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# E-cigarette Unit Sales by Product and Flavor Type, and Top-Selling Brands, United States, 2020–2022

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E-cigarette products, related policies, and use patterns change rapidly. In the United States, the prevalence of e-cigarette use is markedly higher among youths and young adults than it is among adults overall. In 2021, 4.5% of all adults aged ≥18 years (an estimated 11.1 million) and 11.0% of young adults aged 18–24 years (an estimated 3.1 million) currently (≥1 day during the previous 30 days) used e-cigarettes; during 2022, 14.1% of high school students (an estimated 2.14 million) currently used e-cigarettes (*1*,*2*). E-cigarettes often contain high concentrations of nicotine. Nicotine is highly addictive and can harm the adolescent brain, which continues to develop through approximately age 25 years (*3*). Since 2020, the availability of e-cigarette products has changed in response to multiple factors, including local and state policies to address flavored e-cigarette sales, actions undertaken by the Food and Drug Administration (FDA), COVID-19–related closures, and global supply chain disruptions. To assess trends in unit sales of e-cigarettes in the United States, by product and flavor, and top-selling brands, the CDC Foundation, Truth Initiative,* and CDC analyzed retail scanner data during January 26, 2020–December 25, 2022, from Information Resources, Inc. (IRI), a U.S. data analytics and market research company. Overall, unit sales increased by 46.6% during the study period. The unit share of menthol-flavored product sales remained relatively stable during this period, whereas nonmenthol flavor unit shares changed. During January 26, 2020–December 25, 2022, unit shares of tobacco-flavored and mint-flavored products decreased (from 28.4% to 20.1% and from 10.1% to 5.9%, respectively), whereas shares of other flavor sales increased (from 29.2% to 41.3%). In addition, during January 2020–December 2022, unit shares of prefilled cartridges decreased from 75.2% to 48.0%, and disposable e-cigarette unit share increased from 24.7% to 51.8% of total unit sales. The five top-selling e-cigarette brands for the 4-week period ending December 25, 2022, were Vuse, JUUL, Elf Bar, NJOY, and Breeze Smoke. Analysis of information on e-cigarette retail sales can guide strategies to prevent youth access to and use of e-cigarettes, including restrictions on flavored tobacco products (*4*).

U.S. e-cigarette sales data were licensed from IRI, which included Universal Product Code sales from brick-and-mortar

* https://truthinitiative.org/

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retailers only; sales from online retailers and tobacco specialty stores, including vape shops, were not available. For analyses other than top-selling brands, e-cigarette products were categorized as prefilled cartridges, disposable devices, or e-liquids[†] (*5*), and e-cigarette accessories and devices sold without e-liquids (accounting for 9.5% of sales) were excluded. Product flavor names were categorized as tobacco, menthol, mint, or all other flavors (e.g., fruit, clove or spice, candy, desserts, other sweets, chocolate, alcoholic and nonalcoholic drinks). Ambiguous or concept flavors (e.g., "fusion"), which constituted 5.6% of sales, were searched online and back-coded into one of the four flavor categories. E-cigarette unit sales were standardized and summed during 4-week periods during January 26, 2020–December 25, 2022[§]. Analyses were performed for total unit sales and the proportion of total unit sales (unit share) by flavor and product type using Stata (version 17; StataCorp). Trends during the analysis period were analyzed using Joinpoint regression (version 4.9.1.0; National Cancer Institute), which detects points in time when changes in trend (or slope changes) are statistically significant. The average 4-week period percentage change (APPC) was calculated as the average of the slope coefficients of the Joinpoint regression line. P-values <0.05 were considered statistically significant. Total number of brands and a list of the top five brands with the highest unit sales, as provided in the IRI database without unit standardization or exclusions, were reported for the beginning and end of the study period. This study was reviewed by CDC and was conducted consistent with federal law and CDC policy.[¶]

During January 2020–December 2022, total U.S. e-cigarette unit sales increased by 46.6%, from 15.5 million to 22.7 million units per 4-week period (APPC = 1.1; p<0.05); however, sales fluctuated during this period (Figure 1). Although sales increased during January 2020–May 2022, the percentage of increase in sales slowed from 36.5% (15.5 million to 21.2 million; APPC = 6.9) during January 2020–June 2020 to 16.8% (21.2 million to 24.7 million; APPC = 1.3) during June 2020–June 2021 to 4.9% (24.7 million to 25.9 million; APPC = 0.4) during June 2021–May 2022 (p<0.05 for all APPCs). Overall, during January 2020–May 2022, total sales increased 67.2% (APPC = 1.8; p<0.05), from 15.5 million to 25.9 million units per period. During May–December 2022, total sales decreased by 12.3% (APPC = –1.8; p<0.05), to 22.7 million units per period.

Among total e-cigarette unit sales during January 2020–December 2022, the percentage of menthol flavor sales did

[†] Prefilled cartridges include tanks, cartridges, and pods used in rechargeable and reusable e-cigarette devices; the cartridges are not intended to be refilled after the liquid has been depleted. Disposable devices include nonrechargeable and nonreusable e-cigarette devices that are not intended to be refilled with e-liquid after being depleted; the device is disposed of once the e-liquid has been consumed. E-liquids are containers of the liquid used in e-cigarette devices, which typically contains a humectant (e.g., propylene glycol), nicotine, and flavoring.

[§] Consistent with previous studies, unit sales were standardized to reflect the most common package size for each product type. A standardized unit was equal to five prefilled cartridges, one disposable device, or one e-liquid bottle.

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

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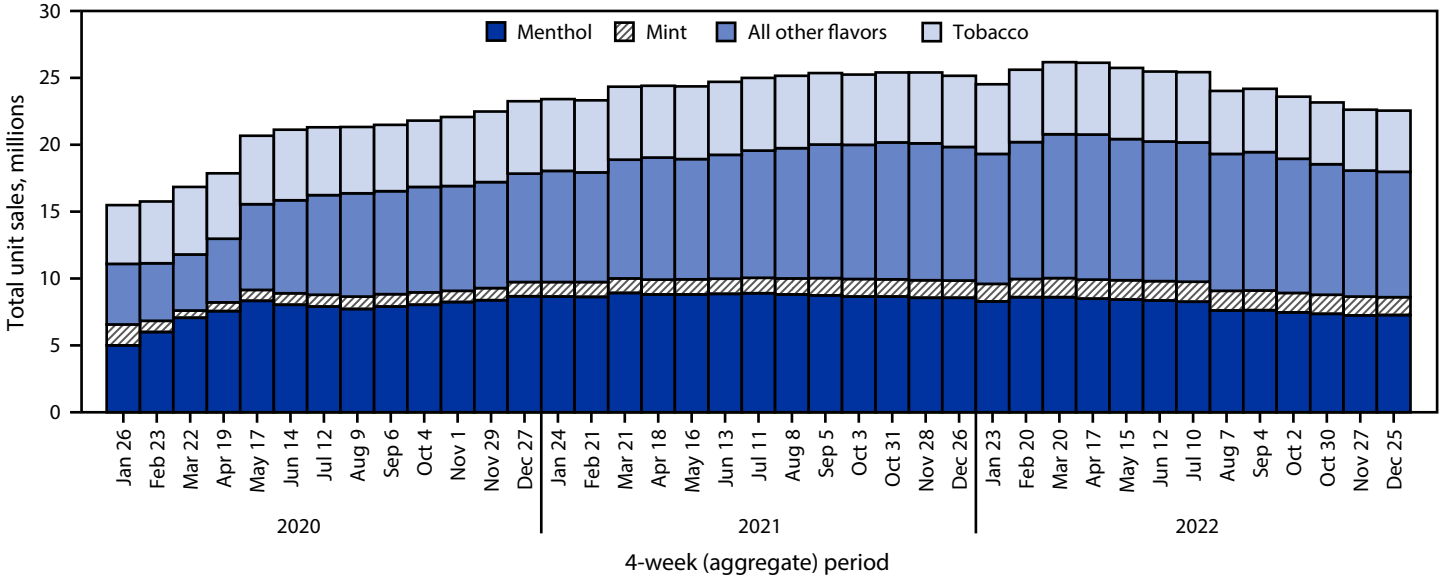
**FIGURE 1. Total e-cigarette unit sales,* by flavor† — United States, January 26, 2020–December 25, 2022**




* Retail sales data obtained from Information Resources, Inc. for convenience stores, gas stations, grocery stores, drug stores or pharmacies, mass merchandiser outlets, club stores, dollar stores, and military sales; Internet and vape shop sales were not recorded.

† The "All other flavors" category includes fruit, clove or spice, chocolate, alcoholic drink (such as wine, cognac, or other cocktails), candy, desserts, other sweets, or some other flavor. Unknown flavors were excluded from this figure (<0.1%).

not significantly change (<1%, from 32.3% in January 2020 to 31.9% in December 2022), whereas the percentages of tobacco, mint, and other flavor sales fluctuated. During the period of increasing total sales (January 2020–May 2022), decreases were observed in the percentages of sales of both tobacco flavor (from 28.4% to 20.5%; APPC = –1.1; p<0.05) and mint flavor e-cigarettes (10.1% to 5.6%; APPC = –1.9; p<0.05), while the percentage of other flavor sales increased from 29.2% to 40.8% (APPC = 1.1; p<0.05). During the period of declining total sales (May–December 2022), the percentage of sales of tobacco-flavored e-cigarettes decreased slightly, from 20.5% to 20.1% (APPC = –0.6; p<0.05), while slight increases in sales of mint-flavored (from 5.6% to 5.9%) and other-flavored e-cigarettes (40.8% to 41.3%) occurred (APPC = 1.3 and 0.4, respectively; p<0.05).

Among total e-cigarette unit sales during January 2020–December 2022, the percentage of prefilled cartridge sales decreased from 75.2% to 48.0% (APPC = –1.1; p<0.05). In contrast, the percentage of disposable e-cigarette sales more than doubled, from 24.7% in January 2020 to 51.8% in December 2022 (APPC = 1.9; p<0.05). Among prefilled cartridge e-cigarettes sales in January 2020, tobacco, menthol, and mint flavors accounted for 34.2%, 40.0%, and 10.5% of sales, respectively, whereas e-cigarette sales of other flavors accounted for 15.3% (Figure 2). During December 2022, the prefilled cartridge market was composed of tobacco- (37.3%) and menthol- (62.2%) flavored sales almost exclusively. Among disposable e-cigarette sales during January 2020, tobacco, menthol, mint, and other flavors accounted for 10.5%, 9.0%, 8.9%, and 71.4%, respectively (Figure 3). By December 2022, the disposable e-cigarette market was led by mint (11.1%) and flavors other than tobacco, menthol, or mint (79.6%); tobacco- and menthol-flavored sales accounted for 4.3% and 3.6%, respectively.

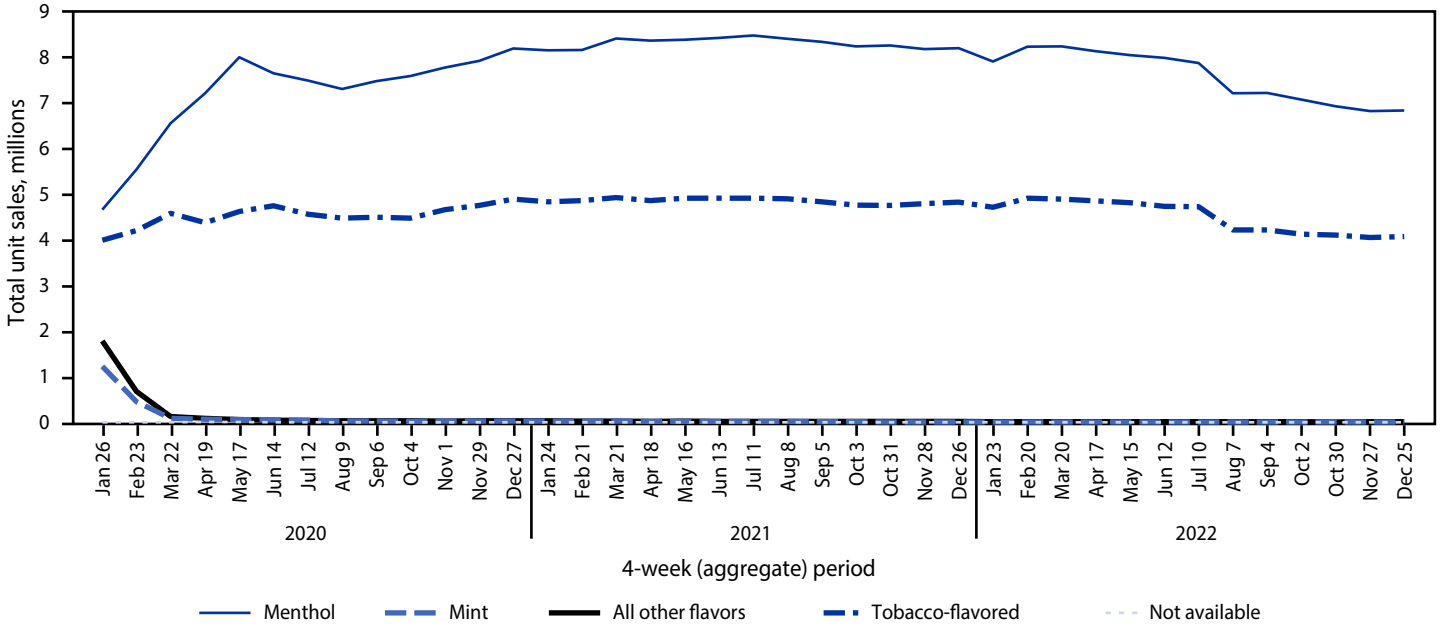
During the 4-week period ending January 26, 2020, among 184 brands, the top five in descending order of sales were JUUL, Vuse, NJOY, My Blu, and Puff.** During the 4-week period ending December 25, 2022, the top five brands were Vuse, JUUL, Elf Bar, NJOY, and Breeze Smoke. The total number of e-cigarette brands increased 46.2% during the study period, from 184 to 269. Vuse, JUUL, NJOY, and My Blu are prefilled cartridge brands; Puff, Elf Bar, and Breeze Smoke are disposable.

## Discussion

E-cigarette unit sales during December 2022 were 46.6% (7.2 million units) higher than sales during January 2020. Declines in total unit sales observed during May 2022–December 2022 likely reflect multiple factors, including local and state restrictions on flavored tobacco product sales, FDA regulatory actions, potential COVID-19–associated supply chain disruptions, inflation, and a recent proliferation of large

** Individual brands (reported by IRI as "brand franchises") might include multiple product lines (e.g., Vuse includes the product lines Vuse Alto and Vuse Solo, Elf Bar includes Elf Bar BC5000 and Elf Bar, and Puff includes Puff Bar).

**FIGURE 2. Prefilled cartridge* e-cigarette unit sales,† by flavor§ — United States, January 26, 2020–December 25, 2022**




* Prefilled cartridges include tanks, cartridges, and pods used in rechargeable and reusable e-cigarette devices; the cartridges are not intended to be refilled after the liquid has been depleted. Unit sales were standardized to reflect the most common package size for each product type; a standardized unit was equal to five prefilled cartridges.
† Retail sales data obtained from Information Resources, Inc. for convenience stores, gas stations, grocery stores, drug stores or pharmacies, mass merchandiser outlets, club stores, dollar stores, and military sales; Internet and vape shop sales were not recorded.
§ The "All other flavors" category includes fruit, clove or spice, chocolate, alcoholic drink (such as wine, cognac, or other cocktails), candy, desserts, other sweets, or some other flavor.

format disposable e-cigarettes capable of delivering thousands of "puffs" that might permit higher nicotine consumption per unit. Increases in the number of available e-cigarette brands during the study period and changes observed in the top five brands during December 2022 reflect the dynamic nature of the e-cigarette market.

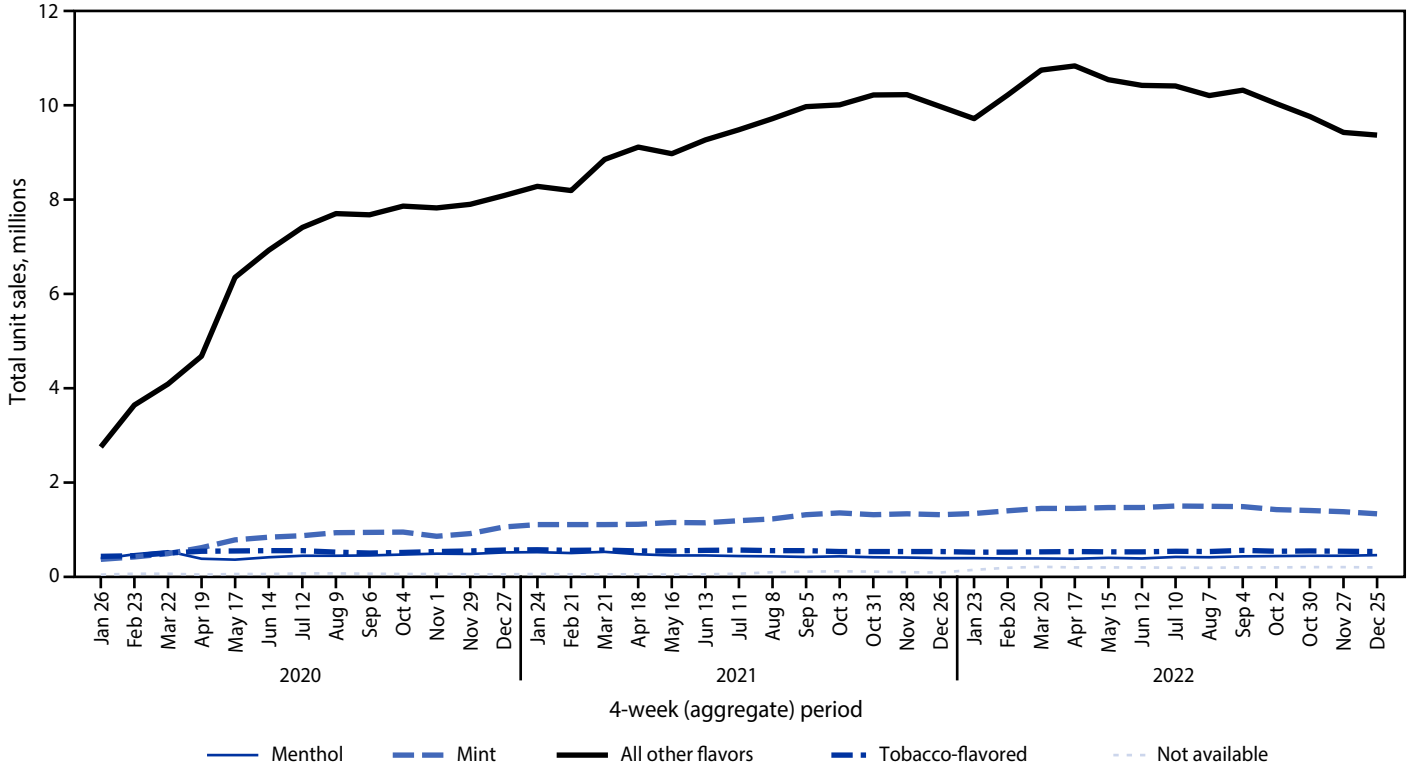
Citing the appeal of flavored e-cigarettes to children, FDA announced during January 2020 that it would prioritize enforcement against prefilled e-cigarettes in flavors other than tobacco and menthol based on the prevalence of use of these products among youth at the time.[††] The present study's findings indicate that after this announcement, retail sales of mint- and other-flavored prefilled cartridges halted while notable increases in sales of fruit- and mint-flavored disposable products occurred. Although disposable e-cigarettes constituted approximately less than one quarter of total unit sales during January 2020, disposable sales surpassed refillable sales in March 2022. As of August 2022, Elf Bar, a disposable brand that has driven sharp increases in e-cigarette use among persons aged 16–19 years in England, is the top disposable brand reported among a sample of 4,142 persons aged 16–19 years in the United States (*6*) and was the top-selling disposable brand in December 2022. In addition, flavored disposable e-cigarettes have emerged as the most commonly used device type among U.S. middle and high school students who use e-cigarettes (*1*). These sales data, coupled with behavioral data, demonstrate that the e-cigarette landscape and use patterns rapidly shift in response to market changes, policy interventions, and other factors.

As of December 31, 2022, seven states (California, Maryland, Massachusetts, New Jersey, New York, Rhode Island, and Utah) and 378 jurisdictions, including counties, cities, towns, and villages, have some type of restriction on flavored e-cigarette sales in place. The comprehensiveness of local and state flavored tobacco product policies varies (*7*), with some policies exempting certain flavors (e.g., menthol) or products (e.g., cigars), which are disproportionately used by certain groups such as non-Hispanic Black or African American youths (*1*). States such as Massachusetts, which have well-enforced comprehensive flavor restrictions, have experienced large and sustained declines in total e-cigarette sales (*8*). Further, a review of nine studies found that after a flavored tobacco product sales restriction, use of tobacco products among young persons declined (*9*). The trends observed nationally in the relative proportions of disposable e-cigarette sales are observable within states lacking e-cigarette flavor restrictions.[§§]

[††] https://www.fda.gov/news-events/press-announcements/fda-finalizes-enforcement-policy-unauthorized-flavored-cartridge-based-e-cigarettes-appeal-children

[§§] https://www.fda.gov/news-events/press-announcements/fda-denies-marketing-applications-about-55000-flavored-e-cigarette-products-failing-provide-evidence

**FIGURE 3. Disposable e-cigarette* unit sales,† by flavor§ — United States, January 26, 2020–December 25, 2022**




* Disposable devices include nonrechargeable and nonreusable e-cigarette devices that are not intended to be refilled with e-liquid after being depleted; the device is disposed of once the e-liquid has been consumed. Unit sales were standardized to reflect the most common package size for each product type; a standardized unit was equal to one disposable device.

† Retail sales data obtained from Information Resources, Inc. for convenience stores, gas stations, grocery stores, drug stores or pharmacies, mass merchandiser outlets, club stores, dollar stores, and military sales; Internet and vape shop sales not captured.

§ The "All other flavors" category includes fruit, clove or spice, chocolate, alcoholic drink (such as wine, cognac, or other cocktails), candy, desserts, other sweets, or some other flavor.

Through the premarket tobacco application process established by the Tobacco Control Act, FDA can authorize or deny the marketing of tobacco products using the standard that allowing the product to be marketed is "appropriate for the protection of public health."[¶¶] FDA issued its first marketing denial orders for approximately 55,000 flavored e-cigarette products on August 26, 2021, and its first marketing denial order for a menthol-flavored, cartridge-based e-cigarette on October 26, 2022[***]; to date, only tobacco-flavored e-cigarette products have received marketing authorization on the basis of a scientific evaluation of their risks and benefits to the population as a whole.[†††] FDA has taken action to address illegal flavored disposable e-cigarette products, including the issuance of warning letters to importers, distributors, and retailers for the unauthorized sale of Puff Bar products, the most commonly used e-cigarette brand among U.S. middle and high school students in 2022 (*10*). Additional FDA enforcement efforts against manufacturers or retailers include no-tobacco-sale orders, permanent injunctions against noncompliant manufacturers in conjunction with the U.S. Department of Justice, and other actions.[§§§]

The findings in this report are subject to at least three limitations. First, sales data from tobacco specialty stores, including vape shops and internet retailers, were not available. However, online sales are estimated to constitute only 20% of total e-cigarette sales (*4*). Second, these analyses did not account for variations in e-cigarette nicotine strength or unit size. Large-format disposable e-cigarettes, including (but not limited to) Elf Bar BC5000, have recently been introduced. Therefore, recent declines in unit sales might not signify declines in consumption. Finally, purchaser age is not available from IRI.

[¶¶] https://www.federalregister.gov/documents/2021/10/05/2021-21011/premarket-tobacco-product-applications-and-recordkeeping-requirements

[***] https://www.cdcfoundation.org/State-E-CigaretteSales-DataBrief-2022-Octo30?inline

[†††] https://www.fda.gov/tobacco-products/premarket-tobacco-product-applications/premarket-tobacco-product-marketing-granted-orders

[§§§] https://www.fda.gov/tobacco-products/compliance-enforcement-training/ctp-compliance-enforcement

**Summary**

What is already known about this topic?

E-cigarette products, related policies, and use patterns change rapidly. Flavored e-cigarette products appeal to young users.

What is added by this report?

E-cigarette unit sales increased by 46.6% during January 2020–December 2022. After January 2020, sales of mint and other flavored prefilled cartridges ceased, and disposable e-cigarettes in fruit, sweet, and other flavors increased. Disposable e-cigarettes in youth-appealing flavors are now more commonly sold than prefilled units.

What are the implications for public health practice?

Monitoring e-cigarette sales can inform strategies to prevent youth tobacco use, including restrictions on flavored tobacco products.

Sales reflect purchases by adults and could also reflect direct or indirect purchases by youths.

Comprehensive restrictions on the sale of all flavored tobacco products that include e-cigarettes, menthol cigarettes, and flavored cigars are warranted in all jurisdictions. These strategies, when coupled with longstanding evidence-based strategies to prevent youth tobacco use such as price increases, comprehensive smokefree policies that include e-cigarettes, and countermarketing campaigns, are expected to reduce youth initiation and use as well as reduce disparities in tobacco product use.

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# Progress Toward Rubella Elimination — World Health Organization South-East Asia Region, 2013–2021

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During 2013, the 11 countries of the World Health Organization (WHO) South-East Asia Region* (SEAR) adopted the goals of measles elimination and rubella and congenital rubella syndrome (CRS) control† by 2020. During 2019, SEAR countries declared a broader goal for eliminating both measles and rubella§ by 2023 (*1*). Before 2013, only five SEAR countries had introduced rubella-containing vaccine (RCV). This report updates a previous report and describes progress toward rubella elimination in SEAR during 2013–2021 (*2*). During 2013–2021, six SEAR countries introduced RCV; all countries in the Region now use RCV in routine immunization. Routine immunization coverage with the first dose of a rubella-containing vaccine (RCV1) increased >600%, from 12% during 2013 to 86% during 2021, and an estimated 515 million persons were vaccinated via RCV supplementary immunization activities (SIAs)¶ during 2013–2021. During this time, annual reported rubella incidence declined by 80%, from 5.5 to 1.1 cases per million population. Maldives and Sri Lanka are verified as having achieved rubella elimination; Bhutan, North Korea, and Timor-Leste have halted endemic transmission of rubella virus for >36 months. SEAR has made substantial progress toward rubella elimination; however, intensified measures are needed to achieve elimination.

Rubella is the leading cause of vaccine-preventable birth defects (*3*). Rubella infection during pregnancy, especially during the first trimester, can result in miscarriage, fetal death, or CRS, a constellation of congenital malformations, frequently including visual, auditory, or cardiac defects. CRS is a cause of mortality among infants and children and a shortened lifespan among adults. Rubella and measles elimination activities are programmatically linked because RCV is administered as a combined measles and rubella vaccine, and rubella cases are detected through case-based surveillance for measles or fever and rash illness (*4*). The WHO SEAR-recommended strategies (*5*) to achieve rubella elimination include 1) achieving and maintaining ≥95% coverage with 2 doses of measles- and rubella-containing vaccine in every district through routine immunization or SIAs; 2) developing and sustaining a sensitive and timely case-based surveillance system for rubella and sentinel site surveillance for CRS that meets recommended performance indicators**; 3) developing and maintaining an accredited laboratory network; 4) achieving timely identification, investigation, and response to rubella outbreaks; and 5) linking with other public health initiatives to achieve the first four strategies.

## Immunization Activities

RCV1 was introduced in five SEAR countries (Bangladesh, Bhutan, Maldives, Sri Lanka, and Thailand) before 2013 and in the remaining six SEAR countries (Burma [Myanmar],†† India, Indonesia, Nepal, North Korea, and Timor-Leste) during 2013–2019. A routine second RCV dose (RCV2) was introduced in three countries (Bhutan, Sri Lanka, and Thailand) before 2013 and in the remaining eight during 2013–2021 (Table 1).

WHO and UNICEF estimated that regional RCV1 coverage increased from 12% during 2013 to 86% during 2021 (*6*) (Figure); five countries reported ≥95% RCV1 coverage during 2021 (Table 1). The highest regional RCV1 coverage (93%) was achieved during 2019, just before the start of the COVID-19 pandemic. During 2013–2021, SIAs with RCV

* Bangladesh, Bhutan, Burma (Myanmar), India, Indonesia, Maldives, Nepal, North Korea, Sri Lanka, Thailand, and Timor-Leste.

† Measles elimination is defined as the absence of endemic measles cases for a period of ≥12 months in the presence of adequate surveillance. Rubella and CRS control is defined as a 95% reduction in disease incidence from the 2013 level.

§ Rubella elimination is defined as the absence of endemic rubella cases for a period of ≥12 months in the presence of adequate surveillance.

¶ Generally, SIAs for measles and rubella are carried out using two target age ranges. An initial, nationwide catch-up SIA focuses on all children and adolescents aged 9 months–14 years, with the goal of eliminating susceptibility to measles and rubella in the general population. Generally, follow-up SIAs are conducted nationwide every 2–4 years and target children aged 9–59 months with the goal of eliminating any measles and rubella susceptibility that has accumulated in recent birth cohorts and protecting children who did not respond to the first measles vaccination.

** These indicators include 1) two or more discarded nonmeasles, nonrubella cases per 100,000 population at the national level per year (a suspected case that has been investigated and determined to be neither measles nor rubella using laboratory testing in a proficient laboratory or epidemiologic linkage to a laboratory-confirmed outbreak of another communicable nonmeasles, nonrubella disease), to measure surveillance sensitivity; 2) two or more discarded nonmeasles, nonrubella cases per 100,000 population per year in ≥80% of subnational administrative units; 3) testing of ≥80% of suspected measles cases for measles immunoglobulin M antibodies; 4) adequate investigation conducted within 48 hours of notification of ≥80% of suspected cases; 5) adequate collection of samples for detecting measles or rubella viruses and testing in accredited laboratory of ≥80% of laboratory-confirmed transmission chains; and 6) an annualized incidence of zero confirmed endemic measles cases.

†† *MMWR* uses the U.S. Department of State's short-form name "Burma"; WHO uses "Myanmar."

**TABLE 1. Estimated coverage* with rubella-containing vaccine, recommended age for vaccination, number of confirmed rubella and congenital rubella syndrome cases, and rubella incidence, by country — World Health Organization South-East Asia Region, 2013 and 2021**

| | 2013 | | | | | 2021 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Country (RCV1, RCV2 introduction) | RCV1 coverage (%) | RCV schedule (age) | No. of confirmed CRS cases | No. of confirmed rubella cases | Rubella incidence† | RCV1 coverage (%) | RCV schedule (age) | No. of confirmed CRS cases | No. of confirmed rubella cases | Rubella incidence† | % Change in rubella incidence 2013–2021 |
| Bangladesh (2012, 2015) | 91 | 9 mos | 19 | 3,034 | 19.7 | 97 | 9 mos, 15 mos | 171 | 129 | 0.8 | −96 |
| Bhutan (2006, 2006) | 94 | 9 mos, 24 mos | 0 | 6 | 8.2 | 97 | 9 mos, 24 mos | 1 | 0 | 0 | −100 |
| Burma (Myanmar)§ (2015, 2017) | NA¶ | NA | NR | 23 | 0.5 | 44 | 9 mos,18 mos | NR | 3 | 0.1 | −80 |
| India (2017, 2017) | NA¶ | NA | NR | 3,698 | 2.9 | 89 | 9–12 mos, 16–24 mos | NR | 1,675 | 1.2 | −59 |
| Indonesia (2017, 2017) | NA¶ | NA | NR | 2,355 | 9.3 | 72 | 9 mos, 18 mos, 7 yrs | 229 | 268 | 1 | −89 |
| Maldives (2007, 2017) | 99 | 9 mos, 18 mos | NR | 0 | 0 | 99 | 9 mos, 18 mos | 0 | 0 | 0 | NC |
| Nepal (2013, 2015) | 88 | 9 mos | NR | 755 | 27.6 | 90 | 9 mos, 15 mos | NR | 28 | 0.9 | −97 |
| North Korea (2019, 2019) | NA¶ | NA | 0 | 0 | 0 | NR | 9 mos, 15 mos | 0 | 0 | 0 | NC |
| Sri Lanka (1996, 2001) | 99 | 3 yrs, 13 yrs | 4 | 24 | 1.1 | 97 | 9 mos, 3 yrs | 0 | 0 | 0 | −100 |
| Thailand (1986, 1997) | 99 | 9 mos, P1** | 0 | 539 | 7.7 | 96 | 9 mos, 1.5 yrs | NR | NR | NR | —†† |
| Timor-Leste (2016)§§ | NA¶ | NA | NR | 0 | 0 | 79 | 9 mos, 18 mos | 0 | 0 | 0 | NC |
| **Total** | **12¶¶** | — | **23** | **10,434** | **5.5** | **86¶¶** | — | **401** | **2,103** | **1.1** | **−80** |

**Abbreviations:** NA = not applicable; NC = not calculated; NR = not reported during the year; P = primary grade of school; RCV = rubella-containing vaccine; RCV1 = first dose of RCV; RCV2 = second dose of RCV; SEAR = South-East Asia Region; WHO = World Health Organization.

* WHO-UNICEF coverage estimates, 2021 revision (as of July 2022). https://immunizationdata.who.int/

† Cases per 1 million population.

§ *MMWR* uses the U.S. Department of State's short-form name "Burma"; WHO uses "Myanmar."

¶ Dose was not included in the vaccination schedule for that year.

** Given to primary grade 1 students (aged approximately 7 years).

†† Change in rubella incidence could not be calculated because cases were not reported via WHO-UNICEF Joint Reporting Form in 2021.

§§ RCV1 and RCV2 were introduced during 2016.

¶¶ The regional estimates are calculated as part of WHO-UNICEF coverage estimates, in which the denominator is the total birth cohort of the region irrespective of the reporting status, and the numerator is the sum of estimated vaccinated children and adolescents from all reporting countries.

were conducted in 10 SEAR countries (all except Sri Lanka) and reached more than 514 million persons.§§

## Surveillance Activities

By 2021, case-based measles and rubella surveillance with laboratory confirmation of suspected cases¶¶ was implemented in all countries in the region. As an integral component of the WHO Global Measles and Rubella Laboratory Network, a measles-rubella laboratory network was established in the region by 2003, and by 2021, the regional laboratory network included 58 proficient laboratories*** with one regional reference laboratory in Thailand; all countries had at least one proficient laboratory. During 2013, two of the 11 countries achieved the sensitivity indicator target of two or more discarded nonmeasles, nonrubella cases per 100,000 population, and the regional discarded case rate was 0.91; this increased to 1.52 during 2021. However, during 2021, only five countries achieved the target discarded case rate of two or more per 100,000 population (Table 2).

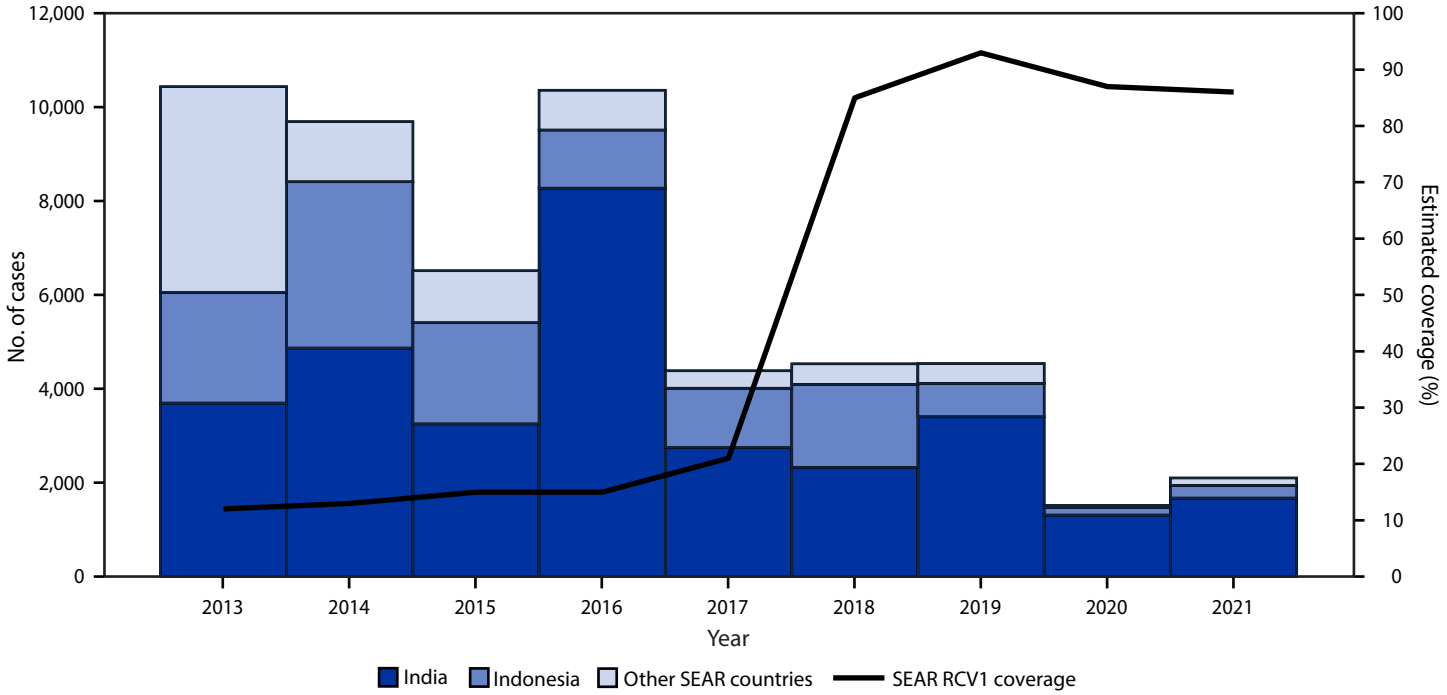
All countries in SEAR have established CRS surveillance. North Korea, Sri Lanka, and Thailand report CRS cases as part of their national integrated disease surveillance programs. The remaining eight countries identify CRS cases through sentinel site surveillance. The number of SEAR countries reporting CRS cases through the WHO-UNICEF Joint Reporting Form increased from six during 2013 to seven during 2021 (Table 1).

§§ https://immunizationdata.who.int/

¶¶ The definition of a suspected measles or rubella case was "acute fever with maculopapular rash" in all SEAR countries.

*** A laboratory that has met defined criteria as outlined at https://www.who.int/publications/i/item/framework-for-verifying-elimination-of-measles-and-rubella

**FIGURE. Number of reported rubella cases,* by country,†,§ and estimated first dose rubella-containing vaccination coverage¶ — World Health Organization South-East Asia Region, 2013–2021**




**Source:** https://immunizationdata.who.int/
**Abbreviations:** RCV = rubella-containing vaccine; SEAR = South-East Asia Region; WHO = World Health Organization.
* Cases of rubella reported to WHO and UNICEF through the Joint Reporting Form to the WHO Regional Office for SEAR.
† Other countries in the region include Bangladesh, Bhutan, Burma (Myanmar), Maldives, Nepal, North Korea, Sri Lanka, Thailand, and Timor-Leste.
§ *MMWR* uses the U.S. Department of State's short-form name "Burma"; WHO uses "Myanmar."
¶ Data are from WHO and UNICEF estimates of routine first RCV dose coverage for SEAR.

**TABLE 2. Year of initiation of surveillance for rubella and key surveillance performance indicator of nonmeasles, nonrubella discard rate, by country and year — World Health Organization South-East Asia Region, 2013–2021**

| | Year rubella surveillance activities initiated | | | Discarded nonmeasles, nonrubella reporting rate* | |
|---|---|---|---|---|---|
| Country | Rubella† | Fever and rash§ | CRS¶ | 2013 | 2021 |
| Bangladesh | 2008 | 2021 | 2012 | 1.1 | 2.00 |
| Bhutan | 2007 | 2015 | 2015 | 12.9 | 19.44 |
| Burma (Myanmar)** | 2008 | 2019 | 2016 | 0.34 | 0.03 |
| India | 2005 | 2019 | 2016 | 1.51 | 1.69 |
| Indonesia | 2008 | 2019 | 2014 | 0.54 | 0.69 |
| Maldives | 2014 | 2017 | 2015 | 0 | 4.21 |
| Nepal | 2007 | 2019 | 2014 | 0.90 | 9.97 |
| North Korea | 2006 | 2018 | 2015 | 0.26 | 1.60 |
| Sri Lanka | 2004 | 2015 | 1991 | 2.99 | 0.10 |
| Thailand†† | 1973 | 2018 | 1973 | 0.63 | 0.30 |
| Timor-Leste | 2009 | 2018 | 2016 | 0 | 2.43 |
| **Total** | **NA** | **NA** | **NA** | **0.91** | **1.52** |

**Source:** https://www.who.int/publications/i/item/SEAR-MR-Bulletin-Q3-2021
**Abbreviations:** CRS = congenital rubella syndrome; NA = not applicable; SEAR = South-East Asia Region; WHO = World Health Organization.
* Discarded cases per 100,000 population. A discarded case is defined as a suspected case that has been investigated and determined to be neither measles nor rubella using 1) laboratory testing in a proficient laboratory or 2) epidemiologic linkage to a laboratory-confirmed outbreak of another communicable disease that is not measles or rubella. The discarded case rate is used to measure the sensitivity of measles-rubella surveillance.
† The year any form of CRS was initiated in the country. Countries defined a suspected measles/rubella case as "acute fever with maculopapular rash and at least one of the following: cough, coryza, or conjunctivitis."
§ The year laboratory supported case-based surveillance with definition of a suspected measles/rubella case as "acute fever with maculopapular rash" was initiated in the country.
¶ The year any form of CRS surveillance was initiated in the country at national level.
** *MMWR* uses the U.S. Department of State's short-form name "Burma"; WHO uses "Myanmar."
†† CRS surveillance was initiated during 1973. At that time, the same reporting code was used for both rubella and CRS; however, during 2020, CRS was formally identified with its own reporting code separate from rubella.

**Summary**

What is already known about this topic?

During 2013, coverage with the first dose of rubella-containing vaccine (RCV1) in the World Health Organization South-East Asia Region was 12%, and only five countries in the region had introduced RCV into their routine immunization programs.

What is added by this report?

By 2021, all 11 SEAR countries had introduced RCV1, and estimated regional RCV1 coverage increased from 12% to 86%; rubella incidence declined by 80%. Maldives and Sri Lanka achieved rubella elimination; Bhutan, North Korea, and Timor-Leste have halted endemic transmission of rubella virus for >36 months.

What are the implications for public health practice?

SEAR has made substantial progress toward rubella elimination. To achieve regional rubella elimination by 2023, optimal and accelerated measures to implement all elimination strategies are needed.

## Rubella and CRS Incidence and Rubella Virus Genotypes

During 2013–2021, the number of reported[†††] rubella cases in the region decreased by 80%, from 10,434 to 2,103 (Figure). Annual rubella incidence also declined by 80%, from 5.5 to 1.1 cases per 1 million population (Table 1). The number of reported CRS cases increased from 23 to 401, likely because of establishment or enhancement of CRS surveillance in multiple SEAR countries.

During 2013–2021, rubella virus genotypes detected in patient isolates in the region included 2B in India and Thailand, with endemic 1E in Thailand, and 1J in India. However, the number of specimens collected and tested for genotyping was low, limiting interpretation about transmission.

## Regional Verification of Rubella Control and Elimination

The WHO South-East Asia Regional Verification Commission (RVC) for measles and rubella elimination was established during 2016 and developed an updated framework for verification of measles and rubella elimination during 2020 (*7*). National verification committees were established in all 11 countries, providing annual reports on progress toward measles and rubella elimination to the RVC. As of 2021, the RVC has verified rubella elimination in Maldives (2020) and Sri Lanka (2020). In addition, three countries (Bhutan, North Korea, and Timor-Leste) have halted endemic transmission of rubella for >36 months and were awaiting verification of elimination (*8*).

[†††] Countries report the number of rubella or CRS cases annually using the WHO-UNICEF Joint Reporting Form.

## Discussion

During 2013–2021, substantial progress was made toward rubella elimination in WHO SEAR. Through the implementation of the regional strategies, estimated RCV1 coverage increased by >600%, and reported rubella incidence declined by 80%. The increase in the number of reported CRS cases during 2013–2021 likely reflects improved surveillance in the countries that initiated CRS surveillance after 2013, rather than an increase in rubella among susceptible pregnant women and CRS in their infants (*3*). By the end of 2021, two of the 11 countries had been verified as having eliminated endemic rubella transmission. As of May 2023, an additional three countries with interrupted rubella virus transmission for >36 months are awaiting verification of elimination.

Despite these successes, challenges to achieving rubella elimination in SEAR exist. During the COVID-19 pandemic, routine RCV1 coverage in the region declined from 93% during 2019 to 86% during 2021. During 2021, among the estimated 25 million infants who did not receive RCV1 worldwide, approximately 18% lived in SEAR, including 2.4 million in India and 1.2 million in Indonesia (*9*). In addition, rubella surveillance activities were affected by the pandemic, likely related to COVID-19 mitigation measures (e.g., physical distancing or masking) that decreased transmission of rubella and other respiratory viruses, in addition to declines in clinic visits for febrile rash illness because of movement restrictions imposed nationally, and the deployment of surveillance personnel to pandemic response activities. A recent independent review of progress toward measles and rubella elimination in SEAR concluded that several challenges, including immunity gaps, suboptimal surveillance sensitivity, inadequate outbreak response and preparedness, funding gaps, and the negative effects of the COVID-19 pandemic on immunization programs threatened the achievement of the 2023 target (*10*).

The findings in this report are subject to at least three limitations. First, coverage estimates are based on administrative data and might be inaccurate because of errors in recording doses administered or in estimates of the target populations. Second, surveillance data might underestimate true disease incidence because not all rubella infections cause fever, not all patients seek care, and not all rubella cases in patients who seek care are reported. In addition, not all countries are consistently reporting CRS cases through the Joint Reporting Form. Finally, genotype data are based on a limited and nonrepresentative number of sequences and do not necessarily reflect the predominant genotypes in the region.

Achieving rubella elimination in WHO-SEAR by 2023 will require urgent, intensified measures by countries to implement strategies in a very short time. The resetting of a new target

date represents an opportunity to galvanize activities and maintain momentum in the region to 1) obtain the highest level of national commitment from SEAR countries and support from partners; 2) strengthen routine immunization and achieve ≥95% coverage with RCV1; 3) conduct high-quality SIAs; 4) enhance surveillance sensitivity and increase collection of specimens for rubella virus detection and genotyping; and 5) leverage elimination activities to enhance measures to restore routine immunization services and reduce immunity gaps for all vaccine-preventable diseases. With the regional birth cohort representing 24% of the world's infants surviving beyond age 1 year, progress toward rubella elimination in SEAR represents an important opportunity to decrease rubella-related death, disability, and illness worldwide.

## Acknowledgments

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# Trends in Laboratory-Confirmed SARS-CoV-2 Reinfections and Associated Hospitalizations and Deaths Among Adults Aged ≥18 Years — 18 U.S. Jurisdictions, September 2021–December 2022

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Although reinfections with SARS-CoV-2 have occurred in the United States with increasing frequency, U.S. epidemiologic trends in reinfections and associated severe outcomes have not been characterized. Weekly counts of SARS-CoV-2 reinfections, total infections, and associated hospitalizations and deaths reported by 18 U.S. jurisdictions during September 5, 2021–December 31, 2022, were analyzed overall, by age group, and by five periods of SARS-CoV-2 variant predominance (Delta and Omicron [BA.1, BA.2, BA.4/BA.5, and BQ.1/BQ.1.1]). Among reported reinfections, weekly trends in the median intervals between infections and frequencies of predominant variants during previous infections were calculated. As a percentage of all infections, reinfections increased substantially from the Delta (2.7%) to the Omicron BQ.1/BQ.1.1 (28.8%) periods; during the same periods, increases in the percentages of reinfections among COVID-19–associated hospitalizations (from 1.9% [Delta] to 17.0% [Omicron BQ.1/BQ.1.1]) and deaths (from 1.2% [Delta] to 12.3% [Omicron BQ.1/BQ.1.1]) were also substantial. Percentages of all COVID-19 cases, hospitalizations, and deaths that were reinfections were consistently higher across variant periods among adults aged 18–49 years compared with those among adults aged ≥50 years. The median interval between infections ranged from 269 to 411 days by week, with a steep decline at the start of the BA.4/BA.5 period, when >50% of reinfections occurred among persons previously infected during the Alpha variant period or later. To prevent severe COVID-19 outcomes, including those following reinfection, CDC recommends staying up to date with COVID-19 vaccination and receiving timely antiviral treatments, when eligible.*

By September 2021, approximately 150 million total SARS-CoV-2 infections were estimated to have occurred in the United States, suggesting a cumulative incidence of 44% in the population.† The number of reinfections is expected to increase as the cumulative incidence of first infections rises, infection- and vaccine-induced immunity wane, and novel variants with increased transmissibility and immune escape characteristics emerge (*1*). The risk for reinfection also might vary individually based on demographic characteristics, vaccination history, and exposure risk, which are known to be interrelated (*2*,*3*). The clinical impact of reinfection remains incompletely understood. Generally, reinfections have been reported to be less clinically severe than initial SARS-CoV-2 infections (*3*,*4*); however, in some studies, reinfections were associated with severe outcomes, particularly among persons who were hospitalized with a previous infection (*4*,*5*). To describe trends over time, laboratory-confirmed SARS-CoV-2 reinfections and associated severe outcomes were characterized during a 16-month period when the Delta variant and several Omicron lineages were predominant in the United States.

Weekly, age-stratified counts of COVID-19 cases,§ COVID-19–associated hospitalizations,¶ and COVID-19–associated deaths** for all infections and reinfections occurring among adults aged ≥18 years during September 5, 2021–December 31, 2022, were reported by 18 U.S. jurisdictions. A SARS-CoV-2 reinfection was defined as a positive result†† from a SARS-CoV-2 RNA or antigen test performed on

* www.cdc.gov/coronavirus/2019-ncov/your-health/reinfection.html

† https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/burden.html

§ Data on SARS-CoV-2 infections and reinfections (confirmed or probable COVID-19 cases) were included for 18 jurisdictions, representing 45% of the U.S. population: California, Colorado, District of Columbia, Georgia, Indiana, Kentucky, Louisiana, Massachusetts, Minnesota, Nebraska, New Jersey, New York, New York City, North Carolina, Oregon, Philadelphia, Tennessee, and Washington.

¶ Data on COVID-19–associated hospitalizations were included for 10 jurisdictions: California, Colorado, Georgia, Minnesota, New Jersey, New York City, Oregon, Philadelphia, Tennessee, and Washington.

** Data on COVID-19–associated deaths were included for 17 jurisdictions: California, Colorado, District of Columbia, Georgia, Indiana, Kentucky, Louisiana, Massachusetts, Minnesota, Nebraska, New Jersey, New York City, North Carolina, Oregon, Philadelphia, Tennessee, and Washington.

†† Based on confirmatory or presumptive laboratory evidence as defined by the Council of State and Territorial Epidemiologists. https://ndc.services.cdc.gov/case-definitions/coronavirus-disease-2019-covid-19/

a respiratory specimen collected >90 days after a previous confirmed or probable COVID-19 case in the same person, based on national surveillance guidance.[§§] Using this definition, reinfections were included if previous infections occurred during March 1, 2020–October 1, 2022. Multiple occurrences of reinfection in a person were included as separate reinfection events, provided each met the same criteria. COVID-19–associated hospitalizations[¶¶] and deaths[***] were defined by participating U.S. jurisdictions. Periods of SARS-CoV-2 variant predominance (i.e., accounting for ≥50% of circulating variants) were defined using estimated variant proportions from national genomic surveillance.[†††]

Percentages of reinfections among all COVID-19 cases, hospitalizations, and deaths were calculated by age group and variant period. Overall weekly trends in median time to reinfection (i.e., the interval from previous infection to reinfection) were estimated by weighting reported weekly medians using the number of weekly reinfections per jurisdiction. Weekly trends in median time to reinfection were compared with trends in the percentage distribution of variant predominant periods of the previous infection. R software (version 4.1.3; R Foundation) was used to conduct all analyses. This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy.[§§§]

During September 5, 2021–December 31, 2022, a total of 2,784,548 laboratory-confirmed SARS-CoV-2 reinfections were reported among adults aged ≥18 years from 18 U.S. jurisdictions, accounting for 12.7% of all SARS-CoV-2 infections reported in this same population and period (21,943,686). Adults aged 18–49 years (who constitute 54% of the U.S. population) accounted for 66.8% of reinfections and 62.0% of overall infections during this period, whereas adults aged 50–64 years and ≥65 years accounted for 21.2% and 11.9% of reinfections, respectively. Reinfections represented 2.7% of all reported SARS-CoV-2 infections during the Delta variant period in late 2021; this percentage increased to 10.3% during the Omicron BA.1 period, 12.5% during the BA.2 period, 20.6% during the BA.4/BA.5 period, and 28.8% during the BQ.1/BQ.1.1 periods (Table) (Figure 1). The absolute increase in the percentage of reinfections among all reported SARS-CoV-2 infections was highest among adults aged 18–49 years, increasing from 3.0% during the Delta period to 34.4% during the Omicron BQ.1/BQ.1.1 period. Among adults aged 50–64 years, the percentage of reinfections among all infections increased from 2.1% (Delta) to 29.0% (Omicron BQ.1/BQ1.1), and among those aged ≥65 years, reinfections increased from 2.0% (Delta) to 18.9% (Omicron BQ.1/BQ.1.1). Among a subset of 2,008,867 persons with one or more reinfections reported by 13 jurisdictions identifying multiple reinfections,[¶¶¶] 95.6% experienced one reinfection, 4.3% experienced two reinfections, and 0.2% experienced three or more reinfections during September 5, 2021–December 31, 2022.

Among SARS-CoV-2 reinfections, 43,432 associated hospitalizations and 6,888 associated deaths were reported from 10 and 17 U.S. jurisdictions, respectively. Increases in the percentages of reinfections among reported COVID-19–associated hospitalizations and deaths were similar to those for COVID-19 cases but with decreased magnitude. The percentages of reported reinfections among COVID-19–associated hospitalizations and deaths increased substantially from 1.9% and 1.2%, respectively, during the Delta period, to 17.0% and 12.3%, respectively, during the Omicron BQ.1/BQ.1.1 period (Table) (Figure 1) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/129923). Among COVID-19–associated hospitalizations and deaths, reinfections were more prevalent among adults aged 18–49 years, compared with older adults, especially during late 2022. Reinfections accounted for 24.8% of hospitalizations and 20.2% of deaths in adults aged 18–49 years during the BQ.1/BQ.1.1 period; by comparison, reinfections accounted for 13.3% of hospitalizations and 11.6% of deaths among adults aged ≥65 years during this period.

[§§] https://ndc.services.cdc.gov/case-definitions/coronavirus-disease-2019-2021/

[¶¶] To ascertain COVID-19–associated hospitalization, five jurisdictions relied upon hospital records and five relied upon hospital records and case investigations. Two jurisdictions reported hospitalizations only when COVID-19 was the cause. The remaining eight reported hospitalizations when a SARS-CoV-2 test result was positive within a specific time window of hospital admission, beginning 7 days (one jurisdiction), 14 days (five), 30 days (one), or 90 days (one) before admission, and lasting until 2 days (one), 7 days (one), 14 days (three), or 21 days (one) after admission, or for the duration of hospitalization (two).

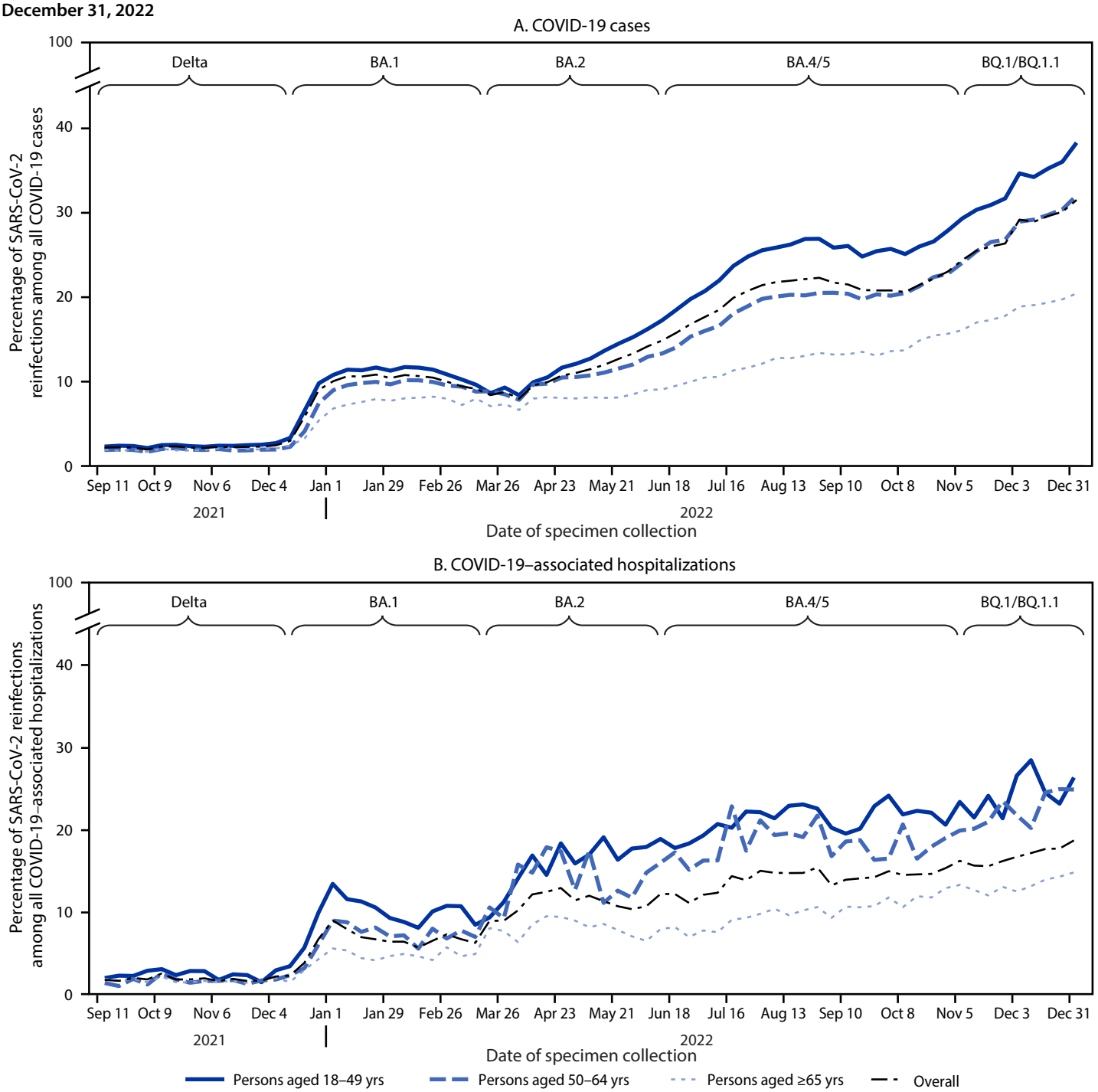
[***] To determine COVID-19–associated deaths, 10 jurisdictions relied upon vital records and seven relied upon both vital records and provider reporting or case investigations. Six jurisdictions provided only deaths with COVID-19 as a listed underlying or probable cause. The remaining 11 jurisdictions also provided deaths from natural causes or without other evident causes that occurred ≤30 days of positive specimen collection (eight) or some other specified time window (42 days, 45 days, and 60 days).

[†††] Periods were defined using ≥50% SARS-CoV-2 variant proportions from national genomic surveillance: ancestral strain (April 3, 2021 and earlier); Alpha (April 4–June 19, 2021); Delta (June 20–December 18, 2021); BA.1 comprising Omicron B.1.1.529/BA.1.1 (December 19, 2021–March 19, 2022); BA.2 comprising BA.2/BA.2.12.1 (March 20–June 18, 2022); and BA.4/BA.5 comprising BA.4/BA.4.6/BA.5 (June 19–November 5, 2022). The BQ.1/BQ.1.1 period (November 6–December 31, 2022) also included other lineages with similar spike protein substitutions and was defined based on when BA.4/BA.4.6/BA.5 lineages reached <50%, as these other lineages increased. https://covid.cdc.gov/covid-data-tracker/#variant-proportions

[§§§] 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.

[¶¶¶] Data on counts of persons with multiple reinfections were included for 13 jurisdictions: Georgia, Indiana, Kentucky, Louisiana, Massachusetts, Michigan, Minnesota, Nebraska, New York, New York City, Oregon, Philadelphia, and Washington.

**FIGURE 1. Percentages of SARS-CoV-2 reinfections* among all infections for COVID-19 cases (A) and COVID-19–associated hospitalizations (B), by week of positive specimen collection date, age group, and SARS-CoV-2 variant period† — 18 U.S. jurisdictions,§ September 5, 2021–December 31, 2022**




* A SARS-CoV-2 reinfection was defined as a SARS-CoV-2 RNA or antigen detection (based on confirmatory or presumptive laboratory evidence, as defined by the Council of State and Territorial Epidemiologists) in a respiratory specimen collected >90 days after a previous confirmed or probable COVID-19 case in the same person. https://ndc.services.cdc.gov/case-definitions/coronavirus-disease-2019-2021/

† Periods were defined using ≥50% SARS-CoV-2 variant proportions from national genomic surveillance: ancestral strain (April 3, 2021, and earlier); Alpha (April 4–June 19, 2021); Delta (June 20–December 18, 2021); BA.1 comprising Omicron B.1.1.529 and BA.1.1 (December 19, 2021–March 19, 2022); BA.2 comprising BA.2 and BA.2.12.1 (March 20–June 18, 2022); and BA.4/BA.5 comprising BA.4, BA.4.6, and BA.5 (June 19–November 5, 2022). The BQ.1/BQ.1.1 period (November 6–December 31, 2022) also included other lineages with similar spike protein substitutions and was defined based on when BA.4/BA.4.6/BA.5 lineages reached <50%, as these other lineages increased. https://covid.cdc.gov/covid-data-tracker/#variant-proportions

§ Data on reinfection–associated COVID-19 cases were included from 18 jurisdictions, representing 45% of the U.S. population: California, Colorado, District of Columbia, Georgia, Indiana, Kentucky, Louisiana, Massachusetts, Minnesota, Nebraska, New Jersey, New York, New York City, North Carolina, Oregon, Philadelphia, Tennessee, and Washington. Data on COVID-19 reinfection-associated hospitalizations were included from 10 jurisdictions: California, Colorado, Georgia, Minnesota, New Jersey, New York City, Oregon, Philadelphia, Tennessee, and Washington.

**TABLE. Reported numbers of all SARS-CoV-2 infections and numbers and percentages of reinfections,* by age group, outcome, and variant period† — 18 U.S. jurisdictions,§ September 5, 2021–December 31, 2022**

| | Sep 5–Dec 18, 2021 (Delta) | | Dec 19, 2021–Mar 19, 2022 (Omicron BA.1) | | Mar 20–Jun 18, 2022 (Omicron BA.2) | | Jun 19–Nov 5, 2022 (Omicron BA.4/BA.5) | | Nov 6–Dec 31, 2022 (Omicron BQ.1/BQ.1.1) | | Sep 5, 2021–Dec 31, 2022 (full outcome period) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome/ Age group, yrs | Reinfections (% of all infections) | All infections | Reinfections (% of all infections) | All infections | Reinfections (% of all infections) | All infections | Reinfections (% of all infections) | All infections | Reinfections (% of all infections) | All infections | Reinfections (% of all infections) | All infections |
| **Cases, 18 jurisdictions** | | | | | | | | | | | | |
| 18–49 | 60,818 (3.0) | 2,020,296 | 779,482 (11.1) | 7,032,087 | 224,417 (14.1) | 1,586,446 | 566,806 (24.6) | 2,307,711 | 229,271 (34.4) | 666,385 | 1,860,794 (13.7) | 13,612,925 |
| 50–64 | 14,164 (2.1) | 674,988 | 207,143 (9.4) | 2,199,892 | 70,852 (11.6) | 611,837 | 198,781 (19.2) | 1,033,953 | 100,672 (29.0) | 347,292 | 591,612 (12.2) | 4,867,962 |
| ≥65 | 8,332 (2.0) | 418,111 | 89,281 (7.4) | 1,212,266 | 39,932 (8.4) | 477,769 | 121,688 (12.6) | 968,243 | 72,909 (18.9) | 386,410 | 332,142 (9.6) | 3,462,799 |
| **Overall** | **83,314 (2.7)** | **3,113,395** | **1,075,906 (10.3)** | **10,444,245** | **335,201 (12.5)** | **2,676,052** | **887,275 (20.6)** | **4,309,907** | **402,852 (28.8)** | **1,400,087** | **2,784,548 (12.7)** | **21,943,686** |
| **Hospitalizations, 10 jurisdictions** | | | | | | | | | | | | |
| 18–49 | 717 (2.6) | 27,138 | 5,123 (10.8) | 47,439 | 1,870 (17.1) | 10,912 | 5,272 (21.3) | 24,731 | 2,324 (24.8) | 9,356 | 15,306 (12.8) | 119,576 |
| 50–64 | 446 (1.7) | 26,915 | 3,023 (7.7) | 39,290 | 1,191 (14.4) | 8,251 | 3,777 (18.6) | 20,354 | 2,040 (22.7) | 8,991 | 10,477 (10.1) | 103,801 |
| ≥65 | 689 (1.7) | 41,451 | 3,919 (4.7) | 83,225 | 2,009 (7.8) | 25,686 | 6,542 (9.9) | 65,991 | 4,490 (13.3) | 33,689 | 17,649 (7.1) | 250,042 |
| **Overall** | **1,852 (1.9)** | **95,504** | **12,065 (7.1)** | **169,954** | **5,070 (11.3)** | **44,849** | **15,591 (14.0)** | **111,076** | **8,854 (17.0)** | **52,036** | **43,432 (9.2)** | **473,419** |
| **Deaths, 17 jurisdictions** | | | | | | | | | | | | |
| 18–49 | 58 (1.4) | 4,158 | 160 (4.7) | 3,407 | 71 (16.1) | 442 | 121 (14.0) | 864 | 69 (20.2) | 341 | 479 (5.2) | 9,212 |
| 50–64 | 103 (1.1) | 9,723 | 400 (3.9) | 10,199 | 145 (13.2) | 1,098 | 355 (14.9) | 2,387 | 165 (15.9) | 1,040 | 1,168 (4.8) | 24,447 |
| ≥65 | 316 (1.2) | 25,952 | 1,569 (3.6) | 43,267 | 658 (8.9) | 7,386 | 1,686 (9.4) | 17,894 | 1,012 (11.6) | 8,755 | 5,241 (5.1) | 103,254 |
| **Overall** | **477 (1.2)** | **39,833** | **2,129 (3.7)** | **56,873** | **874 (9.8)** | **8,926** | **2,162 (10.2)** | **21,145** | **1,246 (12.3)** | **10,136** | **6,888 (5.0)** | **136,913** |

* A SARS-CoV-2 reinfection was defined as a SARS-CoV-2 RNA or antigen detection (based on confirmatory or presumptive laboratory evidence, as defined by the Council of State and Territorial Epidemiologists) on a respiratory specimen collected >90 days after a previous confirmed or probable COVID-19 case in the same person. https://ndc.services.cdc.gov/case-definitions/coronavirus-disease-2019-2021/

† Periods were defined using ≥50% SARS-CoV-2 variant proportions from national genomic surveillance: ancestral strain (April 3, 2021, and earlier); Alpha (April 4–June 19, 2021); Delta (June 20–December 18, 2021); BA.1 comprising Omicron B.1.1.529 and BA.1.1 (December 19, 2021–March 19, 2022); BA.2 comprising BA.2 and BA.2.12.1 (March 20–June 18, 2022); and BA.4/BA.5 comprising BA.4, BA.4.6, and BA.5 (June 19–November 5, 2022). The BQ.1/BQ.1.1 period (November 6–December 31, 2022) also included other lineages with similar spike protein substitutions and was defined based on when BA.4/BA.4.6/BA.5 reached <50%, as these other lineages increased. https://covid.cdc.gov/covid-data-tracker/#variant-proportions

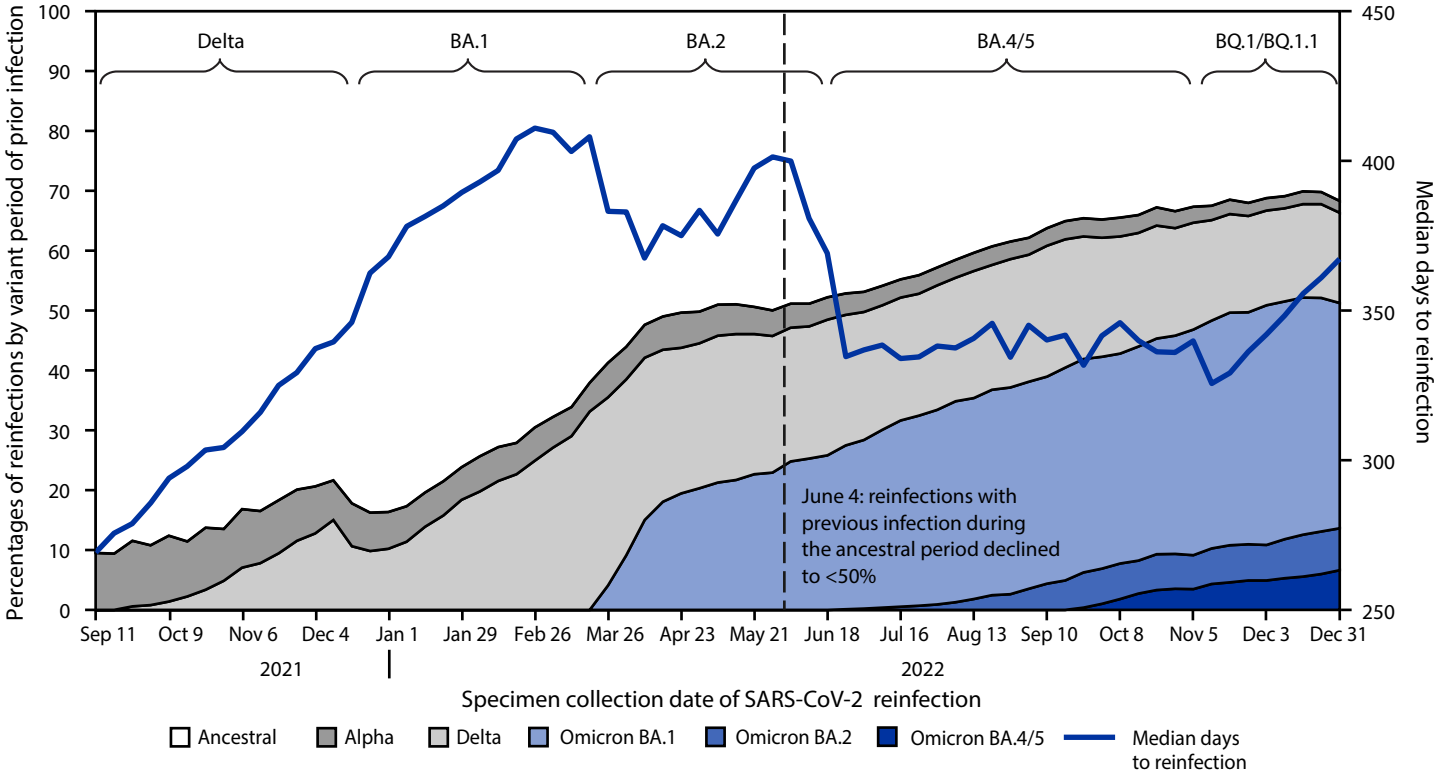
§ Data on COVID-19 reinfection-associated cases were included from the following 18 jurisdictions, representing 45% of the U.S. population: California, Colorado, District of Columbia, Georgia, Indiana, Kentucky, Louisiana, Massachusetts, Minnesota, Nebraska, New Jersey, New York, New York City, North Carolina, Oregon, Philadelphia, Tennessee, and Washington; of these, New York did not report data on COVID-19–associated deaths. Data on COVID-19 reinfection-associated hospitalizations were included from 10 jurisdictions: California, Colorado, Georgia, Minnesota, New Jersey, New York City, Oregon, Philadelphia, Tennessee, and Washington.

Among 17 reporting jurisdictions,**** the median interval between infections by week increased from 269 days in September 2021 to a peak of 411 days in mid-February 2022, near the end of the BA.1 period (Figure 2). The median time to reinfection decreased substantially to 335 days in mid-June 2022 after the start of the BA.4/BA.5 period and remained near that level for the remainder of BA.4/BA.5 predominance. By the week ending December 31, 2022 (the BQ.1/BQ.1.1 period), the median time to reinfection had increased to 367 days.

Among persons reinfected in September 2021, 90.5% had been previously infected during the period when the ancestral strain was predominant, and 9.5% had been previously infected during the Alpha variant period (Figure 2). The large decline in weekly median time to reinfection in June 2022 (at the transition from BA.2 to BA.4/BA.5 predominance) occurred when the proportion of persons previously infected during the ancestral period declined to <50%; conversely, the proportion previously infected during more recent variant periods (i.e., Alpha, Delta, or Omicron) increased to >50%. By the end of 2022, during the Omicron BQ.1/BQ.1.1 period, 51.3% of reinfected persons had been previously infected

**** Data on median time between infections were included for 17 jurisdictions: California, Colorado, District of Columbia, Georgia, Indiana, Kentucky, Louisiana, Massachusetts, Minnesota, Nebraska, New Jersey, New York, New York City, North Carolina, Oregon, Philadelphia, and Washington.

**FIGURE 2. Weekly proportions of SARS-CoV-2 reinfections,* by variant period† of the previous infection and median time§ to reinfection — 17 U.S. jurisdictions,¶ September 5, 2021–December 31, 2022**




* A SARS-CoV-2 reinfection was defined as SARS-CoV-2 RNA or antigen detection (based on confirmatory or presumptive laboratory evidence, as defined by the Council of State and Territorial Epidemiologists) on a respiratory specimen collected >90 days after a previous confirmed or probable COVID-19 case in the same person. https://ndc.services.cdc.gov/case-definitions/coronavirus-disease-2019-2021/

† Periods of previous infections and reinfections were defined using ≥50% SARS-CoV-2 variant proportions from national genomic surveillance: ancestral strain (April 3, 2021, and earlier); Alpha (April 4–June 19, 2021); Delta (June 20–December 18, 2021); BA.1 comprising Omicron B.1.1.529 and BA.1.1 (December 19, 2021–March 19, 2022); BA.2 comprising BA.2 and BA.2.12.1 (March 20–June 18, 2022); and BA.4/BA.5 comprising BA.4, BA.4.6, and BA.5 (June 19–November 5, 2022). The BQ.1/BQ.1.1 period (November 6–December 31, 2022) also included other lineages with similar spike protein substitutions and was defined based on when BA.4/BA.4.6/BA.5 lineages reached <50%, as these other lineages increased. https://covid.cdc.gov/covid-data-tracker/#variant-proportions

§ Overall weekly trends in the median time to reinfection (i.e., median days between positive specimen collection dates) were estimated by weighting the reported medians using the number of weekly reinfections per jurisdiction.

¶ Data were included for 17 jurisdictions: California, Colorado, District of Columbia, Georgia, Indiana, Kentucky, Louisiana, Massachusetts, Minnesota, Nebraska, New Jersey, New York, New York City, North Carolina, Oregon, Philadelphia, and Washington.

earlier in the Omicron period (BA.1 = 37.6%; BA.2 = 7.0%; and BA.4/BA.5 = 6.6%), with the remainder having been previously infected during periods when the ancestral strain (31.7%), Delta variant (15.0%), or Alpha variant (2.0%) were predominant.

## Discussion

This descriptive analysis of surveillance data reported by 18 jurisdictions shows that cases of SARS-CoV-2 reinfection and associated hospitalizations and deaths increased in relative frequency as new Omicron lineages emerged with enhanced transmissibility or immune escape characteristics†††† (*1*), and as the number of persons with first infections increased over time. The weekly median time between infections ranged from 269 to 411 days, with a steep drop observed at the start of the BA.4/BA.5 period, when >50% of reinfections occurred among persons previously infected during the Alpha variant period or later. The changing distribution of variants associated with previous SARS-CoV-2 infections and reinfections over time mirrors observations reported from other studies (*1*,*4*) and highlights the increasing complexity of the SARS-CoV-2 immunologic landscape (*6*).

Higher percentages of reinfections among COVID-19 cases and associated hospitalizations and deaths were observed among younger adults compared with older adults, particularly in late 2022. The higher percentages in younger age groups might be attributable to multiple factors, including higher

†††† https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/scientific-brief-omicron-variant.html; https://www.cdc.gov/mmwr/volumes/72/wr/mm7224a2.htm?s_cid=mm7224a2_w

**Summary**

What is already known about this topic?

Although SARS-CoV-2 reinfections have increased, U.S. epidemiologic trends and associated severe outcomes have not been characterized.

What is added by this report?

During September 2021–December 2022, the percentages of reinfections among all COVID-19 cases, hospitalizations, and deaths reported by 18 U.S. jurisdictions increased substantially as new Omicron lineages became predominant. Increases were more pronounced among adults aged 18–49 years compared with those among older persons.

What are the implications for public health practice?

Cases and severe outcomes associated with SARS-CoV-2 reinfection have increased across the United States since September 2021. CDC recommends staying up to date with COVID-19 vaccinations and receiving early antiviral treatment, if eligible, to reduce the risk for severe COVID-19–associated outcomes.

cumulative incidence of first infections, later eligibility for vaccination, lower vaccination coverage, increased exposure risk, and a possible survival bias because of less severe initial infections (*6*). Reinfections occurred at lower frequencies among persons who were hospitalized or died compared with cases,[§§§§] consistent with evidence that previous infection-induced immunity provides better protection against severe outcomes than against subsequent infections (*7*). The risk of severe outcomes from reinfection can be reduced through vaccination (*7*,*8*), although vaccine effectiveness was not evaluated in this analysis.

The findings from this report are subject to at least six limitations. First, cases of COVID-19 might be increasingly underascertained by public health surveillance because of increasing use of at-home tests throughout 2022 (*9*). Reinfections might not be captured by surveillance if either previous infections or reinfections are not laboratory-confirmed or cannot be linked (e.g., laboratory-confirmed in different jurisdictions). Second, trends in reinfections before September 1, 2021, were not determined because of the lack of a nationally standardized surveillance definition for reinfection before that time. Third, the use of the 90-day definition for reinfections based on national guidance excludes reinfections occurring ≤90 days, which would need to be confirmed using genomic sequencing to rule out prolonged viral shedding.[¶¶¶¶] Fourth, a subset of the 18 jurisdictions submitted data on reinfection-associated severe outcomes, and definitions and approaches used for ascertaining COVID-19–associated hospitalizations and deaths varied by jurisdiction. Fifth, this ecologic analysis of epidemiologic changes in reinfection by period of SARS-CoV-2 variant predominance could not adjust for important confounders, including changes in immunity, behavior, and the population at risk over time (*6*). Finally, this descriptive analysis did not determine the impact of vaccination because it was not possible to adjust for confounding differences in testing behaviors or underlying health conditions by vaccination status.

Some data sources used for this analysis, including test results from electronic laboratory reporting data, have changed or have been discontinued with the expiration of the public health emergency declaration on May 11, 2023 (*10*). However, continued monitoring of reinfections using alternative data sources remains important to characterize trends in severe outcomes following reinfection. To reduce the risk for severe COVID-19–associated outcomes, including those after reinfection, CDC recommends staying up to date with COVID-19 vaccination[*****] and receiving early antiviral treatment, when eligible.

[§§§§] Trends were similar after limiting this comparison to jurisdictions that reported data on all three outcomes (COVID-19 reinfection percentages for cases, hospitalizations, and deaths).

[¶¶¶¶] https://wwwnc.cdc.gov/eid/article/28/11/22-1109_article; https://www.cdc.gov/mmwr/volumes/71/wr/mm7114a2.htm

[*****] https://www.cdc.gov/coronavirus/2019-ncov/vaccines/stay-up-to-date.html

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# Effectiveness of Up-to-Date COVID-19 Vaccination in Preventing SARS-CoV-2 Infection Among Nursing Home Residents — United States, November 20, 2022–January 8, 2023

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Nursing home residents have been disproportionately affected by the COVID-19 pandemic; their age, comorbidities, and exposure to a congregate setting has placed them at high risk for both infection and severe COVID-19–associated outcomes, including death (*1*). Receipt of a primary COVID-19 mRNA vaccination series (*2*) and monovalent booster doses (*3*) have been demonstrated to be effective in reducing COVID-19–related morbidity and mortality in this population. Beginning in October 2022, the National Healthcare Safety Network (NHSN) defined up-to-date vaccination as receipt of a bivalent COVID-19 mRNA vaccine dose or completion of a primary series within the preceding 2 months.* The effectiveness of being up to date with COVID-19 vaccination among nursing home residents in preventing SARS-CoV-2 infection is not known. This analysis used NHSN nursing home COVID-19 data reported during November 20, 2022–January 8, 2023, to describe effectiveness of up-to-date vaccination status (versus not being up to date) against laboratory-confirmed SARS-CoV-2 infection among nursing home residents. Adjusting for calendar week, county-level COVID-19 incidence, county-level social vulnerability index (SVI), and facility-level percentage of staff members who were up to date, up-to-date vaccine effectiveness (VE) against infection was 31.2% (95% CI = 29.1%–33.2%). Nursing home residents should stay up to date with recommended age-appropriate COVID-19 vaccination, which now includes an additional bivalent vaccine dose for moderately or severely immunocompromised adults aged ≥65 years to increase protection against SARS-CoV-2 infection.

The Centers for Medicare & Medicaid Services (CMS) requires CMS-certified nursing homes to submit incident COVID-19 case and vaccination data to NHSN each week.†,§ Data include the number of infections (defined as laboratory-confirmed¶ SARS-CoV-2 infections) stratified by patient vaccination status, and the number of residents in the nursing home (with a stay of ≥24 hours) stratified by vaccination status.** During the study period, NHSN defined up-to-date vaccination status as 1) ever having received a COVID-19 mRNA bivalent vaccine dose, or 2) completion of a primary series <2 months earlier. The number of residents who were not up to date was calculated by subtracting the number who were up to date from the total number of residents in the facility. Residents who were not up to date included those who 1) previously received monovalent booster doses but did not receive a bivalent vaccine dose, 2) received the primary series >2 months earlier but did not receive any subsequent doses, 3) received 1 dose of the primary series, or 4) did not receive any COVID-19 vaccine doses.

NHSN analyzed weekly COVID-19 case and up-to-date vaccination status data for CMS-certified nursing homes during November 20, 2022–January 8, 2023. The study period was chosen to coincide with both the inclusion of bivalent vaccine in the definition of up-to-date status and the increase in COVID-19 infections during the winter months.†† The study included data submitted by CMS-certified nursing homes that reported both COVID-19 cases and up-to-date vaccination status for each week during the study period.

Analysts merged weekly incident case counts (stratified by up-to-date vaccination status) with weekly resident counts (stratified by up-to-date vaccination status) each week during the study period. Nursing homes that reported no data on up-to-date vaccination status throughout the study period were excluded, as were those that did not meet standard data quality criteria.§§ Resident-weeks were calculated by aggregating the

* Up-to-date vaccination status was defined as 1) ever having received a bivalent vaccine dose or 2) completed a primary series <2 months earlier. NHSN defines up-to-date vaccination for surveillance purposes at the start of each quarter; the definition has been updated since the study was conducted. https://www.cdc.gov/nhsn/pdfs/hps/covidvax/UpToDateGuidance-508.pdf

† https://www.cms.gov/files/document/qso-20-29-nh.pdf

§ https://www.federalregister.gov/documents/2021/05/13/2021-10122/medicare-and-medicaid-programs-covid-19-vaccine-requirements-for-long-term-care-ltc-facilities-and

¶ https://www.cdc.gov/nhsn/pdfs/covid19/ltcf/57.144-toi-508.pdf

** https://www.cdc.gov/nhsn/forms/instr/COVIDVax.LTC_.Residents.TOI_.MAY2022-508.pdf

†† https://covid.cdc.gov/covid-data-tracker/#trends_weeklycases_select_00

§§ Data were excluded based on the following conditions: 1) the number of residents was equal to or more than the number of beds occupied or <75% of beds were occupied (295 facilities excluded); 2) facility coverage for ≥1 dose was <60% (518 facilities excluded), because low partial vaccination coverage indicates incorrect reporting or an atypical facility; 3) the number of up-to-date residents was >10 in the previous week, and the number of up-to-date residents declined by >50% in the current week (1,905 facilities excluded), because a large percent decline indicates incident, rather than cumulative, reporting in large facilities.

number of residents who spent ≥1 day at the facility during the week of data collection over the study period.

The ratio of infection between residents who were up to date and those who were not was determined using a zero-inflated negative binomial mixed model (*4*) to evaluate associations with acquisition of COVID-19, while adjusting for potential confounders. The model used data collected by NHSN and included nursing home as a random effect to account for between-facility variability. Covariates included in models were factors known to be associated with either up-to-date vaccination status or infection, including calendar week, SVI, county-level incidence, and percentage of facility staff members who were up to date with COVID-19 vaccination. VE against infection was estimated as 1 – rate ratio x 100. Analyses were performed using SAS software (version 9.4; SAS Institute) and R software (version 4.0.3; R Foundation). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.¶¶

The analysis included 108,727 weekly reports from 14,464 nursing homes. Overall, 4,314,714 (48.1%) nursing home resident-weeks were up to date, and 52,853 (40.6%) of COVID-19 patients were up to date. The resulting crude infection rate among up-to-date residents was 12.3 per 1,000 resident-weeks (95% CI = 12.2–12.4) compared with 16.6 per 1,000 resident-weeks (95% CI = 16.5 –16.7) among residents who were not up to date. During the study period, the weekly percentage of residents who were up to date increased from 44.2% to 51.2%.

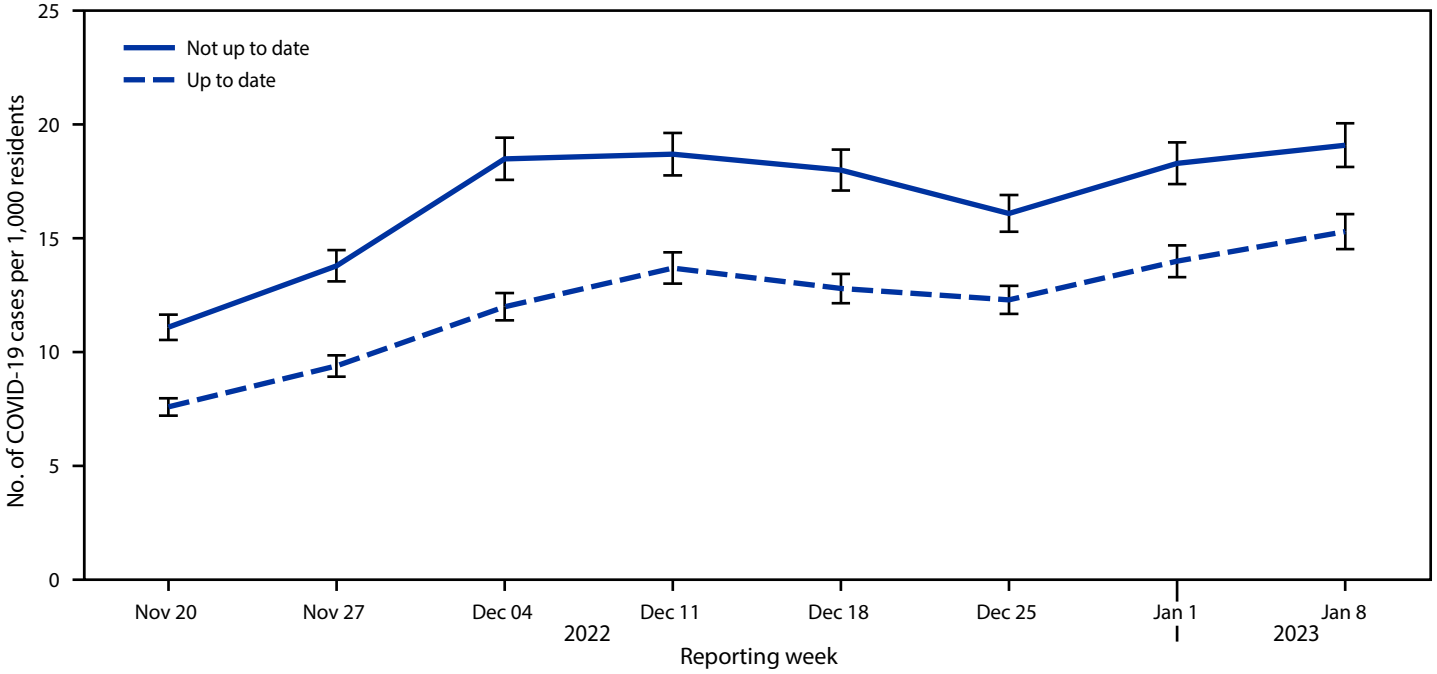
Each week, COVID-19 incidence among nursing home residents who were up to date (7.6–15.3 cases per 1,000 residents) was lower than incidence among those who were not up to date (11.1–19.1 cases per 1,000 residents) (Figure). The adjusted rate ratio of SARS-CoV-2 infection among residents who were up to date compared with those not up to date was 0.69 (95% CI = 0.67–0.71). Among nursing home residents with up-to-date vaccination, VE against infection was 31.2% (95% CI = 29.1%–33.2%) (Table).

## Discussion

Among nursing home residents who were up to date with COVID-19 vaccination, VE against SARS-CoV-2 infection was 31.2% during November 20, 2022–January 8, 2023. An analysis of NHSN nursing home data found that during October 10, 2022–January 8, 2023, >99% of residents classified as being up to date had received a bivalent vaccine dose,

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

**FIGURE. SARS-CoV-2 infections per 1,000 nursing home residents,* by up-to-date vaccination status† and reporting week — National Healthcare Safety Network, United States, November 20, 2022–January 8, 2023**




* With 95% CIs indicated by error bars.

† Up-to-date vaccination status was defined as 1) ever having received a bivalent vaccine dose or 2) primary series completed <2 months earlier. The number of residents who were not up to date was calculated by subtracting the number of up-to-date residents from the total number of residents in the facility and included those who 1) received monovalent booster doses but did not receive a bivalent vaccine dose, 2) received the primary series >2 months earlier but did not receive any subsequent doses, 3) received 1 dose of the primary series, or 4) did not receive any COVID-19 vaccine doses.

**Summary**

What is already known on this topic?

Vaccines prevent severe outcomes and staying up to date with recommended COVID-19 vaccination, including receiving a bivalent vaccine dose, provides additional protection against COVID-19 in persons who previously received monovalent vaccines; however, recent data on effectiveness of up-to-date vaccination status among nursing home residents are limited.

What is added by this report?

Among nursing home residents who were up to date with COVID-19 vaccination (most had received a bivalent vaccine), vaccine effectiveness against SARS-CoV-2 infection was 31.2%.

What are the implications for public health practice?

Staying up to date with COVID-19 vaccination recommendations and, if eligible, receipt of an additional bivalent dose, provides additional protection against SARS-CoV-2 infection. Nursing home residents would benefit from the protection offered by staying up to date with recommended COVID-19 vaccinations.

suggesting that up-to-date vaccination represented the receipt of bivalent vaccine (*5*). During this period, 88% of residents had received ≥1 dose of a primary COVID-19 vaccination series, indicating that most of those who were not up to date had received at least partial vaccination.***

Although this study could not account for waning VE since receiving the bivalent vaccine dose, the VE against infection in this study is similar to other bivalent VE estimates compared with the VE of monovalent vaccine alone against symptomatic infection in adults aged ≥65 years (22%–43%) (*6*), especially considering that this analysis was conducted 2.5–4 months after a bivalent vaccine dose was initially recommended for this population (*7*). In updates on COVID-19 VE presented to CDC's Advisory Committee on Immunization Practices on February 23, 2023 (*8*) and April 19, 2023 (*9*), bivalent VE against symptomatic infection compared with receipt of monovalent vaccine doses only among immunocompetent adults aged ≥65 years was 38% in the 2 weeks to 1 month after receipt of the bivalent vaccine dose and waned to 21% by 4–5 months after vaccination (*8*). Among symptomatic adults aged ≥65 years who visited an emergency department or urgent care center, bivalent VE against SARS-CoV-2 infection compared with no vaccine was 61% at 7–59 days after the bivalent vaccine dose and waned to 25% at 120–179 days after the bivalent vaccine dose (*9*).

The goal of the U.S. COVID-19 vaccination program is to prevent severe COVID-19–associated outcomes, including death (*7*). Although this study could not assess VE against severe outcomes, VE against severe outcomes for both monovalent (*7*) and bivalent (*10*) mRNA vaccines has been demonstrated to be higher and more sustained than it is against symptomatic infection (*6*). Nonetheless, this analysis of bivalent VE against infection provides important insight into vaccine protection among residents of nursing homes and demonstrates that staying up to date with recommended COVID-19 vaccines protects nursing home residents against SARS-CoV-2 infection.

The findings in this report are subject to at least four limitations. First, the data used in this study include COVID-19 vaccination status and infection but do not include outcomes such as hospitalization and death. Although a meaningful reduction in infection is an important finding, the VE estimate presented in this report does not directly assess the goal of COVID-19 vaccination, which is prevention of severe disease (*7*). Second, because NHSN receives aggregate facility-level data and was not randomized, this analysis could not account for time since vaccination, previous SARS-CoV-2 infection, COVID-19 symptoms, person-level demographic characteristics, or any other potential person-level confounders. Third, the data submitted by facilities to NHSN categorized vaccination status as either up to date or not up to date. The group that was not up to date included persons with a range of vaccination histories. The lack of a comparison group that was naïve to COVID-19

**TABLE. Relative effectiveness of being up to date with COVID-19 vaccination in preventing SARS-CoV-2 infection among nursing home residents compared with not being up to date — National Healthcare Safety Network, United States, November 20, 2022–January 8, 2023**

| Up to date* | No. of resident wks† | No. of cases§ | Crude infection rate (95% CI)¶ | RR (95% CI)** | VE (%) (95% CI)†† |
|---|---|---|---|---|---|
| No | 4,648,119 | 77,240 | 16.6 (16.5–16.7) | Ref | Ref |
| Yes | 4,314,714 | 52,853 | 12.3 (12.2–12.4) | 0.69 (0.67–0.71) | 31.2 (29.1–33.2) |

**Abbreviations:** Ref = referent group; RR = rate ratio; VE = vaccine effectiveness.

* Up-to-date vaccination status was defined as 1) ever having received a bivalent vaccine dose or 2) completed a primary series <2 months earlier. The number of residents who were not up to date was calculated by subtracting number of up-to-date residents from the total number of residents in the facility and included those who 1) received monovalent booster doses but did not receive a bivalent vaccine dose, 2) received the primary series >2 months earlier but did not receive subsequent doses, 3) received 1 dose of the primary series, or 4) did not receive any COVID-19 vaccine doses.

† Resident-weeks were the number of residents staying in a facility for ≥1 day during the week of data collection aggregated to the study period, stratified by vaccination status reported by nursing homes.

§ Cases were the aggregate of weekly case counts stratified by vaccination status reported by nursing homes. Cases among residents up to date were defined as infections in residents who became up to date ≥14 days before a positive SARS-CoV-2 test result. Cases who became up to date <14 days before a positive SARS-CoV-2 test result were included in the not up-to-date group.

¶ Infections per 1,000 resident-weeks.

** RR results from zero-inflated negative binomial mixed model.

†† VE was estimated as 1 − RR x 100.

*** https://covid.cdc.gov/covid-data-tracker/#vaccinations-nursing-homes

vaccination and infection meant that it was not possible to calculate the VE of up-to-date vaccination compared with no vaccination. The VE calculated by this study represents added benefit of the bivalent vaccine in a largely vaccinated population. Finally, the aggregate data used in this study were reported by nursing homes and could not be verified against patient records. Therefore, misclassification of case and vaccination status of residents is possible.

NHSN provides robust surveillance of vaccination status and SARS-CoV-2 infection among this vulnerable population; these data remain important to assessing the public health impact of changing vaccination guidance. It is important that nursing home residents stay up to date with COVID-19 vaccines and, if eligible, receive an additional bivalent dose to optimize protection against infection and related complications.

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# Notes from the Field

## E-Cigarette–Associated Cases Reported to Poison Centers — United States, April 1, 2022–March 31, 2023

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E-cigarette–associated cases reported to U.S. poison centers have fluctuated during the past decade, increasing during 2010–2014, and then decreasing during 2015–2017 (*1*). During 2017–2018, the number of e-cigarette exposure cases increased by 25% (from 2,320 to 2,901), and in 2018 nearly two thirds (63.3%) of cases occurred among children aged <5 years (*1*). To understand the number and characteristics of e-cigarette exposure cases in the United States, the Food and Drug Administration (FDA) analyzed National Poison Data System (NPDS) data* from the most recently available 12-month period (April 1, 2022–March 31, 2023). NPDS is maintained by U.S. poison centers. FDA's analyses report a further increase in the number of e-cigarette exposure cases, particularly among children aged <5 years.

NPDS is a repository of cases reported to U.S. poison centers that are recorded by specially trained and certified health care professionals (*2*). Information on exposure cases (reports or reported incidents by persons who contact poison centers regarding an exposure to a substance) in NPDS is recorded based on generic codes (a required general identification code for a substance or group of products) and product codes (product-specific codes, often by brand; these are not required upon case intake). Cases involving e-cigarettes were identified using generic codes; brands were identified using product codes.† E-cigarette exposure cases were defined as an exposure to e-cigarettes or e-liquids and were examined by age group, exposure route, level of care provided, medical outcome, and product brand. This study was determined as exempt by the FDA Institutional Review Board for Human Subject Protection.§

During April 1, 2022–March 31, 2023, a total of 7,043 e-cigarette exposure cases were reported (Table), representing a 32% increase, from 476 in April 2022 to 630 in March 2023. Among all exposures, 6,074 (87.8%) occurred among children aged <5 years. Inhalation or nasal (4,298; 61.0%) and ingestion or oral (2,818; 40.0%) exposure routes were most common.

**TABLE. Characteristics of poisoning exposures involving e-cigarettes (N = 7,043)* — United States, April 1, 2022–March 31, 2023**

| Characteristic | No. (%) |
|---|---|
| **Age group, yrs†** | |
| <5 | 6,074 (87.8) |
| 5–11 | 206 (3.0) |
| 12–17 | 153 (2.2) |
| 18–24 | 198 (2.9) |
| ≥25 | 288 (4.2) |
| **Exposure route§** | |
| Inhalation or nasal | 4,298 (61.0) |
| Ingestion | 2,818 (40.0) |
| Dermal | 245 (3.5) |
| Ocular | 67 (1.0) |
| Other¶ | 39 (0.6) |
| **Level of care at health care facility** | |
| Not referred | 6,113 (86.8) |
| Refused referral or did not arrive | 100 (1.4) |
| Lost to follow up or left against medical advice | 205 (2.9) |
| Treated, evaluated, and released | 582 (8.3) |
| Admitted to a hospital** | 43 (0.6) |
| **Medical outcome** | |
| Not followed †† | 3,584 (50.9) |
| No effect | 1,398 (19.8) |
| Minor effect | 1,915 (27.2) |
| Moderate effect | 133 (1.9) |
| Major effect | 12 (0.2) |
| Death | 1 (0.01) |
| **Brand§§** | |
| No brand reported | 6,701 (95.1) |
| Brand reported | 342 (4.9) |
| Elf Bar | 208 (60.8) |
| JUUL | 55 (16.1) |
| Vuse | 31 (9.1) |
| Pop Vape¶¶ | 20 (5.8) |
| Puff Bar | 14 (4.1) |
| Other brand*** | 14 (4.1) |

* Cases involving exposure to more than one substance were excluded.
† Missing or incomplete data are excluded in the percentage values for age. Data are considered missing or incomplete when no information is provided for the variable or when listed as unknown persons aged ≤19 years, or unknown persons aged 20–29 years. Two persons listed as being aged 30–39 or 50–59 years are categorized as aged ≥25 years. Data are missing or incomplete for 124 persons.
§ More than one exposure route was possible for each case; thus, percentages might not sum to 100%.
¶ Includes less commonly reported routes of exposure, such as aspiration (with ingestion), optic, parenteral, rectal, vaginal, and unknown.
** Patients are categorized as having been admitted to a hospital when coded as being admitted to a critical care unit, noncritical care unit, or psychiatric facility.
†† Data are considered not followed when coded as 1) not followed, judged as nontoxic exposure (clinical effects not expected); 2) not followed, minimal clinical effects possible (no more than minor effects possible); and 3) unable to follow, judged as a potentially toxic exposure.
§§ The percentages reported by brand represent exposures for each brand out of the total number of exposures where brand was reported.
¶¶ Data for Pop Vape were not available until April 30, 2022.
*** "Other brand" includes five cases reported for exposure to Myle Vapor, three for Bidi Stick, two for 7 Daze Pods, two for Aquabar, one for SMPO, and one for Suorin. No cases were reported during this period for Green Smoke, Bo Caps, Crossbar, or MarkTen.

* https://poisoncenters.org/
† Product codes are only available for 16 e-cigarette brands in NPDS.
§ This study was determined as exempt by the FDA Institutional Review Board for Human Subject Protection because data were previously collected and did not contain personally identifiable information.

Overall, 43 (0.6%) e-cigarette exposure cases resulted in hospital admission, and 582 (8.3%) required treatment at a health care facility. A major effect[¶] was experienced in 12 (0.2%) exposure cases and a moderate effect in 133 (1.9%) cases. One reported case resulted in death (a suspected death by suicide of a person ≥18 years). Approximately one half of reported cases resulted in either a minor effect (27.2%) or no reported effect (19.8%); 50.9% of cases were not followed.[**] Among 342 (4.9%) cases with brand information, the most commonly reported brand was Elf Bar (60.8%), a disposable e-cigarette available in a variety of flavors; monthly cases involving Elf Bar increased from two in April 2022 to 36 in March 2023. More than 90% of Elf Bar exposures were among children aged <5 years.

NPDS relies on voluntary reporting of poisoning exposure cases; thus, the number of cases is likely underreported (*3*). In addition, because product codes are not required, only a small proportion of e-cigarette exposure cases included information on the brand associated with the exposure.

The number of reported U.S. e-cigarette exposure cases during this 12-month period is approximately double the number reported in 2018 (*1*). Most of the cases were among children aged <5 years. Among the 5% of cases for which brand was available, Elf Bar, for which sales in the United States have recently increased (*4*), was reported more often than all the other reported brands combined, with nearly all Elf Bar cases occurring among children aged <5 years.

[¶] On the basis of definitions provided by NPDS, patients experiencing a minor effect exhibit some signs and symptoms from the exposure, which would usually resolve rapidly, such as mild, self-limited gastrointestinal symptoms, without dehydration or transient cough. Persons experiencing a moderate effect exhibit more pronounced and prolonged signs and symptoms for which some form of treatment would be indicated, such as a high fever, disorientation, or gastrointestinal symptoms causing dehydration. Major effects from exposure are life-threatening or might result in severe signs and symptoms (e.g., repeated seizures, cardiac arrest, or respiratory arrest), severe disability, or disfigurement.

[**] Data are considered not followed when coded as 1) not followed, judged as nontoxic exposure (clinical effects not expected); 2) not followed, minimal clinical effects possible (no more than minor effects possible); and 3) unable to follow, judged as a potentially toxic exposure.

Continued surveillance is critical to guiding efforts to prevent poisoning exposure associated with e-cigarettes, particularly among young children. Health care providers; the public health community; e-cigarette manufacturers, distributors, sellers, and marketers; and the public should be aware that e-cigarettes have the potential to cause poisoning exposure and are a continuing public health concern (*5*). Adult e-cigarette users should store their e-cigarettes and e-liquids safely to prevent access by young children.

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# Notes from the Field

## Emergence of an Mpox Cluster Primarily Affecting Persons Previously Vaccinated Against Mpox — Chicago, Illinois, March 18–June 12, 2023

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During April 17–May 5, 2023, 13 monkeypox (mpox) cases were reported to the Chicago Department of Public Health (CDPH) after 2 months during which only a single case had been reported. The cluster was remarkable because it comprised more than 10 cases at a time when sporadic cases or small clusters (i.e., involving fewer than three cases) were being reported in the United States, and >69% of the persons in this cluster had received 2 doses of JYNNEOS or 1 dose of ACAM2000 vaccine.* Some cases among persons who received doses of JYNNEOS vaccine are expected to occur based on vaccine effectiveness data (*1*,*2*); however, the observed proportion of cases among persons who had received 2 doses of JYNNEOS or 1 dose of ACAM2000 in this cluster was unusual. This increase in cases before large summer events scheduled nationwide and in Chicago raised concerns about possible future case increases.

On May 9, 2023, CDPH issued a health alert,† urging clinicians to remain vigilant for mpox cases and encouraging vaccination for persons at risk for mpox.§ CDPH and CDC launched an investigation to 1) determine the cluster's scope and etiology by evaluating patients' commonalities, JYNNEOS¶ vaccine cold-chain management, whole genome sequencing of clinical samples, and serologic immune response after infections, and to 2) identify important risk factors for mpox exposure to guide prevention efforts. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.**

During March 18–June 12, 2023, 40 laboratory-confirmed mpox cases were identified in Chicago, including 22 (55%), five (13%), and 13 (33%), respectively, among patients who had received 2 doses of JYNNEOS or 1 dose of ACAM2000 vaccine, those who had received 1 vaccine dose of JYNNEOS vaccine, and those who had not received any vaccines for mpox (Table). All cases occurred among persons who were assigned male sex at birth; 37 (93%) identified as male and 28 (70%) as gay. Median age was 33 years (IQR = 23–49 years), and non-Hispanic White men accounted for the largest percentage of patients (19; 48%), followed by Hispanic or Latino (eight; 20%) and non-Hispanic Black or African American men (seven; 18%). Eleven (28%) patients were living with HIV, 10 of whom had received 2 doses of JYNNEOS or 1 dose of ACAM2000 vaccine and whose HIV was well-controlled (CD4 count >200 cells/mm$^3$ and viral load <200 viral copies/mL). Three (8%) patients experienced concurrent sexually transmitted infections at the time of mpox diagnosis.

Most vaccinated patients in this cluster received 1 or 2 JYNNEOS vaccine doses during July–August 2022; the timing of vaccination is similar to an mpox cluster in France involving vaccinated persons who acquired mpox >6 months after vaccination†† (*3*). In the Chicago cluster, the median interval from receipt of the second JYNNEOS vaccine dose to mpox diagnosis was 8.4 months (IQR = 7.9–8.8 months). Among the 22 patients who received 2 doses of JYNNEOS vaccine or 1 dose of ACAM2000, eight (36%) received 2 subcutaneous doses of JYNNEOS, seven (32%) received 1 subcutaneous and 1 intradermal dose, one (5%) received 2 intradermal doses, and one received 1 dose of ACAM2000§§ abroad.¶¶ In discussions with Bavarian Nordic (the vaccine manufacturer) and the Strategic National Stockpile (SNS),*** CDC and CDPH identified no concerning temperature excursions that

* Persons in this group had received 2 doses of JYNNEOS or 1 dose of ACAM2000 vaccine >2 weeks before illness onset by either subcutaneous or intradermal administration route. One patient received 1 dose of ACAM2000 while in the United Kingdom.

† https://www.chicagohan.org/alert-detail/-/alert-details/46678186?p_r_p_categoryId=undefined

§ Persons recommended to receive mpox vaccination include gay, bisexual, or other men who have sex with men and transgender, nonbinary, or gender-diverse persons who during the previous 6 months have had a new diagnosis of one or more sexually transmitted disease (e.g., chlamydia, gonorrhea, or syphilis) or who have had more than one sex partner. In addition, mpox vaccination is recommended for anyone who has experienced or anticipates experiencing any of the following scenarios: had a known or suspected exposure to someone with mpox, had a sex partner during the previous 2 weeks who was diagnosed with mpox, had sex at a commercial sex venue (e.g., a sex club or bathhouse) during the previous 6 months, had sex during the previous 6 months at a large commercial event or in a geographic area (e.g., city or county) where *Monkeypox virus* transmission is ongoing, or had sex in exchange for money or other items during the previous 6 months.

¶ https://www.fda.gov/media/131078/download

** 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.

†† Persons received 1–2 doses of JYNNEOS (also known by the brand name Imvanex).

§§ https://www.fda.gov/files/vaccines%2C%20blood%20%26%20biologics/published/Package-Insert---ACAM2000.pdf

¶¶ Counts of doses by mode of administration might not sum to the total due to missing data from vaccines received out of jurisdiction.

*** Collaboratively managed by the U.S. Department of Homeland Security and CDC.

**TABLE. Characteristics of patients with mpox, by vaccination status (N = 40) — Chicago, Illinois, March 18–June 12, 2023**

| Characteristic | No. (%) | |
|---|---|---|
| | Persons who received 2 doses of JYNNEOS vaccine or 1 dose of ACAM2000* (n = 22) | Persons who received 1 dose of JYNNEOS vaccine/Unvaccinated (n = 18) |
| **Median age, yrs (IQR)** | 34 (31–40) | 30.5 (28–38) |
| **Current gender identity** | | |
| Male | 20 (91) | 17 (94) |
| Unknown | 2 (9) | 1 (6) |
| **Sexual orientation** | | |
| Gay | 17 (77) | 11 (61) |
| Bisexual | 1 (4.5) | 3 (17) |
| Other | 1 (4.5) | 0 (—) |
| Unknown | 3 (14) | 4 (22) |
| **Race and ethnicity†** | | |
| Asian, non-Hispanic | 1 (4.5) | 0 (—) |
| Black or African American, non-Hispanic | 1 (4.5) | 6 (33) |
| White, non-Hispanic | 13 (59) | 6 (33) |
| Hispanic or Latino | 4 (18) | 4 (22) |
| Other, non-Hispanic | 3 (14) | 1 (6) |
| Unknown | 0 (—) | 1 (6) |
| **Persons living with HIV** | 5 (23) | 6 (33) |
| **Persons hospitalized for mpox** | 0 (—) | 2 (11) |
| **Persons who received tecovirimat for mpox** | 6 (27) | 2 (11) |
| **Persons who reported concurrent sexually transmitted infections§** | 1 (5) | 2 (11) |
| **Persons who reported attending an event¶ 3 weeks before symptom onset** | 6 (27) | 3 (17) |
| **Median no. of sex partners** (range)** | 3 (1–20) | 1 (0–6) |

**Abbreviation:** mpox = monkeypox.

* Persons in this group had received 2 doses of the JYNNEOS vaccine or 1 dose of ACAM2000 >2 weeks before illness onset by either subcutaneous or intradermal administration route.

† No persons identifying as Native Hawaiian or other Pacific Islander or American Indian or Alaska Native were reported.

§ Including syphilis and gonorrhea.

¶ Patients were asked if they attended any large public or private events in the 3 weeks preceding symptom onset (i.e., concerts, weddings, parades, or festivals).

** Number of sexual partners reported in the 3 weeks preceding symptom onset.

could result in reduced vaccine effectiveness among involved vaccine lots at SNS, during transit from SNS to CDPH, or in CDPH custody. Patients were vaccinated at multiple locations, and CDPH is investigating potential temperature excursions in transportation, storage, and handling at vaccination sites.

Preliminary medical record review indicates that vaccinated patients experienced self-limited illness, managed in outpatient settings. Compared with patients who received 2 doses of JYNNEOS or 1 dose of ACAM2000 vaccine, patients who received 1 dose of JYNNEOS or no vaccines experienced a higher prevalence of lesions affecting the genital (43% versus 6%) and ocular (29% versus none) mucosa. The two hospitalized patients in this cluster had not received any mpox vaccine and had advanced HIV (<200 CD4 cells/mm$^3$). Preliminary sequencing results from one unvaccinated patient and three patients who had received 2 doses of JYNNEOS or 1 dose of ACAM2000 vaccine indicate that *Monkeypox virus* (MPXV) among these Chicago patients is consistent with the B.1 variant of clade IIb MPXV, the predominant variant during the 2022–2023 outbreak. Genomic sequences revealed very few point mutations relative to published MPXV genomes, with no changes predicted to cause amino acid changes or increased pathogenicity. In terms of risk factors, patients who received 2 doses of JYNNEOS or 1 dose of ACAM2000 had a median of three sex partners (range = one to 20) during the 3 weeks before symptom onset, compared with 1.5 (range = 0–6) among patients who received 1 dose of JYNNEOS vaccine and unvaccinated patients.

Although the cause of this cluster has not yet been determined, leading hypotheses include a potential high number of sexual exposures in a network with many vaccinated persons, decreased vaccine effectiveness due to waning of humoral immunity, or vaccine mishandling or administration errors. Health departments are encouraged to report vaccination status of mpox patients to CDC for rapid detection of similar clusters among persons who were previously vaccinated. Persons with known or suspected mpox exposures should isolate and seek testing if they develop mpox symptoms, even if they have been vaccinated. Temporary sexual behavior changes, such as limiting the number of new or multiple sex partners and limiting sex in settings where anonymous sexual contact with multiple partners occurs can also help prevent mpox. Persons eligible for vaccination, particularly those with advanced HIV and other immunocompromising conditions, should receive 2 doses of JYNNEOS vaccine. Additional research on the durability of JYNNEOS vaccine–induced immunity is needed.

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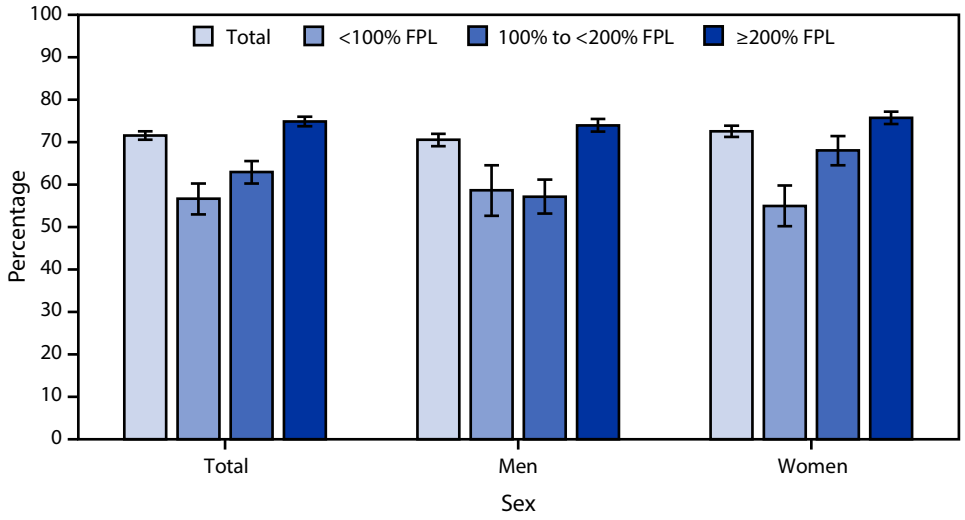
# QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

## Age-Adjusted Percentage* of Adults Aged 50–75 Years Who Received the Recommended Colorectal Cancer Screening,† by Sex and Family Income§ — National Health Interview Survey, United States, 2021¶




**Abbreviations:** FIT = fecal immunochemical test; FPL = federal poverty level.

* Age-adjusted percentages are based on the 2000 U.S. Census Bureau standard population using age groups 50–64 and 65–75 years, with 95% CIs indicated by error bars.

† Based on survey questions that included reports of home fecal occult blood test or FIT in the past year, sigmoidoscopy during the past 5 years, colonoscopy during the past 10 years, computed tomography colonography or virtual colonoscopy during the past 5 years, or Cologuard or FIT-DNA test during the past 3 years. Adults aged 50–75 with a history of colorectal cancer are excluded from the denominator. U.S. Preventive Services Task Force recommendations for colorectal cancer screening were updated in 2021 (https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/colorectal-cancer-screening) to expand the age group to 45–75 years; however, because these recommendations were issued during the middle of 2021 National Health Interview Survey data collection, the estimates in this report are limited to the age group for the previous recommendation.

§ As a percentage of FPL, which is based on family income and family size, using the U.S. Census Bureau's poverty thresholds. Family income was imputed when missing.

¶ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population.

In 2021, 71.6% of adults aged 50–75 years reported they received the recommended colorectal cancer screening, with the percentage increasing with income from 56.7% for those with family incomes <100% of FPL to 63.0% for those with family incomes 100% to <200% of FPL, and 74.9% for those with family incomes ≥200% of FPL. The same pattern by income was found among women, ranging from 55.0% for those with family incomes <100% of FPL to 68.1% for those with family incomes 100% to <200%, and 75.8% for those with family incomes ≥200% of FPL. Among men, the percentage was similar for those with family incomes <100% of FPL (58.7%) and family incomes 100% to <200% of FPL (57.2%), but increased to 74.0% for those with family incomes ≥200% of FPL. Overall, 72.6% of women and 70.6% of men received the recommended screening; the percentage was higher among women than men with family incomes 100% to <200% of FPL (68.1% versus 57.2%), but was similar for the other family income groups.

**Source:** National Center for Health Statistics, National Health Interview Survey, 2021. https://www.cdc.gov/nchs/nhis/index.htm

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