

# COVID-19 Vaccine Initiation and Dose Completion During the SARS-CoV-2 Delta Variant Surge in the United States, December 2020–October 2021

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## Abstract

**Objectives:** In summer 2021, the number of COVID-19–associated hospitalizations in the United States increased with the surge of the SARS-CoV-2 Delta variant. We assessed how COVID-19 vaccine initiation and dose completion changed during the Delta variant surge, based on jurisdictional vaccination coverage before the surge.

**Methods:** We analyzed COVID-19 vaccination data reported to the Centers for Disease Control and Prevention. We classified jurisdictions (50 states and the District of Columbia) into quartiles ranging from high to low first-dose vaccination coverage among people aged  $\geq 12$  years as of June 30, 2021. We calculated first-dose vaccination coverage as of June 30 and October 31, 2021, and stratified coverage by quartile, age (12–17, 18–64,  $\geq 65$  years), and sex. We assessed dose completion among those who initiated a 2-dose vaccine series.

**Results:** Of 51 jurisdictions, 15 reached at least 70% vaccination coverage before the Delta variant surge (ie, as of June 30, 2021), while 35 reached that goal as of October 31, 2021. Jurisdictions in the lowest quartile of vaccination coverage (44.9%–54.9%) had the greatest absolute (9.7%–17.9%) and relative (18.1%–39.8%) percentage increase in vaccination coverage during July 1–October 31, 2021. Of those who received the first dose during this period across all jurisdictions, nearly 1 in 5 missed the second dose.

**Conclusions:** Although COVID-19 vaccination initiation increased during July 1–October 31, 2021, in jurisdictions in the lowest quartile of vaccination coverage, coverage remained below that of jurisdictions in the highest quartile of vaccination coverage before the Delta variant surge. Efforts are needed to improve access to and increase confidence in COVID-19 vaccines, especially in low-coverage areas.

## Keywords

COVID-19 vaccine, vaccination coverage, vaccine uptake, SARS-CoV-2 B.1.617.2 (Delta) variant

The SARS-CoV-2 B.1.617.2 (Delta) variant was first identified in the United States in March 2021. By July 2021, the highly transmissible Delta variant had spread rapidly and become the predominant strain in the United States, causing nearly a million cases and  $>100\,000$  deaths.<sup>1,2</sup> The Delta variant surge disproportionately affected certain geographic areas, with some regions experiencing an increase in incidence and severity of illness, hospitalization, and death driven largely by those who were unvaccinated.<sup>3</sup> During the surge, hospitalization rates among unvaccinated adolescents and adults were 10 and 17 times higher, respectively, than among those who were fully vaccinated.<sup>4,5</sup>

Prior to the Delta variant surge, COVID-19 vaccination coverage varied widely by geographic region,<sup>2,6,7</sup> with some

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states meeting the White House goal of at least 70% of the eligible population receiving  $\geq 1$  dose of a COVID-19 vaccine.<sup>8</sup> Survey data found that the increase in cases due to the Delta variant was a substantial motivator to initiate vaccination, as was personally knowing someone who became seriously ill or died of COVID-19.<sup>9</sup> The objective of this analysis was to assess how COVID-19 vaccine initiation and dose completion changed overall vaccination coverage during the Delta variant surge, based on jurisdictional vaccination coverage before the surge, and to stratify vaccine recipients by age, sex, and jurisdiction (50 states and the District of Columbia).

## Methods

To determine COVID-19 vaccine initiation during the Delta variant surge, we analyzed data on COVID-19 vaccine administration during December 14, 2020–October 31, 2021, in the United States as reported to the Centers for Disease Control and Prevention (CDC) by jurisdictions, pharmacies, and federal entities.<sup>6,7</sup> To assess vaccination coverage prior to the Delta variant becoming the predominant strain in July 2021,<sup>10</sup> we analyzed jurisdiction-level COVID-19 vaccine administration data among people aged  $\geq 12$  years who received their first dose of the Pfizer-BioNTech or Moderna COVID-19 vaccine or a single dose of the Janssen COVID-19 vaccine (Johnson & Johnson) during December 14, 2020–June 30, 2021, in 51 US jurisdictions (50 states and the District of Columbia). We calculated vaccination coverage by dividing the population who received  $\geq 1$  dose of a COVID-19 vaccine by the total population eligible for vaccination living in the defined jurisdiction.<sup>11</sup> We classified jurisdictions into quartiles ranging from high to low vaccination coverage for the first dose of COVID-19 vaccine. The 4 coverage quartiles were as follows: high ( $n = 13$  jurisdictions,  $\geq 71.1\%$  coverage), medium high ( $n = 13$ , 62.2%–71.0%), medium low ( $n = 13$ , 55.7%–61.9%), and low ( $n = 12$ ,  $< 55.7\%$ ).

We calculated vaccination coverage, absolute percentage-point increase, and relative percentage change before (ie, December 14, 2020–June 30, 2021) and after (ie, July 1–October 31, 2021) the Delta variant surge. We stratified vaccination coverage by jurisdiction, age (12–17, 18–64, and  $\geq 65$  years), and sex. We also calculated monthly vaccination rates for the month before (June) and the months during (July, August, September, October) the Delta variant surge. We assessed dose completion among those who initiated a 2-dose series and had adequate time to complete the series (ie, received the second dose within 42 days of the first dose). We obtained data on population size from the US Census 2020 population estimates.<sup>12</sup> We did not conduct tests of significance because these data reflect the US population and were not based on population samples. We conducted analyses using SAS version 9.4 (SAS Institute, Inc). CDC reviewed this activity and determined that it was conducted consistent with applicable federal law and CDC policy.

## Results

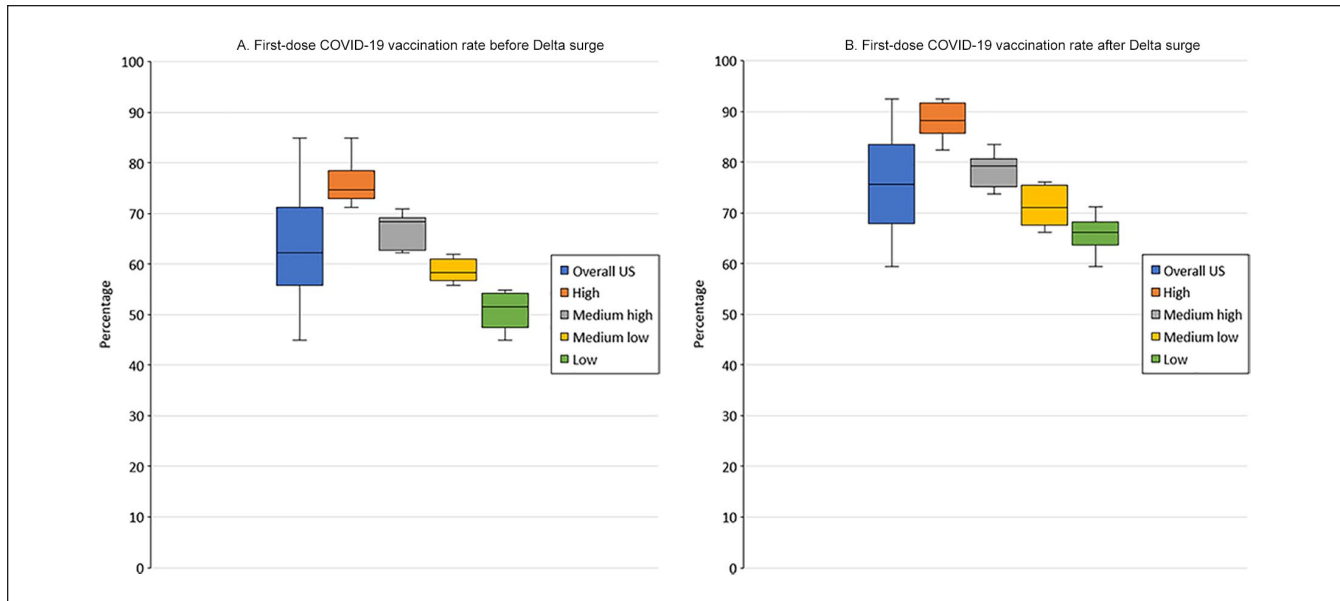
Of 51 jurisdictions, 15 reached at least 70% vaccination coverage before the Delta variant surge (ie, as of June 30, 2021), while 35 reached that goal as of October 31, 2021 (Table 1). All quartiles experienced an increase in COVID-19 vaccination coverage during the Delta variant surge (Figure 1). Several jurisdictions in the lowest quartile (Alabama, Arkansas, Louisiana, Mississippi) had the highest relative percentage change in first-dose vaccination coverage (39.8%, 36.7%, 35.2%, and 33.8%, respectively) across all 51 jurisdictions during July 1–October 31, 2021. The monthly vaccination rate was higher in August than in other months across all quartiles; however, we found the highest rate in jurisdictions in the lowest quartile in August (Table 2). Jurisdictions in the lowest quartile of vaccination coverage also had the greatest absolute percentage-point increase during July 1–October 31, 2021, but the lowest relative decrease in the unvaccinated population (Figure 2). First-dose vaccination coverage varied by age (ie, higher among older populations [ie, aged  $\geq 65$  years] than among adolescents [ie, aged 12–17 years]) but not by sex (before: males = 60.7%, females = 65.6%; after: males = 74.2%, females = 78.7%). Among those who initiated the 2-dose mRNA vaccines during July 1–October 31, 2021, 17.5% were overdue for receipt of the second dose (Table 3).

## Discussion

To our knowledge, this analysis is the first attempt to assess changes in COVID-19 vaccine initiation and dose completion based on prior jurisdictional coverage as the Delta variant emerged and spread rapidly in the United States, leading to a nationwide surge in cases. Overall, jurisdictions in the lowest quartile of vaccination coverage as of June 30, 2021, had the highest percentage increase in vaccine initiation and dose completion and the smallest relative decrease in its unvaccinated population during July 1–October 31, 2021, with several jurisdictions in the lowest quartile of vaccination coverage (eg, Alabama, Arkansas, Louisiana, Mississippi) having the highest relative percentage increase in coverage. The reasons for differences in vaccination uptake in the jurisdictions in the lowest quartile as compared with jurisdictions in the highest quartile may reflect fear of contracting COVID-19 during the Delta variant surge, which is supported by research showing that rising numbers of local COVID-19 cases can lead to behavior change, wherein individuals voluntarily engage in protective behaviors such as social distancing.<sup>9,13</sup> Residents of jurisdictions in the lowest quartile were more likely to experience the Delta variant surge firsthand, as many of these areas were hot spots during the surge.<sup>14</sup> When compared with prior variants, the Delta variant was more transmissible and caused more severe illness resulting in hospitalization and death.<sup>15</sup> Therefore, it is plausible that this Delta variant surge led to a sharp rise in

**Table 1.** First dose<sup>a</sup> COVID-19 vaccine coverage before<sup>b</sup> and after<sup>c</sup> the Delta variant surge among people aged  $\geq 12$  years, by coverage quartile, jurisdiction, age, and sex, United States<sup>d,e</sup>

Jurisdiction <sup>i</sup>	No. (%) vaccinated											
	Total <sup>h</sup>		Age, y <sup>f</sup>						Sex <sup>g</sup>			
	Before	After	12-17		18-64		$\geq 65$		Male		Female	
United States	179 045 341 (63.5)	216 580 198 (76.9)	8 882 621 (35.3)	14 730 341 (58.6)	122 684 863 (61.0)	150 168 368 (74.7)	47 477 857 (85.3)	51 518 515 (92.6)	83 669 029 (60.7)	102 334 455 (74.2)	94 395 768 (65.6)	113 199 187 (87.7)
<b>High</b>	39 729 734 (74.3)	47 091 278 (88.1)	2 158 248 (48.8)	3 279 142 (74.1)	27 994 973 (73.1)	33 306 247 (87.0)	9 576 513 (89.1)	10 401 803 (96.8)	18 470 897 (71.3)	22 060 579 (85.2)	20 829 539 (75.5)	24 547 736 (89.0)
Connecticut	2 437 826 (78.6)	2 845 157 (91.7)	148 750 (56.2)	211 577 (79.9)	1 681 547 (76.7)	1 963 988 (89.6)	5 679 259 (94.0)	645 995 (100.0)	1 138 095 (75.7)	1 335 223 (88.8)	1 289 157 (80.6)	1 498 068 (93.7)
District of Columbia	482 554 (78.3)	570 055 (92.5)	16 810 (50.9)	28 293 (85.7)	385 391 (78.1)	451 134 (91.4)	80 353 (89.4)	89 832 (100.0)	224 340 (77.7)	264 700 (91.7)	254 334 (77.6)	300 856 (91.9)
Hawaii	892 406 (74.1)	1 084 336 (90.1)	50 649 (54.8)	78 336 (84.7)	605 421 (72.4)	749 002 (89.6)	236 336 (85.9)	256 998 (93.4)	435 158 (72.6)	536 282 (89.4)	453 789 (75.1)	543 924 (90.1)
Maine	916 611 (76.9)	1 045 898 (87.8)	44 874 (50.1)	60 658 (67.7)	596 199 (73.8)	686 762 (85.0)	275 538 (93.8)	293 775 (100.0)	429 815 (74.1)	493 887 (85.2)	482 019 (78.8)	546 600 (89.4)
Maryland	3 833 755 (74.1)	4 480 167 (86.5)	235 311 (51.7)	349 684 (76.9)	2 714 903 (72.7)	3 182 922 (85.2)	883 541 (89.5)	947 561 (96.0)	1 762 766 (71.0)	2 076 764 (83.6)	2 040 212 (75.8)	2 364 970 (87.8)
Massachusetts	4 896 853 (81.3)	5 550 738 (92.1)	291 086 (61.4)	385 195 (81.3)	3 474 935 (79.8)	3 915 357 (89.9)	1 130 832 (94.4)	1 198 401 (100.0)	2 260 971 (77.9)	2 581 603 (88.9)	2 564 015 (82.1)	2 895 029 (92.7)
New Hampshire	897 310 (74.4)	992 847 (82.3)	46 768 (50.3)	58 812 (63.2)	604 202 (71.1)	660 368 (77.7)	246 340 (93.6)	263 128 (100.0)	415 887 (69.9)	462 305 (77.7)	470 389 (77.0)	519 003 (84.9)
New Jersey	5 691 947 (74.7)	6 727 489 (88.3)	311 530 (46.3)	485 529 (72.1)	4 047 313 (74.4)	4 776 155 (87.8)	1 333 104 (88.3)	1 465 805 (97.1)	2 663 920 (72.0)	3 171 510 (85.8)	2 997 648 (76.4)	3 523 262 (89.8)
New Mexico	1 281 605 (71.1)	1 513 929 (84.0)	72 844 (43.4)	114 483 (68.3)	860 073 (69.1)	1 019 236 (81.9)	348 688 (89.4)	380 210 (97.5)	598 175 (67.4)	711 179 (80.1)	669 480 (73.2)	777 307 (85.0)
New York	11 955 726 (71.7)	14 680 454 (88.0)	559 019 (41.9)	952 004 (71.4)	8 512 929 (71.1)	10 545 890 (88.0)	2 883 778 (85.6)	3 182 560 (94.5)	5 531 267 (68.9)	6 835 634 (85.1)	6 211 661 (71.8)	7 609 894 (88.0)
Rhode Island	717 662 (77.5)	847 397 (91.5)	38 866 (54.7)	57 956 (81.5)	494 442 (74.6)	589 198 (89.0)	184 354 (95.8)	192 476 (100.0)	333 777 (74.5)	397 093 (88.7)	380 729 (79.6)	446 859 (93.4)
Vermont	467 720 (84.9)	505 327 (91.7)	27 654 (67.4)	33 452 (81.5)	312 160 (81.8)	337 663 (88.5)	127 906 (99.5)	128 593 (100.0)	221 674 (81.9)	241 257 (89.1)	244 518 (87.2)	262 461 (93.6)
Virginia	5 257 759 (71.4)	6 247 484 (84.9)	314 087 (49.2)	463 163 (72.6)	3 705 458 (69.6)	4 427 852 (83.2)	1 238 214 (88.4)	1 356 469 (96.8)	2 455 052 (68.2)	2 953 142 (82.0)	2 771 588 (73.7)	3 259 503 (86.6)
<b>Medium high</b>	71 092 430 (67.7)	84 267 112 (80.2)	3 671 912 (40.4)	5 741 816 (63.1)	48 750 681 (65.2)	58 463 539 (78.2)	18 669 837 (88.2)	20 044 373 (94.7)	33 426 384 (64.6)	39 992 055 (77.3)	36 967 517 (69.3)	43 493 360 (81.6)
Alaska	381 461 (62.6)	451 866 (74.1)	21 828 (38.0)	32 377 (56.4)	283 350 (62.1)	337 120 (73.8)	76 283 (79.6)	82 369 (85.9)	191 030 (59.8)	228 923 (71.7)	181 896 (62.6)	213 002 (73.3)
California	23 847 982 (71.0)	28 054 000 (83.5)	1 391 011 (45.9)	2 139 594 (70.6)	17 211 872 (70.0)	20 333 816 (82.7)	5 245 099 (87.8)	5 580 590 (93.4)	11 386 095 (68.5)	13 522 576 (81.3)	12 343 118 (72.7)	14 400 730 (84.8)
Colorado	3 440 021 (68.9)	3 970 806 (79.5)	195 637 (44.6)	279 665 (63.8)	2 478 048 (67.3)	2 876 706 (78.1)	766 336 (87.4)	814 435 (92.9)	1 656 195 (65.9)	1 931 262 (76.9)	1 766 951 (71.1)	2 019 172 (81.3)
Delaware	584 683 (68.6)	686 572 (80.5)	28 576 (40.6)	42 933 (60.9)	375 013 (64.2)	447 700 (76.6)	181 094 (91.6)	195 939 (99.2)	268 520 (65.8)	318 484 (78.0)	312 966 (70.4)	364 660 (82.1)
Florida	11 778 487 (62.2)	15 011 469 (79.2)	416 470 (28.4)	854 114 (58.3)	7 275 256 (56.6)	9 690 266 (75.4)	4 086 761 (88.1)	4 467 089 (96.3)	5 502 620 (59.8)	7 076 116 (76.9)	6 219 796 (63.8)	7 863 972 (80.7)
Illinois	7 183 554 (66.6)	8 337 098 (77.3)	415 898 (42.6)	600 349 (61.5)	5 011 575 (64.9)	5 863 904 (76.0)	1 756 081 (84.1)	1 872 845 (89.6)	3 365 780 (63.9)	3 931 633 (74.7)	3 787 372 (68.6)	4 370 772 (79.2)
Kansas	1 537 104 (62.6)	1 868 906 (76.1)	72 273 (30.1)	128 208 (53.4)	1 013 019 (58.6)	1 244 290 (72.0)	451 812 (92.5)	488 315 (100.0)	713 751 (58.6)	882 261 (72.4)	815 515 (65.8)	977 679 (78.9)
Minnesota	3 284 631 (68.4)	3 711 736 (77.3)	177 874 (39.9)	259 186 (58.1)	2 241 024 (65.8)	2 546 339 (74.7)	865 733 (91.2)	906 211 (95.5)	1 524 792 (64.0)	1 741 902 (73.2)	1 695 570 (70.0)	1 900 472 (78.5)
Nebraska	1 019 305 (62.8)	1 196 930 (73.8)	51 143 (32.0)	85 135 (53.2)	689 252 (60.3)	816 537 (71.4)	278 910 (87.3)	295 258 (92.4)	467 804 (58.0)	559 543 (69.4)	527 814 (64.7)	611 291 (74.9)
Oregon	2 524 356 (68.6)	2 917 185 (79.3)	135 569 (45.3)	188 682 (63.0)	1 714 949 (66.2)	2 008 024 (77.5)	673 838 (85.3)	720 479 (91.3)	1 193 622 (65.8)	1 391 432 (76.7)	1 309 473 (70.2)	1 500 060 (80.4)
Pennsylvania	7 688 982 (69.4)	8 953 366 (80.8)	386 886 (39.3)	527 710 (57.8)	5 087 848 (65.9)	5 968 679 (77.4)	2 242 248 (91.6)	2 447 686 (100.0)	3 349 175 (63.6)	4 042 251 (74.9)	3 979 748 (70.0)	4 616 642 (81.2)
Washington	6 422 209 (70.2)	5 408 142 (82.1)	255 022 (45.9)	368 255 (63.0)	3 682 094 (88.3)	3 862 094 (80.8)	1 103 500 (88.4)	1 177 793 (94.4)	2 219 848 (67.6)	2 621 547 (79.8)	2 356 704 (71.5)	2 677 831 (83.0)
Wisconsin	3 199 655 (63.8)	3 699 036 (73.7)	151 725 (34.1)	235 608 (53.2)	2 105 788 (59.7)	2 468 064 (70.0)	942 142 (89.9)	995 364 (95.0)	1 497 152 (60.2)	1 744 125 (70.1)	1 671 024 (66.0)	1 917 077 (75.7)
<b>Medium low</b>	41 782 471 (58.1)	51 185 171 (71.2)	2 075 917 (30.2)	3 650 100 (53.2)	28 560 343 (55.5)	35 312 538 (68.6)	11 146 211 (81.9)	12 181 029 (89.5)	19 690 563 (55.6)	24 473 857 (69.2)	22 448 383 (61.4)	27 189 716 (74.4)
Arizona	3 764 834 (59.3)	4 510 929 (71.0)	185 296 (32.1)	321 891 (55.8)	2 456 105 (55.8)	2 989 455 (67.9)	1 123 433 (81.8)	1 199 583 (87.3)	1 781 633 (56.7)	2 158 954 (68.7)	1 958 049 (61.0)	2 324 378 (72.4)
Idaho	725 390 (60.3)	910 198 (75.6)	27 953 (30.2)	54 280 (58.7)	463 938 (55.5)	600 929 (71.9)	233 499 (84.9)	254 989 (92.7)	334 843 (43.6)	429 139 (55.9)	385 292 (50.1)	478 170 (62.2)
Iowa	1 653 627 (61.5)	1 904 668 (70.8)	74 709 (29.8)	119 769 (47.8)	1 079 269 (57.7)	1 258 052 (67.2)	499 649 (88.3)	526 847 (93.1)	750 028 (56.3)	875 773 (65.7)	856 827 (63.2)	977 448 (72.1)
Michigan	5 199 990 (60.6)	5 868 312 (68.3)	244 734 (32.8)	343 655 (46.1)	3 433 145 (57.0)	3 911 693 (64.9)	1 521 211 (83.9)	1 612 964 (89.0)	2 448 108 (58.3)	2 774 404 (66.0)	2 737 615 (62.4)	3 078 432 (70.2)
Montana	523 792 (56.3)	619 065 (66.6)	20 663 (26.2)	35 564 (45.0)	329 194 (51.6)	396 445 (62.2)	173 925 (51.2)	187 056 (87.7)	246 409 (52.8)	295 063 (63.2)	271 083 (58.5)	316 537 (68.3)
Nevada	1 563 581 (58.3)	1 978 150 (73.8)	66 240 (27.7)	129 529 (52.5)	1 084 615 (56.5)	1 389 334 (72.3)	412 726 (79.5)	459 287 (88.4)	752 321 (56.2)	963 166 (72.0)	804 346 (60.0)	1 006 978 (75.1)
North Carolina	5 264 849 (57.8)	6 920 995 (76.0)	241 956 (30.0)	423 109 (52.5)	3 534 639 (54.5)	4 643 551 (71.7)	1 488 254 (82.0)	1 814 541 (100.0)	2 399 869 (54.7)	3 186 399 (72.6)	2 818 699 (59.8)	3 676 426 (78.0)
North Dakota	356 787 (55.7)	434 373 (67.8)	12 758 (22.5)	23 926 (42.2)	240 167 (52.1)	296 786 (64.4)	103 862 (84.3)	113 661 (92.3)	164 544 (50.2)	203 194 (62.0)	177 879 (56.9)	214 107 (68.5)
Ohio	5 729 687 (57.2)	6 618 484 (66.1)	250 303 (28.2)	388 652 (43.7)	3 743 479 (53.3)	4 402 717 (62.7)	1 735 905 (82.8)	1 827 115 (87.1)	2 612 845 (53.6)	3 046 387 (62.5)	3 013 168 (58.6)	3 456 002 (67.3)
South Dakota	459 032 (61.5)	562 414 (75.3)	19 999 (27.7)	37 402 (51.7)	297 815 (57.6)	366 126 (70.8)	141 218 (89.8)	157 176 (100.0)	210 450 (56.0)	261 392 (69.5)	235 690 (63.6)	286 148 (77.2)
Texas	14 031 104 (57.4)	17 801 129 (72.8)	786 479 (31.0)	1 524 327 (60.0)	10 169 866 (56.3)	12 932 991 (71.6)	3 744 759 (79.4)	3 343 811 (86.3)	6 460 946 (53.5)	8 390 018 (69.4)	7 511 170 (60.7)	9 348 795 (75.5)
Utah	1 635 853 (61.9)	2 011 140 (76.1)	110 757 (34.3)	192 372 (59.6)	1 186 756 (61.2)	1 457 744 (75.2)	338 340 (88.7)	361 024 (94.6)	778 419 (58.7)	971 498 (73.2)	839 507 (63.8)	1 020 270 (77.5)
West Virginia	874 845 (56.3)	1 045 314 (67.3)	34 070 (27.2)	55 624 (44.5)	541 355 (51.3)	666 715 (63.2)	299 420 (80.2)	322 975 (86.5)	407 248 (53.2)	491 032 (64.1)	459 960 (58.4)	545 055 (69.2)
<b>Low</b>	26 440 706 (51.5)	34 036 637 (66.3)	976 544 (20.6)	2 059 283 (43.4)	17 378 866 (47.7)	23 086 044 (63.3)	8 085 296 (79.7)	8 891 310 (87.7)	12 081 185 (48.5)	15 807 964 (63.5)	14 150 329 (53.5)	17 968 375 (67.9)
Alabama	2 021 965 (48.0)	2 733 421 (64.9)	53 948 (14.4)	145 831 (39.0)	1 283 721 (43.4)	1 821 794 (61.5)	684 296 (78.3)	765 796 (87.6)	1 100 657 (45.2)	1 256 273 (62.4)	1 101 596 (50.2)	1 465 542 (66.8)
Arkansas	1 317 162 (51.2)	1 762 725 (68.5)	47 562 (19.7)	119 878 (49.6)	850 129 (47.4)	1 176 463 (65.6)	419 471 (78.2)	466 384 (87.0)	585 965 (46.8)	799 598 (63.9)	696 264 (52.7)	912 245 (69.1)
Georgia	4 730 575 (52.0)	6 141 483 (67.5)	207 942 (23.6)	409 140 (46.3)	3 271 346 (49.3)	4 359 283 (65.7)	1 251 287 (79.5)	1 373 060 (87.2)	2 152 442 (49.2)	2 838 623 (64.8)	2 513 514 (53.3)	3 224 923 (68.4)
Indiana	3 082 502 (53.8)	3 640 472 (63.5)	134 573 (24.8)	223 818 (41.3)	2 042 063 (50.1)	2 456 999 (60.3)	905 866 (81.2)	959 655 (86.0)	1 422 098 (50.7)	1 695 061 (60.4)	1 634 397 (55.9)	1 915 925 (65.5)
Kentucky	2 094 732 (54.9)	2 616 277 (68.5)	81 226 (23.7)	154 220 (44.9)	1 383 932 (51.2)	1 771 596 (65.5)	629 574 (81.7)	690 461 (89.6)	966 066 (51.7)	1 223 899 (65.5)	1 118 272 (57.3)	1 380 153 (70.7)
Louisiana</												



**Figure 1.** First-dose COVID-19 vaccination coverage among people aged  $\geq 12$  years before and after the Delta variant surge, by prior vaccination coverage quartile, as of June 30, 2021, United States. First dose of COVID-19 vaccine is defined as the first of 2 doses of the Pfizer-BioNTech or Moderna vaccines or as a single dose of the Janssen (Johnson & Johnson) vaccine. The Delta variant surge period is defined as July 1–October 31, 2021. Jurisdictions were classified into the following quartiles of first-dose vaccination coverage prior to the Delta variant surge: high ( $n = 13$  jurisdictions,  $\geq 71.1\%$  coverage), medium high ( $n = 13$ , 62.2%–71.0%), medium low ( $n = 13$ , 55.7%–61.9%), and low ( $n = 12$ ,  $< 55.7\%$ ). Data sources: Murthy et al.<sup>6,7</sup>, Centers for Disease Control and Prevention<sup>10</sup>, National Center for Health Statistics<sup>11</sup>, and US Census Bureau.<sup>12</sup>

**Table 2.** First-dose monthly COVID-19 vaccination<sup>a</sup> rate, by jurisdictional vaccination coverage quartile,<sup>b</sup> among people aged  $\geq 12$  years from June 1 through October 31, 2021<sup>c</sup>

Quartile	No. (%) <sup>d</sup>				
	June <sup>e</sup>	July	August	September	October <sup>f</sup>
Total, United States ( $n = 281\,797\,953$ )	9 561 683 (3.4)	9 490 043 (3.4)	13 257,905 (4.7)	8 359 989 (3.0)	6 545 728 (2.3)
High ( $n = 53\,467\,312$ )	2 117 967 (4.0)	1 679 682 (3.1)	2 311 148 (4.3)	1 784 435 (3.3)	1 586 279 (3.0)
Medium high ( $n = 105\,040\,974$ )	3 857 155 (3.7)	3 459 478 (3.3)	4 594 486 (4.4)	2 853 429 (2.7)	2 267 289 (2.2)
Medium low ( $n = 71\,935\,971$ )	2 214 659 (3.1)	2 354 674 (3.3)	3 398 633 (4.7)	2 096 410 (2.9)	1 671 791 (2.3)
Low ( $n = 51\,353\,696$ )	1 371 902 (2.7)	1 996 209 (3.9)	2 953 638 (5.8)	1 625 715 (3.2)	1 020 369 (2.0)

<sup>a</sup>First dose of COVID-19 vaccine was defined as the first of 2 doses of the Pfizer-BioNTech or Moderna vaccines or as a single dose of the Janssen (Johnson & Johnson) vaccine.

<sup>b</sup>Jurisdictions were classified into the following quartiles of first-dose vaccination coverage prior to the Delta variant surge: high ( $n = 13$  jurisdictions,  $\geq 71.1\%$  coverage), medium high ( $n = 13$ , 62.2%–71.0%), medium low ( $n = 13$ , 55.7%–61.9%), and low ( $n = 12$ ,  $< 55.7\%$ ).

<sup>c</sup>Data sources: Murthy et al.<sup>6,7</sup> Centers for Disease Control and Prevention<sup>10</sup> National Center for Health Statistics<sup>11</sup> and US Census Bureau.<sup>12</sup>

<sup>d</sup>Percentage was calculated by dividing the number of first-dose vaccinations in that month by the total population of the jurisdictional quartile.

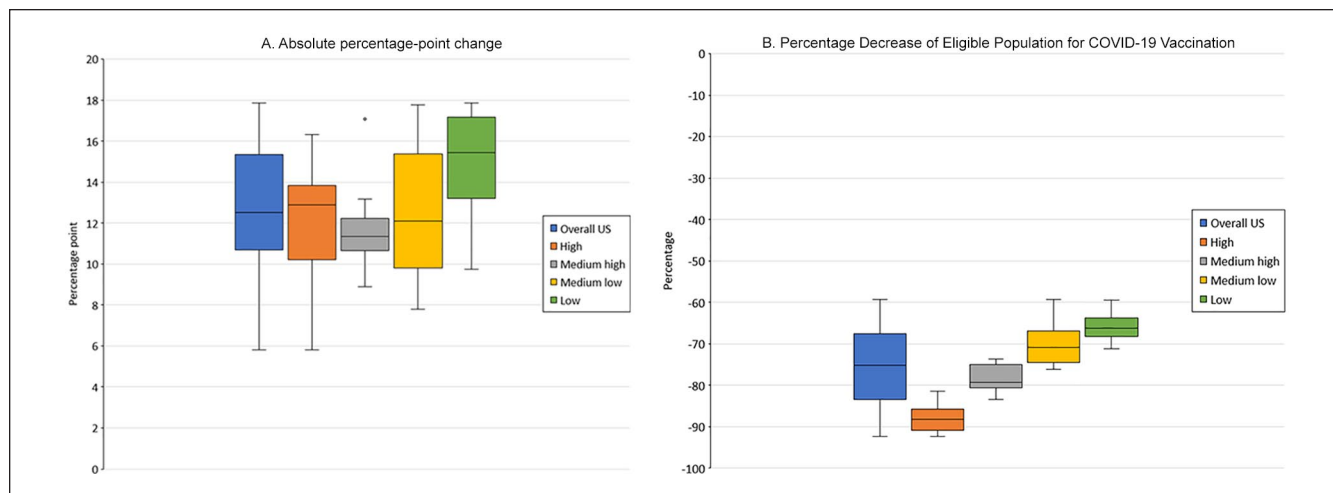
<sup>e</sup>“Before the Delta variant surge” was defined as COVID-19 vaccine coverage as of June 30, 2021 (ie, includes all first-dose vaccinations from December 14, 2020, through June 30, 2021).

<sup>f</sup>“After the Delta variant surge” was defined as COVID-19 vaccine coverage as of October 31, 2021 (ie, includes all first-dose vaccinations from December 14, 2020, through October 31, 2021).

vaccinations, especially during August, as people living in hot spots may have personally known someone who became seriously ill or died of COVID-19, thereby motivating them to initiate vaccination.<sup>9</sup>

Many important events occurred in summer and fall 2021 that could have affected COVID-19 vaccination uptake across all 4 quartiles. For example, in May 2021, the US Food and Drug Administration authorized the Pfizer

BioNTech vaccine for adolescents aged 12–15 years.<sup>7</sup> In July 2021, the White House announced vaccination requirements for federal employees and encouraged private sectors to also ensure that their workers are vaccinated.<sup>16</sup> Although enforcement of the federal vaccine mandate did not go into effect until November 2021, federal employees may have initiated COVID-19 vaccination in late summer or early fall in anticipation of the federal vaccine mandate. Additionally, the US



**Figure 2.** Absolute percentage-point change in first-dose COVID-19 vaccination coverage and relative percentage change among eligible unvaccinated people aged  $\geq 12$  years during the Delta variant surge, by prior vaccination coverage quartile, as of June 30, 2021, United States. First dose of COVID-19 vaccine is defined as the first of 2 doses of the Pfizer-BioNTech or Moderna vaccines or as a single dose of the Janssen (Johnson & Johnson) vaccine. The Delta variant surge period is defined as July 1–October 31, 2021. Jurisdictions were classified into the following quartiles of first-dose vaccination coverage prior to the Delta variant surge: high ( $n = 13$  jurisdictions,  $\geq 71.1\%$  coverage), medium high ( $n = 13$ , 62.2%–71.0%), medium low ( $n = 13$ , 55.7%–61.9%), and low ( $n = 12$ ,  $< 55.7\%$ ). Data sources: Murthy et al.<sup>6,7</sup>, Centers for Disease Control and Prevention<sup>10</sup>, National Center for Health Statistics<sup>11</sup>, and US Census Bureau.<sup>12</sup>

**Table 3.** Second-dose completion status<sup>a</sup> among people aged  $\geq 12$  years who initiated an mRNA COVID-19 vaccination series during the Delta variant surge,<sup>b</sup> by prior vaccination coverage quartile as of June 30, 2021, United States<sup>c,d</sup>

Second-dose completion status	No. (%)				
	Total ( $n = 30\ 433\ 474$ )	High ( $n = 5\ 501\ 361$ )	Medium high ( $n = 10\ 251\ 616$ )	Medium low ( $n = 8\ 348\ 467$ )	Low ( $n = 6\ 332\ 030$ )
Completed series	23 496 558 (77.2)	4 190 769 (76.2)	8 111 537 (79.1)	6 400 822 (76.7)	4 793 430 (75.7)
No second dose but remained within allowable interval <sup>e</sup>	1 621 698 (5.3)	379 519 (6.9)	493 812 (4.8)	464 920 (5.6)	283 447 (4.5)
Missed second dose <sup>f</sup>	5 315 218 (17.5)	931 073 (16.9)	1 646 267 (16.1)	1 482 725 (17.8)	1 255 153 (19.8)

<sup>a</sup>People who had enough time to receive the second dose within the study period were analyzed. People must have received their first dose on or before October 6 for Pfizer-BioNTech ( $> 25$  days between the first dose and October 31) or September 29 for Moderna ( $> 32$  days between the first dose and October 31) to be included in this analysis.

<sup>b</sup>Delta variant surge period was defined as July 1–October 31, 2021.

<sup>c</sup>Jurisdictions were classified into the following quartiles of first-dose vaccination coverage prior to the Delta variant surge: high ( $n = 13$  jurisdictions,  $\geq 71.1\%$  coverage), medium high ( $n = 13$ , 62.2%–71.0%), medium low ( $n = 13$ , 55.7%–61.9%), and low ( $n = 12$ ,  $< 55.7\%$ ).

<sup>d</sup>Data sources: Murthy et al.<sup>6,7</sup> Centers for Disease Control and Prevention<sup>10</sup> National Center for Health Statistics<sup>11</sup> and US Census Bureau.<sup>12</sup>

<sup>e</sup>Allowable interval is defined as 26–42 days (Pfizer-BioNTech) or 33–42 days (Moderna) after first dose; no second dose received.

<sup>f</sup>Missed second dose is defined as  $> 42$  days after first dose; no second dose received.

Food and Drug Administration granted approval for a biologics license application for the Pfizer-BioNTech COVID-19 vaccine on August 23, 2021, which also may have affected vaccination uptake.<sup>17</sup> However, there is no indication that any of these events would have differentially affected certain jurisdictions over others, because the rollout of these events uniformly affected the entire nation.

Vaccination initiation during July 1–October 31, 2021, also varied by age, with initiation being highest among adolescents and lowest among adults aged  $\geq 65$  years.

However, vaccination uptake among adolescents aged 12–17 years may have been affected by expanded eligibility of COVID-19 vaccines for those aged 12–15 years in May 2021.<sup>7</sup> Adults aged  $\geq 65$  years already had relatively high vaccination coverage in most jurisdictions by the end of June 2021, which may explain why this age group had the smallest absolute percentage-point increase in vaccinations during the Delta variant surge.

Among those who initiated the 2-dose mRNA vaccine series during the Delta variant surge, the proportion of people

who did not complete their second dose within the allowable interval was higher in our analysis than in previous analyses on dose completion.<sup>7,18</sup> An analysis on dose completion before the Delta variant surge showed that 88.0% of people initiating vaccination went on to complete the primary series<sup>18</sup>; however, our analysis showed that only 77.2% of people who initiated vaccination during the Delta variant surge completed the primary series. If fear was a motivator to initiate vaccination during the Delta variant surge, then perhaps this perceived fear gradually diminished as the Delta variant surge passed, which could explain why those who initiated vaccination chose not to complete the 2-dose series. Nevertheless, these findings underscore the need for all people to complete the primary series and to stay up-to-date on all recommended vaccines (eg, boosters and additional doses) for maximal protection against COVID-19, especially given that staying up-to-date on all recommended doses is effective against serious illness and death.<sup>19</sup>

### Limitations

Our findings had 3 limitations. First, vaccination coverage was not analyzed at more granular levels (eg, by county), which could better identify geographic areas with low coverage. Second, people who (1) received COVID-19 vaccines from different entities that used different methods for submitting data (eg, if the first dose was administered at a mass vaccination site and the subsequent doses were given at a pharmacy) or (2) received vaccine doses in different jurisdictions might not have their first and subsequent doses linked, which could lead to an underestimation of the percentage of people who completed the vaccination series and the number of people who were unvaccinated. Lastly, if a person had inadvertently received a different recipient identification number when receiving their first and subsequent doses, those records would not be linked.

### Conclusions

Jurisdictions in the lowest quartile of vaccination coverage prior to the Delta variant surge had the highest absolute and relative percentage increase in vaccination coverage during July 1–October 31, 2021. However, as of October 31, 2021, many of these jurisdictions in the lowest quartile of vaccination coverage, as well as some jurisdictions in the medium-low quartile, still did not reach first-dose vaccination coverage of 70%.<sup>8</sup> The highest quartile of vaccination coverage also had substantial vaccination uptake during the Delta variant surge, and lessons learned from these jurisdictions can help identify best practices to improve COVID-19 vaccination coverage that may be applied to jurisdictions in other quartiles. Furthermore, dose completion lagged among those who started the 2-dose mRNA vaccine series during this time, with almost 1 in 5 people missing their second dose. Strategic efforts should be made to identify and reduce barriers to receiving COVID-19 vaccines, including addressing vaccine

hesitancy, especially in jurisdictions with low vaccination coverage to reduce COVID-19–associated morbidity and mortality.<sup>20</sup> Improving vaccination coverage nationally and globally is essential to protect populations and prevent the rise of more variants.

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