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Percentage of Adolescents Meeting Federal Fruit and Vegetable Intake Recommendations — Youth Risk Behavior Surveillance System, United States, 2017

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According to the 2020–2025 Dietary Guidelines for Americans, persons should consume fruits and vegetables as part of a healthy eating pattern to reduce their risk for diet-related chronic diseases, such as cardiovascular disease, type 2 diabetes, some cancers, and obesity.* A healthy diet is important for healthy growth in adolescence, especially because adolescent health behaviors might continue into adulthood (*1*). The U.S. Department of Agriculture (USDA) recommends minimum daily intake of 1.5 cups of fruit and 2.5 cups of vegetables for females aged 14–18 years and 2 cups of fruit and 3 cups of vegetables for males aged 14–18 years.† Despite the benefits of fruit and vegetable consumption, few adolescents consume these recommended amounts (*2*–*4*). In 2013, only 8.5% of high school students met the recommendation for fruit consumption, and only 2.1% met the recommendation for vegetable consumption (*2*). To update the 2013 data, CDC analyzed data from the 2017 national and state Youth Risk Behavior Surveys (YRBSs) to describe the percentage of students who met intake recommendations, overall and by sex, school grade, and race/ethnicity. The median frequencies of fruit and vegetable consumption nationally were 0.9 and 1.1 times per day, respectively. Nationally, 7.1% of students met USDA intake recommendations for fruits (95% confidence interval [CI] = 4.0–10.3) and 2.0% for vegetables (upper 95% confidence limit = 7.9) using previously established scoring algorithms. State-specific estimates of the percentage of students meeting fruit intake recommendations ranged from 4.0% (Connecticut) to 9.3% (Louisiana), and the percentage meeting vegetable intake recommendations ranged from 0.6% (Kansas) to 3.7% (New Mexico). Additional efforts to expand the reach of existing school and community programs or to identify new effective strategies, such as social media approaches, might help address barriers and improve adolescent fruit and vegetable consumption.

The Youth Risk Behavior Surveillance System monitors prevalence of youth health behaviors that contribute to the leading causes of death and disability at the national, state, territorial, tribal, and large urban school district levels.§ Students

* https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf.

† These amounts are appropriate for persons who get <30 minutes per day of moderate physical activity, beyond normal daily activities. Those who are more physically active might be able to consume more while staying within calorie needs. https://www.choosemyplate.gov/eathealthy/vegetables, https://www.choosemyplate.gov/eathealthy/fruits.

§ Methodology of the Youth Risk Behavior Surveillance System–2013 https://www.cdc.gov/mmwr/pdf/rr/rr6201.pdf.

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complete anonymous, self-administered questionnaires during one class period. CDC conducts the national YRBS biennially and uses a three-stage cluster sample design to obtain nationally representative samples of students in grades 9–12 who attend public and private schools. In 2017, the school and student response rates were 75% and 81% respectively, resulting in an overall response rate of 60%.¶

State education and health agencies conduct state YRBSs and employ a two-stage cluster sample design to obtain state-representative samples of students in grades 9–12 who attend public schools. These samples are independent of the national YRBS. Among 46 states that administered YRBS in 2017, 33 states asked all six questions included in the national YRBS about fruits and vegetables, had sufficient response rates (>60%) to obtain weighted state-representative data, and gave CDC permission to include their data. State response rates ranged from 60% to 82%.

The six questions about fruit and vegetable consumption in the 2017 YRBS assess how many times per day or week students consumed 100% fruit juice, fruit, green salad, potatoes (excluding French fries, fried potatoes, and potato chips), carrots, and other vegetables.** The seven response options were 0, 1–3 or 4–6 times during the past 7 days; or 1, 2, 3, or 4 or more times daily. Daily frequency of fruit and vegetable intake was calculated by using the midpoint for intake ranges (e.g., five for 4–6 times during past 7 days) and dividing by seven for intakes reported by week. Student-reported race/ethnicity was classified into non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic other. Estimates for non-Hispanic other are not presented because this category includes multiple racial groups, which makes it difficult to provide meaningful interpretation, but are included in overall and other demographic estimates.

Among 14,765 students in the national YRBS, 1,411 (9.6%) were excluded, including 988 who did not answer fruit and vegetable questions; 376 who did not report sex, grade, or race/ethnicity; and 47 who were aged ≤14 years (to correspond to the age range used in the algorithm described in this report). The final analytic sample was 13,354 students. Similar exclusions were made on state-specific data with 5%–18% excluded across the states.

Median frequencies of fruit and vegetable intake were determined nationally and for 33 states. Previously established scoring algorithms (*2*), developed using 24-hour recall data from the National Health and Nutrition Examination Survey, were used to predict whether students met recommendations for their age and sex based on the number of times per day they reported consuming fruits and vegetables, separately, and accounting for race/ethnicity (*2*). Balanced repeated replication, replicate weights, and Taylor linearization were used to

¶ https://www.cdc.gov/healthyyouth/data/yrbs/pdf/2017/ss6708.pdf.

** https://www.cdc.gov/healthyyouth/data/yrbs/pdf/2017/2017_yrbs_national_hs_questionnaire.pdf.

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calculate 95% CIs for the percentage meeting recommendations (*2*). For vegetables, given CIs that include zero, only upper bounds are shown. T-tests were used to examine statistical differences by demographics (p-value <0.05). Analyses were performed using SAS (version 9.4; SAS Institute) survey procedures to account for complex sampling designs and Stata (version 14.0; StataCorp) to conduct t-tests.

Among students in grades 9–12 in 2017, the median reported daily intake was 0.9 times per day for fruits and 1.1 times per day for vegetables (Table 1). Nationally, 7.1% of high school students met federal intake recommendations for fruits (95% CI = 4.0–10.3), and 2.0% met these recommendations for vegetables (upper 95% CI = 7.9). State-specific estimates ranged from 4.0% (Connecticut) to 9.3% (Louisiana) for fruits and from 0.6% (Kansas) to 3.7% (New Mexico) for vegetables. Estimates were consistently low across demographic groups. Nationally, the percentage of students meeting recommendations for fruit consumption was higher among males (9.7%) than among females (4.7%), and higher among non-Hispanic Black persons (11.9%) and Hispanic persons (7.9%) than among

TABLE 1. Median consumption and percentages of high school students meeting U.S. Department of Agriculture fruit and vegetable* intake recommendations — Youth Risk Behavior Surveillance System, national and 33 states, 2017

		Median times per day		Percent meeting recommendations†	
				Fruit	Vegetable
State	No.§	Fruit	Vegetable	% (95% CI)	% (Upper 95% CL)¶
National	**13,354**	**0.9**	**1.1**	**7.1 (4.0–10.3)**	**2.0 (7.9)**
Alaska	1,239	0.8	1.0	5.6 (1.9–9.3)	2.3 (8.8)
Arizona	1,936	0.8	1.0	4.8 (1.4–8.2)	1.2 (7.4)
Arkansas	1,376	0.7	0.9	7.6 (3.4–11.9)	3.6 (11.4)
California	1,640	0.9	1.0	6.1 (2.7–9.4)	1.8 (8.0)
Connecticut	2,109	0.9	1.2	4.0 (0.8–7.2)	1.0 (7.1)
Florida	5,644	0.9	1.0	7.4 (4.1–10.7)	2.2 (8.6)
Hawaii	5,174	0.7	1.0	4.4 (1.4–7.5)	1.7 (7.5)
Idaho	1,729	0.9	1.1	5.2 (1.7–8.7)	1.3 (7.4)
Illinois	4,331	0.8	1.0	5.4 (1.9–9.0)	1.3 (7.5)
Iowa	1,552	0.8	1.0	5.4 (1.5–9.2)	1.4 (7.7)
Kansas	2,288	0.9	1.1	4.2 (0.8–7.6)	0.6 (6.7)
Kentucky	1,867	0.7	0.9	5.0 (1.6–8.4)	1.0 (7.0)
Louisiana	1,070	0.7	0.8	9.3 (5.1–13.5)	1.9 (8.7)
Maryland	43,802	0.8	1.0	5.6 (2.7–8.4)	1.2 (7.2)
Massachusetts	2,998	0.9	1.1	5.2 (1.8–8.6)	1.1 (7.2)
Michigan	1,506	0.9	1.0	5.8 (1.8–9.7)	1.6 (8.0)
Missouri	1,648	0.7	1.0	4.8 (1.4–8.1)	1.0 (7.1)
Montana	4,475	0.8	1.1	4.6 (1.2–7.9)	1.6 (7.6)
Nebraska	1,306	0.8	1.1	4.5 (0.9–8.0)	1.0 (7.3)
New Mexico	5,333	0.8	1.1	7.5 (4.5–10.6)	3.7 (10.1)
North Carolina	2,837	0.8	1.0	6.1 (2.6–9.6)	1.2 (7.4)
North Dakota	2,009	0.9	1.1	5.3 (1.5–9.0)	1.4 (7.4)
Oklahoma	1,526	0.7	0.9	4.9 (1.6–8.3)	1.1 (7.2)
Pennsylvania	3,344	0.8	1.1	5.7 (2.2–9.1)	1.1 (7.2)
Rhode Island	2,017	0.8	1.0	5.9 (2.5–9.3)	2.2 (8.7)
South Carolina	1,310	0.7	0.9	7.0 (2.9–11.1)	0.9 (7.3)
Tennessee	1,894	0.8	0.9	6.3 (2.5–10.0)	1.6 (7.9)
Texas	1,955	0.8	0.9	6.0 (2.9–9.0)	1.6 (7.9)
Utah	1,712	0.8	1.1	4.6 (1.2–8.1)	1.7 (7.9)
Vermont	19,126	1.0	1.4	5.6 (2.4–8.9)	2.0 (7.9)
Virginia	3,431	0.8	1.1	5.5 (2.1–8.8)	1.7 (7.9)
West Virginia	1,414	0.8	1.0	6.8 (3.1–10.6)	1.5 (7.5)
Wisconsin	1,894	0.9	1.1	4.6 (1.0–8.3)	1.2 (7.5)

Abbreviations: CI = confidence interval; CL = confidence limit.

* Fruit consists of solid fruit and 100% fruit juice. Vegetable consists of green salad, potatoes (excluding French fries, fried potatoes, and potato chips), carrots, and other vegetables.

† Minimum daily intake recommendations for adolescents aged 14–18 years are: 1.5 cups of fruit and 2.5 cups of vegetables for females, and 2 cups of fruit and 3 cups of vegetables for males, per the U.S. Department of Agriculture. Additional information available at https://www.choosemyplate.gov/eathealthy/vegetables and https://www.choosemyplate.gov/eathealthy/fruits. Previously established scoring algorithms, developed using 24-hour recall data from the National Health and Nutritional Examination Survey, were used to predict whether students met recommendations for their age and sex based on the number of times per day they reported consuming fruits and vegetables, separately, and accounting for race/ethnicity.

§ Number of respondents aged 14–18 years with complete data for fruit and vegetable intake and demographic information.

¶ One-sided 95% CLs (i.e., upper bound only) are presented because of low prevalence of percentage meeting vegetable recommendations and CIs that include zero.

non-Hispanic White persons (5.9%). These differences were not statistically significant, and patterns were similar in most states (Table 2). Similar, albeit less pronounced differences by sex and race/ethnicity were observed for the percentage of students meeting vegetable recommendations, nationally and in some states (Table 3). Estimates were similar across grade levels.

Discussion

The proportion of U.S. high school students meeting federal intake recommendations remained low in 2017, with 7.1% consuming enough fruits and 2.0% consuming enough vegetables to meet USDA recommendations. Although estimating the tail ends of distributions can be less precise than estimating mean intake (2), results still indicate that consumption across all demographic groups was insufficient to meet dietary recommendations. These findings are consistent with other studies indicating that adolescents consume fruits and vegetables much less frequently than is recommended for proper nutrition (*2–4*).

Reasons for insufficient consumption of fruits and vegetables by adolescents are complex. Adolescents might face barriers to consumption, including high availability of inexpensive, unhealthy food options, lack of taste preference for fruits and vegetables, and lack of home availability (*5*). Interventions to address some of these barriers are occurring in schools and community programs. For example, the National School Lunch Program[††] requires that meals include a fruit and vegetable option daily. However, on average, 39% of high school

[††] https://www.fns.usda.gov/nslp.

TABLE 2. National and state-specific percentages* and 95% confidence intervals (CIs) of high school students meeting U.S. Department of Agriculture fruit intake recommendations by sex, grade, and race/ethnicity — Youth Risk Behavior Surveillance System, national and 33 states, 2017

		% (95% CI)								
		Sex		Grade				Race/Ethnicity[†]		
State	No.	Female[§]	Male	9[§]	10	11	12	White[§]	Black	Hispanic
National	**13,354**	**4.7 (0.6–8.8)**	**9.7 (4.8–14.6)**	**7.6 (3.4–11.9)**	**7.6 (3.6–11.6)**	**6.7 (2.6–10.7)**	**6.4 (2.3–10.6)**	**5.9 (1.8–10.0)**	**11.9 (5.5–18.3)**	**7.9 (4.1–11.7)**
Alaska	1,239	3.6 (0.0[¶]–7.8)	7.5 (1.8–13.1)	6.5 (1.5–11.5)	5.8 (0.9–10.6)	4.9 (0.0–9.9)	5.1 (0.0–10.2)	4.1 (0.0–8.5)	—**	8.0 (1.3–14.7)
Arizona	1,936	2.3 (0.0–6.6)	7.3 (2.2–12.3)	6.0 (1.6–10.5)	5.0 (0.3–9.7)	4.0 (0.0–8.4)	4.1 (0.0–9.4)	4.0 (0.0–8.2)	—	5.2 (1.0–9.4)
Arkansas	1,376	5.2 (0.0–11.3)	10.0 (4.3–15.7)	7.9 (2.9–12.9)	6.7 (1.6–11.8)	6.3 (0.5–12.0)	9.7 (2.4–17.1)	6.2 (1.8–10.5)	11.8 (5.1–18.6)	5.2 (1.1–9.2)
California	1,640	3.6 (0.0–8.4)	8.6 (3.8–13.4)	5.8 (1.3–10.2)	6.0 (1.4–10.6)	6.9 (1.8–12.0)	5.7 (0.8–10.6)	5.3 (0.0–10.8)	5.8 (0.0–13.2)	6.9 (2.9–11.0)
Connecticut	2,109	2.2 (0.0–6.5)	5.8 (0.7–10.9)	4.4 (0.0–8.8)	3.7 (0.0–8.0)	4.3 (0.0–8.6)	3.6 (0.0–8.0)	3.2 (0.0–7.2)	5.1 (0.0–12.3)	5.3 (1.3–9.3)
Florida	5,644	5.2 (0.1–10.2)	9.6 (5.0–14.2)	7.8 (3.5–12.1)	7.4 (2.8–11.9)	8.1 (3.6–12.5)	6.3 (1.8–10.8)	5.1 (1.1–9.2)	9.8 (3.8–15.9)	8.2 (4.4–12.0)
Hawaii	5,174	2.8 (0.0–6.3)	6.2 (0.9–11.5)	5.2 (0.8–9.5)	4.0 (0.0–8.1)	4.1 (0.0–8.2)	4.4 (0.3–8.6)	4.3 (0.0–8.9)	—	5.2 (0.9–9.6)
Idaho	1,729	2.5 (0.0–6.3)	7.9 (2.0–13.8)	5.6 (1.0–10.3)	5.4 (1.1–9.7)	4.9 (0.1–9.6)	4.7 (0.0–9.6)	4.7 (0.4–9.1)	—	6.6 (2.1–11.2)
Illinois	4,331	3.8 (0.0–8.5)	7.1 (1.7–12.5)	5.1 (0.4–9.8)	4.9 (0.1–9.6)	5.5 (0.5–10.5)	6.3 (0.9–11.6)	4.2 (0.0–8.8)	7.4 (1.0–13.8)	6.7 (2.7–10.7)
Iowa	1,552	2.8 (0.0–7.1)	7.9 (1.4–14.3)	5.3 (0.1–10.5)	6.9 (1.3–12.5)	5.1 (0.0–10.4)	4.1 (0.0–9.6)	4.8 (0.5–9.2)	6.7 (0.0–15.6)	9.0 (1.1–16.9)
Kansas	2,288	2.4 (0.0–6.6)	5.9 (0.5–11.3)	4.8 (0.3–9.4)	3.4 (0.0–7.5)	4.0 (0.0–8.4)	4.6 (0.0–9.3)	3.8 (0.0–7.9)	4.7 (0.0–12.7)	4.9 (0.7–9.1)
Kentucky	1,867	2.9 (0.0–6.9)	7.1 (1.5–12.6)	5.0 (0.3–9.7)	4.4 (0.2–8.7)	6.6 (1.3–12)	4.0 (0.0–8.6)	4.8 (0.8–8.9)	5.2 (0.0–11.9)	7.6 (1.0–14.1)
Louisiana	1,070	7.6 (1.4–13.7)	11.1 (4.9–17.4)	8.9 (3.0–14.8)	8.0 (1.7–14.2)	9.1 (1.7–16.6)	11.5 (4.0–19.0)	7.3 (2.2–12.5)	11.6 (4.3–19.0)	—
Maryland	43,802	3.7 (0.0–7.9)	7.5 (3.2–11.7)	5.5 (1.8–9.3)	5.8 (1.9–9.6)	5.5 (1.7–9.3)	5.3 (1.5–9.2)	4.3 (0.7–7.8)	7.3 (2.4–12.1)	6.2 (3.0–9.4)
Massachusetts	2,998	3.1 (0.0–7.2)	7.4 (2.0–12.7)	4.4 (0.1–8.7)	6.4 (1.6–11.3)	5.0 (0.1–10.0)	5.0 (0.6–9.3)	4.3 (0.0–8.5)	10.2 (3.6–16.8)	5.8 (1.9–9.7)
Michigan	1,506	3.2 (0.0–7.8)	8.3 (2.1–14.4)	5.2 (0.2–10.1)	6.9 (1.1–12.7)	5.4 (0.2–10.6)	5.6 (0.0–11.2)	4.7 (0.5–8.9)	10.5 (2.9–18.1)	8.6 (3.2–14.0)
Missouri	1,648	2.1 (0.0–6.1)	7.5 (2.1–12.9)	4.3 (0.0–8.8)	6.1 (1.3–11.0)	4.7 (0.0–9.6)	3.8 (0.0–8.5)	4.3 (0.5–8.2)	5.6 (0.0–12.3)	6.8 (1.6–11.9)
Montana	4,475	2.5 (0.0–6.0)	6.5 (0.8–12.2)	5.0 (0.7–9.4)	4.9 (0.7–9.1)	4.1 (0.0–8.4)	4.1 (0.0–8.4)	4.1 (0.3–7.9)	—	7.9 (3.3–12.5)
Nebraska	1,306	2.2 (0.0–6.5)	6.7 (1.0–12.4)	6.2 (1.0–11.4)	3.9 (0.0–9.1)	4.6 (0.0–9.5)	3.1 (0.0–7.9)	4.0 (0.0–8.2)	—	6.0 (0.5–11.5)
New Mexico	5,333	5.3 (0.5–10.2)	9.7 (5.6–13.8)	7.7 (3.6–11.9)	7.2 (3.1–11.3)	7.5 (3.4–11.5)	7.6 (3.3–12.0)	5.8 (1.5–10.2)	—	7.5 (3.9–11.0)
North Carolina	2,837	4.0 (0.0–9.0)	8.2 (3.1–13.4)	5.4 (0.9–9.9)	5.6 (1.2–10.1)	7.6 (2.2–13.0)	5.8 (1.1–10.5)	4.3 (0.1–8.5)	8.9 (2.0–15.8)	7.2 (2.1–12.3)
North Dakota	2,009	2.6 (0.0–6.4)	7.8 (1.5–14.2)	5.4 (0.6–10.1)	4.9 (0.2–9.6)	5.5 (0.0–11.4)	5.4 (0.3–10.5)	4.6 (0.3–9.0)	—	8.1 (2.1–14.0)
Oklahoma	1,526	2.2 (0.0–6.0)	7.8 (2.2–13.3)	3.6 (0.0–7.6)	7.3 (2.1–12.5)	5.1 (0.2–10.1)	3.6 (0.0–8.5)	4.7 (0.3–9.1)	—	6.1 (1.7–10.4)
Pennsylvania	3,344	3.3 (0.0–7.4)	8.0 (2.4–13.6)	6.3 (1.4–11.2)	6.1 (1.3–10.9)	5.2 (0.5–9.9)	5.0 (0.5–9.6)	4.5 (0.4–8.5)	9.7 (2.8–16.6)[††]	11.1 (6.0–16.1)
Rhode Island	2,017	3.0 (0.0–7.4)	8.6 (3.0–14.2)	6.7 (1.7–11.7)	7.1 (1.8–12.3)	5.3 (0.3–10.3)	4.1 (0.0–8.8)	5.0 (0.6–9.4)	8.5 (0.9–16.1)	6.9 (2.4–11.4)
South Carolina	1,310	6.1 (0.0–12.1)	8.0 (2.5–13.6)	8.9 (2.9–14.9)	7.2 (1.9–12.5)	5.7 (0.0–11.5)	6.0 (0.0–12.4)	4.5 (0.1–9.0)	10.7 (3.6–17.8)	8.8 (1.3–16.3)
Tennessee	1,894	4.3 (0.0–9.0)	8.2 (2.3–14.0)	6.3 (1.1–11.6)	6.2 (1.3–11.1)	7.0 (1.8–12.1)	5.5 (0.5–10.6)	5.5 (1.0–10.1)	8.0 (1.8–14.3)	6.7 (1.6–11.8)
Texas	1,955	4.6 (0.0–9.7)	7.3 (3.1–11.6)	7.8 (3.4–12.1)	4.8 (0.4–9.2)	5.0 (0.0–10.0)	6.1 (1.0–11.2)	4.4 (0.0–9.0)	9.7 (2.2–17.3)	5.8 (2.3–9.3)
Utah	1,712	2.1 (0.0–5.9)	7.1 (1.3–12.9)	5.2 (0.3–10.2)	4.8 (0.1–9.5)	4.3 (0.0–8.8)	4.1 (0.0–8.9)	4.1 (0.0–8.3)	—	6.5 (1.8–11.2)
Vermont	19,126	2.7 (0.0–6.1)	8.4 (2.9–13.9)	5.6 (1.6–9.7)	5.7 (1.7–9.8)	5.5 (1.5–9.5)	5.6 (1.6–9.6)	5.2 (1.4–9.0)	10.5 (4.3–16.6)	8.4 (4.1–12.7)
Virginia	3,431	3.2 (0.0–7.8)	7.6 (2.7–12.6)	6.1 (1.5–10.8)	5.1 (0.6–9.5)	5.7 (0.9–10.6)	4.9 (0.2–9.5)	4.0 (0.1–8.0)	8.0 (1.5–14.4)	6.7 (2.3–11.0)
West Virginia	1,414	4.6 (0.2–8.9)	9.1 (2.8–15.3)	7.5 (2.0–13.0)	7.8 (2.1–13.4)	6.7 (1.7–11.6)	5.3 (0.2–10.4)	6.5 (2.3–10.8)	—	—
Wisconsin	1,894	1.8 (0.0–5.7)	7.4 (1.5–13.4)	4.6 (0.0–9.4)	6.2 (1.3–11.1)	3.9 (0.0–8.6)	3.9 (0.0–8.4)	4.3 (0.0–8.6)	6.8 (0.1–13.5)	5.2 (0.7–9.6)

* National data are weighted and representative of all private and public school students in grades 9–12 in the United States. State data are weighted and representative of all public school students in grades 9–12 in the respective jurisdiction.

† White and Black students are non-Hispanic. Hispanic students could be of any race. Non-Hispanic other group not reported because this group includes multiple racial groups, which makes it difficult to provide meaningful interpretation, but included in overall estimates and estimates by other demographic characteristics.

§ Female sex, grade 9, and White race/ethnicity were used as referents.

¶ Negative values for lower CI bounds were truncated at zero.

** Dashes indicate that estimates in states where the sample size was <100 were considered unstable and were not reported.

†† P <0.05 for t-test comparing differences by demographic groups to the referent group.

TABLE 3. National and state-specific percentages* and one-sided 95% upper confidence limits (CLs) of high school students meeting U.S. Department of Agriculture vegetable intake recommendations by sex, grade, and race/ethnicity — Youth Risk Behavior Surveillance System, national and 33 states, 2017

		% (95% CL)[†]								
		Sex		Grade				Race/Ethnicity[§]		
State	No.	Female[¶]	Male	9[¶]	10	11	12	White[¶]	Black	Hispanic
National	**13,354**	**1.1 (2.8)**	**3.0 (14.8)**	**2.2 (8.3)**	**2.4 (8.5)**	**1.5 (7.5)**	**2.0 (8.2)**	**1.7 (7.4)**	**2.2 (10.1)**	**2.6 (9.1)**
Alaska	1,239	0.9 (3.1)	3.7 (16.0)	2.1 (9.1)	2.9 (10.3)	1.3 (8.3)	3.0 (10.6)	1.4 (8.0)	—[**]	4.1 (13.9)
Arizona	1,936	0.6 (1.8)	1.9 (13.8)	2.0 (8.5)	0.9 (7.3)	0.6 (6.8)	1.4 (8.2)	1.0 (7.3)	—	1.7 (8.2)
Arkansas	1,376	2.6 (7.9)	4.6 (18.4)	3.4 (11.3)	3.0 (10.7)	1.6 (8.2)	6.7 (19.9)	3.0 (11.1)	5.4 (15.6)	3.8 (13.9)
California	1,640	0.8 (2.2)	2.7 (15.1)	2.1 (8.8)	1.5 (8.3)	2.5 (9.4)	1.0 (7.8)	0.2 (5.7)	0.0 (7.5)	3.0 (9.8)
Connecticut	2,109	0.6 (2.0)	1.4 (13.4)	1.7 (8.3)	1.0 (7.4)	0.9 (7.1)	0.4 (6.7)	1.0 (7.2)	0.7 (7.8)	1.2 (8.2)
Florida	5,644	1.0 (2.8)	3.4 (15.8)	2.1 (8.6)	2.6 (9.6)	2.0 (8.7)	2.2 (8.9)	2.3 (8.6)	1.5 (9.4)	2.6 (8.7)
Hawaii	5,174	0.9 (2.7)	2.6 (14.4)	1.9 (8.2)	1.8 (8.1)	1.4 (7.5)	1.7 (7.9)	2.1 (9.4)	—	1.6 (7.7)
Idaho	1,729	0.7 (2.5)	1.9 (13.8)	1.6 (8.1)	0.9 (7.4)	1.4 (7.9)	1.3 (7.9)	1.0 (7.0)	—	2.4 (9.3)
Illinois	4,331	0.6 (2.0)	2.0 (14.3)	1.2 (7.5)	1.2 (7.6)	0.8 (7.2)	2.0 (9.1)	1.0 (7.1)	0.9 (8.3)	2.0 (9.2)
Iowa	1,552	0.9 (2.4)	2.0 (14.1)	1.3 (8.1)	3.3 (11.5)	0.9 (7.2)	0.1 (6.4)	1.3 (7.4)	2.0 (12.4)	1.4 (10.6)
Kansas	2,288	0.4 (1.5)	0.8 (12.6)	0.5 (6.8)	0.3 (6.4)	0.8 (7.4)	0.8 (7.3)	0.6 (6.7)	0.3 (7.4)	0.7 (7.1)
Kentucky	1,867	0.4 (1.4)	1.6 (13.5)	1.5 (8.1)	0.4 (6.5)	1.2 (7.7)	1.0 (7.5)	1.0 (7.0)	0.1 (7.9)	2.4 (11.7)
Louisiana	1,070	0.6 (2.0)	3.2 (17.2)	2.1 (9.9)	2.0 (9.0)	1.4 (8.4)	2.1 (11.5)	2.5 (9.9)	1.2 (8.6)	—
Maryland	43,802	0.6 (1.6)	1.9 (14.0)	1.4 (7.6)	1.1 (7.2)	1.3 (7.4)	1.2 (7.2)	1.1 (6.7)	1.1 (8.2)	2.0 (8.3)
Massachusetts	2,998	0.6 (1.9)	1.7 (13.6)	1.0 (7.4)	1.3 (7.8)	1.5 (8.3)	0.8 (6.9)	0.8 (6.7)	0.8 (9.2)	2.0 (8.6)
Michigan	1,506	0.4 (1.8)	2.7 (15.2)	1.6 (8.2)	1.5 (8.5)	1.7 (9.0)	1.5 (8.5)	1.3 (7.5)	1.6 (11.2)	3.7 (11.9)
Missouri	1,648	0.2 (1.0)	1.9 (14.0)	1.4 (8.1)	1.3 (7.9)	0.6 (6.6)	0.8 (7.1)	1.0 (6.7)	0.0 (8.2)	3.1 (11.8)
Montana	4,475	0.7 (2.4)	2.3 (13.9)	1.4 (7.8)	1.2 (7.6)	1.6 (8.0)	2.0 (8.4)	1.3 (7.3)	—	3.6 (11.6)
Nebraska	1,306	0.4 (1.5)	1.6 (14.0)	0.4 (6.7)	1.4 (8.1)	0.6 (7.0)	1.7 (9.4)	0.8 (7.0)	—	0.4 (7.2)
New Mexico	5,333	1.7 (4.0)	5.7 (18.1)	4.3 (11.2)	2.6 (9.2)	4.3 (11.4)	3.7 (10.4)	2.9 (9.9)	—	4.0 (10.5)
North Carolina	2,837	0.8 (2.1)	1.7 (14.0)	1.2 (7.8)	1.1 (7.4)	1.1 (7.8)	1.5 (8.0)	1.1 (7.2)	1.0 (8.5)	2.1 (8.9)
North Dakota	2,009	0.6 (2.4)	2.1 (13.9)	1.1 (7.5)	1.5 (7.9)	1.4 (7.8)	1.5 (8.4)	1.3 (7.3)	—	3.9 (12.7)
Oklahoma	1,526	0.6 (2.1)	1.7 (13.6)	0.8 (6.9)	2.0 (8.7)	0.9 (7.4)	0.8 (7.7)	1.0 (7.2)	—	1.6 (8.5)
Pennsylvania	3,344	0.6 (1.7)	1.7 (13.6)	2.1 (8.8)	1.0 (7.5)	0.8 (7.2)	0.7 (7.0)	1.0 (7.0)	1.0 (9.6)	3.3 (10.6)
Rhode Island	2,017	0.8 (2.5)	3.6 (15.8)	2.5 (9.7)	2.8 (10.0)	1.8 (8.4)	1.7 (8.8)	1.9 (8.3)	2.2 (12.8)	2.7 (10.3)
South Carolina	1,310	0.8 (2.7)	1.1 (13.6)	1.2 (8.4)	0.8 (7.7)	1.1 (7.5)	0.5 (7.3)	1.1 (7.6)	0.5 (7.6)	1.6 (9.2)
Tennessee	1,894	0.7 (2.1)	2.6 (14.9)	1.5 (8.6)	1.5 (8.5)	1.3 (7.8)	2.3 (9.6)	1.4 (7.5)	1.8 (10.4)	2.7 (10.2)
Texas	1,955	0.5 (1.9)	2.7 (15.1)	1.8 (8.7)	0.6 (7.3)	1.1 (7.7)	2.9 (10.4)	0.6 (6.5)	3.6 (13.9)	1.6 (7.9)
Utah	1,712	0.7 (2.7)	2.7 (14.6)	1.4 (7.7)	1.7 (8.5)	1.4 (8.2)	2.5 (,9.3)	1.4 (7.7)	—	3.2 (10.6)
Vermont	19,126	1.0 (2.8)	2.9 (14.4)	1.9 (7.9)	2.1 (8.1)	1.7 (7.9)	2.1 (8.3)	1.7 (7.5)	3.8 (13.8)	4.9 (12.8)
Virginia	3,431	0.7 (2.2)	2.7 (14.9)	2.2 (9.0)	1.5 (8.0)	1.5 (8.2)	1.8 (8.4)	1.4 (7.6)	1.1 (8.7)	3.7 (11.7)
West Virginia	1,414	0.8 (2.2)	2.2 (13.9)	0.8 (7.2)	2.6 (9.8)	2.0 (8.5)	0.5 (6.5)	1.6 (7.5)	—	—
Wisconsin	1,894	0.6 (2.0)	1.9 (14.2)	1.0 (7.6)	1.4 (8.4)	1.3 (8.0)	1.2 (8.1)	1.2 (7.3)	1.7 (11.5)	1.2 (9.3)

* National data are weighted and representative of all private and public school students in grades 9–12 in the United States. State data are weighted and representative of all public school students in grades 9–12 in the respective jurisdiction.
† One-sided 95% CLs (i.e., upper bound only) are presented because of low prevalence of percentage meeting vegetable recommendations and CIs that include zero.
§ White and Black students are non-Hispanic. Hispanic students could be of any race. Non-Hispanic other group not reported because this group includes multiple racial groups, which makes it difficult to provide meaningful interpretation, but included in overall estimates and estimates by other demographic characteristics.
¶ Female sex, grade 9, and White race/ethnicity were used as referents.
** Dashes indicate that estimates in states where the sample sizes were <100 were considered unstable and were not reported.

students participate in the National School Lunch Program (*6*), and fewer (14%) participate in the School Breakfast Program; participation is particularly low among students who do not qualify for free or reduced-price meals. Smart Snacks Standards ensure that foods and beverages sold in vending machines, school stores, and fundraisers include nutritious options, including fruits and vegetables (*7*). In addition, state and local farm-to-school programs support experiential learning activities, including cooking and taste-testing, to engage students in preparing and eating fruits and vegetables.[§§]

Community programs can also reduce barriers to fruit and vegetable consumption, including lack of home availability of fruits and vegetables, which is a consistent correlate of intake among adolescents (*8*). For example, projects funded by the Gus Schumacher Nutrition Incentive Program[¶¶] support families with low income by providing financial incentives to purchase more produce. Additional communication approaches, including parent-directed messaging about exposing children to nutritious foods early and repeatedly at home,[***] might enhance preferences for fruits and vegetables. Further, social marketing and health-branding strategies, such as those used by the FNV Campaign,[†††] to positively influence attitudes

§§ https://www.fns.usda.gov/cfs/farm-school-grant-program.

¶¶ https://nifa.usda.gov/program/gus-schumacher-nutrition-incentive-grant-program.
*** https://www.healthychildren.org/English/healthy-living/growing-healthy/Pages/preschool-food-and-feeding.aspx#none.
††† https://fnv.com/about/.

and societal norms about eating fruits and vegetables, might appeal to adolescents, particularly those who use social media. Consistently low fruit and vegetable intake among adolescents suggests that additional efforts are needed to expand the reach of existing programs or to identify new effective strategies such as communication approaches including social media.

The findings in this report are subject to at least two limitations. First, YRBS data are self-reported, which might overestimate fruit and vegetable intake (*9*). Second, intake recommendations are based on adolescents who do not engage in ≥30 minutes of physical activity daily, and active persons should consume more. These results might overestimate percentages meeting recommendations because 46.5% of U.S. students were active for ≥60 minutes per day on 5 or more days.[§§§]

YRBS data are highly representative of the adolescent population because 96% of adolescents aged 14–17 years attend school (*10*). Despite the benefits of healthy eating, these findings indicate that most high school students do not consume enough fruits and vegetables to meet USDA recommendations. Continued efforts to identify and address barriers to consumption might help adolescents eat more fruits and vegetables and support their overall health.

[§§§] https://www.cdc.gov/healthyyouth/data/yrbs/pdf/2017/ss6708.pdf.

Summary

What is already known about this topic?

Consuming fruits and vegetables is associated with reduced risk for cardiovascular disease, type 2 diabetes, some cancers, and obesity. Healthy dietary habits established during adolescence might continue into adulthood. However, few U.S. high-school students eat enough fruits and vegetables to meet U.S. Department of Agriculture recommendations.

What is added by this report?

Adolescents in all demographic groups consume too few fruits and vegetables, consistent with previous findings. In 2017, 7.1% met fruit intake recommendations, and 2.0% met vegetable intake recommendations.

What are the implications for practice?

Efforts to expand the reach of existing school and community programs as well as identify new strategies, such as social media approaches, might be needed to increase fruit and vegetable consumption among adolescents.

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Vaccination Coverage with Selected Vaccines and Exemption Rates Among Children in Kindergarten — United States, 2019–20 School Year

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State and local school vaccination requirements serve to protect students against vaccine-preventable diseases (*1*). This report summarizes data collected by state and local immunization programs* on vaccination coverage among children in kindergarten (kindergartners) in 48 states, exemptions for kindergartners in 49 states, and provisional enrollment and grace period status for kindergartners in 28 states for the 2019–20 school year, which was more than halfway completed when most schools moved to virtual learning in the spring because of the coronavirus 2019 (COVID-19) pandemic. Nationally, vaccination coverage† was 94.9% for the state-required number of doses of diphtheria and tetanus toxoids, and acellular pertussis vaccine (DTaP); 95.2% for 2 doses of measles, mumps, and rubella vaccine (MMR); and 94.8% for the state-required number of varicella vaccine doses. Although 2.5% of kindergartners had an exemption from at least one vaccine,§ another 2.3% were not up to date for MMR and did not have a vaccine exemption. Schools and immunization programs can work together to ensure that undervaccinated students are caught up on vaccinations in preparation for returning to in-person learning. This follow-up is especially important in the current school year, in which undervaccination is likely higher because of disruptions in vaccination during the ongoing COVID-19 pandemic (*2*–*4*).

To meet state and local school entry requirements, parents and guardians submit children's vaccination records or exemption forms to schools, or schools obtain records from state immunization information systems. Federally funded immunization programs work with departments of education, school nurses, and other school personnel to assess vaccination and exemption status of children, typically those aged 4–6 years, enrolled in public and private kindergartens and to report unweighted counts, aggregated by school type, to CDC via a web-based questionnaire in the Secure Access Management System.¶ CDC uses these data to produce state- and national-level estimates of vaccination coverage (*5*). During the 2019–20 school year, 48 states reported coverage for all state-required vaccines among public school kindergartners, and 47 states reported on private school kindergartners.** Forty-nine states reported exemption data among public school kindergartners, and 48 states reported on private school kindergartners.** This report provides data on overall national and median vaccination coverage for the state-required number of doses of DTaP, MMR, and varicella vaccine. Hepatitis B and poliovirus vaccination coverage data, which are not included in this report, are available at SchoolVaxView (*6*). Twenty-eight states reported data on kindergartners who, at the time of assessment, were attending school under a grace period (attendance without proof of complete vaccination or exemption during a set interval) or provisional enrollment (school attendance while completing a catch-up vaccination schedule). Coverage and exemptions from U.S. territories and associated

* Federally funded immunization programs are located in the 50 states and the District of Columbia (DC), five other cities or counties, and eight U.S territories and freely associated states (territories). Two cities reported data to CDC, which were also included in data by their state, to calculate medians and national estimates. Immunization programs in U.S. territories reported vaccination coverage and exemptions to CDC; however, these data were not included in overall national calculations.

† National and median vaccination coverage was determined using estimates for 48 states; Alaska, Delaware, and the District of Columbia did not report school coverage data because of problems with data collection. Data from cities were included with their state data. Data from territories were not included in national and median calculations.

§ National and median exemption rates were determined using estimates for 49 states; Colorado, Minnesota, and Missouri did not collect information on the number of kindergartners with an exemption but instead reported the number of exemptions for each vaccine, which could count some children more than once. For these states, the percentage of kindergartners exempt from the vaccine with the highest number of exemptions (the lower bound of the potential range of exemptions) was included in the national and median exemption rates. Delaware and the District of Columbia did not report school vaccine exemption data because of problems with data collection. Data from cities were included with their state data. Data from territories were not included in national estimates.

¶ Assessment date varied by state and area. Four states assess on the first day of school; 14 states assess by December 31; 16 states assess by some other date, ranging from 30 days after admission to April 30; 15 states assess on a rolling basis.

** Ten states reported coverage and exemption data for at least some homeschooled kindergartners as follows: California included data for students who attend virtual partial or full charter schools with some or all online instruction and students receiving individualized education program services because they are medically unable to attend school in public school data, and data for homeschools with six or more students in private school data. Kansas included data for students educated through public virtual schools in the public school data. New Mexico included all homeschooled students in public school data. North Dakota reported some homeschool data separately. Oregon reported data for students enrolled in exclusively online homeschool programs separately; online students of otherwise traditional public schools were included in the public school data. Pennsylvania included all homeschooled students in their public school data. South Carolina and Wisconsin included homeschooled students in their public or private school data if the students also attended classes, extracurricular activities, or had other contact with a school. Vermont included homeschooled students in their public and private school data if the students were enrolled in one or more classes at a school. Wyoming reported homeschooled students in their public school data if the students also attend classes or extracurricular activities at a public school.

states are presented; however, national estimates, medians, and summary measures include only U.S. states.

Vaccination coverage and exemption estimates were adjusted according to survey type and response rates.[††] National estimates measure coverage and exemptions among all kindergartners, and medians measure the midpoint of state-level coverage regardless of population size. Reported estimates for the 2019–20 school year are based on 3,675,882 kindergartners surveyed for vaccination coverage, 3,914,961 for exemptions, and 2,955,220 for grace period and provisional enrollment among the 4,025,574 children reported as enrolled in kindergarten by immunization programs for 49 states.[§§] Potentially achievable coverage with MMR, defined as the sum of the percentage of children who are up to date with 2 doses of MMR and those with no documented vaccination exemption but who are not up to date, was calculated for each state. Nonexempt students include those provisionally enrolled, in a grace period, or otherwise without documentation of vaccination. SAS (version 9.4; SAS Institute Inc.) was used for all analyses.

Vaccination assessments varied by immunization program because of differences in states' required vaccines and number of doses, vaccines assessed, methods of data collection, and data reported (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/100473). The majority of states reported kindergartners as up to date for a given vaccine if they had received all doses of that vaccine required for school entry.[¶¶] Seven states[***] reported kindergartners as up-to-date for any given vaccine only if they had received all doses of all vaccines required for school entry.

Nationally, 2-dose MMR coverage was 95.2% (range = ≥86.6% [Alabama] to ≥99.1% [Mississippi]). Coverage of ≥95% was reported by 20 states and coverage of <90% by three states (Table). DTaP coverage was 94.9% (range = 84.0% [Indiana] to ≥99.1% [Mississippi]), with 20 states reporting coverage of ≥95%, and three states reporting <90% coverage. Coverage with 2 doses (or 1 dose, as required) of varicella vaccine was 94.8% (range = ≥86.6% [Alabama] to ≥99.1% [Mississippi]), with 21 states reporting coverage ≥95%, and four states reporting <90% coverage.

The percentage of kindergartners with an exemption from one or more required vaccines (not limited to MMR, DTaP, and varicella vaccines) remained unchanged from the 2018–19 school year at 2.5% (range = 0.1% [New York and West Virginia] to 7.6% [Idaho]) (Table). Nationally, 0.3% of kindergartners had a medical exemption, and 2.2% had a nonmedical exemption (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/100473). Only 95.2% of kindergartners were up to date with MMR; 2.5% had an exemption from at least one vaccine,[§] and another 2.3% were not up to date with MMR and did not have a vaccine exemption (Table).

The percentage of kindergartners attending school within a grace period or provisionally enrolled among the 28 states reporting these data was 1.6% (range = <0.1% [Hawaii and Mississippi] to 6.1% [Ohio]) (Table). Of the 28 states with MMR coverage <95%, 24 states could potentially achieve ≥95% MMR coverage if all nonexempt kindergartners, many of whom were within a grace period or provisionally enrolled, were vaccinated (Figure 1). Among the 30 states reporting a decrease in the percentage of kindergartners who were not up to date for MMR and did not have an exemption in 2019–2020 compared with 2018–2019, an increase of MMR coverage in 2019–2020 was also reported by 26 states (Figure 2). In three states with MMR coverage <95% in 2018–2019 (Illinois, North Carolina, and South Carolina), coverage increased to ≥95% in 2019–2020.

Discussion

The purpose of vaccination assessment is to identify populations at risk and aid in taking programmatic steps to increase vaccination coverage. Although the COVID-19 pandemic led to late, truncated, or incomplete assessment of kindergarten vaccination status in the 2019–20 school year compared with the 2018–19 school year in some states (*7*), most student vaccinations would have already occurred before the start of the 2019–20 school year and would not have been affected by the pandemic. National coverage among kindergartners remained approximately 95% (*5*) for MMR, DTaP, and varicella vaccines. However, coverage and exemption rates varied by state. Measles outbreaks that affected school-aged children across multiple states during the 2018–19 school year underscore the importance of both school vaccination requirements for preventing

[††] Most immunization programs that used census or voluntary response provided CDC with data aggregated at the state or local (city or territory) level. Coverage and exemption data based on a census or voluntary response were adjusted for nonresponse using the inverse of the response rate, stratified by school type (public, private, and homeschool, where available). Programs that used complex sample surveys provided CDC with deidentified data aggregated at the school or county level for weighted analysis. Weights were calculated to account for sample design and adjusted for nonresponse for data collected through complex sample design wherever possible.

[§§] The totals reported here are the summations of the kindergartners surveyed among programs reporting data for coverage, exemptions, grace periods, and provisional enrollment. Data from cities and territories were not included in these totals.

[¶¶] All states required 2 doses of a measles-containing vaccine. Local DTaP requirements varied: Nebraska required 3 doses, four states (Illinois, Maryland, Virginia, and Wisconsin) required 4 doses, and all other states required 5 doses, unless the fouth dose was administered on or after the fourth birthday. The reported coverage estimates represent the percentage of kindergartners with the state-required number of DTaP doses, except for Kentucky, which required 5 doses of DTaP by age 5 years but reported 4-dose coverage for kindergartners. Seven states required 1 dose of varicella vaccine; 44 states required 2 doses.

[***] Alabama, Florida, Georgia, Iowa, Mississippi, New Hampshire, and New Jersey did not assess coverage for individual vaccines, but instead considered kindergartners up to date only if they had received all doses of all vaccines required for school entry. For these states, estimates are shown with the "≥" symbol.

TABLE. Estimated* coverage[†] with measles, mumps, and rubella vaccine (MMR), diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP), and varicella vaccines, grace period/provisional enrollment,[§] and any exemption[¶] among children enrolled in kindergarten, by immunization program — United States, territories, and associated states, 2019–20 school year

Immunization program	Kindergarten population**	No. (%) surveyed[††]	Coverage (%) MMR[§§] 2 doses	Coverage (%) DTaP[¶¶] 5 doses	Coverage (%) Varicella*** 2 doses	Grace period/ Provisional enrollment (%)	Any exemption (%)	Percentage point change in any exemption, 2018 to 2019
National estimate[†††]	4,025,574	3,675,882 (91.3)	95.2	94.9	94.8	1.6	2.5	—
Median[†††]	**NA**	**NA**	**94.6**	**94.4**	**94.6**	**1.6**	**2.7**	**0.1**
Alabama[§§§]	59,477	56,416 (94.9)	≥86.6	≥86.6	≥86.6	NP	1.2	0.4
Alaska[§§§,¶¶¶]	10,381	8,580 (82.7)	NR	NR	NR	NR	5.9	−1.2
Arizona****	83,976	82,848 (98.7)	92.8	92.6	95.3	NR	5.5	−0.5
Arkansas[††††]	39,510	37,997 (96.2)	94.3	93.2	93.9	456 (1.2)	1.9	0.1
California[††††]	566,155	554,250 (97.9)	96.5	96.2	96.1	8,262 (1.5)	0.8	0.2
Colorado[§§§§]	69,088	67,876 (98.2)	91.1	92.8	90.1	500 (0.7)	4.9	—
Connecticut[§§§,¶¶¶¶]	38,888	38,888 (100.0)	96.2	96.2	95.9	NP	2.5	−0.2
Delaware[§§§]	NR	NR	NR	NR	NR	NR	NR	NA
District of Columbia[§§§]	NR	NR	NR	NR	NR	NR	NR	NA
Florida[§§§,¶¶¶¶,*****]	228,298	228,298 (100.0)	≥93.5	≥93.5	≥93.5	6,737 (3.0)	3.4	0.2
Georgia[§§§,¶¶¶¶]	130,102	130,102 (100.0)	≥93.1	≥93.1	≥93.1	292 (0.2)	3.0	0.5
Hawaii[§§§]	15,695	1,403 (8.9)	89.7	91.1	91.8	0 (<0.1)	6.1	1.7
Idaho	23,301	22,950 (98.5)	89.1	89.0	88.5	373 (1.6)	7.6	−0.1
Illinois[§§§,¶¶¶¶]	145,891	145,891 (100.0)	96.6	96.5	96.4	925 (0.6)	2.0	0.2
Indiana[§§§]	88,253	57,968 (65.7)	94.4	84.0	94.0	NR	2.2	0.9
Iowa[§§§,¶¶¶¶]	40,812	40,812 (100.0)	≥93.2	≥93.2	≥93.2	1,255 (3.1)	2.5	0.1
Kansas[§§§,††††,†††††]	37,865	12,996 (34.3)	90.4	90.0	89.6	NR	2.1	—
Kentucky[§§§,††††,*****]	59,233	55,031 (92.9)	93.1	93.3	92.5	NR	1.8	0.4
Louisiana[¶¶¶¶]	59,685	59,685 (100.0)	95.6	97.2	95.0	NP	1.5	0.3
Maine	13,450	13,395 (99.6)	94.1	94.1	96.2	NR	5.9	−0.3
Maryland[,§§§,††††]	72,443	71,225 (98.3)	97.9	98.2	97.5	NR	1.4	−0.1
Massachusetts[§§§,¶¶¶¶,††††]	66,756	66,756 (100.0)	97.3	97.2	97.0	NP	1.3	−0.1
Michigan[¶¶¶¶]	120,565	120,565 (100.0)	94.8	94.7	94.4	798 (0.7)	4.4	−0.1
Minnesota[§§§§,*****]	71,223	70,284 (98.7)	92.6	92.3	92.0	NR	3.8	0.1
Mississippi[§§§,****,¶¶¶¶,]	37,870	37,870 (100.0)	≥99.1	≥99.1	≥99.1	17 (<0.1)	0.2	0.1
Missouri[§§§§,¶¶¶¶]	72,324	72,324 (100.0)	94.6	94.5	94.2	NR	2.7	—
Montana[§§§,¶¶¶¶]	12,501	12,501 (100.0)	93.6	93.2	93.2	231 (1.8)	4.3	−0.2
Nebraska[§§§,††††]	26,893	26,012 (96.7)	96.3	96.9	95.6	440 (1.6)	2.2	0.1
Nevada[§§§]	37,724	37,678 (99.9)	95.4	94.0	94.6	896 (2.4)	4.0	0.7
New Hampshire[§§§,¶¶¶¶]	12,447	12,447 (100.0)	≥91.5	≥91.5	≥91.5	561 (4.5)	3.1	−0.2
New Jersey[¶¶¶¶,¶¶¶]	107,900	107,900 (100.0)	≥95.9	≥95.9	≥95.9	958 (0.9)	2.6	0.1
New Mexico[§§§]	23,087	23,087 (100.0)	97.0	96.7	96.7	369 (1.6)	1.5	—
New York (incl. New York City)[§§§,****]	234,165	234,031 (99.9)	98.6	97.8	98.1	3,827 (1.6)	0.1	−1.2
New York City[§§§,****]	96,581	96,447 (99.9)	98.1	97.3	97.7	846 (0.9)	0.1	−0.6
North Carolina [§§§, ††††,*****]	124,548	121,835 (97.8)	95.5	95.5	95.3	1,499 (1.2)	1.7	0.1
North Dakota	10,587	10,536 (99.5)	94.8	94.4	94.8	NR	3.9	−0.4
Ohio	139,103	137,441 (98.8)	92.4	92.3	91.9	8,515 (6.1)	2.8	−0.1
Oklahoma	55,348	47,374 (85.6)	93.0	93.9	96.9	NR	2.7	0.1
Oregon[††††,¶¶¶¶]	45,959	45,959 (100.0)	93.4	92.6	94.6	NR	7.1	−0.6
Pennsylvania	140,197	138,573 (98.8)	96.6	96.8	96.3	3,085 (2.2)	3.0	0.1
Rhode Island[§§§,††††,*****]	11,219	11,054 (98.5)	97.7	97.4	97.0	NR	1.3	—
South Carolina[§§§]	65,938	18,104 (27.5)	95.0	95.2	94.5	174 (0.3)	2.6	—
South Dakota[§§§]	12,367	12,337 (99.8)	96.0	95.9	95.2	NR	2.7	0.1
Tennessee[§§§,††††,¶¶¶¶]	80,595	80,595 (100.0)	96.8	96.4	96.5	1,529 (1.9)	2.0	0.1
Texas (including Houston) [††††,*****]	398,680	397,093 (99.6)	96.9	96.6	96.4	5,507 (1.4)	2.5	0.1
Houston[††††,*****]	38,868	38,655 (99.5)	96.3	96.4	95.2	415 (1.1)	1.5	—
Utah[¶¶¶¶]	49,208	49,208 (100.0)	92.7	92.2	92.4	1,144 (2.3)	5.4	−0.3
Vermont[§§§,¶¶¶¶]	6,293	6,293 (100.0)	94.5	94.1	93.9	262 (4.2)	3.7	−1.0
Virginia[§§§,†††††]	99,399	1,200 (1.2)	94.6	97.6	93.3	NR	1.7	—
Washington*****	87,757	80,623 (91.9)	94.4	92.8	92.7	1,234 (1.4)	5.7	0.7
West Virginia[§§§,****,§§§§§]	17,114	8,481 (49.6)	98.2	98.8	97.8	16 (0.1)	0.1	−0.7
Wisconsin[††††,*****,†††††]	67,391	1,777 (2.6)	92.8	94.5	91.6	68 (0.1)	5.7	−0.2
Wyoming[¶¶¶¶]	7,913	7,913 (100.0)	94.5	94.4	85.6	152 (1.9)	3.5	0.6

See table footnotes on the next page.

TABLE. (*Continued*) **Estimated* coverage† with measles, mumps, and rubella vaccine (MMR), diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP), and varicella vaccines, grace period/provisional enrollment,§ and any exemption¶ among children enrolled in kindergarten, by immunization program — United States, territories, and associated states, 2019–20 school year**

Immunization program	Kindergarten population**	No. (%) surveyed††	Coverage (%)			Grace period/ Provisional enrollment (%)	Any exemption (%)	Percentage point change in any exemption, 2018 to 2019
			MMR§§ 2 doses	DTaP¶¶ 5 doses	Varicella*** 2 doses			
Territories and associated states								
American Samoa§§§,¶¶¶¶,§§§§§	781	781 (100.0)	91.9	71.4	21.0	NP	—	NA
Federated States of Micronesia¶¶¶¶	1,532	1,532 (100.0)	90.7	76.8	NReq	NR	—	—
Guam§§§	2,513	2,492 (99.2)	93.7	92.9	NReq	NR	0.1	—
Marshall Islands§§§,****,¶¶¶¶	1,115	1,115 (100.0)	92.0	90.3	NReq	NR	—	—
Northern Mariana Islands¶¶¶¶	895	895 (100.0)	95.3	97.3	95.0	NR	—	—
Palau¶¶¶¶,¶¶¶¶¶	273	273 (100.0)	90.1	90.1	NReq	NR	—	—
Puerto Rico	26,980	1,266 (4.7)	93.5	89.9	93.0	NR	2.0	0.4
U.S. Virgin Islands	NR	NR	NR	NR	NR	NR	NR	NA

Abbreviations: NA = not available; NP = no grace period/provisional policy; NR = not reported to CDC; NReq = not required for school entry.

* Estimates are adjusted for nonresponse and weighted for sampling where appropriate.

† Estimates based on a completed vaccine series (i.e., not vaccine-specific) use the "≥" symbol. Coverage might include history of disease or laboratory evidence of immunity.

§ A grace period is a set number of days during which a student can be enrolled and attend school without proof of complete vaccination or exemption. Provisional enrollment allows a student without complete vaccination or exemption to attend school while completing a catch-up vaccination schedule. In states with one or both of these policies, the estimates represent the number of kindergartners within a grace period, provisionally enrolled, or some combination of these categories.

¶ Exemptions, grace period/provisional enrollment and vaccination coverage status might not be mutually exclusive. Some children enrolled under a grace period/ provisional enrollment might be exempt from one or more vaccinations, while children with exemptions might be fully vaccinated with one or more required vaccines.

** The kindergarten population is an approximation provided by each program.†† The number surveyed represents the number of kindergartners surveyed for vaccination coverage. For Alaska, this number represents the number surveyed for exemptions as coverage was not reported. The national total excludes the 10,381 kindergartners from Alaska. Exemption estimates are based on 34,011 kindergartners for Kansas, 65,938 kindergartners for South Carolina, 97,236 kindergartners for Virginia, and 67,391 kindergartners for Wisconsin.

§§ Most states require 2 doses of MMR; Alaska, New Jersey, and Oregon require 2 doses of measles, 1 dose of mumps, and 1 dose of rubella vaccines. California, Georgia, New York, New York City, North Carolina, and Virginia require 2 doses of measles and mumps and 1 dose of rubella vaccines. Iowa requires 2 doses of measles and 2 doses of rubella vaccines.

¶¶ Pertussis vaccination coverage might include some diphtheria, tetanus toxoids, and pertussis vaccine (DTP) vaccinations if administered in another country or by a vaccination provider who continued to use DTP after 2000. Most states require 5 doses of DTaP for school entry, or 4 doses if the fourth dose was received on or after the fourth birthday; Illinois, Maryland, Virginia, and Wisconsin require 4 doses; Nebraska requires 3 doses. The reported coverage estimates represent the percentage of kindergartners with the state-required number of DTaP doses, except for Kentucky, which requires ≥5 but reports ≥4 doses of DTaP.

*** Most states require 2 doses of varicella vaccine for school entry; Alabama, Arizona, Hawaii, Maine, New Jersey, Oklahoma, and Oregon require 1 dose. Reporting of varicella vaccination status for kindergartners with a history of varicella disease varied within and among states; some were reported as vaccinated against varicella and others as medically exempt.

††† National coverage estimates and medians calculated from data from 48 states (i.e., do not include Alaska, Delaware, and the District of Columbia). National grace period/provisional enrollment estimates and medians were calculated from data from 28 states that have either a grace period or a provisional enrollment policy and that reported relevant data to CDC. National exemption estimates and medians were calculated from data from 49 states (i.e., do not include Delaware and the District of Columbia). Other jurisdictions excluded were Houston, New York City, American Samoa, Guam, Marshall Islands, Federated States of Micronesia, North Mariana Islands, Palau, Puerto Rico, or U.S. Virgin Islands. Data reported from 3,675,882 kindergartners assessed for coverage, 3,914,961 for exemptions, and 2,955,220 for grace period/provisional enrollment. Estimates represent rates for populations of 4,015,193; 4,025,574; and 3,056,534 kindergartners for coverage, exemptions, and grace period/provisional enrollment, respectively.

§§§ Philosophical exemptions were not allowed.

¶¶¶ Alaska did not report kindergarten vaccination coverage because of problems with data collection. Vaccination coverage among children aged 6 years in VacTrAK, Alaska's Immunization Information System, was 75.5% for MMR, 85.1 for DTaP, and 73.0 for varicella vaccine.

**** Religious exemptions were not allowed.

†††† Counted some or all vaccine doses received regardless of Advisory Committee on Immunization Practices—recommended age and time interval; vaccination coverage rates reported might be higher than those calculated using only valid doses.

§§§§ Program did not report the number of children with exemptions, but instead reported the number of exemptions for each vaccine, which could count some children more than once. Lower bounds of the percentage of children with any exemptions were estimated using the individual vaccines with the highest number of exemptions.

¶¶¶¶ The proportion surveyed likely was <100% but is reported as 100% based on incomplete information about the actual current enrollment.

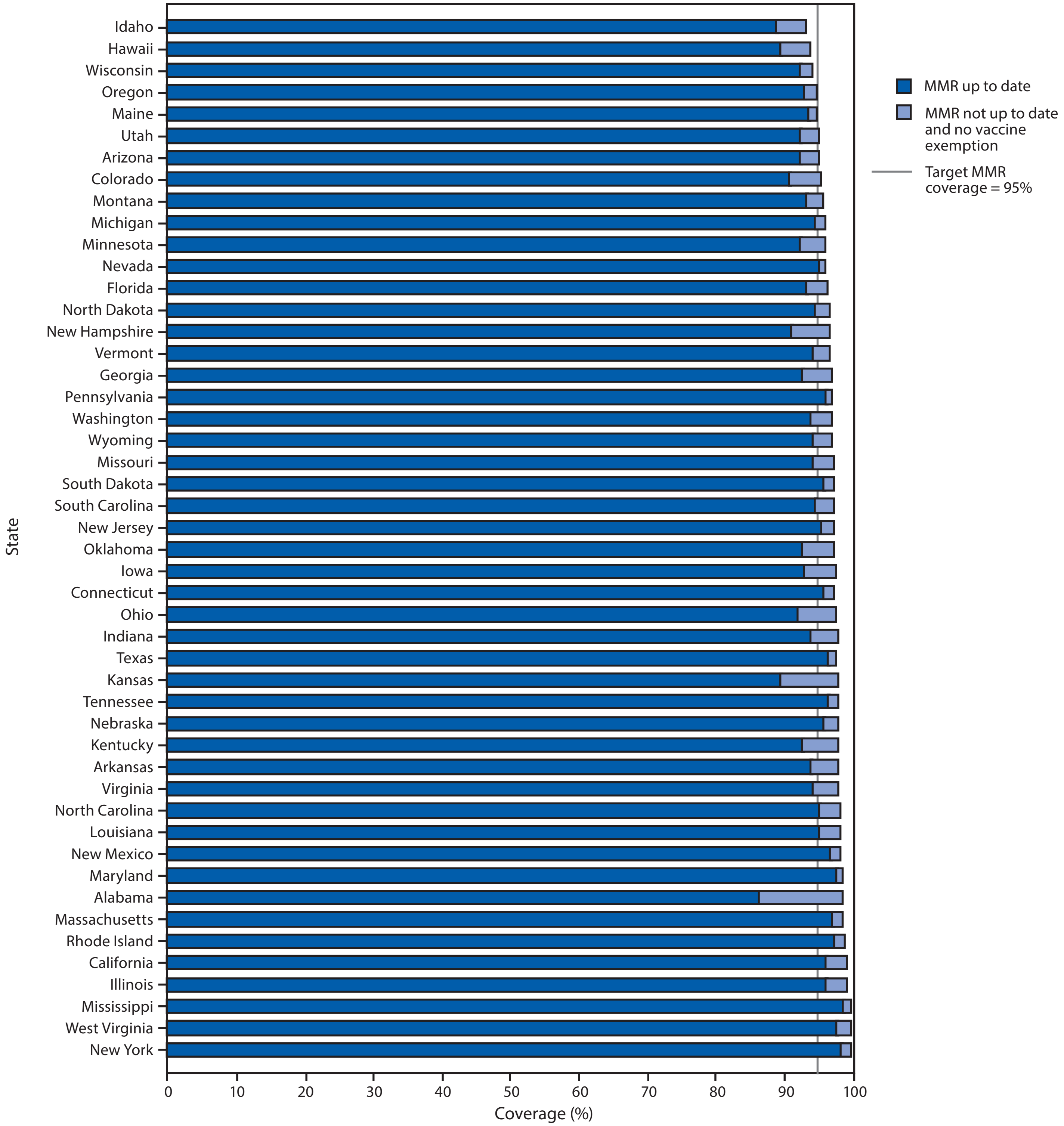
***** Did not include some types of schools, such as online schools or those located in military bases or correctional facilities, or tribal lands.

††††† Kindergarten vaccination coverage data were collected from a sample, and exemption data were collected from a census of kindergartners.

§§§§§ Reported public school data only.

¶¶¶¶¶ For Palau, estimates represent coverage among children in first grade.

FIGURE 1. Potentially achievable coverage*,†,§ with measles, mumps, and rubella vaccine (MMR) among kindergartners, by state — 48 states, 2019–20 school year

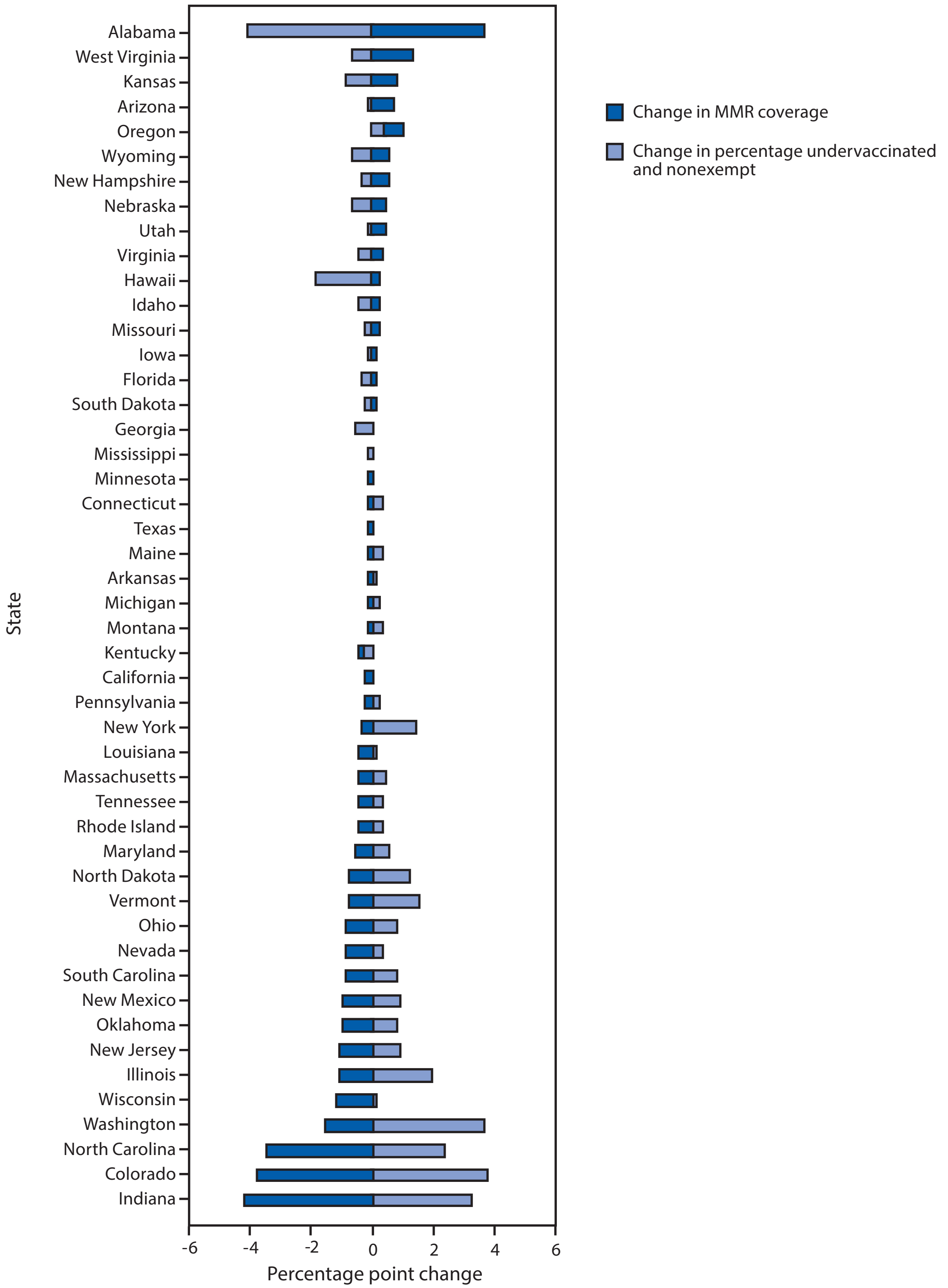


* States are ranked from lowest to highest potentially achievable coverage. Potentially achievable coverage is estimated as the sum of the percentage of students with up-to-date MMR and the percentage of students without up-to-date MMR and without a documented vaccine exemption.

† The exemptions used to calculate the potential increase in MMR coverage for Arizona, Arkansas, Colorado, Idaho, Illinois, Maine, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Rhode Island, Texas, Utah, Vermont, Wisconsin, and Wyoming are the number of children with exemptions specifically for MMR vaccine. For all other states, numbers are based on an exemption to any vaccine.

§ Alaska, Delaware, and the District of Columbia did not report kindergarten vaccination coverage for the 2019–20 school year and are excluded from this analysis.

FIGURE 2. Change in percentage of kindergartners who are fully vaccinated with measles, mumps, and rubella vaccine (MMR) and in the percentage who are undervaccinated and nonexempt,*,†,§ by state — 48 states, 2018–19 to 2019–20 school years



* States are ranked from greatest decrease to highest increase in the percentage of kindergartners who are undervaccinated and nonexempt. The exemptions used to calculate the MMR not up to date and no documented vaccine exemptions for Arizona, Arkansas, Colorado, Idaho, Illinois, Maine, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Rhode Island, Texas, Utah, Vermont, Wisconsin, and Wyoming are the number of children with exemptions specifically for MMR vaccine. For all other states, numbers are based on an exemption to any vaccine.

† Alaska, Delaware, and the District of Columbia did not report kindergarten vaccination coverage for the 2019–20 school year and are excluded from this analysis.

§ California, Michigan, New Jersey, New York, Oregon, Pennsylvania, Texas, and Washington experienced >15 cases of measles during the 2018–2019 outbreak.

disease spread and school coverage assessments to identify pockets of low coverage (*8*). Among eight states with measles outbreaks of ≥15 cases during the 2018–19 school year (*8*), six reported increases in MMR coverage during 2019–2020. Increases in some states were likely attributable to changes in state laws eliminating nonmedical vaccination exemptions (*9*), and vaccination campaigns in response to the outbreaks could also have contributed to the increases in MMR coverage.

The overall percentage of children with an exemption remained at approximately 2.5%; children with exemptions represent a small proportion of kindergartners nationally and in most states. In 25 states, the number of nonexempt undervaccinated kindergartners equaled or exceeded the number of those with exemptions. In many states, nonexempt undervaccinated students are attending school in a grace period or are provisionally enrolled. Follow-up with undervaccinated students can increase vaccination coverage in this group.

Twenty-six states successfully increased MMR coverage by reducing the number of nonexempt students who are not up to date, with three states (Illinois, North Carolina, and South Carolina) reaching coverage of ≥95%. Some states have implemented policies and activities focused on improving coverage. In Colorado, MMR coverage increased from 87.4% in 2018–2019 to 91.1% in 2019–2020. This was accomplished by prioritizing high MMR coverage. In addition to providing technical assistance, media toolkits, strategies, and local kindergarten MMR data and targets, the state health department furnished lists of elementary schools with low coverage to local public health agencies, which implemented community-specific strategies. These included digital media campaigns aimed at parents, vaccination reminder/recall, efforts to improve school compliance, outbreak tabletop exercises with schools, and incentives to families (Diana Herrero, Colorado Department of Public Health and Environment, personal communication, November 13, 2020). Almost all states could achieve ≥95% MMR coverage if nonexempt undervaccinated children were vaccinated according to local and state vaccination policies.

The findings in this report are subject to at least six limitations. First, comparability is limited because of variation in states' requirements, data collection methods, exemptions allowed, and definitions of grace period and provisional enrollment. Second, representativeness might be negatively affected because of data collection methods that missed some schools or students or occurred at different times. Third, results might be underestimated or overestimated because of incomplete documentation. Fourth, national coverage estimates include only 48 of 50 states but use lower bound estimates for seven states; exemption estimates include 49 states but use lower bound estimates for three states; and grace period or provisional enrollment estimates include only 28 states for the 2019–20 school year. Fifth, estimates of potentially achievable MMR coverage are approximations and are underestimated for states that do not report vaccine-specific exemptions (*5*,*7*). Finally, because of the COVID-19 pandemic, schools were closed, and state and local health department staff members were deployed to response activities, limiting the quantity and quality of student vaccination data collected and reported to CDC (CDC, unpublished data, 2020).

Summary

What is already known about this topic?

State immunization programs conduct annual kindergarten vaccination assessments to monitor school-entry vaccination coverage with all state-required vaccines.

What is added by this report?

For the 2019–20 school year, national coverage was approximately 95% for diphtheria and tetanus toxoids, and acellular pertussis; measles, mumps, and rubella; and varicella vaccines. The national exemption rate remained low at 2.5%.

What are the implications for public health practice?

Disruptions caused by the COVID-19 pandemic are expected to reduce vaccination coverage in the 2020–21 school year. Increased follow-up of undervaccinated students is needed from schools and immunization programs to maintain the high vaccination coverage necessary to protect students in preparation for schools returning to in-person learning.

Based on measurements from other data sources, CDC expects that the COVID-19 pandemic has already reduced actual vaccination coverage of kindergarten-aged children through reduced appointment availability at providers' offices, parents delaying preventive health care visits, and other barriers to vaccination, and that those disruptions will reduce kindergarten vaccination coverage in the 2020–21 school year (*2*–*4*). In addition, schools in many states began the 2020–21 school year remotely and might not have enforced the usual vaccination policies. Providers, schools, and immunization programs will need to increase follow-up with undervaccinated students and find ways to overcome pandemic-related barriers to maintain the high level of vaccination coverage necessary to continue protecting school-aged children, their family members, and communities from vaccine-preventable diseases during virtual learning and as schools return to in-person instruction. Jurisdictions should provide resources as appropriate, such as guidance to parents about the importance of maintaining preventive care during the pandemic, lists of immunization providers in the area for children who are unable to be vaccinated by their usual health care provider, or special vaccination clinics at schools or health departments.

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COVID-19 Case Investigation and Contact Tracing Efforts from Health Departments — United States, June 25–July 24, 2020

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Case investigation and contact tracing are core public health tools used to interrupt transmission of pathogens, including SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19); timeliness is critical to effectiveness (*1*,*2*). In May 2020, CDC funded* 64 state, local, and territorial health departments† to support COVID-19 response activities. As part of the monitoring process, case investigation and contact tracing metrics for June 25–July 24, 2020, were submitted to CDC by 62 health departments. Descriptive analyses of case investigation and contact tracing load, timeliness, and yield (i.e., the number of contacts elicited divided by the number of patients prioritized for interview) were performed. A median of 57% of patients were interviewed within 24 hours of report of the case to a health department (interquartile range [IQR] = 27%–82%); a median of 1.15 contacts were identified per patient prioritized for interview§ (IQR = 0.62–1.76), and a median of 55% of contacts were notified within 24 hours of identification by a patient (IQR = 32%–79%). With higher caseloads, the percentage of patients interviewed within 24 hours of case report was lower (Spearman coefficient = –0.68), and the number of contacts identified per patient prioritized for interview also decreased (Spearman coefficient = –0.60). The capacity to conduct timely contact tracing varied among health departments, largely driven by investigators' caseloads. Incomplete identification of contacts affects the ability to reduce transmission of SARS-CoV-2. Enhanced staffing capacity and ability and improved community engagement could lead to more timely interviews and identification of more contacts.

During July 31–August 14, 2020, baseline data on four metrics for June 25–July 24, 2020 (the evaluation period) were submitted by 62 of 64 (97%) health departments funded through the Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases Cooperative Agreement (ELC)¶ to the Research Electronic Data Capture (REDCap) platform (*3*). These metrics, developed by the CDC COVID-19 Contact Tracing Innovations Support Team, were vetted by public health partners, including a number of ELC-funded health departments, and include the following: 1) average caseload per case investigator (the total number of probable and confirmed COVID-19 patients assigned for interview during the evaluation period divided by the total number of case investigators), average contact tracing load (the total number of contacts assigned for follow-up divided by the total number of contact tracers), and staffing model (separate, mostly separate, or the same health department staffing for case investigation and contact tracing); 2) case investigation timeliness (the percentage of persons with probable and confirmed COVID-19 prioritized for interview successfully reached within 24 hours by a health department staff member or representative); 3) contact tracing timeliness (the percentage of contacts notified of potential exposure to COVID-19 within 24 hours of elicitation of contact information by a patient); and 4) contact tracing yield, calculated as the number of contacts elicited divided by number of patients prioritized for interview. Because guidance for prioritization of patient interviews was not provided, health departments developed their own criteria, examples of which included interviewing patients when they became known to the health department or prioritizing patient interviews based on whether the patients were symptomatic, had underlying medical conditions, lived in congregate settings, or worked in health care occupations. Descriptive analyses of the four metrics were performed using SAS (version 9.4; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.**

Among the 62 funded health departments, four (6.5%) (all U.S.-affiliated Pacific islands) reported no cases, and two (3.2%) submitted partial data and were excluded. Data from the remaining 56†† (90%) health departments were analyzed.

* https://www.cdc.gov/media/releases/2020/p0423-CARES-act.html; https://www.cdc.gov/media/releases/2020/p0518-hhs-funding-expand-testing-states.html.

† 50 U.S. states, Chicago, Houston, New York City, Philadelphia, Washington D.C., Los Angeles County, American Samoa, Northern Mariana Islands, Federated States of Micronesia, Guam, Palau, Puerto Rico, Marshall Islands, and U.S. Virgin Islands.

§ Patients prioritized for interview refer to persons with confirmed and probable COVID-19 reported to the health department in the official case report system. Prioritization of patients is defined differently by different health departments.

¶ https://www.cdc.gov/ncezid/dpei/epidemiology-laboratory-capacity.html.

** 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.

†† Alabama, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming, Chicago, Houston, New York City, Philadelphia, Los Angeles County, Northern Mariana Islands, Guam, Puerto Rico, and U.S. Virgin Islands

Because completeness of reporting by health departments varied by metric, denominators varied. Health departments with incomplete data for a metric were excluded for that specific metric.

Among reporting health departments, the median caseload per investigator during the evaluation period was 31, ranging from one to 196, among 54 (96%) health departments with complete data for this metric (Table). Among patients prioritized for interview by these 54 health departments, a median of 57% were interviewed within 24 hours of report to the health department. Among 53 health departments that provided information on the average number of contacts assigned for follow-up per contact tracer, the median was 29, ranging from 0.5 to 200; a median of 55% of contacts were notified within 24 hours of elicitation by a patient. Among 48 health departments that reported information on contact notification, 27 (56%) reported that at least one half of contacts were notified within 24 hours of elicitation. However, 12 health departments reported that fewer than one third (<32%) of contacts were reached within 24 hours.

Caseload and timeliness of case investigation were inversely correlated among 49 health departments with complete data for these metrics (Spearman correlation coefficient = –0.68) (Figure 1). Health departments with smaller average caseloads per investigator completed a larger proportion of patient interviews within 24 hours of report. Among four health departments that interviewed >90% of patients within 24 hours, investigators' average caseloads were fewer than 30 patients each, whereas among four health departments with average caseloads >130 patients per investigator, <30% of interviews were completed within 24 hours.

When restricted to patients prioritized for interview (9,013), among 53 health departments that submitted complete data, 42 (79%) reported fewer than two contacts elicited per patient (median = 1.15). The number of contacts elicited per patient prioritized for interview was smaller in health departments with larger caseloads (Spearman correlation coefficient = –0.60) (Figure 2). These trends persisted in jurisdictions that allocated different staff members, mostly different staff members, or the same staff members to be case investigators and contact tracers (Spearman correlation coefficients = –0.89, –0.69, and –0.32, respectively).

Discussion

Health departments' capacity and ability to conduct timely and effective case investigation and contact tracing varied widely across the United States. The ideal workforce size to adequately conduct case investigation and contact tracing per jurisdiction[§§] likely depends on several factors (*4*); however, the inverse relationship between staff member workload and completeness and timeliness of case investigation and contact tracing suggest that increases in staffing capacity might help reduce delays in interviewing patients and identify more contacts. Most state health departments are hiring more staff members to perform contact tracing[¶¶] (*1*). Health departments might choose to prioritize case investigation and contact tracing based on whether persons are likely to be at higher risk for severe disease, live or work in congregate settings, or are part of a known cluster (*5*). Surges in cases might exceed the workforce capacity of jurisdictions to maintain high coverage of case investigation and contact tracing. Continued efforts to ensure notification of patients of their infection and contacts of their exposure are needed. CDC recommends use of prioritization measures to reach populations at risk as well as use of innovative technologies (*6*) to support this public health imperative.

Approximately one half of health departments were able to achieve a median interval of ≤24 hours from first notification of the patient to interview; likewise, approximately one half also were able to achieve a median interval of ≤24 hours from patient interview to contact notification, although these two groups did not always comprise the same health departments. These findings

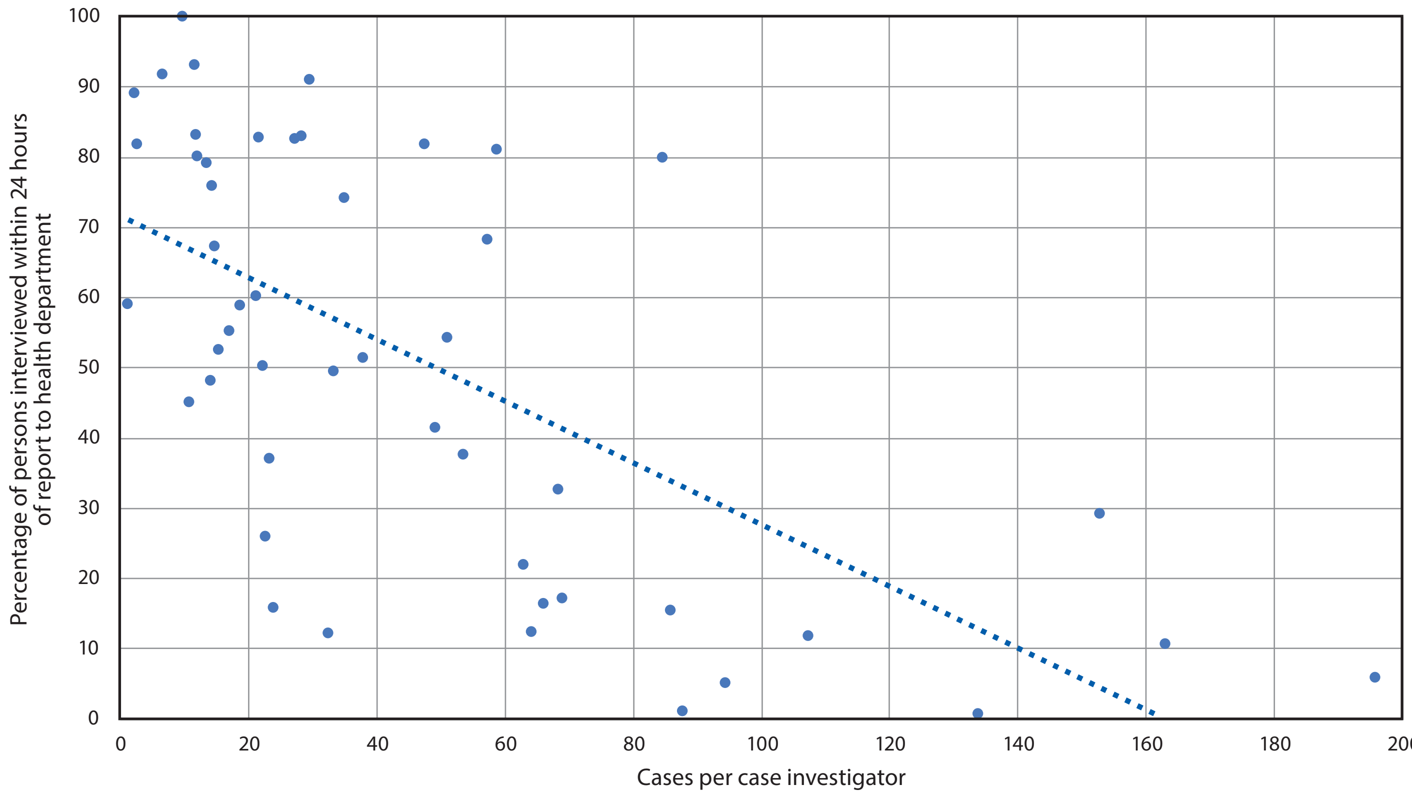
§§ https://www.gwhwi.org/estimator-613404.html.
¶¶ https://www.npr.org/sections/health-shots/2020/06/18/879787448/as-states-reopen-do-they-have-the-workforce-they-need-to-stop-coronavirus-outbre.

TABLE. COVID-19 case investigation and contact tracing metrics — 56 health departments, United States, June 25–July 24, 2020

Metric	Median* (IQR) [total range]	No. (%) of health departments
Case investigation		
Total cases assigned for interview during reporting period	8,306 (1,781–19,671) [22–280,033]	56 (100)
Average no. of cases assigned for interview per case investigator (caseload)	31 (15–68) [1–196]	54 (96)
Prioritized persons interviewed within 24 hrs	57 (27–82) [1–100]	54 (96)
Contact tracing		
Contacts elicited from cases during reporting period	7,498 (2,236–19,937) [124–95,775]	54 (96)
Average no. of contacts assigned for follow-up per contact tracer (contact tracing load)	29 (17–44) [0.5–200]	53 (95)
Contacts notified within 24 hrs of identification by a patient	55 (32–79) [4–100]	48 (86)

Abbreviations: COVID-19 = coronavirus disease 2019; IQR = interquartile range.
* Median caseload and contact tracing loads represent the median of the average per investigator or contact tracer.

FIGURE 1. Association between COVID-19 caseload per health department investigator and timeliness of case interviews — 49 health departments, United States, June 25–July 24, 2020*



Abbreviation: COVID-19 = coronavirus disease 2019.
* The trendline represents the inverse correlation between the average caseload per case investigator and the timeliness of case investigations among 49 health departments.

are comparable with those in recent reports that described median intervals of 1 day from patient report to interview and 1 and 3 days from case investigation to contact notification in two U.S. counties (*1*,*7*). The evaluation period in this report, June 25–July 24, 2020, corresponded to a time of increased COVID-19 incidence (*8*); the capacity of health departments in jurisdictions with large numbers of cases to conduct timely patient follow-up and contact notification could be overwhelmed.

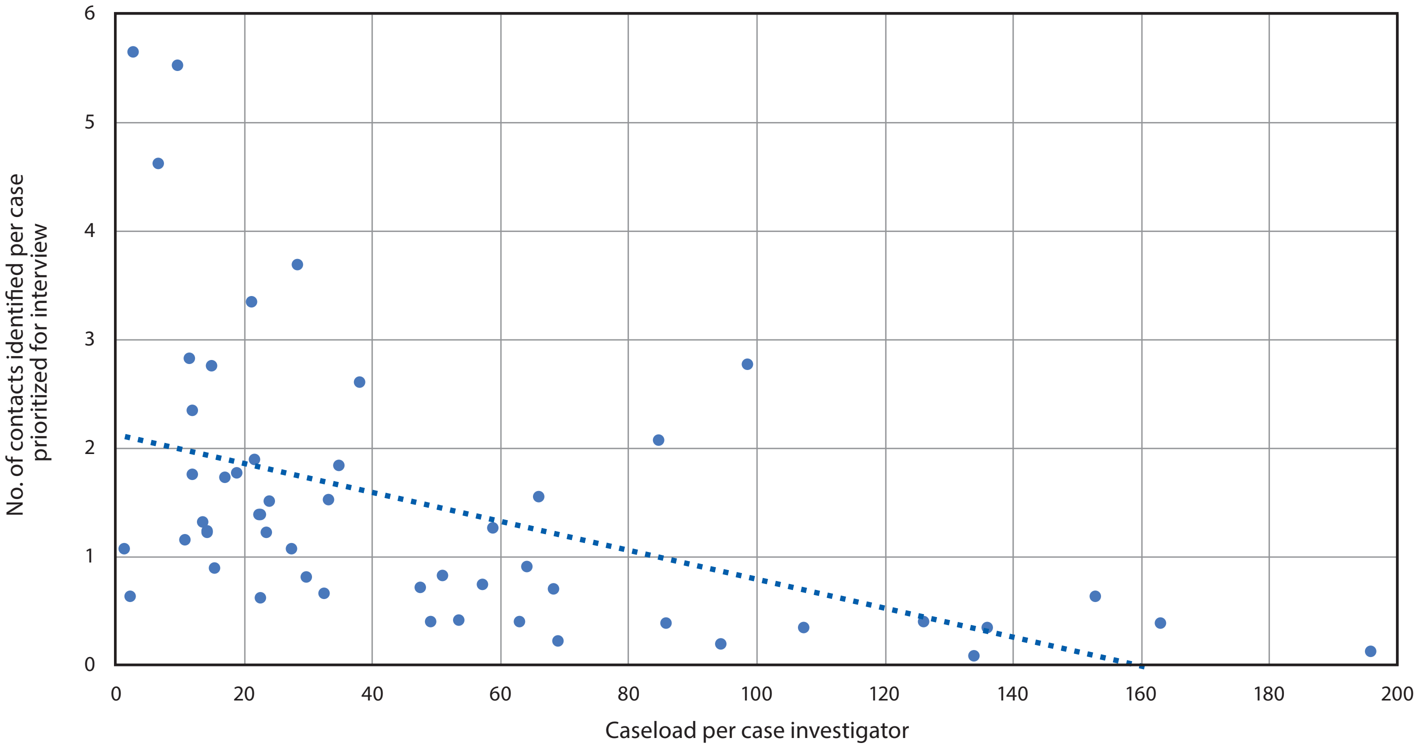
The median number of contacts elicited per patient prioritized for interview was 1.15. The number of contacts elicited per patient would have been higher if limited to the number of patients who completed an interview rather than those who were prioritized for an interview; however, the number of patients who completed an interview was not collected at this time, and the calculation was not possible. A recent assessment of two North Carolina counties reported an average of 3.0 and 4.6 contacts named per interviewed patient during a similar time frame (*1*). A contact tracing team in central Pennsylvania identified 953 contacts elicited among 536 confirmed patients (1.8 contacts per patient) during March 24–May 28; the lower number of contacts per patient might be related to the widespread stay-at-home orders that were in effect during that time (*9*).

One contributor to low numbers of contacts elicited might be related to reluctance to engage in contact tracing efforts*** or to name persons other than household contacts (*1*). The number of contacts elicited might vary by caseload, owing to worker fatigue or inexperience; with higher caseloads, contact tracers might be less likely to persist with questioning to identify additional contacts.

The findings in this report are subject to at least four limitations. First, these data are self-reported by health departments and were likely generated from new data systems designed to monitor case investigation and contact tracing. New systems could be prone to errors and might not reflect complete performance within the jurisdiction. Second, data validity might be affected by health departments' varying interpretations of definitions of metrics. These data include that obtained during health departments' first reporting period on these metrics, which will continue to be refined. Third, these data precluded calculation of the average number of contacts elicited per patient who completed an interview, and therefore do not align with other

*** https://www.scientificamerican.com/article/contact-tracing-a-key-way-to-slow-covid-19-is-badly-underused-by-the-u-s/.

FIGURE 2. Association between the COVID-19 caseload per health department investigator and number of close contacts identified per case prioritized for interview — 52 health departments, United States, June 25–July 24, 2020*



Abbreviation: COVID-19 = coronavirus disease 2019.
* The trendline represents the inverse correlation between the average caseload per case investigator and the number of contacts elicited per patient prioritized for interview among 52 health departments.

studies' methods of calculating contacts elicited (*1*); the actual number is likely higher, warranting cautious interpretation. Finally, an important component of contact tracing is laboratory test timeliness, which is not included in these data. During the COVID-19 pandemic, delays from the time of laboratory specimen collection to report to the health department can have substantial impact on total time to reach a contact (*2*,*9*); the absence of these data in an assessment of contact tracing timeliness is an especially important limitation of this report.

Delays in interviewing COVID-19 patients decrease the likelihood of quickly identifying and quarantining contacts. Low ascertainment of contacts affects the nation's potential to interrupt the transmission of SARS-CoV-2 through rapid notification, quarantining, and testing. Caseloads within jurisdictions influence how quickly health departments can reach patients, which might influence the completeness of data used to reach contacts. Increasing staffing capacity might improve the timeliness of case interviews. Strengthening awareness regarding state and local health department contact tracing efforts might improve community perception or willingness to provide more complete lists of contacts.

Summary

What is already known about this topic?

Resources have been allocated to supplement the U.S. case investigation and contact tracing workforce as a public health tool to interrupt the spread of COVID-19.

What is added by this report?

Analysis of case investigation and contact tracing metric data reported by 56 U.S. health departments found wide variation in capacity and ability to conduct timely and effective contact tracing. Investigator caseload was inversely related to timely interviewing of patients and number of contacts identified per case.

What are the implications for public health practice?

Enhanced staffing capacity and ability and improved community engagement could lead to more timely contact tracing interviews and identification of more contacts.

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COVID-19 Trends Among Persons Aged 0–24 Years — United States, March 1–December 12, 2020

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On January 13, 2021, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

Coronavirus disease 2019 (COVID-19) case and electronic laboratory data reported to CDC were analyzed to describe demographic characteristics, underlying health conditions, and clinical outcomes, as well as trends in laboratory-confirmed COVID-19 incidence and testing volume among U.S. children, adolescents, and young adults (persons aged 0–24 years). This analysis provides a critical update and expansion of previously published data, to include trends after fall school reopenings, and adds preschool-aged children (0–4 years) and college-aged young adults (18–24 years) (*1*). Among children, adolescents, and young adults, weekly incidence (cases per 100,000 persons) increased with age and was highest during the final week of the review period (the week of December 6) among all age groups. Time trends in weekly reported incidence for children and adolescents aged 0–17 years tracked consistently with trends observed among adults since June, with both incidence and positive test results tending to increase since September after summer declines. Reported incidence and positive test results among children aged 0–10 years were consistently lower than those in older age groups. To reduce community transmission, which will support schools in operating more safely for in-person learning, communities and schools should fully implement and strictly adhere to recommended mitigation strategies, especially universal and proper masking, to reduce COVID-19 incidence.

Children, adolescents, and young adults were stratified into five age groups: 0–4, 5–10, 11–13, 14–17, and 18–24 years to align with educational groupings (i.e., pre-, elementary, middle, and high schools, and institutions of higher education), and trends in these groups were compared with those in adults aged ≥25 years. Confirmed COVID-19 cases, defined as positive real-time reverse transcription–polymerase chain reaction (RT-PCR) test results for SARS-CoV-2, the virus that causes COVID-19, were identified from individual-level case reports submitted by state and territorial health departments during March 1–December 12, 2020.* COVID-19 case data for all confirmed cases were analyzed to examine demographic characteristics, underlying health conditions,† and outcomes. Trends in COVID-19 incidence were analyzed using a daily 7-day moving average, aggregated by week,§ and expressed as cases per 100,000 persons.¶

Trends in laboratory testing volume and percentage of positive test results were assessed using COVID-19 electronic laboratory reporting data. SARS-CoV-2 RT-PCR test results for May 31–December 12, 2020 were obtained from electronic laboratory reporting data submitted to CDC by health departments from 44 states, the District of Columbia, two territories, and one freely associated state; when information was unavailable in state-submitted data, records submitted directly by public health, commercial, and reference laboratories were used.** Data represent test results, not number of persons receiving tests; test result date was used for analyses. The weekly percentage of positive SARS-CoV-2 RT-PCR test results was calculated as the number of positive test results divided by the sum of positive and negative test results. Because some data elements are incomplete for more than 47% of cases, percentages were calculated only from among those with available information. This project was deemed nonresearch public health practice by the CDC and conducted consistent with applicable federal law and CDC policy.†† Analyses were conducted using R software (version 4.0.2; The R Foundation).

* CDC official counts of COVID-19 cases and deaths, released daily at https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html, are aggregate counts from reporting jurisdictions. Individual-level case report data were available for approximately 75% of the aggregate number of confirmed cases. Cases reported without sex or age data and in persons repatriated to the United States from Wuhan, China, or the Diamond Princess cruise ship were excluded from this analysis.

† Underlying health conditions were defined based on the categories included in the COVID-19 Case Report Form. https://www.cdc.gov/coronavirus/2019-ncov/downloads/pui-form.pdf.

§ Weekly incidence date based on the earliest symptom onset date reported for each COVID-19 case. If symptom onset date was missing, earliest onset date was populated with the earliest date in a series of variables submitted by the jurisdiction, including symptom resolution date, positive specimen date, diagnosis date, specimen collection date (for sputum, nasopharyngeal, oropharyngeal, or other specimen type), hospital or ICU admission or discharge date, date of death, or the date of case reporting to CDC.

¶ Population estimates used in calculating incidence were obtained from the Kids Count Data Center. https://datacenter.kidscount.org/data.

** COVID-19 Electronic Laboratory Reporting data submitted by state health departments from all laboratories performing SARS-CoV-2 RT-PCR testing were used for 44 states, the District of Columbia, Guam, Marshall Islands, and Northern Mariana Islands. SARS-CoV-2 RT-PCR testing data from a subset of public health, commercial, and reference laboratories were used for six states for which data were not directly submitted by state health departments (Maine, Missouri, Ohio, Oklahoma, Washington, and Wyoming), Puerto Rico, and the U.S. Virgin Islands. The data might not include results from all testing sites within a jurisdiction and therefore might reflect the majority of, but not all, SARS-CoV-2 RT-PCR tests in the United States. The data represent laboratory test totals, not individual persons tested, and exclude antibody and antigen tests.

†† 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.

During March 1–December 12, 2020, a total of 2,871,828 laboratory-confirmed cases of COVID-19 in children, adolescents, and young adults aged 0–24 years were reported in the United States. Among these cases, the majority (57.4%) occurred among young adults aged 18–24 years; children and adolescents aged 14–17 years accounted for 16.3% of cases, those 11–13 years for 7.9%, those 5–10 years for 10.9%, and those 0–4 years for 7.4% (Table). Overall, 51.8% of cases occurred in females. Among the 1,504,165 (52.4%) children, adolescents, and young adults with COVID-19 with complete information on race/ethnicity, 50.2% were non-Hispanic White, 27.4% were Hispanic/Latino (Hispanic), and 11.7% were non-Hispanic Black. The proportion of cases among Hispanic persons decreased with increasing age from 34.4% among those aged 0–4 years to 24.6% among those aged 18–24 years.[§§]

Among persons aged 0–24 years, weekly incidence was higher in each successively increasing age group; weekly incidence among adults aged 25–64 years and ≥65 years exceeded that among children and adolescents aged 0–13 years throughout the review period (Figure 1). Weekly incidence was highest during the final week of the review period (the week of December 6) in all age groups: 99.9 per 100,000 (0–4 years), 131.4 (5–10 years), 180.6 (11–13 years), 255.6 (14–17 years), and 379.3 (18–24 years). Trends in weekly incidence for all age groups aged 0–17 years paralleled those observed among adults since June. The trend in incidence among young adults aged 18–24 years had a distinct and more prominent peak during the week of September 6.

Weekly SARS-CoV-2 laboratory testing among children, adolescents, and young adults increased 423.3% from 435,434 tests during the week beginning May 31 to 2,278,688 tests during the week beginning December 6 (Figure 2).[¶¶] At their peak during the week of November 15, tests conducted among children and adolescents aged 0–17 years represented 9.5% of all tests performed, and tests among young adults aged 18–24 years represented 15.3% (Supplementary Figure 1, URL https://stacks.cdc.gov/view/cdc/100246). As observed in trends in incidence, weekly percentage of positive test results among children and adolescents paralleled those of adults, declining between July and September, and then increasing through December (Supplementary Figure 2, URL https://stacks.cdc.gov/view/cdc/100246). Percentage of positive test results among young adults aged 18–24 years peaked earlier in June and increased slightly in late August; this was not observed among other age groups. In contrast to incidence, percentage of positive test results among children and adolescents aged 11–17 years exceeded that among younger children for all weeks and that of all age groups since the week beginning September 6; test volumes over time were lowest among children and adolescents aged 11–13 years, suggesting incidence among these age groups might be underestimated.

Among cases reviewed, data were available for 41.9%, 8.9%, and 49.1% of cases for hospitalizations, intensive care unit (ICU) admissions, and deaths, respectively. Among children, adolescents, and young adults with available data for these outcomes, 30,229 (2.5%) were hospitalized, 1,973 (0.8%) required ICU admission, and 654 (<0.1%) died (Table), compared with 16.6%, 8.6%, and 5.0% among adults aged ≥25 years, respectively. Among children, adolescents, and young adults, the largest percentage of hospitalizations (4.6%) and ICU admissions (1.8%) occurred among children aged 0–4 years. Among 379,247 (13.2%) children, adolescents, and young adults with COVID-19 and available data on underlying conditions, at least one underlying condition or underlying health condition was reported for 114,934 (30.3%), compared with 836,774 (60.4%) among adults aged ≥25 years.

Discussion

Reported weekly incidence of COVID-19 and percentage of positive test results among children, adolescents, and young adults increased during the review period, with spikes in early summer, followed by a decline and then steeply increased in October through December. In general, trends in incidence and percentage of positive test results among preschool-aged children (0–4 years) and school-aged children and adolescents (5–17 years) paralleled those among adults throughout the summer and fall, including during the months that some schools were reopening or open for in-person education. In addition, reported incidence among children, adolescents, and young adults increased with age; among children aged 0–10 years, incidence and percentage of positive test results were consistently lower than they were among older age groups. Case data do not indicate that increases in incidence or percentage of positive test results among adults were preceded by increases among preschool- and school-aged children and adolescents. In contrast, incidence among young adults (aged 18–24 years) was higher than that in other age groups throughout the summer and fall, with peaks in mid-July and early September that preceded increases among other age groups, suggesting that young adults might contribute more to community transmission than do younger children.

Findings from national case and laboratory surveillance data complement available evidence regarding risk for transmission in school settings. As of December 7, nearly two thirds

§§ In 2019, children and adolescents of Hispanic/Latino ethnicity accounted for 26% of children aged 0–17 years; children and adolescents of non-Hispanic Black race accounted for 14% of children aged 0–17 years; and children and adolescents of non-Hispanic White race accounted for 50% of children and adolescents aged 0–17 years in the United States. https://datacenter.kidscount.org/data/customreports/1/103/compared,single#ind103.

¶¶ The percentage increase in test volume between the weeks beginning May 31 and December 6 by age group were 328.0% (0–4 years), 644.1% (5–10 years), 669.2% (11–13 years), 536.3% (14–17 years), and 368.1% (18–24 years).

TABLE. Demographic characteristics and underlying conditions among persons aged 0–24 years with positive test results for SARS-CoV-2 — United States, March 1–December 12, 2020

Characteristic	Age group, yrs, no. (%)						
	0–24	0–17	0–4	5–10	11–13	14–17	18–24
Total	**2,871,828 (100)**	**1,222,023 (42.6)**	**212,879 (7.4)**	**313,913 (10.9)**	**227,238 (7.9)**	**467,993 (16.3)**	**1,649,805 (57.4)**
Sex							
Female	1,469,744 (51.8)	603,948 (50.0)	100,935 (48.2)	152,494 (49.1)	111,683 (49.7)	238,836 (51.6)	865,796 (53.1)
Male	1,367,271 (48.2)	603,029 (50.0)	108,457 (51.8)	157,769 (50.8)	112,930 (50.3)	223,873 (48.4)	764,242 (46.9)
Other	53 (<0.1)	18 (<0.1)	2 (<0.1)	3 (<0.1)	2 (<0.1)	11 (<0.1)	35 (<0.1)
Missing/Unknown	34,760 (N/A)	15,028 (N/A)	3,485 (N/A)	3,647 (N/A)	2,623 (N/A)	5,273 (N/A)	19,732 (N/A)
Median age (years)	**19**	**9**	**2**	**8**	**12**	**16**	**21**
Symptom Status							
Yes	1,247,552 (94.1)	524,390 (91.9)	87,646 (90.4)	126,010 (88.9)	97,831 (91.8)	212,903 (94.5)	723,162 (95.8)
No	77,899 (5.9)	46,166 (8.1)	9,281 (9.6)	15,720 (11.1)	8,736 (8.2)	12,429 (5.5)	31,733 (4.2)
Missing/Unknown*	1,546,377 (N/A)	651,467 (N/A)	115,952 (N/A)	172,183 (N/A)	120,671 (N/A)	242,661 (N/A)	894,910 (N/A)
Race/Ethnicity†							
Hispanic/Latino	411,775 (27.4)	200,397 (31.0)	38,553 (34.4)	54,457 (33.0)	38,094 (32.0)	69,293 (27.8)	211,378 (24.6)
White, non-Hispanic	754,801 (50.2)	292,930 (45.4)	42,384 (37.8)	68,887 (41.8)	53,772 (45.1)	127,887 (51.3)	461,871 (53.8)
Black, non-Hispanic	176,059 (11.7)	79,291 (12.3)	16,355 (14.6)	21,308 (12.9)	14,228 (11.9)	27,400 (11.0)	96,768 (11.3)
Asian/Pacific Islander, non-Hispanic	50,224 (3.3)	21,243 (3.3)	4,716 (4.2)	6,109 (3.7)	3,556 (3.0)	6,862 (2.8)	28,981 (3.4)
American Indian/Alaska Native, non-Hispanic	23,396 (1.6)	12,887 (2.0)	2,249 (2.0)	3,653 (2.2)	2,610 (2.2)	4,375 (1.8)	10,509 (1.2)
Multiracial/Other race	87,910 (5.8)	38,923 (6.0)	7,860 (7.0)	10,490 (6.4)	6,911 (5.8)	13,662 (5.5)	48,987 (5.7)
Missing/Unknown*	1,367,663 (N/A)	576,352 (N/A)	100,762 (N/A)	149,009 (N/A)	108,067 (N/A)	218,514 (N/A)	791,311 (N/A)
Underlying condition§							
Any	114,934 (30.3)	43,388 (27.6)	6,334 (23.7)	10,203 (26.4)	8,206 (28.8)	18,645 (29.5)	71,546 (32.2)
None	264,313 (69.7)	113,621 (72.4)	20,426 (76.3)	28,386 (73.6)	20,280 (71.2)	44,529 (70.5)	150,692 (67.8)
Missing/Unknown*	2,492,581 (N/A)	1,065,014 (N/A)	186,119 (N/A)	275,324 (N/A)	198,752 (N/A)	404,819 (N/A)	1,427,567 (N/A)
Known condition¶	421,078 (14.7)	176,766 (14.5)	30,665 (14.4)	43,765 (13.9)	32,122 (14.1)	70,214 (15.0)	244,312 (14.8)
Chronic lung disease	26,937 (6.4)	10,521 (6.0)	786 (2.6)	2,495 (5.7)	2,316 (7.2)	4,924 (7.0)	16,416 (6.7)
Disability**	4,162 (1.0)	1,992 (1.1)	243 (0.8)	497 (1.1)	411 (1.3)	841 (1.2)	2,170 (0.9)
Immunosuppression	3,495 (0.8)	1,373 (0.8)	196 (0.6)	323 (0.7)	237 (0.7)	617 (0.9)	2,122 (0.9)
Diabetes mellitus	4,030 (1.0)	1,104 (0.6)	63 (0.2)	133 (0.3)	237 (0.7)	671 (1.0)	2,926 (1.2)
Psychological	3,055 (0.7)	1,176 (0.7)	23 (0.1)	153 (0.3)	231 (0.7)	769 (1.1)	1,879 (0.8)
Cardiovascular disease	3,103 (0.7)	1,133 (0.6)	266 (0.9)	239 (0.5)	163 (0.5)	465 (0.7)	1,970 (0.8)
Current/Former smoker	15,362 (3.6)	798 (0.5)	37 (0.1)	42 (0.1)	39 (0.1)	680 (1.0)	14,564 (6.0)
Severe obesity††	1,865 (0.4)	566 (0.3)	32 (0.1)	109 (0.2)	121 (0.4)	304 (0.4)	1,299 (0.5)
Chronic kidney disease	796 (0.2)	336 (0.2)	80 (0.3)	77 (0.2)	44 (0.1)	135 (0.2)	460 (0.2)
Hypertension	1,788 (0.4)	272 (0.2)	43 (0.1)	20 (0)	29 (0.1)	180 (0.3)	1,516 (0.6)
Autoimmune disease	919 (0.2)	305 (0.2)	17 (0.1)	45 (0.1)	56 (0.2)	187 (0.3)	614 (0.3)
Chronic liver disease	407 (0.1)	137 (0.1)	22 (0.1)	24 (0.1)	22 (0.1)	69 (0.1)	270 (0.1)
Substance abuse/use	355 (0.1)	72 (<0.1)	1 (<0.1)	1 (<0.1)	6 (<0.1)	64 (0.1)	283 (0.1)
Other	10,100 (2.4)	3,511 (2.0)	665 (2.2)	725 (1.7)	581 (1.8)	1,540 (2.2)	6,589 (2.7)

See table footnotes on the next page.

(62.0%) of U.S. kindergarten through grade 12 (K–12) school districts offered either full or partial (hybrid with virtual) in-person learning.*** Despite this level of in-person learning, reports to CDC of outbreaks within K–12 schools have been limited,††† and as of the week beginning December 6, aggregate COVID-19 incidence among the general population in counties where K–12 schools offer in-person education (401.2 per 100,000) was similar to that in counties offering only virtual/online education (418.2 per 100,000).§§§ Several U.S. school districts with routine surveillance of in-school cases report lower incidence among students than in the

*** https://www.mchdata.com/covid19/schoolclosings.

††† In addition to routine case surveillance reports, CDC receives regular updates from state, local, and tribal health departments, as well as various school districts. School-based outbreaks have been periodically reported to CDC at the time jurisdictions request technical assistance. In the context of childcare and K–12 schools, requests for assistance have more frequently been in response to a single case or small clusters of cases. Reports of large outbreaks in these settings have been rare.

§§§ Data presented are for the week beginning December 6, 2020. Aggregate case incidence is the rate derived after summing the case and population values for counties that currently have that K–12 teaching plans. Among the 2,717 counties having school districts with currently known teaching plans, 1,696 had school districts with differing methods. For these counties, case incidence and positive test result data are proportionately allocated into a specific plan based on the ratio of total enrollment for school districts that currently have that plan type to the total enrollment for all school districts in that county. Population estimates were obtained from the Vintage 2019 Bridged-Race Postcensal Population Estimates for Calculating Vital Rates (https://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm). County-level case counts were obtained from CDC County Aggregate figures (extracted December 28, 2020). School enrollment data and school reopening plans were obtained from MCH Strategic Data (https://www.mchdata.com/covid19/schoolclosings, extracted December 28, 2020). Data were extracted and analyzed by the Johns Hopkins University Applied Physics Laboratory.

TABLE. (*Continued*) Demographic characteristics and underlying conditions among persons aged 0–24 years with positive test results for SARS-CoV-2 — United States, March 1–December 12, 2020

	Age group, yrs, no. (%)						
Characteristic	**0–24**	**0–17**	**0–4**	**5–10**	**11–13**	**14–17**	**18–24**
Outcome							
Hospitalized							
Yes	30,229 (2.5)	11,882 (2.3)	4,294 (4.6)	1,983 (1.5)	1,598 (1.6)	4,007 (2.0)	18,347 (2.7)
No	1,172,310 (97.5)	514,834 (97.7)	88,786 (95.4)	132,108 (98.5)	96,021 (98.4)	197,919 (98.0)	657,476 (97.3)
Missing/Unknown*	1,669,289 (N/A)	695,307 (N/A)	119,799 (N/A)	179,822 (N/A)	129,619 (N/A)	266,067 (N/A)	973,982 (N/A)
ICU admission							
Yes	1,973 (0.8)	866 (0.8)	288 (1.8)	168 (0.6)	131 (0.6)	279 (0.6)	1,107 (0.8)
No	252,961 (99.2)	109,234 (99.2)	16,091 (98.2)	25,968 (99.4)	20,574 (99.4)	46,601 (99.4)	143,727 (99.2)
Missing/Unknown*	2,616,894 (N/A)	1,111,923 (N/A)	196,500 (N/A)	287,777 (N/A)	206,533 (N/A)	421,113 (N/A)	1,504,971 (N/A)
Died							
Yes	654 (<0.1)	178 (<0.1)	52 (<0.1)	30 (<0.1)	27 (<0.1)	69 (<0.1)	476 (0.1)
No	1,409,626 (100)	620,989 (100)	111,437 (100)	162,971 (100)	115,664 (100)	230,917 (100)	788,637 (99.9)
Missing/Unknown*	1,461,548 (N/A)	600,856 (N/A)	101,390 (N/A)	150,912 (N/A)	111,547 (N/A)	237,007 (N/A)	860,692 (N/A)

Abbreviations: ICU = intensive care unit; N/A = not available.
* Data are missing for more than 47% of cases. Percentages are calculated from among those with available information only.
† Cases reported as Hispanic or Latino were categorized as "Hispanic/Latino" regardless of availability of race data.
§ Underlying conditions were defined based on the categories included in the COVID-19 Case Report Form including diabetes mellitus, hypertension, severe obesity, cardiovascular disease, chronic renal disease, chronic liver disease, chronic lung disease (asthma, emphysema, and chronic obstructive pulmonary disease [COPD]), other (specified) chronic diseases, other (specified) underlying condition or risk behavior, immunosuppressive conditions, autoimmune conditions, being a current or former smoker, substance abuse or misuse, disability, and psychological/psychiatric condition. Although obesity in children is defined using body mass index percentile, these data are drawn from the COVID-19 Case Report Form, in which severe obesity is defined as noted.
¶ Status of underlying health conditions were known for 421,078 persons aged 0–24 years. Condition status was classified as "known" if any of the conditions included in the COVID-19 Case Report Form were reported as present or absent. Proportion of cases with each individual condition were calculated among persons with known condition status.
** Disability included neurologic or neurodevelopmental disorders, intellectual or physical disability, and vision or hearing impairment.
†† Body mass index ≥40 kg/m2. Although obesity in children is defined using body mass index percentile, these data are drawn from the COVID-19 Case Report Form, in which severe obesity is defined as noted.

surrounding communities¶¶¶ (*2*), and a recent study found no increase in COVID-19 hospitalization rates associated with in-person education (*3*). In contrast to the evidence regarding K–12 school reopenings, previous studies provide evidence for increased community incidence in counties where institutions of higher education reopened for in-person instruction (*4*), and presented case surveillance data showed unique trends.

Success in preventing introduction and transmission of SARS-CoV-2 in schools depends upon both adherence to mitigation strategies in schools and controlling transmission in communities (*5*). In settings with low community incidence, where testing and effective mitigation strategies were in place, studies of in-school transmission have provided preliminary evidence of success in controlling secondary transmission in child care centers and schools (*6*–*8*). Schools provide a structured environment that can support adherence to critical mitigation measures to help prevent and slow the spread of COVID-19. When community transmission is high, cases in schools should be expected, and as with any group setting, schools can contribute to COVID-19 transmission (*5*–*7*), especially when mitigation measures, such as universal and proper masking, are not implemented or followed.

The findings in this report are subject to at least four limitations. First, COVID-19 incidence is likely underestimated among children and adolescents because testing volume among these age groups was lower than that for adults, the rate of

Summary

What is already known about this topic?

Studies have consistently shown that children, adolescents, and young adults are susceptible to SARS-CoV-2 infections. Children and adolescents have had lower incidence and fewer severe COVID-19 outcomes than adults.

What is added by this report?

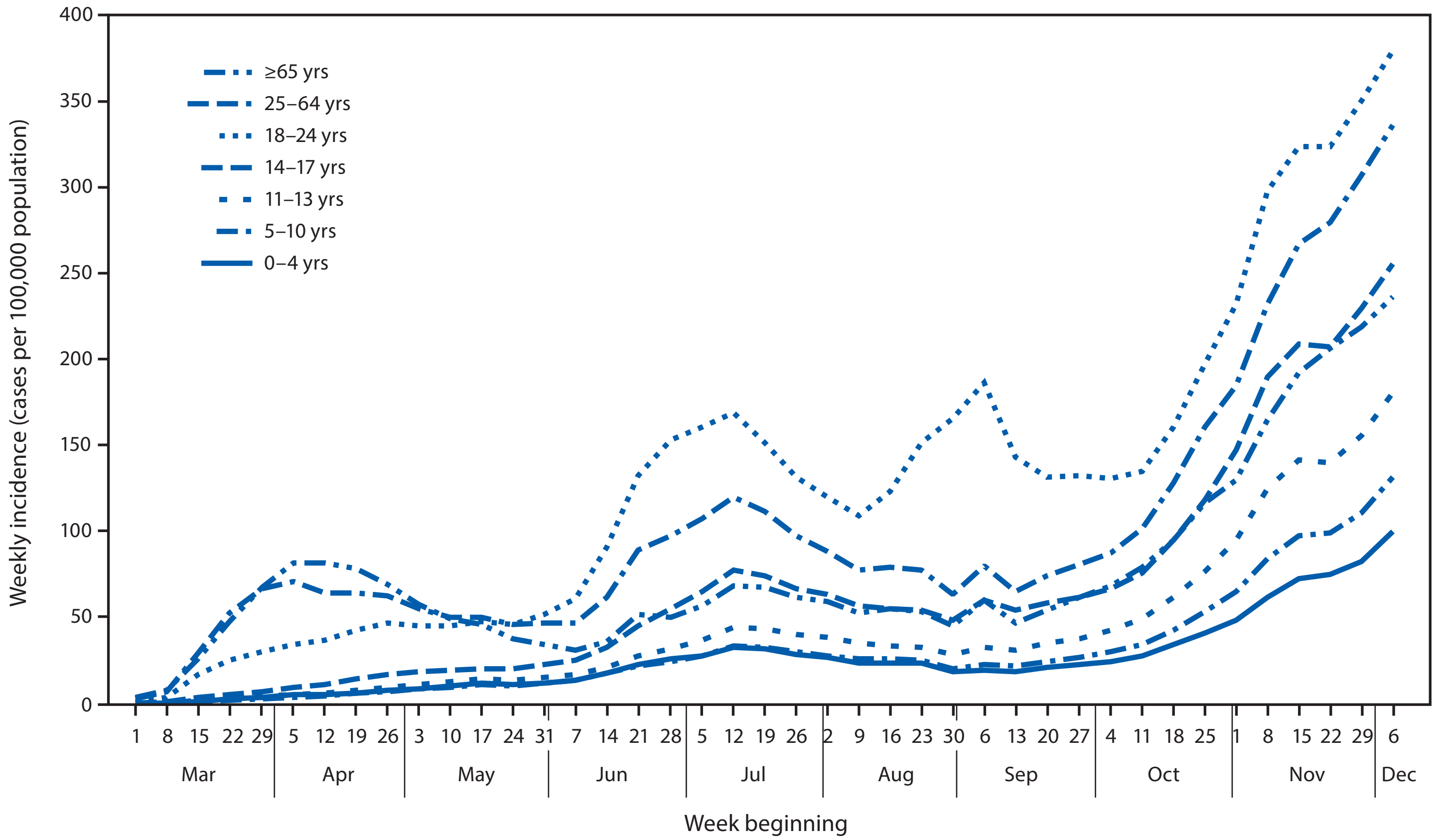
COVID-19 cases in children, adolescents, and young adults have increased since summer 2020, with weekly incidence higher in each successively increasing age group. Trends among children and adolescents aged 0–17 years paralleled those among adults.

What are the implications for public health practice?

To enable safer in-person learning, schools and communities should fully implement and strictly adhere to multiple mitigation strategies, especially universal and proper mask wearing, to reduce both school and community COVID-19 incidence to help protect students, teachers, and staff members from COVID-19.

¶¶¶ Cases and enrollment reported by the New York Department of Health (https://schoolcovidreportcard.health.ny.gov/#/summary) since October 12, 2020, are analyzed on the National COVID-19 School Response Dashboard (https://covidschooldashboard.com) which presents case and infection rates.

FIGURE 1. COVID-19 weekly incidence,*,† by age group — United States, March 1–December 12, 2020§



Abbreviation: COVID-19 = coronavirus disease 2019.
* The 7-day moving average of new cases (current day + 6 preceding days/7) was calculated to smooth expected variation in daily case counts.
† Incidence was calculated per 100,000 population using 2019 U.S. Census population estimates obtained from Kids Count Data Center (https://datacenter.kidscount.org/data).
§ Data included through December 12, 2020, so that each week has a full 7 days of data.

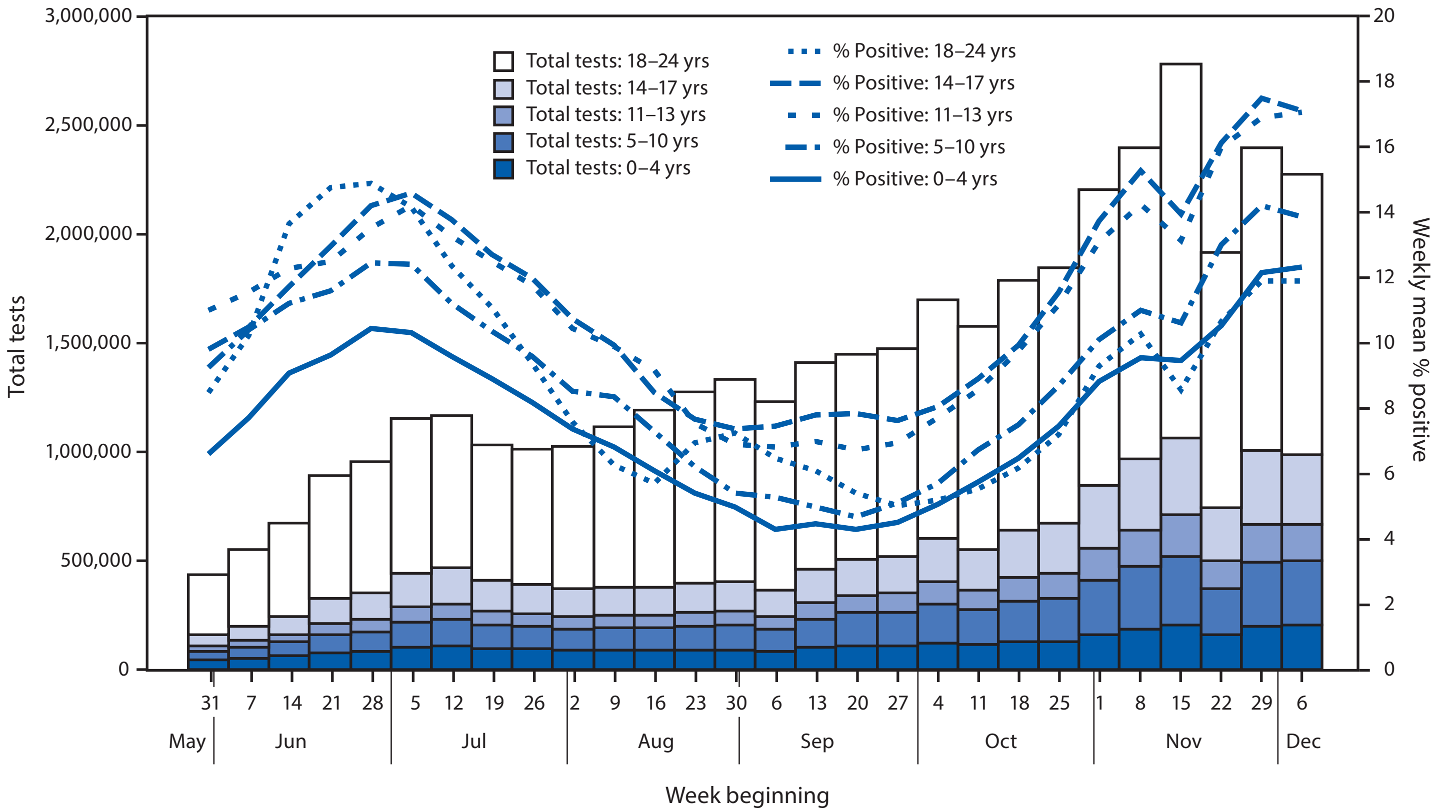
positive test results was generally higher among children and adolescents (particularly those aged 11–17 years) than that among adults, and testing frequently prioritized persons with symptoms; asymptomatic infection in children and adolescents occurs frequently (*9*). Second, data on race/ethnicity, symptom status, underlying conditions, and outcomes are incomplete, and completeness varied by jurisdiction; therefore, results for these variables might be subject to reporting biases and should be interpreted with caution. Future reporting would be enhanced by prioritizing completeness of these indicators for all case surveillance efforts. Third, the reporting of laboratory data differs by jurisdiction and might underrepresent the actual volume of laboratory tests performed; as well, reporting of laboratory and case data are not uniform.**** Finally, the presented analysis explores case surveillance data for children, adolescents, and young adults; trends in cases among teachers and school staff members are not available because cases are not routinely reported nationally by occupations other than health care workers.

Lower incidence among younger children and evidence from available studies (*2*–*8*) suggest that the risk for COVID-19 introduction and transmission among children associated with reopening child care centers and elementary schools might be lower than that for reopening high schools and institutions of higher education. However, for schools to operate safely to accommodate in-person learning, communities should fully implement and strictly adhere to multiple mitigation strategies, especially universal and proper masking, to reduce COVID-19 incidence within the community as well as within schools to protect students, teachers, and staff members. CDC recommends that K–12 schools be the last settings to close after all other mitigation measures have been employed and the first to reopen when they can do so safely (*10*). CDC offers tools†††† to help child care programs, schools, colleges and universities, parents, and caregivers plan, prepare, and respond to

**** Percentage positive for laboratory data for some states relied on data reported directly to CDC from public health laboratories and a sample of six large commercial laboratories.

†††† https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/index.html.

FIGURE 2. Weekly test volume and percentage of SARS-CoV-2-positive test results* among persons aged 0–24 years, by age group — United States, May 31–December 12, 2020†



* By reverse transcription–polymerase chain reaction testing.
† Data included through December 12, 2020, so that each week has a full 7 days of data.

COVID-19, thereby helping to protect students, teachers, and staff members and slowing community spread of COVID-19.

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Emergence of SARS-CoV-2 B.1.1.7 Lineage — United States, December 29, 2020–January 12, 2021

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On December 14, 2020, the United Kingdom reported a SARS-CoV-2 variant of concern (VOC), lineage B.1.1.7, also referred to as VOC 202012/01 or 20I/501Y.V1.* The B.1.1.7 variant is estimated to have emerged in September 2020 and has quickly become the dominant circulating SARS-CoV-2 variant in England (*1*). B.1.1.7 has been detected in over 30 countries, including the United States. As of January 13, 2021, approximately 76 cases of B.1.1.7 have been detected in 12 U.S. states.† Multiple lines of evidence indicate that B.1.1.7 is more efficiently transmitted than are other SARS-CoV-2 variants (*1*–*3*). The modeled trajectory of this variant in the U.S. exhibits rapid growth in early 2021, becoming the predominant variant in March. Increased SARS-CoV-2 transmission might threaten strained health care resources, require extended and more rigorous implementation of public health strategies (*4*), and increase the percentage of population immunity required for pandemic control. Taking measures to reduce transmission now can lessen the potential impact of B.1.1.7 and allow critical time to increase vaccination coverage. Collectively, enhanced genomic surveillance combined with continued compliance with effective public health measures, including vaccination, physical distancing, use of masks, hand hygiene, and isolation and quarantine, will be essential to limiting the spread of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19). Strategic testing of persons without symptoms but at higher risk of infection, such as those exposed to SARS-CoV-2 or who have frequent unavoidable contact with the public, provides another opportunity to limit ongoing spread.

Global genomic surveillance and rapid open-source sharing of viral genome sequences have facilitated near real-time detection, comparison, and tracking of evolving SARS-CoV-2 variants that can inform public health efforts to control the pandemic. Whereas some mutations in the viral genome emerge and then recede, others might confer a selective advantage to the variant, including enhanced transmissibility, so that such a variant can rapidly dominate other circulating variants. Early in the pandemic, variants of SARS-CoV-2 containing the D614G mutation in the spike (S) protein that increases receptor binding avidity rapidly became dominant in many geographic regions (*5*,*6*).

In late fall 2020, multiple countries reported detecting SARS-CoV-2 variants that spread more efficiently. In addition to the B.1.1.7 variant, notable variants include the B.1.351 lineage first detected in South Africa and the recently identified B.1.1.28 subclade (renamed "P.1") detected in four travelers from Brazil during routine screening at the Haneda (Tokyo) airport.§ These variants carry a constellation of genetic mutations, including in the S protein receptor-binding domain, which is essential for binding to the host cell angiotensin-converting enzyme-2 (ACE-2) receptor to facilitate virus entry. Evidence suggests that other mutations found in these variants might confer not only increased transmissibility but might also affect the performance of some diagnostic real-time reverse transcription–polymerase chain reaction (RT-PCR) assays¶ and reduce susceptibility to neutralizing antibodies (*2*,*3*,*5*–*10*). A recent case report documented the first case of SARS-CoV-2 reinfection in Brazil with a SARS-CoV-2 variant that contained the E484K mutation,** which has been shown to reduce neutralization by convalescent sera and monoclonal antibodies (*9*,*10*).

This report focuses on the emergence of the B.1.1.7 variant in the United States. As of January 12, 2021, neither the B.1.351 nor the P.1 variants have been detected in the United States. For information about emerging SARS-CoV-2 variants of concern, CDC maintains a webpage dedicated to providing information on emerging SARS-CoV-2 variants.††

B.1.1.7 lineage (20I/501Y.V1)

The B.1.1.7 variant carries a mutation in the S protein (N501Y) that affects the conformation of receptor-binding domain. This variant has 13 other B.1.1.7 lineage-defining

* https://www.gov.uk/government/news/phe-investigating-a-novel-variant-of-covid-19.

† https://www.cdc.gov/coronavirus/2019-ncov/transmission/variant-cases.html.

§ https://www.japantimes.co.jp/news/2021/01/11/national/science-health/new-coronavirus-variant-japan/.

¶ https://www.fda.gov/news-events/press-announcements/fda-issues-alert-regarding-sars-cov-2-viral-mutation-health-care-providers-and-clinical-laboratory?utm_medium.

** https://virological.org/t/spike-e484k-mutation-in-the-first-sars-cov-2-reinfection-case-confirmed-in-brazil-2020/584.

†† https://www.cdc.gov/coronavirus/2019-ncov/more/science-and-research/scientific-brief-emerging-variants.html.

Summary

What is already known about this topic?

A more highly transmissible variant of SARS-CoV-2, B.1.1.7, has been detected in 12 U.S. states.

What is added by this report?

Modeling data indicate that B.1.1.7 has the potential to increase the U.S. pandemic trajectory in the coming months. CDC's system for genomic surveillance and the effort to expand sequencing will increase the availability of timely U.S. genomic surveillance data.

What are the implications for public health practice?

The increased transmissibility of the B.1.1.7 variant warrants universal and increased compliance with mitigation strategies, including distancing and masking. Higher vaccination coverage might need to be achieved to protect the public. Genomic sequence analysis through the National SARS-CoV-2 Strain Surveillance program will enable a targeted approach to identifying variants of concern in the United States.

mutations (Table), several of which are in the S protein, including a deletion at positions 69 and 70 (del69–70) that evolved spontaneously in other SARS-CoV-2 variants and is hypothesized to increase transmissibility (*2*,*7*). The deletion at positions 69 and 70 causes S-gene target failure (SGTF) in at least one RT-PCR–based diagnostic assay (i.e., with the ThermoFisher TaqPath COVID-19 assay, the B.1.1.7 variant and other variants with the del69–70 produce a negative result for S-gene target and a positive result for the other two targets); SGTF has served as a proxy in the United Kingdom for identifying B.1.1.7 cases (*1*).

Multiple lines of evidence indicate that B.1.1.7 is more efficiently transmitted compared with other SARS-CoV-2 variants circulating in the United Kingdom. U.K. regions with a higher proportion of B.1.1.7 sequences had faster epidemic growth than did other areas, diagnoses with SGTF increased faster than did non-SGTF diagnoses in the same areas, and a higher proportion of contacts were infected by index patients with B.1.1.7 infections than by index patients infected with other variants (*1*,*3*).

Variant B.1.1.7 has the potential to increase the U.S. pandemic trajectory in the coming months. To illustrate this effect, a simple, two-variant compartmental model was developed. The current U.S. prevalence of B.1.1.7 among all circulating viruses is unknown but is thought to be <0.5% based on the limited number of cases detected and SGTF data (*8*). For the model, initial assumptions included a B.1.1.7 prevalence of 0.5% among all infections, SARS-CoV-2 immunity from previous infection of 10%–30%, a time-varying reproductive number (R_t) of 1.1 (mitigated but increasing transmission) or 0.9 (decreasing transmission) for current variants, and a reported incidence of 60 cases per 100,000 persons per day on January 1, 2021. These assumptions do not precisely represent any single U.S. location, but rather, indicate a generalization of conditions common across the country. The change in R_t over time resulting from acquired immunity and increasing prevalence of B.1.1.7, was modeled, with the B.1.1.7 R_t assumed to be a constant 1.5 times the R_t of current variants, based on initial estimates from the United Kingdom (*1*,*3*).

Next, the potential impact of vaccination was modeled assuming that 1 million vaccine doses were administered per day beginning January 1, 2021, and that 95% immunity was achieved 14 days after receipt of 2 doses. Specifically, immunity against infection with either current variants or the B.1.1.7 variant was assumed, although the effectiveness and duration of protection against infection remains uncertain, because these were not the primary endpoint of clinical trials for initial vaccines.

In this model, B.1.1.7 prevalence is initially low, yet because it is more transmissible than are current variants, it exhibits rapid growth in early 2021, becoming the predominant variant in March (Figure 1). Whether transmission of current variants is increasing (initial R_t = 1.1) or slowly decreasing (initial R_t = 0.9) in January, B.1.1.7 drives a substantial change in the transmission trajectory and a new phase of exponential growth. With vaccination that protects against infection, the early epidemic trajectories do not change and B.1.1.7 spread still occurs (Figure 2). However, after B.1.1.7 becomes the dominant variant, its transmission was substantially reduced. The effect of vaccination on reducing transmission in the near term was greatest in the scenario in which transmission was already decreasing (initial R_t = 0.9) (Figure 2). Early efforts that can limit the spread of the B.1.1.7 variant, such as universal and increased compliance with public health mitigation strategies, will allow more time for ongoing vaccination to achieve higher population-level immunity.

Discussion

Currently, there is no known difference in clinical outcomes associated with the described SARS-CoV-2 variants; however, a higher rate of transmission will lead to more cases, increasing the number of persons overall who need clinical care, exacerbating the burden on an already strained health care system, and resulting in more deaths. Continued genomic surveillance to identify B.1.1.7 cases, as well as the emergence of other variants of concern in the United States, is important for the COVID-19 public health response. Whereas the SGTF results can help identify potential B.1.1.7 cases that can be confirmed by sequencing, identifying priority variants that do not exhibit SGTF relies exclusively on sequence-based surveillance.

TABLE. Characteristics of SARS-CoV-2 variants of concern — worldwide, September 2020–January 2021

Variant designation	First identification: Location	First identification: Date	Characteristic mutations (protein: mutation)	No. of current sequence-confirmed cases: United States	No. of current sequence-confirmed cases: Worldwide	No. of countries with sequences
B.1.1.7 (20I/501Y.V1)	United Kingdom	Sep 2020	ORF1ab: T1001I, A1708D, I2230T, del3675–3677 SGF S: del69–70 HV, del144 Y, N501Y, A570D, D614G, P681H, T761I, S982A, D1118H ORF8: Q27stop, R52I, Y73C N: D3L, S235F	76	15,369	36
B.1.351 (20H/501Y.V2)	South Africa	Oct 2020	ORF1ab: K1655N E: P71L N: T205I S:K417N, E484K, N501Y, D614G, A701V	0	415	13
P.1 (20J/501Y.V3)	Brazil and Japan	Jan 2021	ORF1ab: F681L, I760T, S1188L, K1795Q, del3675–3677 SGF, E5662D S: L18F, T20N, P26S, D138Y, R190S, K417T, E484K, N501Y, D614G, H655Y, T1027I ORF3a: C174G ORF8: E92K ORF9: Q77E ORF14: V49L N: P80R	0	35	2

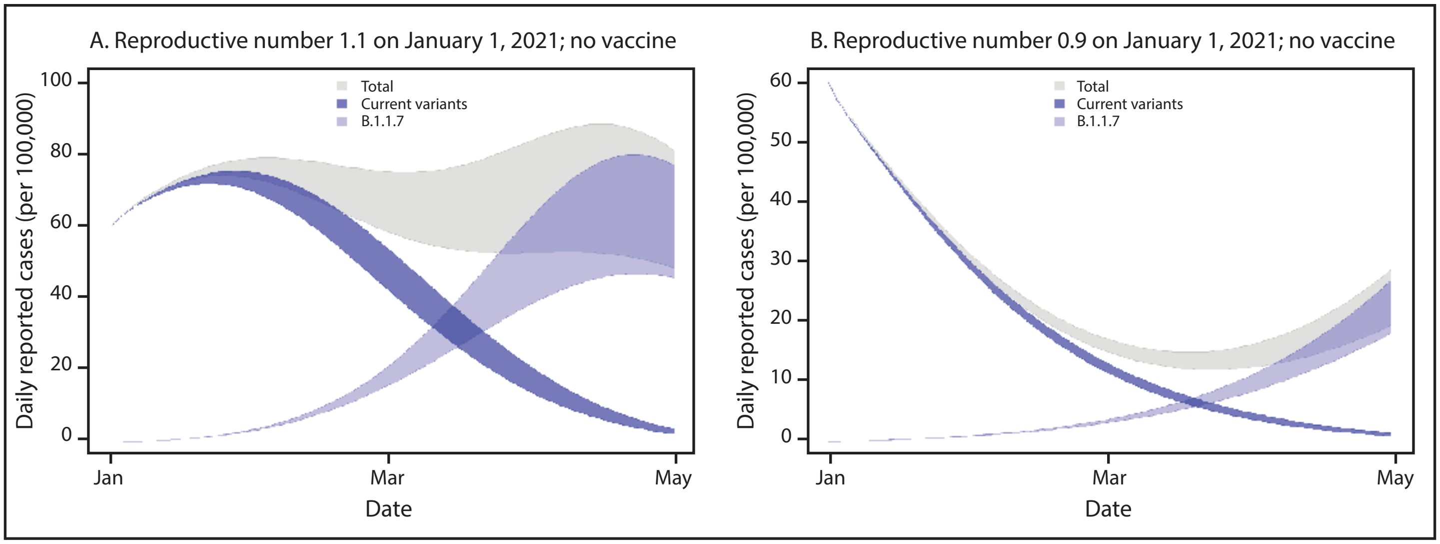
Abbreviations: del = deletion; E = envelope protein; N = nucleocapsid protein; ORF = open reading frame; S = spike protein.

The experience in the United Kingdom and the B.1.1.7 models presented in this report illustrate the impact a more contagious variant can have on the number of cases in a population. The increased transmissibility of this variant requires an even more rigorous combined implementation of vaccination and mitigation measures (e.g., distancing, masking, and hand hygiene) to control the spread of SARS-CoV-2. These measures will be more effective if they are instituted sooner rather than later to slow the initial spread of the B.1.1.7 variant. Efforts to prepare the health care system for further surges in cases are warranted. Increased transmissibility also means that higher than anticipated vaccination coverage must be attained to achieve the same level of disease control to protect the public compared with less transmissible variants.

In collaboration with academic, industry, state, territorial, tribal, and local partners, CDC and other federal agencies are coordinating and enhancing genomic surveillance and virus characterization efforts across the United States. CDC coordinates U.S. sequencing efforts through the SARS-CoV-2 Sequencing for Public Health Emergency Response, Epidemiology, and Surveillance (SPHERES)[§§] consortium, which includes approximately 170 participating institutions and promotes open data-sharing to facilitate the use of SARS-CoV-2 sequence data. To track SARS-CoV-2 viral evolution, CDC is implementing multifaceted genomic surveillance to understand the epidemiologic, immunologic, and evolutionary processes that shape viral phylogenies (phylodynamics); guide outbreak investigations; and facilitate the detection and characterization of possible reinfections, vaccine breakthrough cases, and emerging viral variants. In November 2020, CDC established the National SARS-CoV-2 Strain Surveillance (NS3) program to improve the representativeness of domestic SARS-CoV-2 sequences. The program collaborates with 64 U.S. public health laboratories to support a genomic surveillance system; NS3 is also building a collection of SARS-CoV-2 specimens and sequences to support public health response and scientific research to evaluate the impact of concerning mutations on existing recommended medical countermeasures. CDC has also contracted with several large commercial clinical laboratories to rapidly sequence tens of thousands of SARS-CoV-2–positive specimens each month and has funded seven academic institutions to conduct genomic surveillance in partnership with public health agencies, thereby adding substantially to the availability of timely genomic surveillance data from across the United States. In addition to these national initiatives, many state and local public health agencies are sequencing

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

FIGURE 1. Simulated case incidence trajectories* of current SARS-CoV-2 variants and the B.1.1.7 variant,† assuming no community vaccination and either initial R_t = 1.1 (A) or initial R_t = 0.9 (B) for current variants — United States, January–April 2021

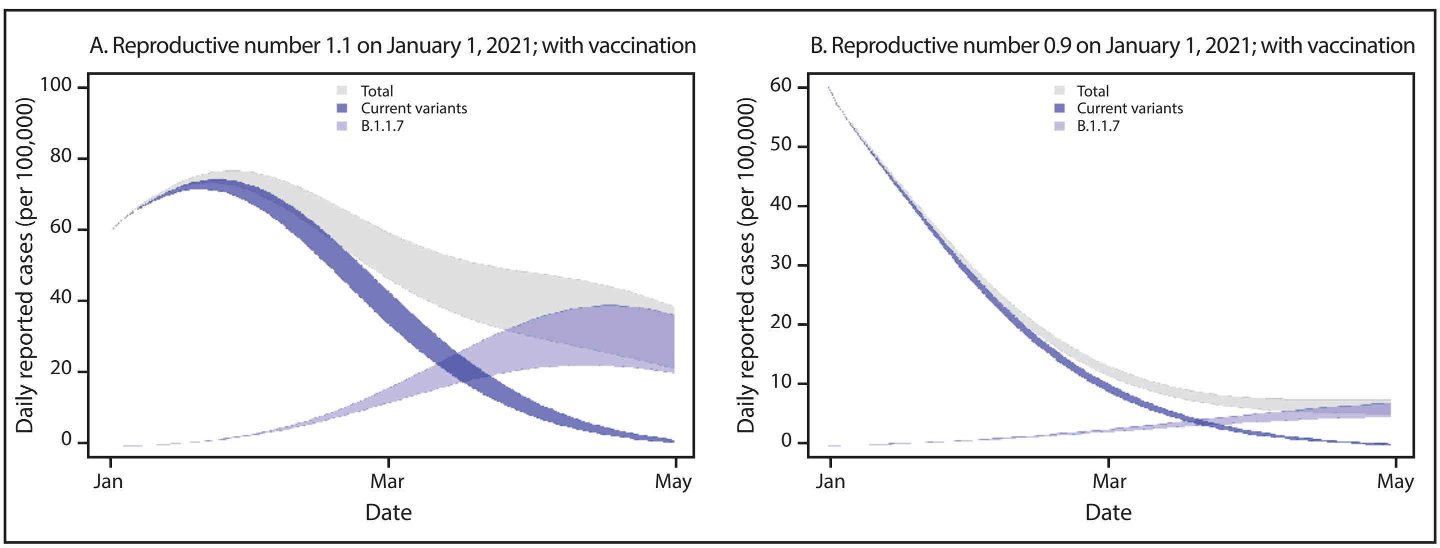


Abbreviation: R_t = time-varying reproductive number.

* For all simulations, it was assumed that the reporting rate was 25% and that persons who were seropositive or infected within the simulation became immune. The simulation was initialized with 60 reported cases of SARS-CoV-2 infection per 100,000 persons (approximately 200,000 cases per day in the U.S. population) on January 1, 2021. Bands represent simulations with 10%–30% population-level immunity as of January 1, 2021.

† Initial B.1.1.7 prevalence is assumed to be 0.5% among all infections and B.1.1.7 is assumed to be 50% more transmissible than current variants.

FIGURE 2. Simulated case incidence trajectories* of current SARS-CoV-2 variants and the B.1.1.7 variant,† assuming community vaccination§ and initial R_t = 1.1 (A) or initial R_t = 0.9 (B) for current variants — United States, January–April 2021



Abbreviation: R_t = time-varying reproductive number.

* For all simulations, it was assumed that the reporting rate was 25% and that persons who were seropositive or infected within the simulation became immune. The simulation was initialized with 60 reported cases of SARS-CoV-2 infection per 100,000 persons (approximately 200,000 cases per day in the U.S. population) on January 1, 2021. Bands represent simulations with 10%–30% population-level immunity as of January 1, 2021.

† Initial B.1.1.7 prevalence is assumed to be 0.5% among all infections and B.1.1.7 is assumed to be 50% more transmissible than current variants.

§ For vaccination, it was assumed that 300 doses were administered per 100,000 persons per day (approximately 1 million doses per day in the U.S. population) beginning January 1, 2021, that 2 doses achieved 95% immunity against infection, and that there was a 14-day delay between vaccination and protection.

SARS-CoV-2 to better understand local epidemiology and support public health response to the pandemic.

The findings in this report are subject to at least three limitations. First, the magnitude of the increase in transmissibility in the United States compared with that observed in the United Kingdom remains unclear. Second, the prevalence of B.1.1.7 in the United States is also unknown at this time, but detection of variants and estimation of prevalence will improve with enhanced U.S. surveillance efforts. Finally, local mitigation measures are also highly variable, leading to variation in R_t. The specific outcomes presented here are based on simulations and assumed no change in mitigations beyond January 1.

The increased transmissibility of the B.1.1.7 variant warrants rigorous implementation of public health strategies to reduce transmission and lessen the potential impact of B.1.1.7, buying critical time to increase vaccination coverage. CDC's modeling data show that universal use of and increased compliance with mitigation measures and vaccination are crucial to reduce the number of new cases and deaths substantially in the coming months. Further, strategic testing of persons without symptoms of COVID-19, but who are at increased risk for infection with SARS-CoV-2, provides another opportunity to limit ongoing spread. Collectively, enhanced genomic surveillance combined with increased compliance with public health mitigation strategies, including vaccination, physical distancing, use of masks, hand hygiene, and isolation and quarantine, will be essential to limiting the spread of SARS-CoV-2 and protecting public health.

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Evaluation of Abbott BinaxNOW Rapid Antigen Test for SARS-CoV-2 Infection at Two Community-Based Testing Sites — Pima County, Arizona, November 3–17, 2020

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Rapid antigen tests, such as the Abbott BinaxNOW COVID-19 Ag Card (BinaxNOW), offer results more rapidly (approximately 15–30 minutes) and at a lower cost than do highly sensitive nucleic acid amplification tests (NAATs) (*1*). Rapid antigen tests have received Food and Drug Administration (FDA) Emergency Use Authorization (EUA) for use in symptomatic persons (*2*), but data are lacking on test performance in asymptomatic persons to inform expanded screening testing to rapidly identify and isolate infected persons (*3*). To evaluate the performance of the BinaxNOW rapid antigen test, it was used along with real-time reverse transcription–polymerase chain reaction (RT-PCR) testing to analyze 3,419 paired specimens collected from persons aged ≥10 years at two community testing sites in Pima County, Arizona, during November 3–17, 2020. Viral culture was performed on 274 of 303 residual real-time RT-PCR specimens with positive results by either test (29 were not available for culture). Compared with real-time RT-PCR testing, the BinaxNOW antigen test had a sensitivity of 64.2% for specimens from symptomatic persons and 35.8% for specimens from asymptomatic persons, with near 100% specificity in specimens from both groups. Virus was cultured from 96 of 274 (35.0%) specimens, including 85 (57.8%) of 147 with concordant antigen and real-time RT-PCR positive results, 11 (8.9%) of 124 with false-negative antigen test results, and none of three with false-positive antigen test results. Among specimens positive for viral culture, sensitivity was 92.6% for symptomatic and 78.6% for asymptomatic individuals. When the pretest probability for receiving positive test results for SARS-CoV-2 is elevated (e.g., in symptomatic persons or in persons with a known COVID-19 exposure), a negative antigen test result should be confirmed by NAAT (*1*). Despite a lower sensitivity to detect infection, rapid antigen tests can be an important tool for screening because of their quick turnaround time, lower costs and resource needs, high specificity, and high positive predictive value (PPV) in settings of high pretest probability. The faster turnaround time of the antigen test can help limit transmission by more rapidly identifying infectious persons for isolation, particularly when used as a component of serial testing strategies.

Paired upper respiratory swabs were collected at the same timepoint from persons aged ≥10 years receiving testing for SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), at two Pima County Health Department community testing sites during November 3–17 (site A) and November 8–16 (site B). The sites offered SARS-CoV-2 testing to anyone in the community who wanted testing. A questionnaire capturing demographic information and current and past–14-day symptoms was administered to all participants. At both sites, a health care professional first collected a bilateral anterior nasal swab, using a swab provided in the BinaxNOW kit, immediately followed by a bilateral nasopharyngeal (NP) swab for real-time RT-PCR testing. Anterior nasal swabs were immediately tested on-site using the BinaxNOW antigen test according to the manufacturer's instructions (*4*). NP swabs were stored in phosphate buffered saline at 39°F (4°C) and analyzed within 24–48 hours by real-time RT-PCR using either the CDC 2019-nCoV Real-Time RT-PCR Diagnostic Panel for detection of SARS-CoV-2 (*5*) (2,582 swabs) or the Fosun COVID-19 RT-PCR Detection Kit (*6*) (837 swabs). Viral culture*,† was attempted on 274 of 303 residual real-time RT-PCR specimens if either the real-time RT-PCR or BinaxNOW antigen test result was positive (the remaining 29 were not available for viral culture). Results from real-time RT-PCR and the BinaxNOW antigen test were compared to evaluate sensitivity, specificity, negative predictive value (NPV), and PPV. Statistical analyses were performed using SAS (version 9.4; SAS Institute). Cycle threshold (Ct) values from real-time RT-PCR were compared using a Mann-Whitney U Test; 95% confidence intervals (CIs)

* Specimens were used to perform a limiting-dilution inoculation of Vero CCL-81 cells, and cultures showing evidence of cytopathic effect were tested by real-time RT-PCR for the presence of SARS-CoV-2 RNA. Viral recovery was defined as any culture in which the first passage had an N1 Ct value at least two Ct values lower than the corresponding clinical specimen.

† https://www.biorxiv.org/content/10.1101/2020.03.02.972935v1.

were calculated using the exact binomial method. The investigation protocol was reviewed by CDC and determined to be nonresearch and was conducted consistent with applicable federal law and CDC policy.[§]

Paired upper respiratory swabs were collected from 3,419 persons, including 1,458 (42.6%) from site A and 1,961 (57.4%) from site B (Table 1). Participants ranged in age from 10 to 95 years (median = 41 years) with 236 (6.9%) aged 10–17 years, 1,885 (55.1%) aged 18–49 years, 743 (21.7%) aged 50–64 years, and 555 (16.2%) aged ≥65 years. Approximately one third (31.4%) of participants identified as Hispanic or Latino, and three quarters (75.1%) identified as White.

At the time of testing, 827 (24.2%) participants reported at least one COVID-19–compatible sign or symptom,[¶] and 2,592 (75.8%) were asymptomatic. Among symptomatic participants, 113 (13.7%) received a positive BinaxNOW antigen test result, and 176 (21.3%) received a positive real-time RT-PCR test result. Among asymptomatic participants, 48 (1.9%) received a positive BinaxNOW antigen test result, and 123 (4.7%) received a positive real-time RT-PCR test result.

Testing among symptomatic participants indicated the following for the BinaxNOW antigen test (with real-time RT-PCR as the standard): sensitivity, 64.2%; specificity, 100%; PPV, 100%; and NPV, 91.2% (Table 2); among asymptomatic persons, sensitivity was 35.8%; specificity, 99.8%; PPV, 91.7%; and NPV, 96.9%. For participants who were within 7 days of symptom onset, the BinaxNOW antigen test sensitivity was 71.1% (95% CI = 63.0%–78.4%), specificity was 100% (95% CI = 99.3%–100%), PPV was 100% (95% CI = 96.4%–100%), and NPV was 92.7% (95% CI = 90.2%–94.7%). Using real-time RT-PCR as the standard, four false-positive BinaxNOW antigen test results occurred, all among specimens from asymptomatic participants. Among 299 real-time RT-PCR positive results, 142 (47.5%) were false-negative BinaxNOW antigen test results (63 in specimens from symptomatic persons and 79 in specimens from asymptomatic persons).

Virus was recovered from 96 (35.0%) of 274 analyzed specimens that were positive by either test, including 85 (57.8%) of 147 with concordant positive results and 11 (8.9%) of 124 with false-negative BinaxNOW antigen test results. Virus was not recovered from any of the three available specimens with false-positive BinaxNOW antigen test results. Among the 224 specimens undergoing viral culture that were analyzed with the CDC 2019-nCoV Real-Time RT-PCR Diagnostic Panel for detection of SARS-CoV-2, median Ct values** were significantly higher for specimens with false-negative BinaxNOW antigen test results, indicating lower viral RNA levels than in those with concordant positive results (33.9 versus 22.0 in specimens from symptomatic persons [p<0.001] and 33.9 versus 22.5 in specimens from asymptomatic persons [p<0.001]) (Figure). Median Ct values for SARS-CoV-2 culture-positive specimens (22.1) were significantly lower than were those for culture-negative specimens (32.8) (p<0.001), indicating higher levels of viral RNA in culture-positive specimens. Among specimens with positive viral culture, the sensitivity of the BinaxNOW antigen test compared with real-time RT-PCR in specimens from symptomatic participants was 92.6% (95% CI = 83.7%–97.6%) and in those from asymptomatic participants was 78.6% (95% CI = 59.1%–91.7%).

Discussion

In this evaluation, using real-time RT-PCR as the standard, the sensitivity of the BinaxNOW antigen test was lower among specimens from asymptomatic persons (35.8%) than among specimens from symptomatic persons (64.2%). Specificity (99.8%–100%) was high in specimens from both asymptomatic and symptomatic groups. The prevalence of having SARS-CoV-2 real-time RT-PCR positive test results in this population was moderate (8.7% overall; 4.7% for asymptomatic participants); administering the test in a lower prevalence setting will likely result in a lower PPV.[††] Among 11 participants with antigen-negative, real-time RT-PCR–positive specimens with positive viral culture, five were symptomatic and six asymptomatic. Some antigen-negative, real-time RT-PCR–positive specimens possibly could represent noninfectious viral particles, but some might also represent infectious virus not detected by the antigen test. In a clinical context, real-time RT-PCR provides the most sensitive assay to detect infection. Viral culture, although more biologically relevant than real-time RT-PCR, is still an artificial system and is subject to limitations. Numerous biological (e.g., individual antibody status and specific sequence of the virus) and environmental (e.g., storage conditions and number of freeze-thaw cycles) variables can affect the sensitivity and

§ 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.

¶ Participants were asked whether they had each sign or symptom from a list based on Council for State and Territorial Epidemiologists clinical criteria for COVID-19 that included fever, cough, shortness of breath, fatigue, sore throat, headache, muscle aches, chills, nasal congestion, difficulty breathing, diarrhea, nausea, vomiting, abdominal pain, rigors, loss of taste, and loss of smell. https://cdn.ymaws.com/www.cste.org/resource/resmgr/ps/positionstatement2020/Interim-20-ID-02_COVID-19.pdf.

** Ct values from the N1 viral nucleocapsid protein gene region from real-time RT-PCR were compared only for specimens that were analyzed with the CDC 2019-nCoV Real-Time RT-PCR Diagnostic Panel for detection of SARS-CoV-2. Lower Ct values represent higher levels of viral RNA in the specimen and higher Ct values represent lower levels of viral RNA.

†† https://www.cdc.gov/coronavirus/2019-ncov/lab/faqs.html#Interpreting-Results-of-Diagnostic-Tests.

TABLE 1. Characteristics of persons providing paired upper respiratory swabs (N = 3,419)* for the Abbott BinaxNOW COVID-19 Ag Card Point of Care Diagnostic Test and real-time reverse transcription–polymerase chain reation (RT-PCR) testing† for SARS-CoV-2 at two community-based testing sites, by test results — Pima County, Arizona, November 2020

Characteristic	Total no. of persons (column %)	No. of persons (row %)§			
		Antigen-positive	Real-time RT-PCR–positive	Real-time RT-PCR–positive, antigen-negative	Real-time RT-PCR–negative, antigen-positive
Total	**3,419 (100)**	**161 (4.7)**	**299 (8.7)**	**142 (4.2)**	**4 (0.1)**
Testing site					
A	**1,458 (42.6)**	72 (4.9)	145 (9.9)	74 (5.1)	1 (0.1)
B	**1,961 (57.4)**	89 (4.5)	154 (7.9)	68 (3.5)	3 (0.2)
Sex					
Male	**1,290 (37.7)**	74 (5.7)	138 (10.7)	65 (5.0)	1 (0.1)
Female	**1,681 (49.2)**	76 (4.5)	127 (7.6)	54 (3.2)	3 (0.2)
Undisclosed	**448 (13.1)**	11 (2.5)	34 (7.6)	23 (5.1)	0 (—)
Ethnicity					
Hispanic/Latino	**1,075 (31.4)**	86 (8.0)	150 (14.0)	65 (6.0)	1 (0.1)
Not Hispanic or Latino	**1,930 (56.4)**	63 (3.3)	118 (6.1)	58 (3.0)	3 (0.2)
Undisclosed	**414 (12.1)**	12 (2.9)	31 (7.5)	19 (4.6)	0 (—)
Race					
White	**2,567 (75.1)**	110 (4.3)	204 (7.9)	98 (3.8)	4 (0.2)
Black/African American	**83 (2.4)**	3 (3.6)	8 (9.6)	5 (6.0)	0 (—)
American Indian/Alaska Native	**69 (2.0)**	1 (1.4)	2 (2.9)	1 (1.4)	0 (—)
Asian	**84 (2.5)**	4 (4.8)	10 (11.9)	6 (7.1)	0 (—)
Native Hawaiian/Pacific Islander	**24 (0.7)**	1 (4.2)	1 (4.2)	0 (—)	0 (—)
Undisclosed	**592 (17.3)**	42 (7.1)	74 (12.5)	32 (5.4)	0 (—)
Age group, yrs					
10–17	**236 (6.9)**	10 (4.2)	22 (9.3)	13 (5.5)	1 (0.4)
18–49	**1,885 (55.1)**	91 (4.8)	178 (9.4)	89 (4.7)	2 (0.1)
50–64	**743 (21.7)**	41 (5.5)	69 (9.3)	29 (3.9)	1 (0.1)
≥65	**555 (16.2)**	19 (3.4)	30 (5.4)	11 (2.0)	0 (—)
Median age (range)	**41 (10–95)**	40 (13–84)	38 (11–84)	35 (11–83)	27 (16–63)
Current symptoms¶					
≥1	**827 (24.2)**	113 (13.7)	176 (21.3)	63 (7.6)	0 (—)
None	**2,592 (75.8)**	48 (1.9)	123 (4.7)	79 (3.0)	4 (0.2)
Days from symptom onset**					
Median (range)	**4 (0–210)**	3 (0–14)	4 (0–45)	4 (0–45)	2 (0–12)
0–3	**382 (11.2)**	59 (15.4)	84 (22.0)	25 (6.5)	0 (—)
4–7	**280 (8.2)**	42 (15.0)	58 (20.7)	16 (5.7)	0 (—)
8–10	**43 (1.3)**	6 (14.0)	12 (27.9)	6 (14.0)	0 (—)
11–14	**63 (1.8)**	6 (9.5)	16 (25.4)	10 (15.9)	0 (—)
>14	**55 (1.6)**	0 (—)	6 (10.9)	6 (10.9)	0 (—)
≤7	**662 (19.4)**	101 (15.3)	142 (21.5)	41 (6.2)	0 (—)
Exposure to a diagnosed COVID-19 case††					
Yes	**1,138 (33.3)**	93 (8.2)	162 (14.2)	71 (6.2)	2 (0.2)
No/Unknown	**2,281 (66.7)**	68 (3.0)	137 (6.0)	71 (3.1)	2 (0.1)
Days since last exposure, median (range)	**5 (0–14)**	4 (0–14)	3 (0–14)	1 (0–14)	9 (4–14)
Positive test results in past 90 days§§					
Yes	**179 (5.2)**	22 (12.3)	83 (46.4)	62 (34.6)	1 (14.3)
No/Unknown	**3,239 (94.7)**	139 (4.3)	216 (6.7)	80 (2.5)	3 (42.9)

Abbreviation: COVID-19 = coronavirus disease 2019.

* Includes 113 persons who received testing multiple times and were included more than once in the analysis.

† Testing with real-time RT-PCR was performed using the CDC 2019-nCoV Real-Time RT-PCR Diagnostic Panel for detection of SARS-CoV-2 (2,582 participants) or Fosun assay (837 participants).

§ Only selected categories shown; therefore, row numbers and percentages do not sum to total or 100%.

¶ Participants were asked whether they had each individual sign or symptom from a list based on the Council of State and Territorial Epidemiologists' clinical criteria for COVID-19 interim case definition, which include fever, cough, shortness of breath, fatigue, sore throat, headache, muscle aches, chills, nasal congestion, difficulty breathing, diarrhea, nausea, vomiting, abdominal pain, rigors, loss of taste, and loss of smell (https://cdn.ymaws.com/www.cste.org/resource/resmgr/ps/positionstatement2020/Interim-20-ID-02_COVID-19.pdf).

** Based on one or more symptoms.

†† Exposure was defined as close contact (within 6 ft for ≥15 min) in the 14 days before the day of testing with a person with diagnosed COVID-19.

§§ Received positive real-time RT-PCR or antigen test result.

TABLE 2. Test results and performance characteristics of the Abbott BinaxNOW COVID-19 Ag Card Point of Care Diagnostic Test (BinaxNOW antigen test) compared with real-time reverse transcription–polymerase chain reaction (RT-PCR) for testing received among asymptomatic and symptomatic persons at two community-based testing sites — Pima County, Arizona, November 2020

	Real-time RT-PCR, no. of tests		
Results and Performance	**Positive**	**Negative**	**Total**
BinaxNOW antigen test result			
All participants (N = 3,419)			
Positive	157	4	**161**
Negative	142	3,116	**3,258**
Total	**299**	**3,120**	**3,419**
Symptomatic (≥1 symptom) (n = 827)			
Positive	113	0	**113**
Negative	63	651	**714**
Total	**176**	**651**	**827**
Asymptomatic (n = 2,592)			
Positive	44	4	**48**
Negative	79	2,465	**2,544**
Total	**123**	**2,469**	**2,592**
BinaxNOW antigen test performance, % (95% CI)			
All participants (N = 3,149)			
Sensitivity		52.5 (46.7–58.3)	
Specificity		99.9 (99.7–100.0)	
PPV		97.5 (93.8–99.3)	
NPV		95.6 (94.9–96.3)	
Symptomatic (n = 827)			
Sensitivity		64.2 (56.7–71.3)	
Specificity		100.0 (99.4–100.0)	
PPV		100.0 (96.8–100.0)	
NPV		91.2 (88.8–93.1)	
Asymptomatic (n = 2,592)			
Sensitivity		35.8 (27.3–44.9)	
Specificity		99.8 (99.6–100.0)	
PPV		91.7 (80–7.7)	
NPV		96.9 (96.1–97.5)	

Abbreviations: CI = confidence interval; COVID-19 = coronavirus disease 2019; NPV = negative predictive value; PPV = positive predictive value.

outcome of viral culture. Despite the limitations of interpreting culture-negative specimens, a positive viral culture is strong evidence for the presence of infectious virus. The performance of the BinaxNOW antigen test compared with real-time RT-PCR was better for those specimens with positive viral culture than for all specimens, with a sensitivity of 92.6% for specimens from symptomatic persons and 78.6% for those from asymptomatic persons. The results of the current evaluation differ from those of an evaluation of the BinaxNOW antigen test in a community screening setting in San Francisco (*7*), which found a BinaxNOW antigen test overall sensitivity of 89.0% among specimens from all 3,302 participants, regardless of the Ct value of the real-time RT-PCR–positive specimens.

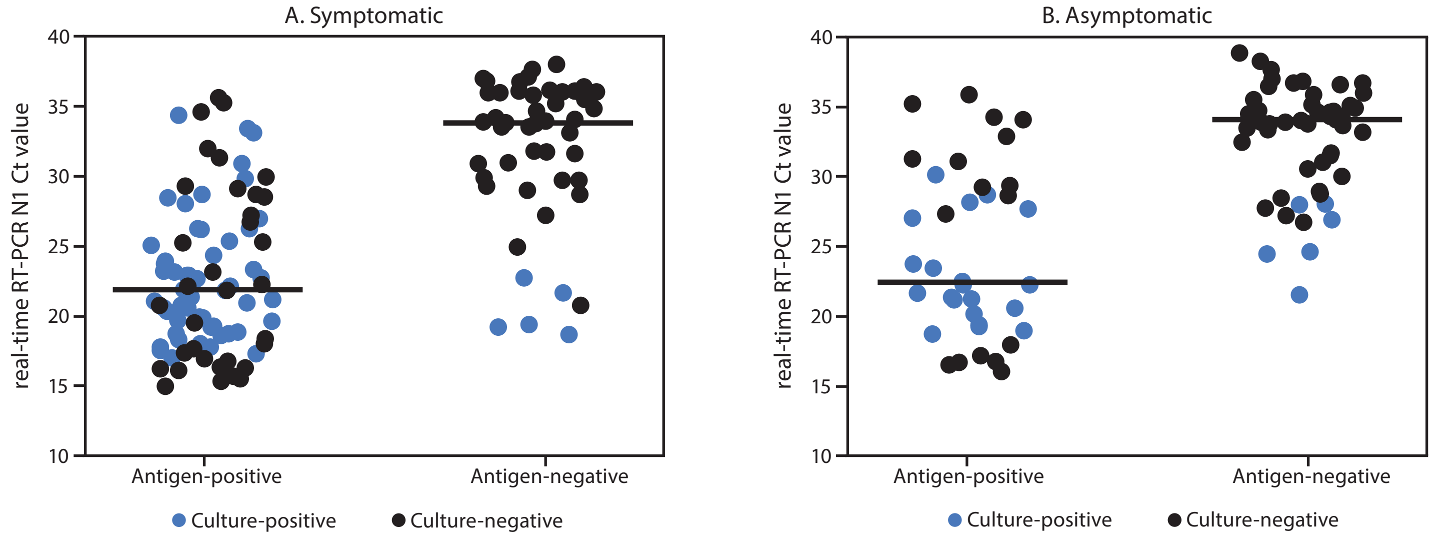
The findings in this investigation are subject to at least five limitations. First, anterior nasal swabs were used for BinaxNOW antigen testing, but NP swabs were used for real-time RT-PCR testing, which might have contributed to increased detection for the real-time RT-PCR assay (*8*). Second, participants might have inadvertently reported common nonspecific symptoms as COVID-19–compatible symptoms. Third, this investigation evaluated the BinaxNOW antigen test, and results presented here cannot be generalized to other FDA-authorized SARS-CoV-2 antigen tests. Fourth, the BinaxNOW antigen test characteristics might be different depending on whether an individual had previously tested positive. Finally, many factors might limit the ability to culture virus from a specimen, and the inability to detect culturable virus should not be interpreted to mean that a person is not infectious.

Public health departments are implementing various strategies to reduce or prevent SARS-CoV-2 transmission, including expanded screening testing for asymptomatic persons (*3*). Because estimates suggest that over 50% of transmission occurs from persons who are presymptomatic or asymptomatic (*9*), expanded screening testing, potentially in serial fashion for reducing transmission in specific venues (e.g., institutions of higher education, schools, and congregate housing settings), is essential to interrupting transmission (*3*).

Rapid antigen tests can be an important tool for screening because of their quick turnaround time, lower requirement for resources, high specificity, and high PPV in settings of high pretest probability (e.g., providing testing to symptomatic persons, to persons with a known COVID-19 exposure, or where community transmission is high). Importantly, the faster time from testing to results reporting can speed isolation of infectious persons and will be particularly important in communities with high levels of transmission.

Although the sensitivity of the BinaxNOW antigen test to detect infection was lower compared with real-time RT-PCR, it was relatively high among specimens with positive viral culture, which might reflect better performance for detecting infection in a person with infectious virus present. Community testing strategies focused on preventing transmission using antigen testing should consider serial testing (e.g., in kindergarten through grade 12 schools, institutions of higher education, or congregate housing settings), which might improve test sensitivity in decting infection (*10*). When the pretest probability for receiving positive SARS-CoV-2 test results is elevated (e.g. for symptomatic persons or for persons with a known COVID-19 exposure) a negative antigen test result should be confirmed by NAAT. Asymptomatic persons who receive a positive BinaxNOW antigen test result in a setting with a high risk for adverse consequences resulting from false-positive results (e.g. in long-term care facilities) should also receive confirmatory testing by NAAT (*1*).

FIGURE. Abbott BinaxNOW COVID-19 Ag Card Point of Care Diagnostic Test (antigen test) results, N1 cycle threshold (Ct) values,* and viral culture results† among A) symptomatic (N = 136)§ and B) asymptomatic (N = 88)¶ participants receiving positive SARS-CoV-2 real-time reverse transcription–polymerase chain reaction (RT-PCR) test results at two community-based testing sites — Pima County, Arizona, November 2020



* Only those specimens that were analyzed using the CDC 2019-nCoV Real-Time RT-PCR Diagnostic Panel for detection of SARS-CoV-2 and that were analyzed using viral culture are included in the graph.

† Twenty specimens with Ct values <18 had positive antigen and real-time RT-PCR results but were culture negative. The culture showed evidence of cytopathic effects and had presence of SARS-CoV-2 RNA as detected by real-time RT-PCR in the first passage culture, but viral recovery was not two Ct values lower than the corresponding clinical specimen Ct.

§ Antigen test results: 88 positive and 48 negative; median Ct values indicated with black line: 22.0 for antigen-positive specimens and 33.9 for antigen-negative specimens.

¶ Antigen test results: 37 positive and 51 negative; median Ct values indicated with black line: 22.5 for antigen-positive specimens and 33.9 for antigen-negative specimens.

Summary

What is already known about this topic?

The BinaxNOW rapid antigen test received Emergency Use Authorization by the Food and Drug Administration for testing specimens from symptomatic persons; performance among asymptomatic persons is not well characterized.

What is added by this report?

Sensitivity of the BinaxNOW antigen test, compared with polymerase chain reaction testing, was lower when used to test specimens from asymptomatic (35.8%) than from symptomatic (64.2%) persons, but specificity was high. Sensitivity was higher for culture-positive specimens (92.6% and 78.6% for those from symptomatic and asymptomatic persons, respectively); however, some antigen test-negative specimens had culturable virus.

What are the implications for public health practice?

The high specificity and rapid BinaxNOW antigen test turn-around time facilitate earlier isolation of infectious persons. Antigen tests can be an important tool in an overall community testing strategy to reduce transmission.

Despite their reduced sensitivity to detect infection compared with real-time RT-PCR, antigen tests might be particularly useful when real-time RT-PCR tests are not readily available or have prolonged turnaround times. Persons who know their positive test result within 15–30 minutes can isolate sooner, and contact tracing can be initiated sooner and be more effective than if a test result is returned days later. Serial antigen testing can improve detection, but consideration should be given to the logistical and personnel resources needed. All persons receiving negative test results (NAAT or antigen) should be counseled that wearing a mask, avoiding close contact with persons outside their household, and washing hands frequently remain critical to preventing the spread of COVID-19.§§

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

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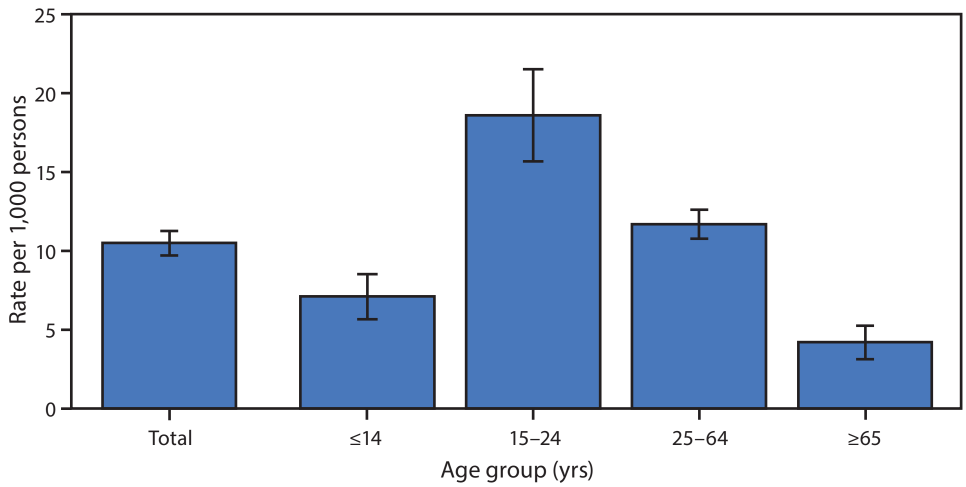
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Emergency Department Visit Rates* for Motor Vehicle Crashes,† by Age Group — United States, 2018§



* Visit rates are based on the July 1, 2018, set of estimates of the U.S. civilian noninstitutionalized population as developed by the U.S. Census Bureau, Population Division. 95% confidence intervals indicated with error bars.

† Motor vehicle crashes defined as a visit with *International Classification of Diseases, Tenth Revision*, *Clinical Modification* codes: [V02–V04] (with fourth character = 1, 9), V09.2, V09.3, [V12–V14, V20–V28] (with fourth character = 3, 4, 5, 9), V19.4–V19.6, V19.9, V29.4–V29.9, [V30–V79] (with fourth character = 4, 5, 6, 7, 8, 9), [V83–V86] (with fourth character = 0, 1, 2, 3), V80.3–V80.5, V81.1, V82.1, V87.0–V87.8, V89.2, X81.0, X82, Y02.0, Y03, Y32. Injured persons included motor vehicle occupants, motorcyclists, pedal cyclists, and pedestrians.

§ Based on a sample of visits to emergency departments in noninstitutional general and short-stay hospitals, exclusive of federal, military, and Veterans Administration hospitals, located in the 50 U.S. states and the District of Columbia.

In 2018, the U.S. emergency department (ED) visit rate for motor vehicle crashes was 10.5 visits per 1,000 persons. The ED visit rate for motor vehicle crashes among persons aged 0–14 years was 7.1 ED visits per 1,000 persons. The visit rate for motor vehicle crashes was highest for persons aged 15–24 years (18.6) and declined with age to 11.7 for those aged 25–64 years and to 4.2 for those aged ≥65 years.

Source: National Center for Health Statistics. National Hospital Ambulatory Medical Care Survey, 2018. https://www.cdc.gov/nchs/ahcd/ahcd_questionnaires.htm.

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For more information on this topic, CDC recommends the following link: https://www.cdc.gov/transportationsafety.

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