport, New York City, New York) receiving the highest volume of passengers arriving from Wuhan Tianhe International Airport (Table 1) (Figure). Beginning February 3, entry screening expanded to all passengers arriving from mainland China after the issuance of a presidential proclamation† restricting entry to U.S. citizens, lawful permanent residents, and other excepted persons. These travelers were routed to one of 11 designated airports. On March 2, travelers from Iran were added.§ As Europe became a new epicenter of COVID-19, travelers from 26 countries in the European Schengen Area¶ (effective March 14), the United Kingdom, and Ireland** (effective for both March 17) were added, and the number of airports to which passengers were routed expanded to 13. When travelers from Brazil†† were added on May 28, screening expanded to 15 designated airports.

* https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safos/media/2020/SAFO20009.pdf.

† https://www.whitehouse.gov/presidential-actions/proclamation-suspension-entry-immigrants-nonimmigrants-persons-pose-risk-transmitting-2019-novel-coronavirus/.

§ https://www.whitehouse.gov/presidential-actions/proclamation-suspension-entry-immigrants-nonimmigrants-certain-additional-persons-pose-risk-transmitting-coronavirus/.

¶ https://www.whitehouse.gov/presidential-actions/proclamation-suspension-entry-immigrants-nonimmigrants-certain-additional-persons-pose-risk-transmitting-2019-novel-coronavirus/.

** https://www.whitehouse.gov/presidential-actions/proclamation-suspension-entry-immigrants-nonimmigrants-certain-additional-persons-pose-risk-transmitting-coronavirus-2/.

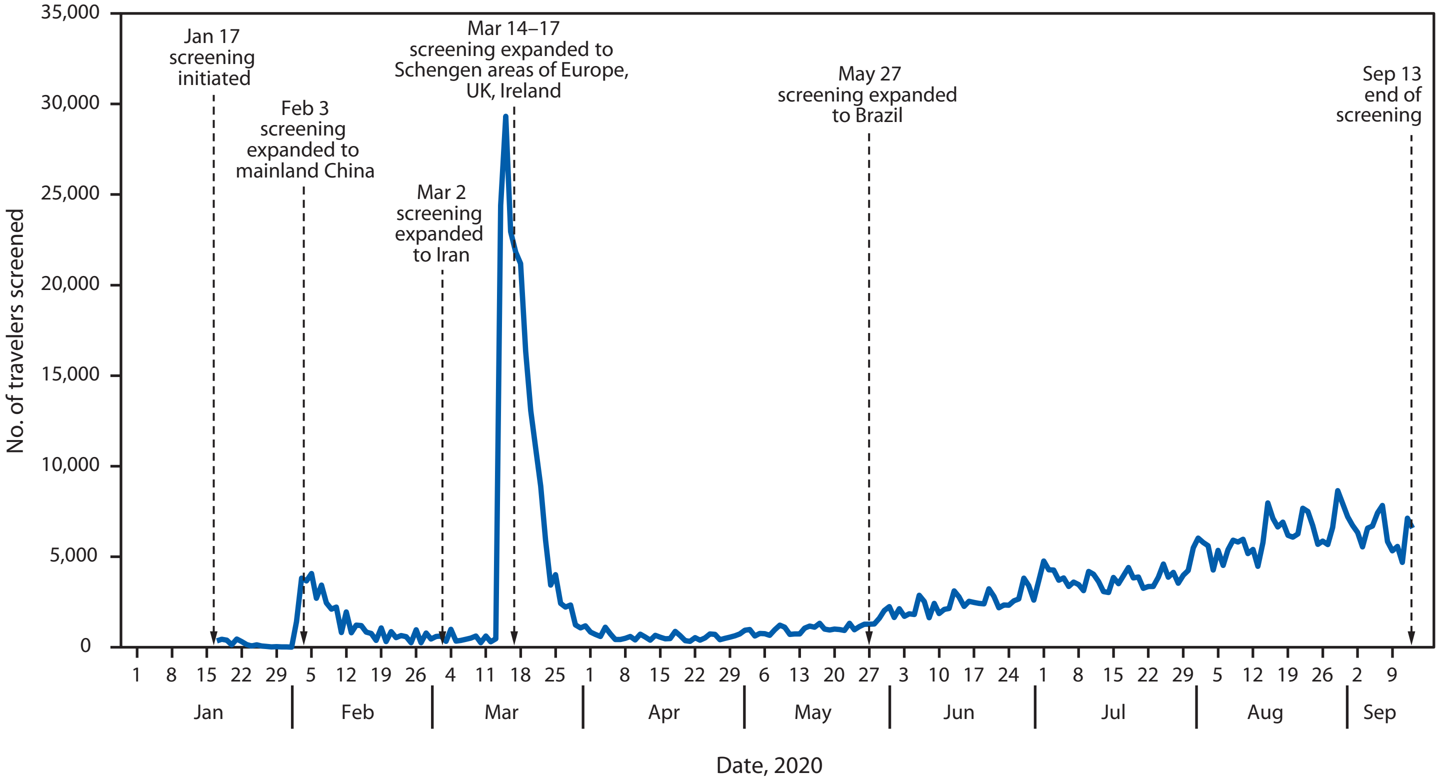
†† https://www.whitehouse.gov/presidential-actions/proclamation-suspension-entry-immigrants-nonimmigrants-certain-additional-persons-pose-risk-transmitting-novel-coronavirus/.

TABLE 1. Airports participating in COVID-19 entry screening operations and volume of passengers screened, by date of initiation of screening (N = 15) — United States, January 17–September 13, 2020

Date screening began	Screening airport	City, State	IATA code	No. of passengers screened (%)
Jan 17, 2020	John F. Kennedy International	New York City, New York	JFK	146,127 (19.1)
	Los Angeles International	Los Angeles, California	LAX	79,486 (10.4)
	San Francisco International	San Francisco, California	SFO	45,237 (5.9)
Jan 21, 2020	O'Hare International	Chicago, Illinois	ORD	86,412 (11.3)
	Hartsfield-Jackson Atlanta International	Atlanta, Georgia	ATL	78,893 (10.3)
Feb 3, 2020	Newark Liberty International	Newark, New Jersey	EWR	79,507 (10.4)
	Washington Dulles International	Dulles, Virginia	IAD	66,107 (8.6)
	Dallas-Fort Worth International	Dallas, Texas	DFW	45,289 (5.9)
	Detroit Metropolitan	Detroit, Michigan	DTW	24,739 (3.2)
	Seattle-Tacoma International	Seattle, Washington	SEA	11,781 (1.5)
	Daniel K. Inouye International	Honolulu, Hawaii	HNL	1,052 (0.1)
Mar 14, 2020	Miami International	Miami, Florida	MIA	40,871 (5.3)
	Boston Logan International	Boston, Massachusetts	BOS	38,937 (5.1)
	George Bush Intercontinental	Houston, Texas	IAH	15,024 (2.0)
	Fort Lauderdale-Hollywood International	Fort Lauderdale, Florida	FLL	6,582 (0.9)
Total	—	—	—	**766,044 (100)**

Abbreviations: COVID-19 = coronavirus disease 2019; IATA = International Air Transport Association.

FIGURE. Number of travelers screened for COVID-19 and changes in screening program — 15 designated U.S. airports, January 17–September 13, 2020



Abbreviations: COVID-19 = coronavirus disease 2019; UK = United Kingdom.

Screening consisted of three steps. First, U.S. Customs and Border Protection officers identified and referred travelers for screening if they had been in one of the specified countries during the previous 14 days. Next, initial screening was conducted, which included observation for signs of illness, a temperature check using a noncontact infrared thermometer (fever defined as temperature ≥100.4°F [38°C]), administration of a questionnaire about signs and symptoms (fever, cough, and difficulty breathing) in the preceding 24 hours or exposure to a person with COVID-19 in the preceding 14 days, and collection of travelers' U.S. contact information. The third step included referral of ill travelers and those disclosing an exposure for additional public health assessment by an on-site medical officer; if indicated, travelers were sent to a local health care facility for medical evaluation. The threshold for sending symptomatic travelers for public health assessment and deciding which among those would be sent for medical evaluation varied during the evaluation period, reflecting evolution of CDC's definition for "person under investigation"[§§] and operational considerations (e.g., testing capacity). Until March 20, travelers from Hubei Province were quarantined for 14 days upon arrival under federal or state authority.

All screened travelers received a Travel Health Alert Notice, an information card that advised them to stay home (or in a comparable setting, such as a hotel room) for 14 days after arrival and provided messaging on self-monitoring for COVID-19 symptoms and actions to take if symptoms develop. Traveler contact information was transmitted securely to state health departments via CDC's Epidemic Information Exchange (Epi-X). In addition to covering all costs for CDC personnel and contractors conducting screening, CDC transferred about $57 million to DHS to support the screening operation and incurred additional costs for equipment, travel, and housing of quarantined travelers. At the program's peak volume on March 20, designated airports were staffed with approximately 750 screeners, plus other supporting personnel.

During January 17–September 13, 2020, 766,044 travelers were screened (Table 1), 298 (0.04%) of whom met CDC criteria for referral. Travelers were referred because they had either been in Hubei Province (16, 5.4%), reported contact with a person with COVID-19 (four, 1.3%), or had signs or symptoms that triggered a public health assessment (278, 93.3%). Among the 278 persons who had COVID-19–like symptoms, the most common signs or symptoms triggering assessment were cough (73%), self-reported fever (41%), measured fever (17%), and difficulty breathing (13%) (Table 2). Forty (14%) of these travelers were medically evaluated at a local health care facility, and 35 (13%) were tested for SARS-CoV-2 using reverse transcription–polymerase chain reaction (RT-PCR); nine of the 35 tests returned positive results, representing 0.001% (one per 85,000) of all travelers screened. Fourteen additional travelers with laboratory-confirmed COVID-19 were identified through other mechanisms rather than as a direct result of entry screening: six via established processes with airlines and airport partners to detect ill travelers and notify CDC and eight through notifications about travelers who had received a positive test result in the United States or another country before travel.

CDC relied initially on existing federal traveler databases to obtain passenger contact information to share with states, but missing or inaccurate data prompted adding manual data collection to the screening process. Manual data collection resulted in 98.1% complete records (i.e., records contained both phone number and physical address). CDC sent state health departments contact information for approximately 68% of screened travelers. CDC did not send records processed 12 days after travelers' arrival, with insufficient contact data, or belonging to six states that opted out of receiving travelers' data because of competing response priorities. Analysis of traveler data submitted electronically by airlines during September 14–24, after discontinuation of manual data collection, and supplemented by previously untapped federal databases, showed that 22% of traveler contact information records had phone number and physical address.

[§§] https://www.emergency.cdc.gov/han/2020.asp.

TABLE 2. Characteristics of symptomatic travelers screened for COVID-19 at U.S. airports who were referred for on-site public health assessment, tested for SARS-CoV-2, and who received a diagnosis of laboratory-confirmed SARS-CoV-2 infection — 15 U.S. airports, January 17–September 13, 2020

Sign/Symptom	No. (%) among symptomatic travelers: Referred for public health assessment (n = 278)	No. (%) among symptomatic travelers: Received SARS-CoV-2 testing (n = 35)	Laboratory-confirmed COVID-19, no. (% of symptomatic travelers), [% of tested travelers] (n = 9)
Cough	202 (72.7)	28 (10.1)	7 (2.5), [20.0]
Self-reported fever	113 (40.6)	27 (9.7)	8 (2.9), [22.9]
Measured fever (temperature ≥100.4°F [38°C])	48 (17.3)	15 (5.4)	5 (1.8), [14.3]
Difficulty breathing	36 (12.9)	17 (6.1)	2 (0.7), [5.7]
Measured fever plus difficulty breathing	2 (0.7)	2 (0.7)	0 (0), [0]
Measured fever plus cough	10 (3.6)	7 (2.5)	3 (1.1), [8.6]

Abbreviation: COVID-19 = coronavirus disease 2019.

Discussion

These findings demonstrate that temperature and symptom screening at airports detected few COVID-19 cases and required considerable resources. The observed yield was approximately one identified case per 85,000 travelers screened. Reasons for the low yield were likely multifactorial and might have included an overall low COVID-19 prevalence in travelers; the relatively long incubation period; an illness presentation with a wide range of severity, afebrile cases, and nonspecific symptoms common to other infections; asymptomatic infections; and travelers who might deny symptoms or take steps to avoid detection of illness (e.g., through use of antipyretic or cough suppressant medications) (*1*).

SARS-CoV-2 presents a formidable control challenge because asymptomatic (i.e., never symptomatic) and presymptomatic (i.e., contagious infections before symptom onset) infections can result in substantial transmission, which was unknown early in the pandemic (*2*,*3*). The proxy for infectiousness, viral shedding in the upper respiratory tract, is greatest early in the course of infection, before prominent symptoms are apparent, suggesting peak infectiousness at or before symptom onset (*3*).

These findings are consistent with mathematical models examining the effectiveness of airport screening for COVID-19, which suggest that most infected travelers would be undetected by symptom-based screening at airports (*4*,*5*). Nonetheless, reductions in travel (e.g., associated with issuance of travel health notices to avoid nonessential travel and some entry restrictions) and airport-based activities might have lessened the incidence of COVID-19 in the United States early in the pandemic by discouraging symptomatic persons from traveling, limiting entry of potentially infected travelers, and promoting actions to prevent transmission from infected travelers, including a recommendation to stay home for 14 days after arrival (*6*–*8*).

Challenges associated with providing complete and accurate traveler contact information to health departments, the high volume of travelers to some locations, and competing health department priorities when jurisdictions were confronting outbreaks, precluded efforts to contact most travelers after arrival to oversee self-monitoring as recommended at the time (*9*). Manual data collection of traveler contact information on arrival is resource-intensive and poses a risk to travelers who might have to wait in crowded, enclosed spaces while the information is collected. CDC is working with government and industry partners to develop a framework to collect reliable contact information electronically for airline passengers before arrival in the United States and enable secure, real-time data transfer for any public health follow-up, including air travel-related contact tracing, when indicated.

The findings in this report are subject to at least three limitations. First, not all symptomatic travelers were referred for public health assessment because many COVID-19 symptoms are nonspecific and available data (for travelers who were not referred) are insufficient to determine the proportion who might have had some symptoms. Second, most travelers referred for public health assessment were not sent to a local health care facility or tested for SARS-CoV-2. Both could have been sources of selection bias toward underestimation of the number of cases in screened travelers. Third, screening was limited to travelers from certain countries, and current surveillance systems lack information to match COVID-19 cases reported by states to known international travelers. Therefore, this report is unable to provide definitive assessment of the outcomes of screened travelers who were not referred for medical evaluation or to compare outcomes for screened travelers with those arriving from countries not targeted for screening.

The hallmark of effective public health programs is reassessment of methods used for public health practice based on available evidence. Therefore, CDC recommended a shift from resource-intensive, low-yield, symptom-based screening of air travelers to an approach that better fits the current stage of the pandemic, and on September 14, 2020, the screening program was discontinued. Protecting travelers and destination communities during the pandemic will require continued emphasis on implementation of health precautions before, during, and after travel, and communicating these recommendations to travelers and the airline industry.[¶¶,***,†††,§§§] After the removal of requirements for enhanced entry screening operations, CDC continued to invest in strengthening illness detection and response under CDC's regulatory authorities,[¶¶¶] by training of partners at ports of entry, as well as overall public health response capacity at 20 CDC quarantine station locations. CDC, along with U.S. government partners, also issued recommendations for airlines, airports, and travelers[****,††††] to prevent COVID-19 transmission associated with air travel. All travelers should follow CDC recommendations for mask use,[§§§§] hand hygiene, self-monitoring for symptoms, and social distancing during travel and after arrival to the United

¶¶ https://www.cdc.gov/coronavirus/2019-ncov/travelers/when-to-delay-travel.html.
*** https://www.cdc.gov/coronavirus/2019-ncov/travelers/travel-during-covid19.html.
††† https://www.cdc.gov/coronavirus/2019-ncov/travelers/after-travel-precautions.html.
§§§ https://www.cdc.gov/quarantine/travel-restrictions.html.
¶¶¶ https://www.cdc.gov/quarantine/specificlawsregulations.html.
**** https://www.cdc.gov/coronavirus/2019-ncov/travelers/airline-toolkit.html.
†††† https://www.transportation.gov/sites/dot.gov/files/2020-07/Runway_to_Recovery_07022020.pdf.
§§§§ https://www.cdc.gov/quarantine/masks/mask-travel-guidance.html.

Summary

What is already known about this topic?

As an early effort to prevent importation of SARS-CoV-2, CDC established entry screening at designated airports for passengers from certain countries.

What is added by this report?

Passenger entry screening was resource-intensive with low yield of laboratory-diagnosed COVID-19 cases (one case per 85,000 travelers screened). Contact information was missing for a substantial proportion of screened travelers in the absence of manual data collection.

What are the implications for public health practice?

Symptom-based screening programs are ineffective because of the nonspecific clinical presentation of COVID-19 and asymptomatic cases. Reducing COVID-19 importation has transitioned to enhancing communication with travelers to promote recommended preventive measures, strengthening response capacity at ports of entry, and encouraging predeparture and postarrival testing. Collection of contact information from international air passengers before arrival would facilitate timely postarrival management when indicated.

States. Travellers with higher exposure risk should take additional precautions, including postarrival testing, avoiding contact with persons at higher risk for severe disease, and staying home as recommended or required by jurisdictional public health authorities. Predeparture testing of travelers, ideally with specimen collection within 72 hours before departure, might reduce the risk for SARS-CoV-2 transmission during travel. Postarrival testing could allow for shortening of posttravel self-quarantine periods that protect against travel-associated imported (translocated) infections.[¶¶¶¶] Finally, progress in understanding immunity biomarkers and duration of protection, in developing one or more vaccines, and in testing hold promise for refining risk stratification and optimizing management of travelers to reduce COVID-19 transmission and translocation related to commercial air travel.

¶¶¶¶ https://www.medrxiv.org/content/10.1101/2020.07.24.20161281v2.full.pdf.

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Multiple COVID-19 Outbreaks Linked to a Wedding Reception in Rural Maine — August 7–September 14, 2020

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Large indoor gatherings pose a high risk for transmission of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), and have the potential to be super-spreading events (*1*,*2*). Such events are associated with explosive growth, followed by sustained transmission (*3*). During August 7–September 14, 2020, the Maine Center for Disease Control and Prevention (MeCDC) investigated a COVID-19 outbreak linked to a wedding reception attended by 55 persons in a rural Maine town. In addition to the community outbreak, secondary and tertiary transmission led to outbreaks at a long-term care facility 100 miles away and at a correctional facility approximately 200 miles away. Overall, 177 COVID-19 cases were epidemiologically linked to the event, including seven hospitalizations and seven deaths (four in hospitalized persons). Investigation revealed noncompliance with CDC's recommended mitigation measures. To reduce transmission, persons should avoid large gatherings, practice physical distancing, wear masks, stay home when ill, and self-quarantine after exposure to a person with confirmed SARS-CoV-2 infection. Persons can work with local health officials to increase COVID-19 awareness and determine the best policies for organizing social events to prevent outbreaks in their communities.

Investigation and Results

On August 12, 2020, MeCDC received laboratory reports of two persons who received positive SARS-CoV-2 polymerase chain reaction (PCR) test results from nasopharyngeal swab specimens. Both persons reported attending a wedding reception on August 7, and both experienced onset of fever, cough, and sore throat on August 11. Three more persons who reported attending the same reception received positive SARS-CoV-2 test results the next day, prompting initiation of an outbreak investigation by MeCDC on August 14.

MeCDC used the Council of State and Territorial Epidemiologists' COVID-19 case definitions (*4*). Confirmed cases were defined by receipt of a positive SARS-CoV-2 PCR test result, and probable cases were defined by the reported presence of COVID-19–compatible symptoms and epidemiologic linkage to a confirmed case, without laboratory testing (*4*). Close contact was defined as being within 6 feet of a person with COVID-19 for at least 15 minutes (*4*). MeCDC defines a COVID-19 outbreak as the occurrence of three or more confirmed cases within 14 days in persons from different households, with an epidemiologic link to a single facility or event. MeCDC investigators interviewed patients using a standardized questionnaire*; entered data on demographic characteristics, onset date, symptoms, and relevant exposures into the National Electronic Disease Surveillance System Base System; and enrolled close contacts in Sara Alert,† an automated, web-based, symptom-monitoring tool (*5*).

Primary cases were defined as confirmed or probable cases in persons present at the reception. Through contact tracing, MeCDC identified secondary and tertiary cases (close contacts of primary and secondary cases, respectively). MeCDC developed transmission chains using MicrobeTrace (version 0.6.1; CDC)§ and performed descriptive statistics using SAS software (version 9.4; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.¶

The reception, attended by 55 persons, was held on August 7 in a rural Maine town located in county A. The town had a total population of approximately 4,500 persons and no previously reported COVID-19 cases. COVID-19 incidence in county A before the reception was 97 cases per 100,000 persons. The bride, groom, and groom's family (seven persons) traveled from California to Maine on August 6. In compliance with the governor of Maine's executive order,** because they had received negative SARS-CoV-2 test results shortly after arrival, they were not required to quarantine for 14 days. The index patient was a Maine resident and a wedding reception guest who reported onset of fever, runny nose, cough, and fatigue on August 8 and received a positive SARS-CoV-2 test result on August 13. During August 8–14, 24 persons who received positive SARS-CoV-2 PCR test results in county A reported having attended the event, prompting a health inspection of the facility to investigate compliance with Maine's COVID-19 guidelines.††

* https://www.cdc.gov/coronavirus/2019-ncov/downloads/pui-form.pdf.
† https://saraalert.org/.
§ https://www.biorxiv.org/content/10.1101/2020.07.22.216275v1.
¶ 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.
** https://www.maine.gov/governor/mills/sites/maine.gov.governor.mills/files/inline-files/EO-57.pdf.
†† https://www.maine.gov/decd/covid-19-prevention-checklists.

The reception was held at a lodging establishment in county A that had an attached restaurant and four dining areas, including the event room, breakfast room, bar, and an open deck. Guests were seated indoors in the event room, which had 10 tables, with 4–6 guests seated around each table. The total number of wedding guests (55) exceeded Maine's 50-person limit for indoor gathering in a shared space. Facility staff members had conducted temperature checks for all guests at the facility entrance; these were reported as normal. Although the facility had signs posted at the entrance instructing visitors to wear masks, guests did not comply with this requirement nor maintain a physical distance of ≥6 feet, and staff members did not enforce these measures; all staff members wore masks. The facility did not collect contact information from guests. A member of the wedding party informed MeCDC of the total number of guests but did not provide their contact information. MeCDC investigators linked cases to the event by backward tracing,[§§] in which persons with confirmed or probable COVID-19 were interviewed to determine whether they had attended an event or were a close contact of a person who had received a diagnosis of COVID-19 ≤14 days before their symptom onset or testing date.

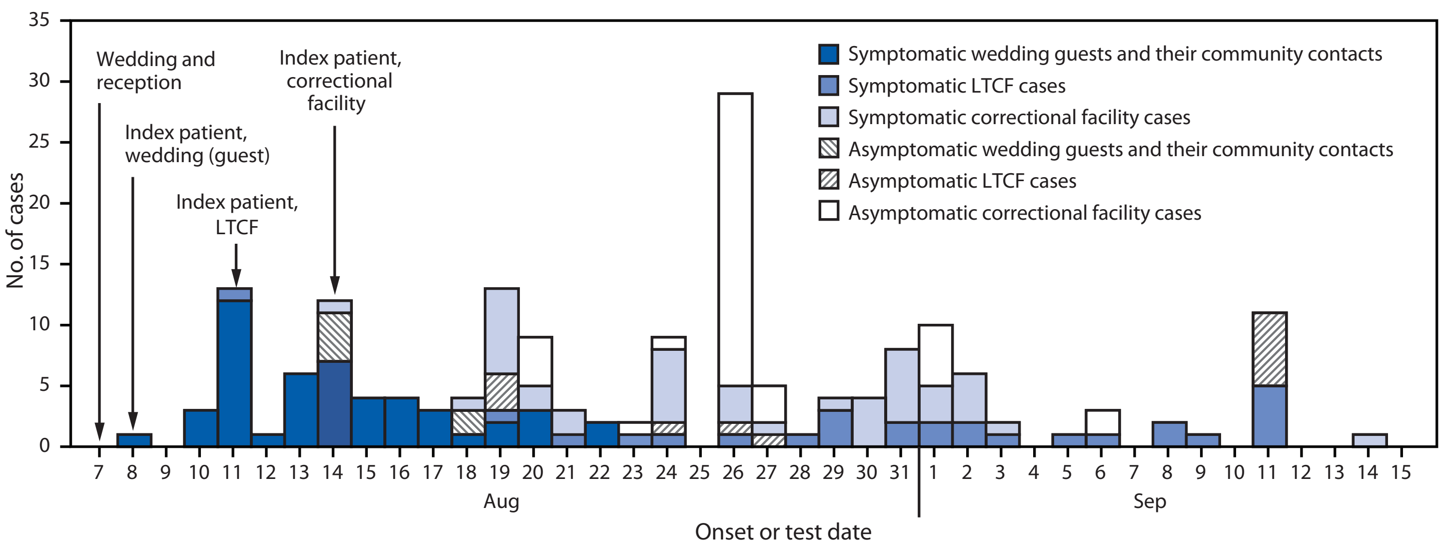
§§ https://www.medrxiv.org/content/10.1101/2020.08.01.20166595v1.

Wedding Guests, Facility Staff Members, and Their Community Contacts

By August 20, MeCDC identified 30 primary cases (Figure). Confirmed SARS-CoV-2 infection was identified in 27 (49.1%) of 55 wedding guests. The other three primary cases occurred in a staff member at the venue, a vendor, and a patron dining at the venue who was not a wedding guest. The facility manager informed MeCDC that among the 30 staff members, 23 (76.7%) received negative SARS-CoV-2 test results, five (16.7%) self-quarantined without testing, and two (6.7%) received a positive test result (one primary case, one secondary case). MeCDC subsequently identified an additional 17 secondary and 10 tertiary cases (Supplementary Figure, https://stacks.cdc.gov/view/cdc/96482). Fifty-one (89.5%) patients were symptomatic, and 51 (89.5%) cases were confirmed (Table). The median age was 51 years, seven (12.3%) patients were aged ≥75 years, and the majority of cases occurred in women (57.9%). Among four persons hospitalized, one died; all four hospitalized patients were aged ≥75 years, had underlying medical conditions, and were not wedding guests.

One event attendee with COVID-19 (patient A1) reported cough onset on August 10 and attended an in-person school meeting the same day. Two school staff members subsequently received diagnoses of COVID-19 on August 14 and 17. Local schools delayed reopening by 2 weeks while all exposed staff members completed isolation or quarantine.

FIGURE. Distribution of COVID-19 cases (N = 177) linked to a rural wedding reception, by date of onset or test* — Maine, August 7–September 14, 2020



Abbreviations: COVID-19 = coronavirus disease 2019; LTCF = long-term care facility.
* Date of test was used for asymptomatic cases.

TABLE. Demographic and clinical characteristics of COVID-19 cases associated with a wedding reception event and linked outbreaks (N = 177) — Maine, August 7–September 14, 2020

Characteristic	Outbreak cases/persons no./total no. (%)		
	Wedding reception attendees and their community contacts*	Long-term care facility	Correctional facility
Total no. of cases	**57**	**38**	**82**
Case classification, no. (%) of all outbreak cases)	Primary: 30 (52.6) Secondary: 17 (29.8) Tertiary: 10 (17.5)	Staff member: 14 (36.8) Resident: 24 (63.2) —	Staff member: 18 (22.0) Incarcerated person: 48 (58.5) Household contact of staff member:16 (19.5)
Case status			
Symptomatic confirmed	45/57 (79.0)	26/38 (68.4)	33/82 (40.2)
Symptomatic probable	6/57 (10.5)	0 (—)	9/82 (11.0)
Asymptomatic confirmed	6/57 (10.5)	12/38 (31.6)	40/82 (48.8)
Age group, yrs, median (IQR)	51 (27–63)	68 (46–83)	35 (29–48)
<18	11/57 (19.3)	1/38 (2.6)	7/82 (8.5)
18–29	5/57 (8.8)	3/38 (7.9)	17/82 (20.7)
30–59	22/57 (38.6)	8/38 (21.1)	52/82 (63.4)
60–75	12/57 (21.1)	10/38 (26.3)	6/82 (7.3)
≥75	7/57 (12.3)	16/38 (42.1)	0 (—)
Sex			
Male	24/57 (42.1)	6/38 (15.8)	63/82 (76.8)
Female	33/57 (57.9)	32/38 (84.2)	19/82 (23.2)
Symptoms†	51/57 (89.5)	26/38 (68.4)	42/82 (51.2)
No. of signs/symptoms per patient, median (IQR)	4 (2–6)	6 (4–9)	5 (3–7)
Duration of symptoms in days, median (IQR)	8 (6–10)	11 (1–12)	8 (6.5–10)
Underlying medical conditions†	19/57 (33.3)	26/38 (68.4)	43/82 (52.4)
No. of cases hospitalized	4/57 (7.0)	3/38 (7.9)	0 (—)
No. of deaths	1/57 (1.8)	6/38 (15.8)	0 (—)

Abbreviations: COVID-19 = coronavirus disease 2019; IQR = interquartile range.
* Includes the index cases at the long-term care and correctional facilities.
† Each case could have multiple symptoms or underlying medical conditions.

Long-Term Care Facility Outbreak

After the reception, one of the guests (patient A2) had a close interaction with patient B1 (A2's parent), a health care worker at long-term care facility (LTCF) A (Supplementary Figure, https://stacks.cdc.gov/view/cdc/96482) on August 8 and 9. Patient B1 reported fever, chills, cough, myalgia, runny nose, and headache on August 11, but nevertheless worked on August 11 and 12; patient B1 was tested for SARS-CoV-2 on August 13 and received a positive result on August 18.

MeCDC recommended universal testing for all LTCF A residents and staff members, which was conducted on August 19, after which five additional cases were detected in four residents and one staff member. An investigation at the facility was initiated on August 21. During August 19–September 11, MeCDC identified 38 additional persons with confirmed SARS-CoV-2 infection at LTCF A (Table); in 14 (18.4%) of 76 staff members and 24 (54.5%) of 44 residents. These persons accounted for 36.8% (staff members) and 63.2% (residents) of respective facility-associated cases. Compared with LTCF A staff member patients, more resident patients were aged ≥75 years (66.7% versus 0%) and had at least one underlying medical condition (87.5% versus 35.7%); however, symptoms were more prevalent in staff members (92.9%) than in residents (54.2%). Three residents were hospitalized, and six died; all decedents were aged ≥60 years and had underlying medical conditions.

Correctional Facility Outbreak

One wedding guest (patient A3) was a correctional facility staff member and reported onset of cough, myalgia, runny nose, sore throat, and a new onset loss of taste sensation on August 14 (Supplementary Figure, https://stacks.cdc.gov/view/cdc/96482). During August 15–19, patient A3 worked daily 8-hour shifts in two separate correctional facility housing units while symptomatic. On August 19, four staff members, including patient A3, received confirmation of COVID-19 diagnoses, which led MeCDC to initiate an investigation at this facility.

By September 1, 18 additional staff members and 46 incarcerated persons had received positive SARS-CoV-2 test results (Figure). MeCDC and the Maine Department of Corrections visited the correctional facility on September 4 to assess mitigation measures. The facility had not implemented daily symptom screening for staff members or enforced regular use of masks after the first case was identified. During August 27–September 10, the facility implemented COVID-19 mitigation measures consistent with CDC guidelines for correctional facilities.¶¶

In addition to patient A3, MeCDC identified 82 confirmed COVID-19 cases at the correctional facility (Table), including cases in 18 (41.9%) of 43 staff members, 48 (41.4%) of 116 incarcerated persons, and 16 household contacts of staff members; these persons accounted for 22.0%, 58.5%, and 19.5% of facility-associated cases, respectively. Most patients were men (76.8%, including all incarcerated persons) and aged 30–59 years (76%). More staff members than incarcerated persons were symptomatic (83.3% versus 22.9%). No hospitalizations or deaths occurred.

Summary

What is already known about this topic?

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

What is added by this report?

A wedding reception with 55 persons in a rural Maine town led to COVID-19 outbreaks in the local community, as well as at a long-term care facility and a correctional facility in other counties. Overall, 177 COVID-19 cases were linked to the event, including seven hospitalizations and seven deaths (four in hospitalized persons). Investigation revealed noncompliance with CDC's recommended mitigation measures.

What are the implications for public health practice?

To mitigate transmission, persons should avoid large gatherings, practice physical distancing, wear masks, stay home when ill, and self-quarantine after exposure to a person with confirmed SARS-CoV-2 infection.

Discussion

A wedding reception in a small rural town was the likely source of COVID-19 outbreaks in the local community, an LTCF, and a correctional facility, leading to 177 cases, seven hospitalizations, and seven deaths, highlighting the importance of adhering to recommended mitigation measures even in communities where transmission rates are low. None of the persons who were hospitalized or died had attended the event. Robust case investigation and contact tracing allowed seemingly disparate outbreaks to be epidemiologically linked to the event. Index patients at the LTCF and the correctional facility both worked while symptomatic, underscoring the importance of staying home when ill.

Community gatherings such as weddings, birthday parties, church events, and funerals have the potential to be SARS-CoV-2 super-spreading events (*1–3*). Increased transmission risk at such events might result from failure to maintain physical distancing and inconsistent use of masks. Transmission risk is further increased when events are held indoors.*** Findings from this investigation also demonstrate that, in addition to asymptomatic and presymptomatic transmission (*6,7*), lack of adherence to CDC's COVID-19 guidelines to stay home from work while symptomatic is an important contributor to spread of SARS-CoV-2 infection.†††

The findings in this report are subject to at least two limitations. First, a list of reception attendees was not available, and some infected persons might have been missed. Therefore, MeCDC likely undercounted cases of illness that were linked to the event, and the attack rate for the reception guests is thus a conservative estimate. Second, staff members at the LTCF and correctional facility possibly had exposures outside the facilities, and a definitive linkage of outbreaks at these facilities to the event was not possible in the absence of whole-genome sequencing.

Persons should avoid large gatherings, practice physical distancing and hand hygiene, wear masks in public places, and stay home when ill to protect their family, friends, and the public. Asymptomatic and presymptomatic transmission of SARS-CoV-2 is well documented (*6,7*); therefore, persons who have had close contact with confirmed COVID-19 cases should consider being tested.§§§ Close contacts should also self-quarantine for 14 days, irrespective of COVID-19-related symptoms.¶¶¶ Persons can work with local health officials to increase COVID-19 awareness and determine the best policies for organizing social events to prevent outbreaks in their communities.****

¶¶ https://www.cdc.gov/coronavirus/2019-ncov/community/correction-detention/guidance-correctional-detention.html.
*** https://www.medrxiv.org/content/10.1101/2020.04.04.20053058v1.
††† https://www.cdc.gov/coronavirus/2019-ncov/hcp/long-term-care.html.
§§§ https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/testing.html.
¶¶¶ https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/quarantine.html.
**** https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/other-at-risk-populations/rural-communities.html.

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Declines in SARS-CoV-2 Transmission, Hospitalizations, and Mortality After Implementation of Mitigation Measures— Delaware, March–June 2020

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On November 6, 2020, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

Mitigation measures, including stay-at-home orders and public mask wearing, together with routine public health interventions such as case investigation with contact tracing and immediate self-quarantine after exposure, are recommended to prevent and control the transmission of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19) (*1*–*3*). On March 11, the first COVID-19 case in Delaware was reported to the Delaware Division of Public Health (DPH). The state responded to ongoing community transmission with investigation of all identified cases (commencing March 11), issuance of statewide stay-at-home orders (March 24–June 1), a statewide public mask mandate (from April 28), and contact tracing (starting May 12). The relationship among implementation of mitigation strategies, case investigations, and contact tracing and COVID-19 incidence and associated hospitalization and mortality was examined during March–June 2020. Incidence declined by 82%, hospitalization by 88%, and mortality by 100% from late April to June 2020, as the mask mandate and contact tracing were added to case investigations and the stay-at-home order. Among 9,762 laboratory-confirmed COVID-19 cases reported during March 11–June 25, 2020, two thirds (6,527; 67%) of patients were interviewed, and 5,823 (60%) reported completing isolation. Among 2,834 contacts reported, 882 (31%) were interviewed and among these contacts, 721 (82%) reported completing quarantine. Implementation of mitigation measures, including mandated mask use coupled with public health interventions, was followed by reductions in COVID-19 incidence and associated hospitalizations and mortality. The combination of state-mandated community mitigation efforts and routine public health interventions can reduce the occurrence of new COVID-19 cases, hospitalizations, and deaths.

Using laboratory and case investigation data, changes in COVID-19 incidence and associated hospitalization and mortality in Delaware during March 11–June 25 were assessed. Laboratory data from the Delaware Electronic Reporting and Surveillance System (DERSS) and case investigation data from Delaware DPH were obtained. DERSS data included case classification (e.g., laboratory-confirmed or probable*); case investigation data included hospitalization status and outcome, including death. Incidence was defined as the number of newly confirmed COVID-19 patients per 10,000 Delaware residents per week (*4*). Hospitalization and mortality rates were calculated similarly, as the number of patients with confirmed COVID-19 who were hospitalized or died per 10,000 persons per week. Percent change was calculated to describe the magnitude of rate change. Delaware mitigation and public health interventions included 1) case investigations (starting March 11), which involved interviewing patients with SARS-CoV-2 infection, asking each to immediately self-isolate while collecting information on demographic characteristics, potential exposure source, symptoms,† and close contacts§; 2) statewide mandated stay-at-home order¶ (March 24–June 1); 3) statewide mandated mask use in public** (instituted April 28); and 4) contact tracing (starting May 12), wherein close contacts were interviewed and asked to self-quarantine and report symptoms for 14 days following an exposure. Changes in COVID-19 incidence and associated hospitalizations and mortality from March through June were assessed.

After the initial case report and stay-at-home order, COVID-19 incidence, hospitalization, and mortality rates increased, peaking during the week of April 13 at 15.0, 2.0, and 0.8 per 10,000 persons, respectively (Figure). After the peak, incidence declined by 18%, hospitalizations by 20%, and

* A probable case was defined as an illness meeting clinical criteria and having an epidemiologic link with no confirmatory laboratory testing performed for COVID-19, or an illness with presumptive laboratory evidence (detection of antigen or antibody) and either meeting clinical criteria or having an epidemiologic link, or an illness in a person meeting vital records criteria with no confirmatory laboratory testing for COVID-19 performed. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/faq-surveillance.html.

† The following signs and symptoms were monitored: cough, fever, fatigue, body aches, loss of taste/smell, shortness of breath, chills, and sore throat.

§ Case investigation included inquiries about close contacts in May 2020. At time of data collection, CDC guidance on contact definition was "persons less than 6 feet from a confirmed case for at least 10 minutes." CDC guidance now defines contacts as any person within 6 feet of an infected person for a cumulative total of 15 minutes or more over a 24-hour period starting from 2 days before illness onset (or, for asymptomatic patients, 2 days prior to test specimen collection). https://www.cdc.gov/coronavirus/2019-ncov/php/contact-tracing/contact-tracing-plan/appendix.html#contact.

¶ https://governor.delaware.gov/health-soe/fifth-state-of-emergency/.

** https://governor.delaware.gov/health-soe/thirteenth-state-of-emergency/.

deaths by 13%, before increasing slightly during the week of April 20. Rates declined again the same week the mask mandate went into effect (April 28) and continued to decline by 82% (incidence), 88% (hospitalization) and 100% (mortality) from late April through June, as contact tracing was added to case investigations, the stay-at-home order, and the mask mandate.

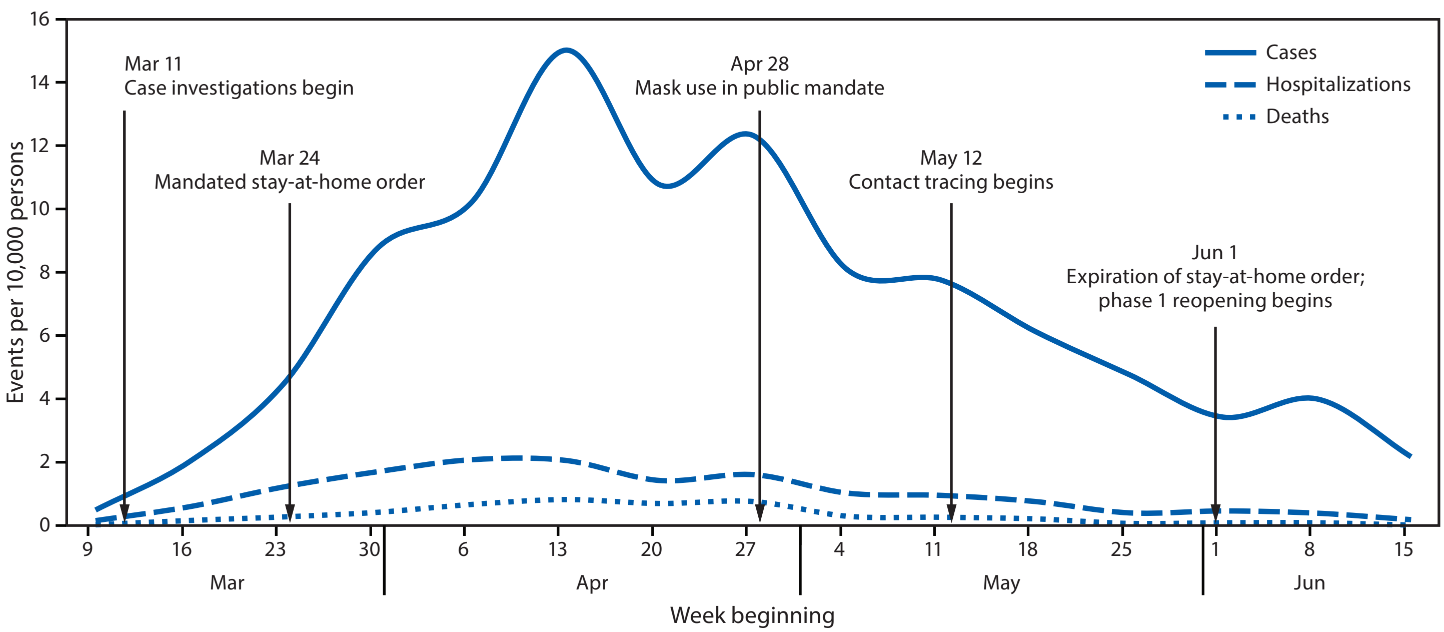
During March 11–June 25, a total of 9,762 newly confirmed COVID-19 cases were identified in DERSS; among these cases, 6,527 (67%) patients were interviewed and asked to self-isolate, among whom 5,823 (89%) had been released from isolation[††] at the time of data collection. Median patient age was 41 years (interquartile range [IQR] = 28–54 years), and 55% were female (Table). The median interval from receiving a positive test result to interview was 8 days (IQR = 6–12 days) and from DPH's receipt of case report to interview was 5 days (IQR = 2–8 days). Patients who were not interviewed were those who did not respond to call attempts (1,134, 12%), were in a hospital/long-term care facility at time of contact (788, 8%), did not have an available phone number (673, 7%), had died (433, 4%), or were not interviewed for other reasons[¶¶] (207, 2%). Among interviewed patients, 5,742 (88%) reported having any COVID-19–related symptoms before the interview date, and 55% reported close contact with someone with diagnosed COVID-19.

Among 6,527 interviewed patients with laboratory-confirmed COVID-19, 5,390 (83%) either refused to name contacts or could not recall contacts. The mean number of contacts reported per patient who reported one or more contacts was 2.5 (IQR = 1–3). Among the 2,834 contacts reported, complete contact information was obtained for 1,869 (66%), and 882 (47%) of those were interviewed and asked to self-quarantine. The median interval from patient interview to contact interview was 2 days (IQR = 1–4 days). The median age of interviewed contacts was 25 years (IQR = 14–47 years), 433 (49%) were female, 721 (82%) did not develop symptoms during quarantine, and 771 (87%) lived in the same household as someone with confirmed COVID-19. Overall, 161 (18%) of the 882 contacts who were reached experienced symptoms during quarantine and were urged to be tested for SARS-CoV-2. A manual search of DERSS data determined that among 161 symptomatic contacts, 20 (12%) were tested, four of whom (3%) received a COVID-19 diagnosis. Reasons for not interviewing contacts included that the contact did not respond to call attempts (265, 14%), had no available phone number (208, 11%), refused (88, 5%), was a non-Delaware resident (20, 1%), or other reasons (406, 22%).

[††] Release from isolation was dependent on CDC guidance during this study period: initially, patients were asked to isolate for 14 days from symptom onset or test date and be symptom-free for 7 days. Later, patients were asked to isolate for 10 days from symptom onset or test date and be symptom-free for 3 days. Patients with asymptomatic cases were asked to isolate for 10 days after test date.

[¶¶] Other status was reserved for unique circumstances that could not be addressed by case investigators or contact tracers without additional information.

FIGURE. Confirmed COVID-19 cases, associated hospitalizations, and deaths reported to Delaware Division of Public Health, by week, and COVID-19 mitigation efforts — Delaware Department of Health and Social Services, March 9–June 15, 2020



Abbreviation: COVID-19 = coronavirus disease 2019.

Discussion

A stay-at-home order and case investigations instituted weeks before the peak in COVID-19 cases (week of April 13) in Delaware likely contributed to the subsequent decline observed in COVID-19 incidence and associated hospitalization and deaths. As expected, the impact on incidence was not immediate but occurred weeks after measures were implemented, as new cases represented exposure that occurred during previous weeks. Additional steep declines in reports of new cases occurred after a public mask use mandate was issued in late April. Masks are critical for reducing SARS-CoV-2 transmission from persons with symptomatic or asymptomatic infection (*5*). Wearing masks can prevent respiratory droplets containing SARS-CoV-2 from traveling into the air and being transmitted to other persons and thus can reduce exposures and infections (*6*,*7*).

TABLE. Characteristics of persons with confirmed COVID-19 (patients) and contacts interviewed during case and contact investigations — Delaware, March–June 2020

Characteristic	No. (%) Interviewed patients (n = 6,527)	No. (%) Interviewed contacts (n = 882)
Age, yrs, median (IQR)	41 (28–54)	25 (14–74)
Time from positive COVID-19 test to interview, days, median (IQR)	8 (6–12)	N/A
Time from report to interview, days, median (IQR)	5 (2–8)	2 (1–4)
Sex		
Male	2,911 (44.6)	449 (50.9)
Female	3,614 (55.4)	433 (49.1)
Missing	2 (0.03)	0 (—)
Race/Ethnicity		
White, non-Hispanic	1,769 (27.1)	202 (22.9)
Black or African American, non-Hispanic	1,949 (29.9)	155 (17.6)
Hispanic/Latino	2,237 (34.3)	350 (39.7)
Asian, non-Hispanic	128 (2.0)	6 (0.7)
Other/Multiple races, non-Hispanic	327 (5.0)	20 (2.3)
Unknown/Missing	117 (1.8)	149 (16.9)
Any symptoms*		
No	753 (11.5)	721 (81.8)
Yes	5,742 (88.0)	161 (18.3)
Unknown/Missing	32 (0.5)	0 (—)
Close contact with confirmed COVID-19 case		
No	2,222 (34.0)	N/A
Yes	3,574 (54.8)	882 (100)
Unknown/Missing	731 (11.2)	0 (—)
Household exposure† to known COVID-19 case		
No	1,235 (19.0)	100 (11.3)
Yes	2,039 (31.3)	771 (87.4)
Unknown/Missing	3,253 (49.8)	11 (1.3)
Hospitalized		
No	5,606 (85.9)	N/A
Yes	742 (11.4)	N/A
Unknown/Missing	179 (2.7)	N/A
Died from COVID-19		
No	6,477 (99.2)	N/A
Yes	14 (0.2)	N/A
Unknown/Missing	36 (0.6)	N/A

Sources: Delaware Case Investigation and Contract Tracing Systems, Delaware Department of Health and Social Services, Division of Public Health.

Abbreviations: COVID-19 = coronavirus disease 2019; IQR = interquartile range; N/A = not applicable.

* Patients were asked if they had symptoms from 14 days before test date to date of interview; contacts were asked during monitoring period if they had symptoms.

† Household exposure defined as possible exposure to COVID-19 from a household member with confirmed COVID-19.

Early detection, self-isolation, and investigation of COVID-19 cases and self-quarantine of close contacts can be effective in preventing community transmission, if contacts are identified and reached soon after exposure (*8*). Because of limited resources and the growing number of cases, contact tracing in Delaware officially began in May when the Delaware National Guard was activated to assist Delaware DPH. In Delaware, contacts were monitored until symptom onset or quarantine completion. Testing was recommended for contacts reporting symptoms; however, no active follow-up was performed because of constrained resources. Case investigation was completed among contacts who received positive test results; therefore, having active follow-up and referral systems for testing contacts could expand disease prevention and containment opportunities.

Several barriers to case investigation and contact tracing were identified. First, low numbers of contacts were identified: 83% of interviewed patients either refused to disclose contacts or could not recall contacts. Second, cases were contacted a median of 8 days after receiving their positive test result and 5 days after report of this result to DPH. Earlier initiation of case investigation might increase recall and early identification of close contacts and thus prevent further disease transmission. Lastly, 22% of contacts could not be reached for reasons designated as "other," an interaction outcome in case investigations and contact tracing reserved for circumstances interviewers could not address without additional information. Daily and weekly data monitoring to provide additional information for those with "other" as an interaction outcome could increase the number of persons reached. These barriers to contact tracing might have limited effectiveness and were missed opportunities to recommend other mitigation strategies (e.g., testing, quarantine, or isolation).

The findings in this report are subject to at least three limitations. First, data on adherence to the state-mandated stay-at-home order and use of masks in public were not available. Second, adherence to self-quarantine was self-reported. Finally, because of the observational design of the study, the decline in COVID-19 incidence, hospitalization, and mortality could not be attributed to the relative contribution of each mitigation measure.

A combination of mitigation measures including stay-at-home orders, mandated mask use in public, and case investigations with contact tracing, can reduce COVID-19 incidence and associated deaths (*9*). No single mitigation strategy is likely

Summary

What is already known about this topic?

COVID-19 mitigation measures (e.g., stay-at-home orders and public mask mandate) and fundamental public health interventions (e.g., case investigations and contact tracing with prompt isolation or quarantine) are primary approaches to preventing and controlling SARS-CoV-2 community transmission.

What is added by this report?

State-mandated stay-at-home orders and public mask mandates coupled with case investigations with contact tracing contributed to an 82% reduction in COVID-19 incidence, 88% reduction in hospitalizations, and 100% reduction in mortality in Delaware during late April–June.

What are the implications for public health practice?

The combination of state-mandated community mitigation efforts and routine public health interventions can reduce the occurrence of new COVID-19 cases, hospitalizations, and deaths.

to be effective alone. These strategies are effective in limiting potential exposure to SARS-CoV-2 and reducing community transmission when implemented as part of a multicomponent strategy (*10*). In Delaware, state-mandated community mitigation efforts, such as stay-at-home orders, coupled with mask use, likely contributed to the decline in new COVID-19 cases. SARS-CoV-2 community transmission, hospitalization, and mortality can be reduced with statewide mitigation strategies implemented in tandem with the routine public health interventions of case investigation with contact tracing, and immediate self-isolation of cases and self-quarantine of contacts.

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COVID-19 Case Investigation and Contact Tracing teams, Delaware Division of Public Health; Delaware National Guard; CDC COVID-19 Health Department Task Force

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Characteristics of Hospitalized COVID-19 Patients Discharged and Experiencing Same-Hospital Readmission — United States, March–August 2020

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Coronavirus disease 2019 (COVID-19) is a complex clinical illness with potential complications that might require ongoing clinical care (*1*–*3*). Few studies have investigated discharge patterns and hospital readmissions among large groups of patients after an initial COVID-19 hospitalization (*4*–*7*). Using electronic health record and administrative data from the Premier Healthcare Database,* CDC assessed patterns of hospital discharge, readmission, and demographic and clinical characteristics associated with hospital readmission after a patient's initial COVID-19 hospitalization (index hospitalization). Among 126,137 unique patients with an index COVID-19 admission during March–July 2020, 15% died during the index hospitalization. Among the 106,543 (85%) surviving patients, 9% (9,504) were readmitted to the same hospital within 2 months of discharge through August 2020. More than a single readmission occurred among 1.6% of patients discharged after the index hospitalization. Readmissions occurred more often among patients discharged to a skilled nursing facility (SNF) (15%) or those needing home health care (12%) than among patients discharged to home or self-care (7%). The odds of hospital readmission increased with age among persons aged ≥65 years, presence of certain chronic conditions, hospitalization within the 3 months preceding the index hospitalization, and if discharge from the index hospitalization was to a SNF or to home with health care assistance. These results support recent analyses that found chronic conditions to be significantly associated with hospital readmission (*6,7*) and could be explained by the complications of underlying conditions in the presence of COVID-19 (*8*), COVID-19 sequelae (*3*), or indirect effects of the COVID-19 pandemic (*9*). Understanding the frequency of, and risk factors for, readmission can inform clinical practice, discharge disposition decisions, and public health priorities such as health care planning to ensure availability of resources needed for acute and follow-up care of COVID-19 patients. With the recent increases in cases nationwide, hospital planning can account for these increasing numbers along with the potential for at least 9% of patients to be readmitted, requiring additional beds and resources.

Data for this study were obtained from the Premier Healthcare Database, which includes discharge records from 865 nongovernmental, community, and teaching hospitals that contributed inpatient data during the study period. COVID-19 patients were identified through *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) discharge diagnosis code of U07.1 (COVID-19, virus identified) during April–July 2020 or B97.29 (Other coronavirus as the cause of disease classified elsewhere [recommended before the April 2020 release of U07.1]†) during March–April 2020. Both codes were used for discharges during April. The patient's first hospitalization with a COVID-19 discharge diagnosis was defined as the index hospitalization. Any subsequent hospitalization occurring within 2 months of the index hospitalization discharge date through August 2020, whether for COVID-19 or other health complications, was considered a hospital readmission.§ Hospital readmissions that occurred >2 months after the index hospitalization were excluded. In the Premier Healthcare Database, readmissions were only recorded if a patient returned to the same hospital where the index hospitalization occurred.

Demographic and clinical characteristics of patients at their index hospitalization were compared regarding discharge disposition and readmission status (none versus one or more). Presence of selected chronic conditions associated with a more severe COVID-19 clinical course were identified through ICD-10-CM diagnosis codes during or before the index COVID-19 hospitalization. Visits before the index hospitalization included all inpatient encounters for the cohort during calendar year 2020 only. Five chronic conditions that have been identified by CDC to increase or possibly increase the risk for severe COVID-19–associated illness (chronic obstructive pulmonary disease, heart failure, diabetes [type 1 or type 2, with chronic complications], chronic kidney disease, and obesity [body mass index ≥30 kg/m^2], including

* The Premier Healthcare Database includes discharge records for adult and pediatric patients from >1,000 nongovernmental, teaching and community hospitals representing approximately 25% of U.S. hospital admissions. Data for this study represented a subset of 865 medical facilities that contributed inpatient encounters to the Premier Healthcare Database during March–August 2020. https://www.premierinc.com/newsroom/category/education/page/2.

† https://www.cdc.gov/nchs/data/icd/Announcement-New-ICD-code-for-coronavirus-3-18-2020.pdf.

§ Two months was twice the period used by the Centers for Medicare & Medicaid Services for unplanned readmission measures as knowledge of COVID-19 has been evolving regarding acute and chronic sequelae.

severe obesity, [body mass index ≥40 kg/m^2]) were mapped to ICD-10-CM codes using the Elixhauser Comorbidity Index (a method for classifying comorbidities based on ICD diagnosis codes found in administrative data; each comorbidity category is dichotomous [present or absent]) and implemented with the Elixhauser Comorbidity Software for ICD-10-CM (beta version; Agency for Healthcare Research and Quality) and R software (version 4.0.92020; The R Foundation)¶ (*10*). The following three clinical severity indicators were defined using hospital chargemaster records (i.e., the comprehensive list of all items billable to a hospital patient or to a patient's insurance provider): intensive care unit (ICU) admission, invasive mechanical ventilation, and noninvasive ventilation. Time to readmission after the index hospitalization was calculated as the difference in days between date of readmission and date of discharge from the previous hospitalization. The primary discharge diagnosis for each hospitalization was categorized into Clinical Classification Software Refined Categories to approximate the primary reason for the hospital stay. A multivariable generalized estimating equation model assessed the odds of readmission, accounting for within-facility correlation. Covariates included in the model were age, sex, race/ethnicity, presence of selected chronic conditions, discharge disposition category, and clinical severity indicators. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.**

During March–July 2020, a total of 126,137 patients within the Premier Healthcare Database were hospitalized for COVID-19. The majority of patients were admitted from a non–health care setting (81%), followed by transfer from another hospital, clinic, or SNF (18%) (Table 1). During the index hospitalization, 15% of patients were admitted to an ICU, 13% required invasive mechanical ventilation, and 4% required noninvasive ventilation. At the time of the index hospitalization or at any time during 2020 before the hospitalization, 62% of patients had an ICD-10-CM diagnosis code for one or more of the following five chronic conditions: chronic obstructive pulmonary disease (21%), heart failure (16%), diabetes mellitus type 1 or type 2 (27%), chronic kidney disease (21%), or obesity (27%). Overall, 10,008 (8%) patients had been hospitalized at the same hospital in the 3 months preceding their index COVID-19 hospitalization. Approximately 15% of patients (19,594) died during the index hospitalization.

Among the 106,543 patients discharged from the index admission, 9,504 (9%) were readmitted, including 1,667 (1.6%) who were readmitted more than once. The median interval from discharge to first readmission was 8 days (interquartile range = 3–20 days). Less than 0.1% of patients died during readmission (data suppressed for privacy).

Among all patients who were discharged after the index hospitalization, 60% were discharged to home or self-care (to home without any additional professional services provided such as home nursing health care), 15% to a SNF, 10% to home with assistance from a home health organization, 4% to hospice, 4% to ongoing care, and 5% to other locations (Table 2). Readmission was more common among patients discharged to a SNF (15%) or with home health organization support (12%), compared with patients discharged to home or self-care (7%). Median age, severity markers, time to readmission and length of stay differed by index hospitalization discharge disposition category.

When controlling for covariates, the odds of readmission increased with the presence of chronic obstructive pulmonary disease (OR = 1.4), heart failure (OR = 1.6), diabetes (OR = 1.2), and chronic kidney disease (OR = 1.6). Patients were more likely to be readmitted if they had been discharged from the index hospitalization to a SNF (OR = 1.4) or with home health organization support (OR = 1.3) than if they had been discharged to home or self-care. Compared with persons aged 18–39 years, the odds of readmission increased with age among persons aged ≥65 years (Table 3). Adjusted odds of readmission of patients with a hospitalization in the 3 months preceding their index hospitalization were 2.6 times the odds of those who were not hospitalized in the preceding 3 months. Non-Hispanic White persons were more likely to be readmitted than were those of other racial/ethnic groups. Common primary discharge diagnoses after readmission were infectious and parasitic diseases (primarily COVID-19; 45%) and diseases of the circulatory (11%) and digestive (7%) systems (Supplementary Table, https://stacks.cdc.gov/view/cdc/96391).

Discussion

In a cohort of 106,543 patients discharged after an index COVID-19 hospitalization, 9% experienced at least one readmission to the same hospital within 2 months of discharge. More than one readmission occurred in 1.6% of cases. In this analysis, the odds of hospital readmission increased with age among persons aged ≥65 years, presence of one of five selected chronic conditions, hospitalization within the 3 months preceding the index hospitalization, and if discharge from the index hospitalization was to a SNF or to home with health care assistance. Although the proportions of patients in the Premier Healthcare Database cohort who were non-Hispanic Black (23%) or Hispanic (21%) were higher than those proportions in the U.S. Census (13% and 18%, respectively), their odds of readmission were lower than those of non-Hispanic White

¶ https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.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.

TABLE 1. Demographic characteristics of hospitalized COVID-19 patients at index hospitalization, by readmission status — Premier Healthcare Database, United States, March–August 2020

	No. (%)		
	Total	Not readmitted	Readmitted at least once
Characteristic	N = 126,137	N = 116,633	N = 9,504
Age group (yrs)			
<18	1,170 (0.9)	1,095 (0.9)	75 (0.8)
18–39	16,699 (13.2)	15,741 (13.5)	958 (10.1)
40–49	14,490 (11.5)	13,674 (11.7)	816 (8.6)
50–64	35,451 (28.1)	32,923 (28.2)	2,528 (26.6)
65–74	25,419 (20.2)	23,250 (19.9)	2,169 (22.8)
75–84	19,864 (15.7)	18,061 (15.5)	1,803 (19.0)
≥85	13,044 (10.3)	11,889 (10.2)	1,155 (12.2)
Race/Ethnicity			
Asian, non-Hispanic	3,652 (2.9)	3,429 (2.9)	223 (2.4)
Black, non-Hispanic	29,226 (23.2)	26,819 (23.0)	2,407 (25.3)
Hispanic	26,921 (21.3)	25,412 (21.8)	1,509 (15.9)
White, non-Hispanic	49,133 (39.0)	44,807 (38.4)	4,326 (45.5)
Other	13,048 (10.3)	12,194 (10.5)	854 (9.0)
Sex			
Female	60,426 (47.9)	55,827 (47.9)	4,599 (48.4)
Male	65,597 (52.0)	60,695 (52.0)	4,902 (51.6)
Unknown	114 (0.1)	111 (0.1)	—*
Point of origin			
Non–health care	102,482 (81.2)	94,796 (81.3)	7,686 (74.5)
Clinic	6,787 (5.4)	6,217 (5.3)	570 (5.5)
Transfer from a different hospital	8,425 (6.7)	7,968 (6.8)	457 (4.4)
Transfer from SNF or ICF	5,940 (4.7)	5,324 (4.6)	616 (6.0)
Transfer from health facility	1,437 (1.1)	1,339 (1.1)	98 (1.0)
Court/Law enforcement	252 (0.2)	241 (0.2)	11 (0.1)
Born inside the hospital	45 (0.0)	44 (0.0)	—*
Not available	441 (0.3)	410 (0.4)	31 (0.3)
U.S. Census division			
East North Central	16,009 (12.7)	14,547 (12.5)	1,462 (15.4)
East South Central	5,986 (4.7)	5,544 (4.8)	442 (4.7)
Middle Atlantic	39,673 (31.5)	36,456 (31.3)	3,217 (33.9)
Mountain	8,852 (7.0)	8,355 (7.2)	497 (5.2)
New England	3,768 (3.0)	3,346 (2.9)	422 (4.4)
Pacific	6,511 (5.2)	6,138 (5.3)	373 (3.9)
South Atlantic	27,407 (21.7)	25,683 (22.0)	1,724 (18.1)
West North Central	4,364 (3.5)	3,998 (3.4)	366 (3.9)
West South Central	13,567 (10.8)	12,566 (10.8)	1,001 (10.5)

Abbreviations: COVID-19 = coronavirus disease 2019; ICF = intermediate care facility; SNF = skilled nursing facility.
* Cell sizes <10 were suppressed.

patients. The slight association of readmission with lengths of stay for hospitalized COVID-19 patients merits further study.

These results are comparable to those of recently published analyses, which found a similar group of chronic conditions to be significantly associated with hospital readmission (*6*,*7*) and could be explained by the complications of underlying conditions in the presence of COVID-19 (*8*), COVID-19 sequelae (*3*), or indirect effects of the COVID-19 pandemic (*9*). Although only a small proportion of patients discharged to home or self-care were readmitted, 7% returned to the hospital within a median of 7 days. One explanation for their readmission is that approximately two thirds of these 4,406 patients had one or more of the selected chronic conditions.

After hospitalization for COVID-19, the most common primary discharge diagnoses from hospital readmission were diseases of the circulatory, digestive, or respiratory systems. Future work will examine the detailed diagnoses recorded during readmissions to better understand COVID-19 sequelae or health conditions that require extended or ongoing care.

The findings in this report are subject to at least five limitations. First, COVID-19 diagnoses were determined by ICD-10-CM, not through laboratory confirmation, potentially leading to misclassification of cases. Second, chronic conditions were identified using ICD-10-CM diagnostic codes used at the index hospitalization or a previous encounter. If a patient had a chronic condition but the condition was not assigned a diagnostic code, that condition would not be recorded in this

TABLE 2. Discharge status and subsequent readmissions among 126,137 COVID-19 patients* with an index hospitalization — United States, March–August 2020

Characteristic	Location to which patient was discharged from index hospitalization					
	Home or self-care	SNF	Home health organization	Hospice	Ongoing care†	Other§
Discharged (N = 106,543 [85%])						
No. of patients discharged, (%)	64,475 (60)	16,339 (15)	12,223 (10)	3,807 (4)	4,404 (4)	5,295 (5)
Length of index hospitalization, days, median (IQR)	4 (2–7)	8 (5–15)	8 (4–14)	7 (4–12)	16 (7–29)	3 (1–7)
Male, %	51	47	49	47	57	61
Median age, yrs	53	76	68	83	66	61
≥1 chronic condition, %	53	72	70	67	70	57
ICU admission, %	35	42	45	53	63	42
Readmitted (N = 9,504, 9%)¶						
No. (%) of patients readmitted	4,406 (7)	2,517 (15)	1,469 (12)	136 (4)	494 (11)	482 (9)
No. days to readmission, median (IQR)	7 (3–17)	11 (5–25)	8 (3–19)	0 (0–3)	10 (3–25)	6 (1–21)
Length of hospitalization, days, median (IQR)	4 (2–7)	6 (3–9)	5 (3–8)	3 (1–6)	6 (3–10)	4 (2–8)
Male, %	51	50	49	51	62	64
Median age, yrs	58	75	72	80	67	59
≥1 chronic condition, %	67	80	80	75	77	67

Abbreviations: COVID-19 = coronavirus disease 2019; ICU = intensive care unit; IQR = interquartile range; SNF = skilled nursing facility.

* A total of 19,594 (15%) patients died during the index hospitalization; 59% of decedents were male, median age was 74 years, 75% had one or more chronic conditions, the median hospitalization duration was 8 days (IQR = 4–15 days), and 68% of patients were admitted to an ICU.

† Ongoing care categories include discharged/transferred to cancer center, admitted as an inpatient to this hospital, still a patient, discharged/transferred to federal hospital, discharged/transferred to swing bed unit (a unit within an acute care hospital where patients receive the same skilled level of care that is available at skilled nursing facilities), discharged/transferred to another rehabilitation facility, discharged/transferred to long-term care hospitals that provide acute inpatient care with an average length of stay of ≥25 days, discharged to a psychiatric hospital, discharged/transferred to a critical access hospital.

§ Other category includes patients who were discharged to other facilities and those who left against medical advice.

¶ Readmitted from discharged location noted in column (after index hospitalization).

Summary

What is already known about this topic?

Evidence suggests that potential health complications after COVID-19 illness might require ongoing clinical care.

What is added by this report?

After discharge from an initial COVID-19 hospitalization, 9% of patients were readmitted to the same hospital within 2 months of discharge. Multiple readmissions occurred in 1.6% of patients. Risk factors for readmission included age ≥65 years, presence of certain chronic conditions, hospitalization within the 3 months preceding the first COVID-19 hospitalization, and discharge to a skilled nursing facility or with home health care.

What are the implications for public health practice?

Understanding frequency of, and potential reasons for, readmission after a COVID-19 hospitalization can inform clinical practice, discharge disposition decisions, and public health priorities, such as health care resource planning.

analysis. Third, primary discharge diagnosis was used to infer the primary reason for hospital admission; other diagnoses might have contributed to the reason for index admission and readmissions. Fourth, patients who received care at different hospitals would not be assessed longitudinally. Finally, the sequelae of COVID-19 could not be completely described among hospitalized patients or among those readmitted. Sequelae might be experienced by patients who are never readmitted to a hospital.

Information on the frequency of, and risk factors for, readmission can inform clinical practice and discharge disposition decisions especially with regard to the acuity and location of ongoing care needed for persons who might appear stable at discharge. Further, addressing priorities such as health care planning to ensure adequate health care resources for acute and post-acute follow-up care of COVID-19 patients is critical at a local, regional, and national level. With the recent increase in cases nationwide, hospital planning can account for these increasing numbers along with the potential for at least 9% of patients to be readmitted, requiring additional beds and resources. Continued public health messaging and interventions to prevent COVID-19 among older persons and those with underlying medical conditions is essential.

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TABLE 3. Generalized estimating equation model showing the adjusted odds of readmission among persons hospitalized with COVID-19 — United States, March–August 2020

Characteristic	Odds ratio (95%CI)	Standard error*	P-value
Age group (yrs), (referent = 18–39 yrs)			
<18	1.03 (0.80–1.33)	0.13	0.806
40–49	0.94 (0.84–1.04)	0.05	0.204
50–64	1.08 (0.99–1.17)	0.04	0.078
65–74	1.22 (1.12–1.34)	0.05	<0.001
75–84	1.32 (1.20–1.46)	0.05	<0.001
≥85	1.37 (1.23–1.53)	0.06	<0.001
Race/Ethnicity (referent = White, non-Hispanic)			
Asian, non-Hispanic	0.82 (0.71–0.95)	0.07	0.007
Black, non-Hispanic	0.90 (0.85–0.95)	0.03	<0.001
Hispanic	0.75 (0.71–0.81)	0.03	<0.001
Other	0.80 (0.74–0.87)	0.04	<0.001
Sex (referent = male)			
Female	0.94 (0.90–0.99)	0.02	0.015
Chronic conditions			
COPD	1.35 (1.28–1.42)	0.03	<0.001
Heart failure	1.58 (1.48–1.67)	0.03	<0.001
Diabetes	1.21 (1.14–1.28)	0.03	<0.001
Chronic kidney disease	1.64 (1.55–1.74)	0.03	<0.001
Obesity	0.95 (0.90–1.00)	0.03	0.049
Previous hospitalization† (yes versus no)	2.61 (2.45–2.78)	0.03	<0.001
Severity measures at index hospitalization			
Length of stay, days	0.99 (0.99–1.00)	0.00	0.001
ICU admission	0.94 (0.89–0.99)	0.03	0.014
Mechanical ventilation	1.15 (1.04–1.27)	0.05	0.006
Noninvasive ventilation	0.86 (0.81–0.90)	0.03	<0.001
Discharge category from index hospitalization (referent = home/self-care)			
SNF	1.37 (1.29–1.47)	0.03	<0.001
Home health organization	1.30 (1.21–1.39)	0.04	<0.001
Hospice	0.24 (0.20–0.29)	0.09	<0.001
Ongoing care	1.22 (1.09–1.36)	0.06	0.001

Abbreviations: CI = confidence interval; COPD = chronic obstructive pulmonary disease; COVID-19 = coronavirus disease 2019; ICU = intensive care unit; SNF = skilled nursing facility.

* Standard error of coefficient.

† Patients who had a hospitalization within 3 months before their COVID-19 index hospitalization.

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Progress Toward Regional Measles Elimination — Worldwide, 2000–2019

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In 2010, the World Health Assembly (WHA) set the following three milestones for measles control to be achieved by 2015: 1) increase routine coverage with the first dose of measles-containing vaccine (MCV1) among children aged 1 year to ≥90% at the national level and to ≥80% in every district, 2) reduce global annual measles incidence to <5 cases per 1 million population, and 3) reduce global measles mortality by 95% from the 2000 estimate* (*1*). In 2012, WHA endorsed the Global Vaccine Action Plan,† with the objective of eliminating measles§ in five of the six World Health Organization (WHO) regions by 2020. This report describes progress toward WHA milestones and regional measles elimination during 2000–2019 and updates a previous report (*2*). During 2000–2010, estimated MCV1 coverage increased globally from 72% to 84% but has since plateaued at 84%–85%. All countries conducted measles surveillance; however, approximately half did not achieve the sensitivity indicator target of two or more discarded measles and rubella cases per 100,000 population. Annual reported measles incidence decreased 88%, from 145 to 18 cases per 1 million population during 2000–2016; the lowest incidence occurred in 2016, but by 2019 incidence had risen to 120 cases per 1 million population. During 2000–2019, the annual number of estimated measles deaths decreased 62%, from 539,000 to 207,500; an estimated 25.5 million measles deaths were averted. To drive progress toward the regional measles elimination targets, additional strategies are needed to help countries reach all children with 2 doses of measles-containing vaccine, identify and close immunity gaps, and improve surveillance.

* The coverage milestone is to be achieved by every country, whereas the incidence and mortality reduction milestones are to be achieved globally.

† The Global Vaccine Action Plan is the implementation plan of the Decade of Vaccines, a collaboration between WHO; UNICEF; the Bill and Melinda Gates Foundation; the National Institute of Allergy and Infectious Diseases; the African Leaders Malaria Alliance; Gavi, the Vaccine Alliance; and others to extend the full benefit of immunization to all persons by 2020 and beyond. In addition to 2015 targets, it also set a target for measles and rubella elimination in five of the six WHO regions by 2020. https://www.who.int/immunization/global_vaccine_action_plan/en.

§ Measles elimination is defined as the absence of endemic measles virus transmission in a region or other defined geographic area for ≥12 months, in the presence of a high-quality surveillance system that meets targets of key performance indicators.

Immunization Activities

WHO and the United Nations Children's Fund (UNICEF) determine vaccination coverage using data from administrative records (calculated by dividing the number of vaccine doses administered by the estimated target population, reported annually) and vaccination coverage surveys, to estimate MCV1 and second dose measles-containing vaccine (MCV2) coverage through routine (i.e., not through mass campaigns) immunization services.¶ During 2000–2010, estimated MCV1 coverage increased worldwide from 72% to 84%; however, coverage has remained at 84%–85% since 2010, with considerable regional variation (Table 1).

Among 194 WHO member states, 122 (63% of member states) achieved ≥90% MCV1 coverage in 2019, a 42% increase from 86 (45%) countries in 2000, but a 4% decrease from a peak of 127 (65%) countries in 2012. In 2019, 42 (22%) countries achieved MCV1 coverage ≥90% nationally and ≥80% in all districts**; however, during that year 19.8 million infants did not receive MCV1 through routine immunization services. The six countries with the highest numbers of infants who had not received MCV1 were Nigeria (3.3 million), Ethiopia (1.5 million), Democratic Republic of the Congo (DRC) (1.4 million), Pakistan (1.4 million), India (1.2 million), and Philippines (0.7 million), accounting for nearly half (48%) of the world's total.

Estimated global MCV2 coverage nearly quadrupled from 18% in 2000 to 71% in 2019, largely because of an 86% increase in the number of countries providing MCV2, from 95 (50%) countries in 2000 to 177 (91%) in 2019 (Table 1). Six countries (Cameroon, Ethiopia, Liberia, Mali, Republic of the Congo, and Togo) introduced MCV2 in 2019.

¶ Calculated for MCV1, among children aged 1 year or, if MCV1 is given at age ≥1 year, among children aged 24 months. Calculated for MCV2 among children at the recommended age for administration of MCV2, per the national immunization schedule. WHO/UNICEF estimates of national immunization coverage are available at https://www.who.int/immunization/monitoring_surveillance/data/en.

** In 2000, 191 countries were requested to report to WHO; by 2019, 194 member states were requested to report because of the creation of new countries. For district level coverage, only countries that reported data are in the numerator, while the denominator is all WHO countries in that year (191–194) regardless of whether they reported data.

Approximately 204 million persons received MCV during supplementary immunization activities (SIAs)†† in 55 countries in 2019; in addition, 9 million persons received MCV during measles outbreak response activities.

Reported Measles Incidence

In 2019, all 194 countries conducted measles surveillance, and 193§§ (99%) had access to standardized quality-controlled laboratory testing through the WHO Global Measles and Rubella Laboratory Network. In spite of this, however, surveillance remains weak in many countries, and only 81 (52%) of 157 countries that reported discarded¶¶ cases achieved the sensitivity indicator target of two or more discarded measles and rubella cases per 100,000 population.

Countries report the number of incident measles cases*** to WHO and UNICEF annually using the Joint Reporting Form.††† During 2000–2016, the number of reported measles cases decreased 84%, from 853,479 in 2000 to 132,490 in 2016. From 2000 to 2016, annual measles incidence decreased 88%, from 145 cases per 1 million (2000) to 18 (2016), the lowest reported incidence during this period; incidence then increased 567% to 120 per million in 2019, the highest since 2001 (Table 1). The percentage of reporting countries with annual measles incidence of <5 cases per 1 million population increased from 38% (64 of 169) in 2000 to 70% (125 of 179) in 2016, but then decreased to 46% (85 of 184) in 2019.

The number of measles cases increased 556% from 132,490 in 2016 to 869,770 in 2019, the most reported cases since 1996. Since 2016, the number of reported measles cases increased 1,606% in WHO's African Region (AFR), 19,739% in the Region of the Americas (AMR), 194% in the Eastern Mediterranean Region (EMR), 2,282% in the European Region (EUR), 6% in the South-East Asia Region (SEAR), and 36% in the Western Pacific Region (WPR). In 2019, nine (5%) of 184 reporting countries (Central African Republic, DRC, Georgia, Kazakhstan, Madagascar, North Macedonia, Samoa, Tonga, and Ukraine) experienced large outbreaks, and in each of these countries, reported measles incidence exceeded 500 per 1 million population; these nine countries accounted for 631,847 (73%) of all reported cases worldwide during 2019.

Genotypes of viruses isolated from persons with measles were reported by 88 (62%) of 141 countries reporting at least one measles case in 2019. From 2005 to 2019, 20 of 24 recognized measles genotypes were eliminated by immunization activities. The number of genotypes detected decreased from 11 during 2005–2008, to eight during 2009–2014, six in 2016, five in 2017, and four during 2018–2019 (*3*). In 2019, among 8,728 reported sequences, 1,920 (22%) were genotype B3; six (0.1%) were D4; 6,774 (78%) were D8; and 28 (0.3%) were H1.§§§

Measles Case and Mortality Estimates

A previously described model for estimating measles cases and deaths (*4*) was updated with annual vaccination coverage data, case data, and United Nations population estimates for all countries during 2000–2019, enabling derivation of a new series of disease and mortality estimates. For countries with anomalous estimates (e.g., a decrease in reported cases, but an increase in estimated deaths, or vice versa), the model was modified slightly to generate mortality estimates consistent with observed cases. Based on updated annual data, the estimated number of measles cases decreased 65%, from 28,340,700 in 2000 to 9,828,400 in 2019. During this period, estimated annual measles deaths decreased 62%, from 539,000 to 207,500 (Table 2). During 2000–2019, compared with no measles vaccination, measles vaccination prevented an estimated 25.5 million deaths globally (Figure).

Regional Verification of Measles Elimination

By the end of 2019, no WHO region had achieved and maintained measles elimination; 83 (43%) individual countries had been verified by independent regional commissions as

†† SIAs generally are carried out using two target age ranges. An initial, nationwide catch-up SIA focuses on all children aged 9 months–14 years, with the goal of eliminating susceptibility to measles in the general population. Periodic follow-up SIAs then focus on all children born since the last SIA. Follow-up SIAs generally are conducted nationwide every 2–4 years and focus on children aged 9–59 months; their goal is to eliminate any measles susceptibility that has developed in recent birth cohorts because of low MCV coverage and to protect children who did not respond to MCV1. Data on SIAs by country are available at https://www.who.int/immunization/monitoring_surveillance/data/Summary_Measles_SIAs.xls?ua.

§§ Sao Tome and Principe did not have access to standardized quality-controlled testing by the WHO Measles and Rubella Laboratory Network in 2019.

¶¶ A discarded case is defined as a suspected case that has been investigated and determined to neither be measles nor rubella using 1) laboratory testing in a proficient laboratory or 2) epidemiologic linkage to a laboratory-confirmed outbreak of a communicable disease that is not measles or rubella. The discarded case rate is used to measure the sensitivity of measles surveillance.

*** https://apps.who.int/immunization_monitoring/globalsummary/timeseries/tsincidencemeasles.html; data as of July 15, 2020. Only countries that reported data are in the numerator and denominator.

††† https://www.who.int/immunization/monitoring_surveillance/routine/reporting/en/ Twenty-five countries did not report case data in 2000: Algeria, Austria, Belgium, Comoros, Equatorial Guinea, Fiji, Finland, Germany, Guinea-Bissau, Ireland, Libya, Mauritania, Monaco, Montenegro, North Korea, Samoa, Saudi Arabia, Seychelles, Slovenia. Solomon Islands, South Sudan, Switzerland, Timor-Leste, Tuvalu, and Yemen. Fifteen countries did not report case data in 2016: Belgium, Cabo Verde, Cook Islands, Haiti, Italy, Kiribati, Marshall Islands, Monaco, Morocco, Mozambique, Niue, Samoa, Singapore, Tuvalu, and Vanuatu. Ten countries did not report case data in 2019: Belgium, Djibouti, Malta, Marshall Islands, Morocco, North Korea, Palau, Solomon Islands, Switzerland, and the United States. Countries do not provide WHO with their reasons for not reporting case data.

§§§ http://www.who-measles.org/; data as of September 5, 2020.

TABLE 1. Estimates of coverage with the first and second dose of measles-containing vaccine administered through routine immunization services, reported measles cases, and incidence by World Health Organization (WHO) region — worldwide, 2000, 2010, 2016, and 2019

	Percentage					
WHO region/Year (no. of countries in region)	MCV1* coverage	Countries with ≥90% MCV1 coverage	MCV2* coverage	Reporting countries with <5 measles cases per 1 million population	No. of reported measles cases†	Measles incidence per 1 million population†,§
African						
2000 (46)	53	9	5	8	520,102	836
2010 (46)	73	37	4	30	199,174	232
2016 (47)	69	34	23	51	36,269	37
2019 (47)	69	32	33	34	618,595	567
Americas						
2000 (35)	93	63	65	89	1,754	2
2010 (35)	93	74	67	100	247	0.3
2016 (35)	92	66	80	100	97	0.1
2019 (35)	88	71	75	91	19,244	28
Eastern Mediterranean						
2000 (21)	71	57	28	17	38,592	90
2010 (21)	77	62	52	40	10,072	17
2016 (21)	82	57	74	55	6,275	10
2019 (21)	82	52	75	42	18,458	27
European						
2000 (52)	91	62	48	45	37,421	50
2010 (53)	93	83	80	69	30,625	34
2016 (53)	93	81	88	82	4,440	5
2019 (53)	96	85	91	32	105,755	116
South-East Asia						
2000 (10)	63	30	3	0	78,558	51
2010 (11)	83	45	15	36	54,228	30
2016 (11)	89	64	75	27	27,530	14
2019 (11)	94	73	83	30	29,239	15
Western Pacific						
2000 (27)	85	48	2	30	177,052	105
2010 (27)	96	63	87	68	49,460	27
2016 (27)	96	63	91	68	57,879	31
2019 (27)	94	67	91	46	78,479	41
Totals						
2000 (191)	**72**	**45**	**18**	**38**	**853,479**	**145**
2010 (193)	**84**	**63**	**42**	**60**	**343,806**	**50**
2016 (194)	**85**	**61**	**67**	**70**	**132,490**	**18**
2019 (194)	**85**	**63**	**71**	**46**	**869,770**	**120**

Abbreviations: MCV1 = routine first dose of measles-containing vaccine; MCV2 = routine second dose of measles-containing vaccine.
* http://www.who.int/immunization/monitoring_surveillance/data/en.
† http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tsincidencemeasles.html; data as of July 15, 2020. Only countries that reported data are in the numerator and denominator.
§ Population data from United Nations, Department of Economic and Social Affairs, Population Division, 2020. Any country not reporting data on measles cases for that year was removed from both the numerator and denominator in calculating incidence.

having achieved or maintained measles elimination. The two countries verified in 2019 to have achieved elimination were Iran and Sri Lanka. No AFR country has yet been verified as having eliminated measles. The AMR had achieved verification of measles elimination in 2016; however, endemic measles transmission was reestablished in Venezuela in 2018 and in Brazil in 2019.

Discussion

Despite substantial decreasing global measles incidence and measles-associated mortality during 2000–2016, the global measles resurgence that commenced during 2017–2018 continued in 2019 and marked a significant step backward in progress toward global measles elimination. Compared with the historic low in reported cases in 2016, reported measles cases increased 556% in 2019, with increases in numbers of reported cases and incidence in all WHO regions. Estimated global measles mortality increased nearly 50% since 2016. In all WHO regions, the fundamental cause of the resurgence was a failure to vaccinate, both in recent and past years, causing immunity gaps in both younger and some older age groups. Lessons can be learned from outbreaks in various countries,

TABLE 2. Estimated number of measles cases and deaths,* by World Health Organization (WHO) region — worldwide, 2000 and 2019

WHO region/Year (no. of countries in region)	Estimated no. of measles cases (95% CI)	Estimated no. of measles deaths (95% CI)	Estimated % measles mortality reduction from 2000 to 2019	Cumulative no. of measles deaths averted by vaccination, 2000–2019
African				
2000 (46)	10,727,500 (7,417,700–17,448,900)	346,400 (227,600–569,000)	57	13,620,000
2019 (47)	4,548,000 (3,266,700–8,376,100)	147,900 (99,500–271,100)		
Americas				
2000 (35)	8,800 (4,400–35,000)	NA†	NA	102,500
2019 (35)	102,700 (51,400–411,000)	NA†		
Eastern Mediterranean				
2000 (21)	2,565,800 (1,534,500–4,774,400)	40,000 (22,200–69,200)	33	2,877,900
2019 (21)	1,384,500 (717,900–3,201,000)	27,000 (14,700–49,500)		
European				
2000 (52)	816,600 (216,900–5,116,000)	350 (100–1,900)	66	101,300
2019 (53)	494,600 (192,800–6,571,400)	120 (20–1,700)		
South-East Asia				
2000 (10)	11,379,100 (8,937,200–15,299,200)	141,400 (102,000–194,600)	80	7,387,800
2019 (11)	2,655,000 (902,200–6,886,500)	28,700 (8,400–75,400)		
Western Pacific				
2000 (27)	2,843,000 (1,934,700–22,297,700)	10,900 (5,200–77,300)	65	1,385,500
2019 (27)	643,700 (127,600–18,007,600)	3,800 (500–75,100)		
Totals				
2000 (191)	**28,340,700 (20,045,300–64,971,300)**	**539,000 (357,200–911,900)**	**62**	**25,475,000**
2019 (194)	**9,828,400 (5,258,500–43,453,500)**	**207,500 (123,100–472,900)**		

Abbreviations: CI = confidence interval; NA = not applicable; UNICEF = United Nations Children's Fund.
* The measles mortality model used to generate estimated measles cases and deaths is rerun each year using the new and revised annual WHO/UNICEF estimates of national immunization coverage (WUENIC) data, as well as updated surveillance data; therefore, the estimated number of cases and mortality estimates in this report might differ slightly from those in previous reports.
† Estimated measles mortality was too low to allow reliable measurement of mortality reduction.

as well as from notable successes in countries such as China, Colombia, and India (*5*–*7*). Identifying and addressing gaps in population immunity will require additional strategies as outlined in the Immunization Agenda 2030¶¶¶ and the Measles-Rubella Strategic Framework 2021–2030 (*8*).

In 2019, the global increase in cases was driven by large outbreaks in several countries. Huge outbreaks occurred in DRC and Madagascar during 2018–2019 as a consequence of accumulations of large numbers of measles-susceptible children, which resulted from longstanding extremely low MCV1 coverage, no introduction of MCV2 into the immunization program, and suboptimal SIA implementation. Samoa's outbreak resulted from a steady decline in MCV1 and MCV2 coverage during 2014–2018, exacerbated by a decline in vaccine confidence after two infant deaths occurred from an error in measles-mumps-rubella vaccine administration (*9*). Ukraine's outbreak was the result of low vaccine confidence among health care professionals, low demand from the public, and challenges with vaccine supply, storage, and handling.**** Brazil's outbreak was caused by previously unidentified immunity gaps, revealed by sustained transmission following multiple measles virus importations from the outbreak in neighboring Venezuela.††††

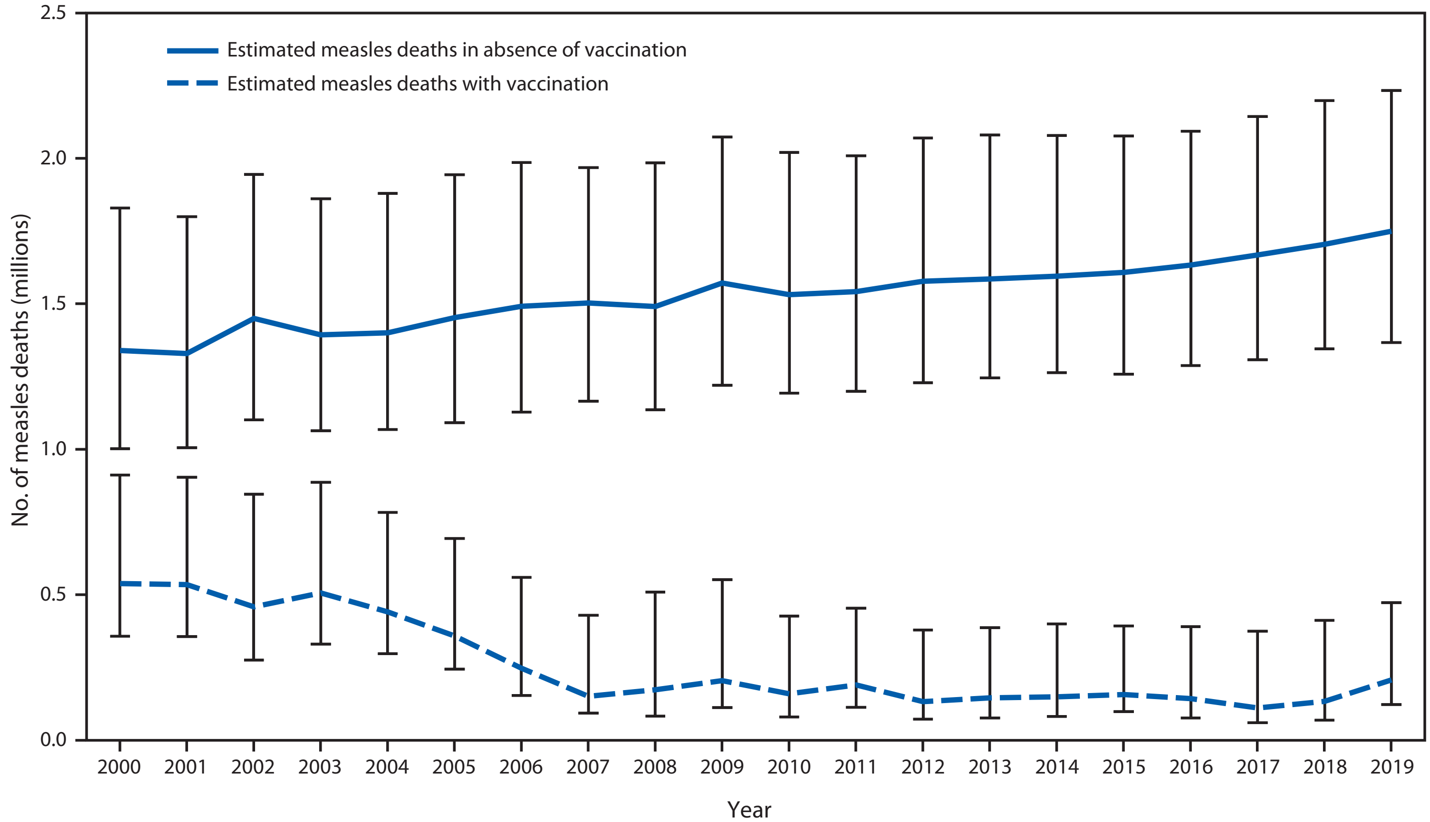
Outbreaks must be investigated to understand whether and why communities were missed by vaccination, so that immunization services can be strengthened to close population immunity gaps. Where low vaccination coverage exists in specific populations, assessment of behavioral and social drivers of low coverage is needed to inform the design and implementation of targeted strategies, whether related to practical factors such as limited access to services, or to social influences that affect confidence and motivation to receive vaccination. Programs need to work to achieve and sustain the trust of parents and communities to ensure understanding that receipt of vaccination is in their children's best interests. Programs should always be well prepared to respond to any vaccine-related adverse event

¶¶¶ Immunization Agenda 2030 is the global vision and strategy to extend the benefits of vaccines to everyone, everywhere, developed by immunization stakeholders and endorsed by the World Health Assembly in 2020. https://www.who.int/immunization/immunization_agenda_2030/en/.

**** Strategic Response Plan for the Measles Emergency in the WHO European Region, September 2019–December 2020. Copenhagen, Denmark, 2019. https://www.euro.who.int/_data/assets/pdf_file/0020/414182/WHO-Measles-Emergency-v8a_hires_pages.pdf.

†††† https://www.paho.org/en/documents/epidemiological-update-measles-28-february-2020.

FIGURE. Estimated number of annual measles deaths with vaccination and in the absence of vaccination — worldwide, 2000–2019*



* Deaths prevented by vaccination are estimated by the area between estimated deaths with vaccination and those without vaccination (cumulative total of 25.5 million deaths prevented during 2000–2019). Vertical bars represent upper and lower 95% confidence intervals around the point estimate.

in a timely and effective manner to obviate fears and hesitancy that can erode progress.

The findings in this report are subject to at least three limitations. First, large differences between estimated and reported incidence indicate overall low surveillance sensitivity, making comparisons between regions difficult to interpret. Second, some countries have multiple measles surveillance systems and choose which data to submit to WHO. In 2019, for example, Chad reported 1,882 cases to WHO from one surveillance system, but another surveillance system identified 26,623 suspected measles cases. Finally, the measles mortality model estimates might be biased upward or downward by inaccurate model inputs, including vaccination coverage and surveillance data.

In 2020, the coronavirus disease 2019 pandemic has produced increased programmatic challenges, leading to fewer children receiving vaccinations and poorer surveillance (*10*). Progress toward measles elimination during and after the pandemic will require strategies to integrate catch-up vaccination policies into essential immunization services, assurance of safe provision of services, engagement with communities to regain trust and confidence in the health system, and rapid outbreak response.

As outlined in the Immunization Agenda 2030, a global immunization strategy for 2021–2030, further progress toward

Summary

What is already known about this topic?

All six World Health Organization (WHO) regions have a measles elimination goal.

What is added by this report?

During 2000–2016, annual reported measles incidence decreased globally; however, measles incidence increased in all regions during 2017–2019. Since 2000, estimated measles deaths decreased 62% and measles vaccination has prevented an estimated 25.5 million deaths worldwide. No WHO region has achieved and maintained measles elimination.

What are the implications for public health practice?

To achieve regional measles elimination goals, additional strategies are needed to help countries strengthen routine immunization systems, identify and close immunity gaps, and improve case-based surveillance.

achieving measles elimination goals will require strengthening essential immunization systems to increase 2-dose coverage, identify and close historical immunity gaps through catch-up vaccination to prevent outbreaks, improve surveillance and preparedness for rapidly responding to outbreaks, and leverage measles as a tracer and guide to improving immunization programs (*8*).

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Routine Vaccination Coverage — Worldwide, 2019

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Endorsed by the World Health Assembly in 2020, the Immunization Agenda 2030 strives to reduce morbidity and mortality from vaccine-preventable diseases across the life course (*1*). This report, which updates previous reports (*2*), presents global, regional,* and national vaccination coverage estimates and trends as of 2019 and describes the number of surviving infants who did not receive the first dose of diphtheria and tetanus toxoids and pertussis-containing vaccine (DTP1) during the first year of life (i.e., zero-dose children), which serves as a proxy for children with poor access to immunization and other health services. Global estimates of coverage with the third dose of DTP (DTP3), the first dose of measles-containing vaccine (MCV1), and the third dose of polio vaccine (Pol3) ranged from 84% to 86% during 2010–2019. Worldwide, 19.7 million children (15%) were not vaccinated with DTP3 in 2019, 13.8 million (70%) of whom were zero-dose children. During 2010–2019, the number of zero-dose children increased in the African, Americas, and Western Pacific regions. Global coverage with the second MCV dose (MCV2) increased from 42% in 2010 to 71% in 2019. During 2010–2019, global coverage with underused vaccines increased for the completed series of rotavirus vaccine (rota), pneumococcal conjugate vaccine (PCV), rubella-containing vaccine (RCV), *Haemophilus influenzae* type b vaccine (Hib), hepatitis B vaccine (HepB), and human papillomavirus vaccine (HPV). Achieving universal coverage with all recommended vaccines will require tailored, context-specific strategies to reach communities with substantial proportions of zero-dose and incompletely vaccinated children, particularly those in remote rural, urban poor, and conflict-affected communities (*3*).

In 1974, the World Health Organization (WHO) established the Expanded Programme on Immunization to ensure that all infants have access to four recommended vaccines (bacillus Calmette-Guérin vaccine [BCG], DTP, Pol, and MCV) to protect against six diseases (tuberculosis, diphtheria, tetanus, pertussis, poliomyelitis, and measles). Since then, additional vaccines and doses have been introduced in the first year of life (PCV, rota, RCV, Hib, and HepB) and beyond (MCV2 and HPV) (*4*). WHO and the United Nations Children's Fund (UNICEF) derive national vaccination coverage estimates through annual country-by-country review of available data, including administrative† and survey-based coverage (*5*,*6*); generally, only doses administered through routine immunization visits are counted. DTP3 coverage by age 12 months is considered an indicator of immunization program performance. Children who have not received any doses of DTP by age 12 months (zero-dose children) represent a lack of access to immunization services; those who receive DTP1 but do not complete the series are considered to have dropped out. DTP1-to-DTP3 dropout, an indicator of immunization program utilization, is calculated as the percentage of children who received DTP1 but not DTP3.

Based on WHO and UNICEF estimates during 2010–2019, global coverage with DTP1 (89%–90%) and DTP3 (84%–85%) remained stable. The only region with a decline in DTP3 coverage during 2000–2019 was the Americas (from 91% to 84%). In 2019, DTP1 coverage ranged from 81% in the African region to 97% in the European region (Table 1). DTP3 coverage followed similar regional trends, with estimates ranging from 74% in the African region to 95% in the European region. Among 19.7 million children worldwide who did not complete the 3-dose DTP series in 2019, 13.8 million (70%) were zero-dose children and 5.9 million (30%) had started, but not completed, the DTP series. In 2019, overall DTP1-to-DTP3 dropout was 6% and ranged from 1% in the Western Pacific region to 9% in the African region.

The number of zero-dose children varied by region and economic classification§ (Table 2). The number of zero-dose children changed little or declined in all regions from 2000 to

* Based on World Health Organization regional classifications. https://www.who.int/about/who-we-are/regional-offices.

† For a given vaccine, the administrative coverage is the number of vaccine doses administered to persons in a specified target group divided by the estimated target population. Doses administered during routine immunization visits are counted, but doses administered during supplemental immunization activities (mass campaigns) usually are not. During vaccination coverage surveys, a representative sample of households is visited, and caregivers of children in a specified target age group (e.g., aged 12–23 months) are interviewed. Dates of vaccination are transcribed from the child's home-based record, recorded based on caregiver recall, or transcribed from health facility records. Survey-based vaccination coverage is calculated as the proportion of persons in a target age group who received a vaccine dose.

§ Low-income economies are defined as those with a gross national income (GNI), in USD, per capita in 2000 of ≤$755, in 2010 of ≤$1,005, and in 2019 of ≤$1,035; middle-income economies are those with a GNI per capita in 2000 of $756–$9,265, in 2010 of $1,006–$12,275, and in 2019 of $1,036–$12,535; high-income economies are those with a GNI per capita in 2000 of >$9,265, in 2010 of >$12,275, and in 2019 of >$12,535; calculated using the World Bank Atlas method (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups). Cook Islands and Niue (Western Pacific Region) are missing GNI data and are excluded from this categorization.

TABLE 1. Vaccination coverage, by vaccine and World Health Organization (WHO) region — worldwide, 2019

Vaccine	No. (%) of countries with vaccine in schedule	WHO region % coverage*						
		Global	AFR	AMR	EMR	EUR	SEAR	WPR
BCG	156 (80)	88	80	83	87	92	93	96
DTP1	194 (100)	90	81	90	89	97	94	95
DTP3	194 (100)	85	74	84	82	95	91	94
HepB BD	111 (49)	43	6	55	34	41	54	84
HepB3	189 (97)	85	73	81	82	92	91	94
Hib3	192 (98)	72	73	85	82	79	89	24
HPV, last†	106 (55)	15	19	55	0	24	2	4
MCV1	194 (100)	85	69	88	82	96	94	94
MCV2	178 (91)	71	33	75	75	91	83	91
PCV3	148 (74)	48	70	83	52	80	23	14
Pol3	194 (100)	86	74	87	83	95	90	94
RCV1	173 (88)	71	33	88	45	96	93	94
Rota, last§	108 (52)	39	50	74	49	25	37	2

Abbreviations: AFR = African Region; AMR = Region of the Americas; BCG = bacille Calmette-Guérin vaccine; DTP1 = first dose of diphtheria and tetanus toxoids and pertussis-containing vaccine; DTP3 = third dose of diphtheria and tetanus toxoids and pertussis-containing vaccine; EMR = Eastern Mediterranean Region; EUR = European Region; HepB BD = birth dose of hepatitis B vaccine; HepB3 = third dose of hepatitis B vaccine; Hib3 = third dose of Haemophilus influenzae type b vaccine; HPV, last = final dose of human papillomavirus vaccine; MCV1 = first dose of measles-containing vaccine; MCV2 = second dose of measles-containing vaccine; PCV3 = third dose of pneumococcal conjugate vaccine; Pol3 = third dose of polio vaccine; RCV1 = first dose of rubella-containing vaccine; Rota, last = final dose of rotavirus vaccine series; SEAR = South-East Asia Region; WPR = Western Pacific Region.

* BCG coverage is based on 156 countries with BCG in the national schedule, whereas coverage for all other vaccines is based on 194 countries (global) or all countries in the specified region. Administrative coverage is the number of vaccine doses administered to those in a specified target group divided by the estimated target population. During vaccination coverage surveys, a representative sample of households are visited and caregivers of children in a specified target group (e.g., aged 12–23 months) are interviewed. Dates of vaccination are transcribed from the child's home-based record, recorded based on caregiver recall, or transcribed from health facility records. Survey-based vaccination coverage is calculated as the proportion of persons in a target age group who received a vaccine dose.

† Number of doses to complete the HPV series depends on age of recipient.

§ Number of doses to complete the rota series varies among vaccine products.

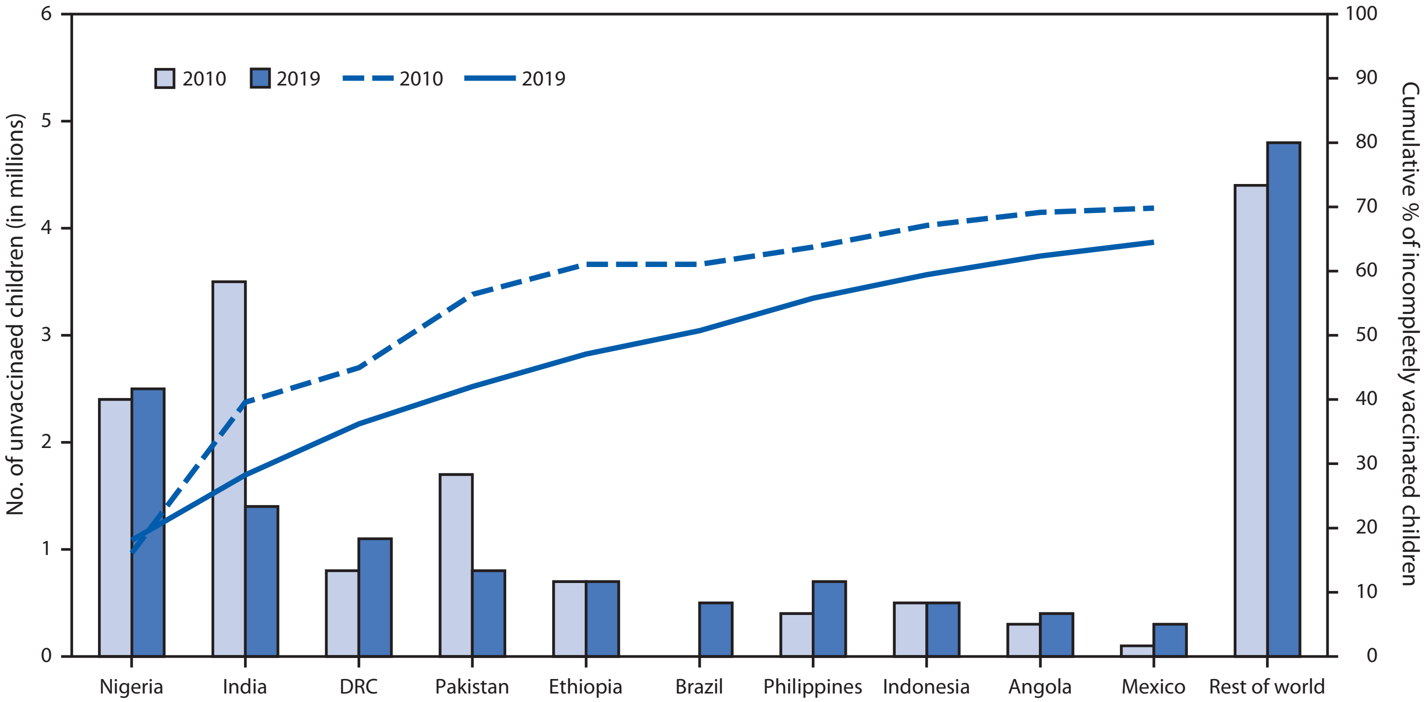
TABLE 2. Number of surviving infants not receiving DTP1 (zero-dose children), by World Health Organization (WHO) region and World Bank economic classification — worldwide, 2000–2019

Characteristic/Year	Global	WHO region						Economic classification*		
		AFR	AMR	EMR	EUR	SEAR	WPR	Low	Middle	High
2000										
Total no. of countries	191	46	35	21	52	10	27	63	86	37
No. of surviving infants (millions)	124.6	24.1	15.5	13.8	10.1	37.3	24.0	69.8	44.5	10.2
Global % of surviving infants	—	19	12	11	8	30	19	56	36	8
No. of zero-dose children (millions)	21.4	8.2	0.5	2.7	0.3	8.2	1.5	18.9	2.2	0.3
Global % of zero-dose children	—	38	2	13	1	38	7	88	10	1
2010										
Total no. of countries	193	46	35	21	53	11	27	35	106	49
No. of surviving infants (millions)	133.0	30.5	15.0	16.1	11.2	35.8	24.4	25.1	95.3	12.6
Global % of surviving infants	—	23	11	12	8	27	18	19	72	9
No. of zero-dose children (millions)	14.9	6.1	0.5	2.6	0.5	4.3	0.9	3.6	11.0	0.3
Global % of zero-dose children	—	41	3	17	3	29	6	24	74	2
2019										
Total no. of countries	194	47	35	21	53	11	27	29	103	60
No. of surviving infants (millions)	135.6	35.8	14.6	17.3	10.9	33.8	23.2	21.8	101.3	12.5
Global % of surviving infants	—	26	11	13	8	25	17	16	75	9
No. of zero-dose children (millions)	13.8	6.8	1.5	2.0	0.3	2.0	1.2	4.0	9.5	0.3
Global % of zero-dose children	—	49	11	14	2	14	9	29	69	2

Abbreviations: AFR = African Region; AMR = Region of the Americas; DTP1 = first dose of diphtheria and tetanus toxoids and pertussis-containing vaccine; EMR = Eastern Mediterranean Region; EUR = European Region; SEAR = South-East Asia Region; WPR = Western Pacific Region.

* Low-income economies are defined as those with a gross national income (GNI), in USD, per capita in 2000 of ≤$755, in 2010 of ≤$1,005, and in 2019 of ≤$1,035; middle-income economies are those with a GNI per capita in 2000 of $756–$9,265, in 2010 of $1,006–$12,275, and in 2019 of $1,036–$12,535; high-income economies are those with a GNI per capita in 2000 of >$9,265, in 2010 of >$12,275, and in 2019 of >$12,535, calculated using the World Bank Atlas method (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups). Cook Islands and Niue, in the Western Pacific Region, are missing GNI data and are excluded from this categorization.

FIGURE. Estimated number of zero-dose children* among the 10 countries with the most zero-dose children and cumulative percentage of all incompletely vaccinated children accounted for by these 10 countries — worldwide, 2019



Abbreviation: DRC = Democratic Republic of the Congo.
* Zero-dose children are surviving infants who did not receive the first dose of diphtheria and tetanus toxoids and pertussis-containing vaccine during the first year of life.

2010. However, during 2010–2019, the number of zero-dose children increased in the African region (from 6.1 million to 6.8 million), the Americas (from 0.5 million to 1.5 million), and the Western Pacific region (from 0.9 million to 1.2 million).

In 2000, low-income countries accounted for the highest percentage of zero-dose children (88%; 18.9 million); by 2019, however, middle-income countries accounted for the highest percentage of zero-dose children (69%; 9.5 million). This shift occurred largely because 36 countries advanced from low- to middle-income classification from 2000 to 2019 and because the number of zero-dose children increased in 32 (51%) of the 63 countries classified as middle-income in both 2000 and 2019. In 2019, 10.6 million (77%) zero-dose children lived in countries eligible for support from Gavi, the Vaccine Alliance¶; these countries receive financial assistance to pay for vaccines and health system strengthening to extend the reach and quality of their immunization programs. Approximately two thirds (65%; 9.0 million) of zero-dose children in 2019 lived in 10 countries: Nigeria, India, Democratic Republic of the Congo (DRC), Pakistan, Ethiopia, Brazil, Philippines, Indonesia, Angola, and Mexico (Figure). Fragile or conflict-affected countries** accounted for 44% of zero-dose children in 2019.

During 2010–2019, global coverage with MCV1 remained stable at 84%–85%, and in 2019 ranged from 69% in the African region to 96% in the European region. MCV2 coverage increased from 42% to 71% (Table 1). Among all countries (including those yet to introduce MCV2), coverage ranged from 33% in the African region to 91% in the European and Western Pacific regions. Among underused vaccines, global coverage increased during 2010–2019 for the completed series of rota (from 8% to 39%), PCV (from 11% to 48%), RCV (first dose: from 35% to 71%), Hib (from 40% to 72%), HepB (birth dose: from 26% to 43%; 3-dose series: from 73% to 85%), and HPV (from 3% to 15%) (Table 1).

¶ Based on Gavi 4.0, eligibility includes 68 low- and middle-income countries eligible to receive financial assistance through grants contingent on a country's GNI per capita. Eligibility is defined as a country's average 3-year GNI per capita in USD of ≤$1,580. As GNI increases, a country moves through Gavi's different eligibility phases until reaching the transition phase when GNI exceeds the eligibility threshold. https://www.gavi.org.

** Based on the World Bank's classification of fragile and conflict-affected situations for 2019. Fragile countries are defined as those with high levels of institutional and social fragility, measured by the quality of policy, institutions, and manifestations of fragility. Conflict-affected countries are defined as those affected by violent conflict, measured by the number of conflict-related deaths per capita. https://www.worldbank.org/en/topic/fragilityconflictviolence/brief/harmonized-list-of-fragile-situations.

Discussion

Since establishment of the Expanded Programme on Immunization in 1974, substantial progress in vaccination coverage has been made worldwide. In 2019, 90% of children received at least 1 DTP dose and 85% received 3 DTP doses and at least 1 MCV dose. However, challenges to achieving higher routine immunization coverage remain. Despite large gains in vaccination coverage during 2000–2010, coverage with established vaccines has increased little since 2010 and progress is uneven: coverage in the African region lags that in other regions, and progress in the Americas has reversed.

Extending immunization services to regularly reach zero-dose and underimmunized children and communities is one of the objectives of the Immunization Agenda 2030 (*1*). Low-income, fragile, and conflict-affected countries are homes to large numbers of zero-dose children and remain vulnerable to outbreaks of vaccine-preventable diseases. Since 2010, however, a larger proportion of zero-dose children live in middle-income countries. Although some middle-income countries experienced notable declines in DTP1 coverage (e.g., Brazil, Mexico, Philippines), this shift is driven mostly by countries advancing from low-income to middle-income status. As countries' economic statuses advance, they become less eligible for external funding, necessitating increasing domestic investments in immunization programs. Identifying demographic, social, and systemic factors inhibiting vaccine delivery and developing locally tailored, context-specific strategies to increase access, availability, and demand for immunization services will be important for reaching zero-dose children. Increasing and optimizing vaccine delivery opportunities at existing health system contact points can reduce missed vaccination opportunities (*7*); providing catch-up vaccination, particularly for older children who missed doses, can help close coverage gaps that would otherwise grow as populations age.

Catch-up policies and strategies will be essential to recovering from disruptions to routine immunization programs experienced during the coronavirus disease 2019 (COVID-19) pandemic. Although countries have attempted to maintain their immunization programs, reduced availability of health workers and personal protective equipment, vaccine distribution system delays, and reduced demand for immunization have contributed to fewer children being vaccinated in 2020 (*8*,*9*). Addressing immunization gaps created by the pandemic will require monitoring immunization program setbacks, implementing catch-up vaccination policies and strategies, and expanding and intensifying routine immunization services.

The findings in this report are subject to at least three limitations. First, data quality limitations could have resulted in inaccurate estimations of administrative coverage. Second, recall bias could have affected survey-based estimates of coverage (*5*). Finally, conflict-affected countries likely have limited external evaluation of coverage, which might have affected accuracy of coverage estimates.

Increasing vaccination coverage above the levels achieved in the past decade will require locally driven, targeted strategies that address barriers to vaccination, particularly in communities with large populations of zero-dose children. Reducing missed opportunities for vaccination and defining country-specific strategies for catch-up vaccination, especially during the COVID-19 pandemic, can improve vaccination coverage and help advance progress toward achieving global immunization goals.

Summary

What is already known about this topic?

Global coverage with the third dose of diphtheria and tetanus toxoids and pertussis-containing vaccine (DTP), third dose of polio vaccine, and first dose of measles-containing vaccine has remained between 84% and 86% since 2010.

What is added by this report?

In 2019, 13.8 million children worldwide did not receive the first dose of DTP (zero-dose children). During 2010–2019, the number of zero-dose children increased in the African, Americas, and Western Pacific regions.

What are the implications for public health practice?

Increasing vaccination coverage beyond levels achieved in the past decade will require targeted, context-specific strategies to identify zero-dose and underimmunized children, introduce interventions to minimize missed vaccinations, monitor vaccination coverage, and respond to immunization program setbacks.

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Errata

Vol. 69, No. 43

In the report "COVID-19–Associated Hospitalizations Among Health Care Personnel — COVID-NET, 13 States, March 1–May 31, 2020," on page 1579, in the Table, the row headings for rows 13 and 14 were incorrect and should have appeared as below:

Asian or Pacific Islander, non-Hispanic	39 (6.8)	(4.2–10.8)	29 (6.8)	(4.0–11.5)	10 (6.7)	(2.5–16.9)
American Indian or Alaska Native, non-Hispanic	12 (3.2)	(1.5–6.6)	10 (4.4)	(2.0–9.6)	2 (0.6)	(0.1–2.3)

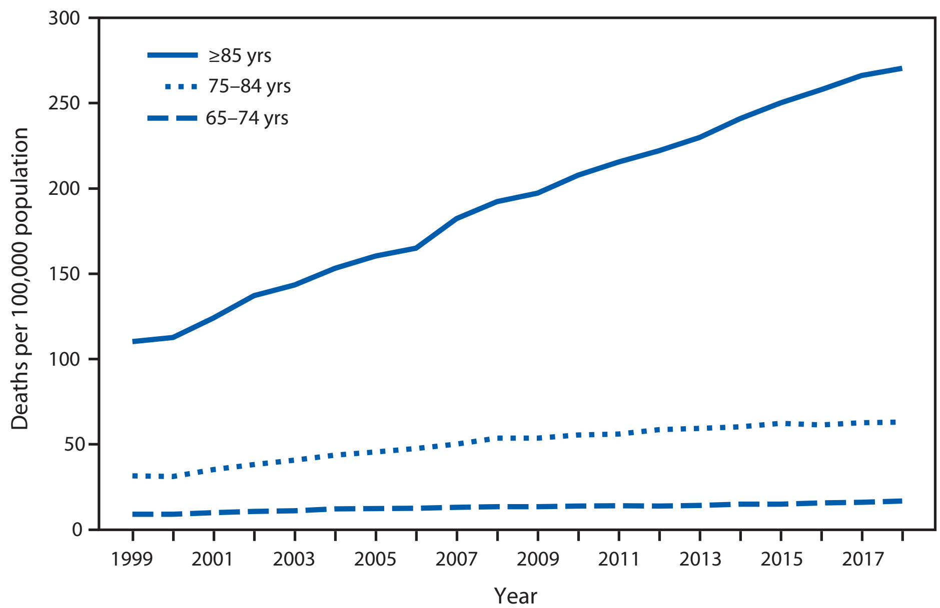
Vol. 69, No. 43

In the report "Trends in the Use of Telehealth During the Emergence of the COVID-19 Pandemic — United States, January–March 2020," on page 1595, a name in the list of authors was incorrect. The author's name should have read **B. Tilman Jolly**. In addition, on page 1597, a comma was mistakenly included in the phrase 1,135 waivers. The phrase should have read "**1135** waivers."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Death Rates* from Unintentional Falls† Among Persons Aged ≥65 Years, by Age Group — National Vital Statistics System, United States, 1999–2018



* Deaths per 100,000 population.
† Deaths from unintentional falls are identified using the *International Classification of Diseases, Tenth Revision* underlying cause of death codes W00–W19.

From 1999 to 2018, death rates from unintentional falls among persons aged ≥65 years increased among all age groups. The largest increase occurred among persons aged ≥85 years, from 110.2 per 100,000 in 1999 to 270.5 in 2018. For persons aged 75–84 years, the rate increased from 31.5 to 63.1, and among those aged 65–74 years, the rate increased from 9.0 to 16.8. Throughout the period, rates were highest among persons aged ≥85 years, followed by rates among persons aged 75–84 years, and were lowest among persons aged 65–74 years.

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

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