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Deaths from Excessive Alcohol Use — United States, 2016–2021

Marissa B. Esser, PhD[1]; Adam Sherk, PhD[2]; Yong Liu, MD[1]; Timothy S. Naimi, MD[2]

Abstract

Deaths from causes fully attributable to alcohol use have increased during the past 2 decades in the United States, particularly from 2019 to 2020, concurrent with the onset of the COVID-19 pandemic. However, previous studies of trends have not assessed underlying causes of deaths that are partially attributable to alcohol use, such as injuries or certain types of cancer. CDC's Alcohol-Related Disease Impact application was used to estimate the average annual number and age-standardized rate of deaths from excessive alcohol use in the United States based on 58 alcohol-related causes of death during three periods (2016–2017, 2018–2019, and 2020–2021). Average annual number of deaths from excessive alcohol use increased 29.3%, from 137,927 during 2016–2017 to 178,307 during 2020–2021; age-standardized alcohol-related death rates increased from 38.1 to 47.6 per 100,000 population. During this time, deaths from excessive alcohol use among males increased 26.8%, from 94,362 per year to 119,606, and among females increased 34.7%, from 43,565 per year to 58,701. Implementation of evidence-based policies that reduce the availability and accessibility of alcohol and increase its price (e.g., policies that reduce the number and concentration of places selling alcohol and increase alcohol taxes) could reduce excessive alcohol use and alcohol-related deaths.

Introduction

Deaths from causes fully attributable to alcohol use (i.e., 100% alcohol-attributable causes, such as alcoholic liver disease and alcohol use disorder) have increased during the past 2 decades in the United States (*1*); rates were particularly elevated from 2019 to 2020,* concurrent with the onset of the COVID-19 pandemic. In addition, emergency department visit rates associated with acute alcohol use (*2*) and per capita alcohol sales† also increased during this time. Previous studies of trends have not included underlying causes of death that are partially attributable to alcohol (*1*,*3*), such as injuries or certain types of cancer, for which drinking is a substantial risk factor (*4*,*5*). A comprehensive assessment of changes in deaths from excessive alcohol use that includes conditions that are fully and partially attributable to alcohol can guide the rationale for and implementation of effective prevention strategies.

Methods

Data Sources and Measures

Total U.S. deaths from alcohol-related conditions during 2016–2021 identified from the National Vital Statistics System were grouped into three periods (2016–2017, 2018–2019,

* https://www.cdc.gov/nchs/products/databriefs/db448.htm

† https://www.niaaa.nih.gov/publications/surveillance-reports/surveillance120

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and 2020–2021). Deaths were defined using the underlying cause of death for the 58 alcohol-related conditions[§] in CDC's Alcohol-Related Disease Impact (ARDI) application and estimated using ARDI methods.[¶] For each cause of death, alcohol-attributable fractions were used, reflecting the cause-specific proportion that is due to excessive alcohol use. For the 15 fully alcohol-attributable conditions,[**] the alcohol-attributable fraction is 1.0. Fully alcohol-attributable conditions include the 100% alcohol-attributable chronic causes as well as the 100% alcohol-attributable acute causes (i.e., alcohol poisonings that are a subset of deaths in the alcohol-related poisonings category and deaths from suicide by exposure to alcohol that are a subset of the suicide category). Partially alcohol-attributable conditions are those that are caused by alcohol use or other factors, and alcohol-attributable fractions are applied to calculate the deaths from alcohol use. For most of the partially alcohol-related chronic conditions, population-attributable fractions were estimated using relative risks from published meta-analyses and adjusted prevalence estimates of low, medium, and high average daily alcohol use among U.S. adults. Prevalence estimates were obtained from the Behavioral Risk Factor Surveillance System[††] and adjusted using alcohol per capita sales information to account for underreporting of self-reported drinking (*6*).

Alcohol-attributable fractions for acute causes (e.g., injuries) were determined mostly from a recent meta-analysis that generally measured the proportion of decedents who had a blood alcohol concentration (BAC) ≥0.10% (*7*). Alcohol-attributable fractions for motor vehicle crashes and other road vehicle crash deaths were obtained from the Fatality Analysis Reporting System, based on the proportion of crash deaths that involved a decedent with BAC ≥0.08%.[§§]

Deaths from excessive alcohol use (as opposed to deaths from any level of drinking) includes all decedents whose deaths were attributed to conditions that are fully caused by alcohol use, alcohol-related acute causes of death that involved binge drinking, and alcohol-related chronic conditions that

[§] https://www.cdc.gov/alcohol/ardi/alcohol-related-icd-codes.html

[¶] https://www.cdc.gov/alcohol/ardi/methods.html

[**] Deaths from causes fully attributable to alcohol use (i.e., 100% alcohol-attributable causes) include alcohol abuse, alcohol cardiomyopathy, alcohol dependence syndrome, alcohol poisoning, alcohol polyneuropathy, alcohol-induced acute pancreatitis, alcohol-induced chronic pancreatitis, alcoholic gastritis, alcoholic liver disease, alcoholic myopathy, alcoholic psychosis, degeneration of the nervous system due to alcohol use, fetal alcohol syndrome, fetus and newborn issues caused by maternal alcohol use, and suicide by exposure to alcohol.

[††] Daily average alcohol use prevalence estimates were from the Behavioral Risk Factor Surveillance System (https://www.cdc.gov/brfss/data_documentation/index.htm), aligning with the respective years of the death data for the three periods in this study, and used in population attributable fraction calculations. Prevalence estimates of daily average alcohol use were calculated for three levels, including low (females: >0 to ≤1 drink, males: >0 to ≤2 drinks), medium (females: >1 to ≤2 drinks, males: >2 to ≤4 drinks), and high (females: >2 drinks, males: >4 drinks), unless the source of the relative risk estimates specified otherwise. For the three periods in this study, the categorical relative risks were calculated to correspond with the median of the alcohol use distribution for each drinking level.

[§§] https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars

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involved medium or high average daily levels of alcohol use. For the chronic causes of death estimated using cause-specific population-attributable fractions by sex, the relative risks for death at medium daily average drinking levels (females: >1 to ≤2 drinks, males: >2 to ≤4 drinks) and high daily average drinking levels (females: >2 drinks, males: >4 drinks) were relative to the risks at low daily average drinking levels (females: >0 to ≤1 drink, males: >0 to ≤2 drinks).

Data Analyses

The average annual number of deaths resulting from excessive alcohol use during three 2-year periods, percentage change in numbers of deaths,[¶¶] and death rates were calculated overall and by sex and cause of death category. The number of sex-stratified deaths from excessive drinking was also assessed by age group. In general, deaths from chronic conditions were calculated among decedents aged ≥20 years, and deaths from acute causes were calculated among decedents aged ≥15 years. Younger children whose deaths resulted from someone else's drinking (e.g., as passengers in motor vehicle crashes) were also included for several causes of death. Death rates (deaths per 100,000 population) were calculated based on midyear postcensal population estimates and age-standardized to the 2000 U.S. Census Bureau standard population. Nonoverlapping 95% CIs were considered significantly different. Analyses were conducted using SAS software (version 9.4; SAS Institute). This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[***]

Results

Average annual deaths from excessive alcohol use in the United States increased 5.3%, from 137,927 during 2016–2017 to 145,253 during 2018–2019; these deaths then increased more sharply (22.8%) from 2018–2019 to 178,307 during 2020–2021, for an overall 29.3% increase from 2016–2017 to 2020–2021 (Table 1). Age-standardized death rates increased from 38.1 per 100,000 population during 2016–2017 to 39.1 during 2018–2019 to 47.6 during 2020–2021. Approximately two thirds of these deaths resulted from chronic causes during each period: alcohol-attributable death rates from chronic causes increased from 23.2 per 100,000 population to 24.3 to 29.4 during the respective analysis periods. During 2020–2021, fully alcohol-attributable causes[†††] accounted for 51,665 deaths (29.0% of all alcohol-attributable deaths), a 46.2% increase compared with the 35,344 deaths that occurred during 2016–2017. During 2020–2021, partially alcohol-attributable causes accounted for 126,642 deaths (71.0% of all alcohol-attributable deaths), a 23.5% increase compared with the 102,583 partially alcohol-attributable deaths that occurred during 2016–2017.

Increases Among Males and Females

The average annual number of deaths from excessive alcohol use among males increased by 25,244 (26.8%), from 94,362 deaths during 2016–2017 to 119,606 during 2020–2021 (Table 2). Age-standardized death rates among males increased from 54.8 per 100,000 population during 2016–2017 to 55.9 during 2018–2019, and to 66.9 during 2020–2021. During each period, among all excessive alcohol use cause of death categories, death rates among males were highest from 100% alcohol-attributable chronic conditions.

Among females, the average annual number of deaths from excessive alcohol use increased by 15,136 (34.7%), from 43,565 during 2016–2017, to 58,701 during 2020–2021. Age-standardized alcohol-attributable death rates among females increased from 22.7 per 100,000 population during 2016–2017 to 23.6 during 2018–2019, and to 29.4 during 2020–2021. Death rates among females were highest from heart disease and stroke during each period. Among both males and females, alcohol-attributable death rates increased for most cause of death categories. The average number of sex-specific alcohol-attributable deaths increased among all age groups from 2016–2017 to 2020–2021(Figure).

Discussion

From 2016–2017 to 2020–2021, the average annual number of U.S. deaths from excessive alcohol use increased by more than 40,000 (29%), from approximately 138,000 per year (2016–2017) to 178,000 per year (2020–2021). This increase translates to an average of approximately 488 deaths each day from excessive drinking during 2020–2021. From 2016–2017 to 2020–2021, the average annual number of deaths from excessive alcohol use increased by more than 25,000 among males and more than 15,000 among females; however, the percentage increase in the number of deaths during this time was larger for females (approximately 35% increase) than for males (approximately 27%). These findings are consistent with another recent study that found a larger increase in fully alcohol-attributable death rates among females compared with males (*8*).

Increases in deaths from excessive alcohol use during the study period occurred among all age groups. A recent study found that one in eight total deaths among U.S. adults aged

[¶¶] The percentage represents the equation {[(estimated average annual number of deaths from excessive alcohol use in more recent period – estimated average annual number of deaths from excessive alcohol use in earlier period) / estimated average annual number of deaths from excessive alcohol use in earlier period] x 100}.

[***] 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.

[†††] Fully alcohol-attributable conditions include the 100% alcohol-attributable chronic causes as well as the 100% alcohol-attributable acute causes (i.e., alcohol poisonings that are a subset of deaths in the alcohol-related poisonings category and suicide by exposure to alcohol that are a subset of deaths in the suicide category).

TABLE 1. Average annual number of deaths from excessive alcohol use, cause of death, and age-standardized death rates, by period — United States, 2016–2021

Cause of death	Average annual no. of deaths from excessive alcohol use			% Change in average annual no. of deaths from excessive alcohol use			Age-standardized deaths per 100,000 population (95% CI)		
	2016–2017	2018–2019	2020–2021	2018–2019 vs. 2016–2017	2020–2021 vs. 2018–2019	2020–2021 vs. 2016–2017	2016–2017	2018–2019	2020–2021
All causes*	**137,927**	**145,253**	**178,307**	**5.3**	**22.8**	**29.3**	**38.1 (37.9–38.3)**	**39.1 (38.9–39.3)†**	**47.6 (47.4–47.8)†,§**
Chronic cause									
All chronic causes	**88,587**	**95,462**	**117,245**	**7.8**	**22.8**	**32.4**	**23.2 (23.1–23.4)**	**24.3 (24.1–24.5)†**	**29.4 (29.3–29.6)†,§**
100% alcohol-attributable (chronic)¶	32,937	35,819	48,972	8.8	36.7	48.7	9.0 (8.9–9.1)	9.6 (9.3–9.7)†	13.2 (13.1–13.3)†,§
Cancer**	16,123	16,686	17,072	3.5	2.3	5.9	4.1 (4.0–4.2)	4.1 (4.0–4.1)	4.0 (4.0–4.1)
Heart disease and stroke††	27,952	30,814	37,317	10.2	21.1	33.5	7.2 (7.1–7.2)	7.5 (7.5–7.6)†	8.8 (8.7–8.8)†,§
Liver, gallbladder, and pancreas§§	10,673	11,178	12,719	4.7	13.8	19.2	2.8 (2.7–2.8)	2.8 (2.7–2.8)	3.1 (3.1–3.2)†,§
Other chronic cause¶¶	902	965	1,165	7.0	20.7	29.2	0.3 (0.2–0.3)	0.3 (0.2–0.3)	0.3 (0.3–0.4)
Acute cause									
All acute causes	**49,340**	**49,791**	**61,063**	**0.9**	**22.6**	**23.8**	**14.9 (14.8–15.0)**	**14.8 (14.7–15.0)**	**18.2 (18.0–18.3)†,§**
Alcohol-related poisoning***	14,944	15,400	21,806	3.1	41.6	45.9	4.6 (4.5–4.7)	4.7 (4.6–4.8)	6.6 (6.5–6.7)†,§
Motor vehicle traffic crash	13,009	12,579	15,055	−3.3	19.7	15.7	4.0 (3.9–4.0)	3.8 (3.7–3.9)	4.5 (4.5–4.6)†,§
Suicide†††	9,608	9,974	9,801	3.8	−1.7	2.0	2.9 (2.8–2.9)	2.9 (2.9–3.0)	2.9 (2.8–2.9)
Other acute cause§§§	11,779	11,838	14,400	0.5	21.6	22.3	3.5 (3.4–3.5)	3.4 (3.4–3.5)	4.2 (4.1–4.2)†,§

* Includes 58 causes of death related to alcohol use. Deaths from excessive alcohol use includes all decedents whose deaths were attributed to conditions that were fully caused by alcohol use, alcohol-related acute causes of death that involved binge drinking, and alcohol-related chronic conditions that involved medium (females: >1 to ≤2 drinks, males: >2 to ≤4 drinks) or high (females: >2 drinks, males: >4 drinks) daily average drinking levels.

† Nonoverlapping 95% CIs of age-standardized death rates compared with 2016–2017.

§ Nonoverlapping 95% CIs of age-standardized death rates compared with 2018–2019.

¶ The 100% alcohol-attributable chronic causes of death included alcohol abuse, alcohol cardiomyopathy, alcohol dependence syndrome, alcohol polyneuropathy, alcohol-induced acute pancreatitis, alcohol-induced chronic pancreatitis, alcoholic gastritis, alcoholic liver disease, alcoholic myopathy, and alcoholic psychosis.

** Cancer deaths from excessive alcohol use were estimated for deaths from breast cancer (females only), colorectal cancer, esophageal cancer (for the proportion due to squamous cell carcinoma only, based on the Surveillance, Epidemiology, and End Results Program data in 17 states), laryngeal cancer, liver cancer, oral cavity and pharyngeal cancer, pancreatic cancer, prostate cancer (males only), and stomach cancer. Deaths from pancreatic and stomach cancers were calculated among people consuming high daily average levels of alcohol only (females: >2 drinks, males: >4 drinks).

†† Deaths from excessive alcohol use from heart disease and stroke were estimated for deaths from atrial fibrillation, coronary heart disease, hemorrhagic stroke, hypertension, and ischemic stroke.

§§ Deaths from excessive alcohol use were estimated for deaths from conditions of the gallbladder, liver, and pancreas, including those from acute pancreatitis, chronic pancreatitis, esophageal varices, gallbladder disease, gastroesophageal hemorrhage, portal hypertension, and unspecified liver cirrhosis.

¶¶ Deaths from excessive alcohol use were estimated for deaths from other chronic conditions including chronic hepatitis; infant deaths due to low birthweight, preterm birth, and small for gestational age; pneumonia; and seizure disorder, seizures, and unprovoked epilepsy.

*** Deaths from alcohol-related poisonings included those from alcohol poisoning (100% attributable to alcohol) and the portion of deaths from poisonings that involved another substance (e.g., drug overdoses) in addition to a high blood alcohol concentration (≥0.10%).

††† Deaths from excessive alcohol use from suicide included those from suicide by exposure to alcohol (100% attributable to alcohol) and a portion of deaths from suicide based on the alcohol-attributable fraction of 0.21.

§§§ Deaths from excessive alcohol use from other acute conditions included the cause-specific portion of deaths for air-space transport, aspiration, child maltreatment, drowning, fall injuries, fire injuries, firearm injuries, homicide, hypothermia, motor vehicle nontraffic crashes, occupational and machine injuries, other road vehicle crashes, and water transport.

20–64 years during 2015–2019 resulted from excessive alcohol use (*9*). Because of the increases in these deaths during 2020–2021, including among adults in the same age group, excessive alcohol use could account for an even higher proportion of total deaths during that 2-year period. In addition, data from Monitoring the Future, an ongoing study of the behaviors, attitudes, and values of U.S. residents from adolescence through adulthood, showed that the prevalence of binge drinking among adults aged 35–50 years was higher in 2022 than in any other year during the past decade[§§§]; this increase could contribute to future increases in alcohol-attributable deaths. In

§§§ https://monitoringthefuture.org/wp-content/uploads/2023/07/mtfpanel2023.pdf

this study, fewer than one third of deaths from excessive alcohol use were from fully alcohol-attributable causes, highlighting the importance of also assessing partially alcohol-attributable causes to better understand the harms from excessive drinking, including binge drinking.

The nearly 23% increase in the deaths from excessive alcohol use that occurred from 2018–2019 to 2020–2021 was approximately four times as high as the previous 5% increase that occurred from 2016–2017 to 2018–2019. Increases in the availability of alcohol in many states might have contributed to this disproportionate increase (*10*). During the peak of the COVID-19 pandemic in 2020–2021, policies were widely implemented to expand alcohol carryout and delivery to homes, and places that sold alcohol for off-premise consumption (e.g., liquor stores) were deemed as essential businesses in many states (and remained open during lockdowns).[¶¶¶] General delays in seeking medical attention, including avoidance of emergency departments[****] for alcohol-related conditions[††††]; stress, loneliness, and social isolation; and mental health conditions might also have contributed to the increase in deaths from excessive alcohol use during the COVID-19 pandemic.

Limitations

The findings in this report are subject to at least two limitations. First, population-attributable fractions were calculated based on data including only persons who currently drank alcohol. Because some persons who formerly drank alcohol might also die from alcohol-related causes, population-attributable fractions might underestimate alcohol-attributable deaths. Second, several conditions (e.g., HIV/AIDS and tuberculosis) for which excessive alcohol use is a substantial risk factor were not included because relative risk estimates relevant to the U.S. population were not available for calculating the portion of these deaths attributable to drinking alcohol, further contributing to conservative death estimates in this report.

[¶¶¶] https://alcoholpolicy.niaaa.nih.gov/sites/default/files/file-page/digest_state_alcohol_policies_in_response_to_covid-19_220101.pdf

[****] https://www.cdc.gov/mmwr/volumes/70/wr/mm7015a3.htm
[††††] https://onlinelibrary.wiley.com/doi/10.1111/joim.13545

TABLE 2. Average annual number of deaths from excessive alcohol use, cause of death, and age-standardized death rates, by period and sex — United States, 2016–2021

Cause of death/Sex	Average annual no. of deaths from excessive alcohol use			% Change in average annual no. of deaths from excessive alcohol use			Deaths per 100,000 population (95% CI)		
	2016–2017	2018–2019	2020–2021	2018–2019 vs. 2016–2017	2020–2021 vs. 2018–2019	2020–2021 vs. 2016–2017	2016–2017	2018–2019	2020–2021
Male									
All causes*	**94,362**	**98,637**	**119,606**	**4.5**	**21.3**	**26.8**	**54.8 (54.5–55.2)**	**55.9 (55.6–56.3)†**	**66.9 (66.5–67.3)†,§**
Chronic cause									
All chronic causes	**57,791**	**61,746**	**73,921**	**6.8**	**19.7**	**27.9**	**32.4 (32.2–32.7)**	**33.6 (33.3–33.9)†**	**39.4 (39.1–39.7)†,§**
100% alcohol-attributable (chronic)[¶]	23,753	25,600	34,811	7.8	36.0	46.6	13.4 (13.3–13.6)	14.3 (14.1–14.4)†	19.2 (19.0–19.5)†,§
Cancer**	12,367	12,815	12,647	3.6	–1.3	2.3	6.8 (6.7–6.9)	6.8 (6.7–6.9)	6.4 (6.3–6.5)†,§
Heart disease and stroke[††]	14,985	16,378	18,663	9.3	14.0	24.5	8.4 (8.3–8.6)	8.8 (8.7–8.9)†	9.6 (9.5–9.7)†,§
Liver, gallbladder, and pancreas[§§]	6,021	6,229	6,949	3.5	11.6	15.4	3.3 (3.3–3.4)	3.4 (3.3–3.4)	3.6 (3.6–3.7)†,§
Other chronic cause[¶¶]	664	724	851	9.0	17.5	28.2	0.4 (0.4–0.4)	0.4 (0.4–0.4)	0.5 (0.4–0.5)
Acute cause									
All acute causes	**36,571**	**36,891**	**45,685**	**0.9**	**23.8**	**24.9**	**22.4 (22.2–22.6)**	**22.3 (22.1–22.5)**	**27.5 (27.2–27.8)†,§**
Alcohol-related poisoning***	10,315	10,789	15,557	4.6	44.2	50.8	6.4 (6.3–6.5)	6.7 (6.5–6.8)	9.5 (9.4–9.7)†,§
Motor vehicle traffic crash	9,910	9,450	11,364	–4.6	20.3	14.7	6.1 (6.0–6.2)	5.7 (5.6–5.9)†	6.9 (6.7–7.0)†,§
Suicide[†††]	7,465	7,815	7,812	4.7	—[§§§]	4.6	4.5 (4.4–4.6)	4.7 (4.6–4.8)	4.6 (4.5–4.7)
Other acute cause[¶¶¶]	8,881	8,836	10,953	–0.5	24.0	23.3	5.4 (5.3–5.5)	5.3 (5.2–5.4)	6.5 (6.4–6.6)†,§

See table footnotes on the next page.

TABLE 2. (*Continued*) Average annual number of deaths from excessive alcohol use, cause of death, and age-standardized death rates, by period and sex — United States, 2016–2021

Cause of death/Sex	Average annual no. of deaths from excessive alcohol use			% Change in average annual no. of deaths from excessive alcohol use			Deaths per 100,000 population (95% CI)		
	2016–2017	2018–2019	2020–2021	2018–2019 vs. 2016–2017	2020–2021 vs. 2018–2019	2020–2021 vs. 2016–2017	2016–2017	2018–2019	2020–2021
Female									
All causes*	**43,565**	**46,616**	**58,701**	**7.0**	**25.9**	**34.7**	**22.7 (22.5–22.9)**	**23.6 (23.3–23.8)†**	**29.4 (29.1–29.6)†,§**
Chronic cause									
All chronic causes	**30,796**	**33,717**	**43,324**	**9.5**	**28.5**	**40.7**	**15.1 (15.0–15.3)**	**16.0 (15.9–16.2)†**	**20.3 (20.1–20.5)†,§**
100% alcohol-attributable (chronic)¶	9,184	10,220	14,161	11.3	38.6	54.2	4.9 (4.8–5.0)	5.4 (5.3–5.5)†	7.6 (7.4–7.7)†,§
Cancer**	3,756	3,871	4,426	3.1	14.3	17.8	1.8 (1.7–1.9)	1.8 (1.7–1.8)	2.0 (1.9–2.0)§
Heart disease and stroke††	12,967	14,436	18,653	11.3	29.2	43.8	6.0 (5.9–6.1)	6.4 (6.3–6.5)†	8.0 (7.9–8.1)†,§
Liver, gallbladder, and pancreas§§	4,652	4,949	5,770	6.4	16.6	24.0	2.2 (2.2–2.3)	2.3 (2.2–2.4)	2.6 (2.6–2.7)†,§
Other chronic cause¶¶	238	240	314	0.8	30.8	31.9	0.1 (0.1–0.2)	0.1 (0.1–0.2)	0.2 (0.2–0.2)
Acute cause									
All acute causes	**12,769**	**12,900**	**15,378**	**1.0**	**19.2**	**20.4**	**7.5 (7.4–7.7)**	**7.5 (7.4–7.7)**	**9.0 (8.9–9.2)†,§**
Alcohol-related poisoning***	4,629	4,610	6,249	–0.4	35.6	35.0	2.8 (2.7–2.9)	2.8 (2.7–2.9)	3.8 (3.7–3.9)†,§
Motor vehicle traffic crash	3,098	3,128	3,691	1.0	18.0	19.1	1.9 (1.8–2.0)	1.9 (1.8–2.0)	2.2 (2.2–2.3)†,§
Suicide†††	2,143	2,159	1,990	0.7	–7.8	–7.1	1.3 (1.2–1.3)	1.3 (1.2–1.3)	1.2 (1.1–1.2)
Other acute cause¶¶¶	2,898	3,002	3,448	3.6	14.9	19.0	1.6 (1.5–1.7)	1.6 (1.6–1.7)	1.9 (1.8–1.9)†,§

* Includes 58 causes of death related to alcohol use. Deaths from excessive alcohol use includes all decedents whose deaths were attributed to conditions that were fully caused by alcohol use, alcohol-related acute causes of death that involved binge drinking, and alcohol-related chronic conditions that involved medium (females: >1 to ≤2 drinks, males: >2 to ≤4 drinks) or high (females: >2 drinks, males: >4 drinks) daily average drinking levels.

† Nonoverlapping 95% CIs of age-standardized death rates compared with 2016–2017.

§ Nonoverlapping 95% CIs of age-standardized death rates compared with 2018–2019.

¶ The 100% alcohol-attributable chronic causes of death included alcohol abuse, alcohol cardiomyopathy, alcohol dependence syndrome, alcohol polyneuropathy, alcohol-induced acute pancreatitis, and alcohol-induced chronic pancreatitis, alcoholic gastritis, alcoholic liver disease, alcoholic myopathy, and alcoholic psychosis.

** Cancer deaths from excessive alcohol use were estimated for deaths from breast cancer (females only), colorectal cancer, esophageal cancer (for the proportion due to squamous cell carcinoma only, based on the Surveillance, Epidemiology, and End Results Program data in 17 states), laryngeal cancer, liver cancer, oral cavity and pharyngeal cancer, pancreatic cancer, prostate cancer (males only), and stomach cancer. Deaths from pancreatic and stomach cancers were calculated among people consuming high daily average levels of alcohol only (females: >2 drinks, males: >4 drinks).

†† Deaths from excessive alcohol use from heart disease and stroke were estimated for deaths from atrial fibrillation, coronary heart disease, hemorrhagic stroke, hypertension, and ischemic stroke.

§§ Deaths from excessive alcohol use were estimated for deaths from conditions of the gallbladder, liver, and pancreas including those from acute pancreatitis, chronic pancreatitis, esophageal varices, gallbladder disease, gastroesophageal hemorrhage, portal hypertension, and unspecified liver cirrhosis.

¶¶ Deaths from excessive alcohol use were estimated for deaths from other chronic conditions including chronic hepatitis; infant deaths due to low birth weight, preterm birth, and small for gestational age; pneumonia; and seizure disorder, seizures, and unprovoked epilepsy.

*** Deaths from alcohol-related poisonings included those from alcohol poisoning (100% attributable to alcohol) and the portion of deaths from poisonings that involved another substance (e.g., drug overdoses) in addition to a high blood alcohol concentration (≥0.10%).

††† Deaths from excessive alcohol use from suicide included those from suicide by exposure to alcohol (100% attributable to alcohol) and a portion of deaths from suicide based on the alcohol-attributable fraction of 0.21.

§§§ No change in percentage of average annual deaths.

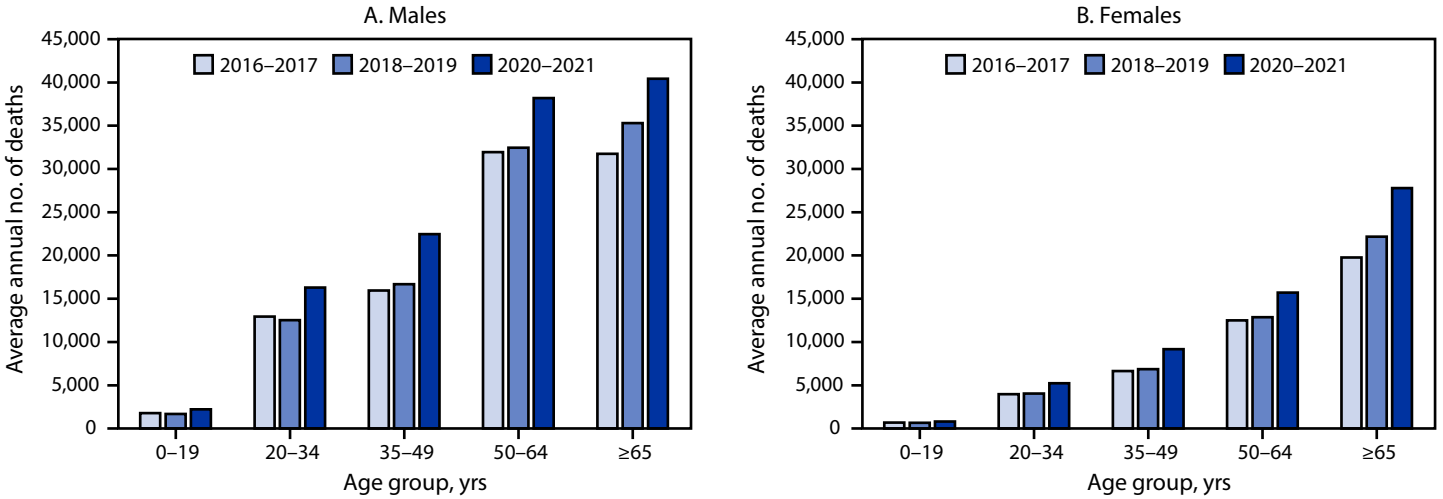
¶¶¶ Deaths from excessive alcohol use from other acute conditions included the cause-specific portion of deaths for air-space transport, aspiration, child maltreatment, drowning, fall injuries, fire injuries, firearm injuries, homicide, hypothermia, motor vehicle nontraffic crashes, occupational and machine injuries, other road vehicle crashes, and water transport.

Implications for Public Health Practice

States and communities can discourage excessive alcohol use and reverse recent increases in alcohol-attributable deaths by implementing comprehensive strategies, including evidence-based alcohol policies that reduce the availability and accessibility of alcohol and increase its price (e.g., policies that reduce the number and concentration of places selling alcohol and increase alcohol taxes).[§§§§] Also, CDC's electronic screening and brief

[§§§§] https://www.cdc.gov/alcohol/fact-sheets/prevention.htm

FIGURE. Average annual number of deaths from excessive alcohol use,* by age group and period among males (A) and females (B) — United States, 2016–2021



* Deaths from excessive alcohol use includes all decedents whose deaths were attributed to conditions that were fully caused by alcohol use, alcohol-related acute causes of death that involved binge drinking, and alcohol-related chronic conditions that involved medium (females: >1 to ≤2 drinks, males: >2 to ≤4 drinks) or high (females: >2 drinks, males: >4 drinks) daily average drinking levels.

Summary

What is already known about this topic?

U.S. deaths from causes fully due to excessive alcohol use increased during the past 2 decades.

What is added by this report?

Average annual number of deaths from excessive alcohol use, including partially and fully alcohol-attributable conditions, increased approximately 29% from 137,927 during 2016–2017 to 178,307 during 2020–2021, and age-standardized death rates increased from approximately 38 to 48 per 100,000 population. During this time, deaths from excessive drinking among males increased approximately 27%, from 94,362 per year to 119,606, and among females increased approximately 35%, from 43,565 per year to 58,701.

What are the implications for public health practice?

Evidence-based alcohol policies (e.g., reducing the number and concentration of places selling alcohol and increasing alcohol taxes) could help reverse increasing alcohol-attributable death rates.

intervention[¶¶¶¶] can be used in primary and acute care, or nonclinical, settings to allow adults to check their alcohol use, receive personalized feedback, and create a plan for drinking less alcohol. Integration of screening and brief intervention into routine clinical services[*****] for adults and mass media communications campaigns[†††††] to support people in drinking less can also help. Increased use of these strategies, particularly effective alcohol policies, could help reduce excessive alcohol use and related deaths among persons who drink and also reduce harms to persons who are affected by others' alcohol use (e.g., child and adult relatives, friends, and strangers).

Corresponding author: Marissa B. Esser, messer@cdc.gov.

[1]Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion, CDC; [2]Canadian Institute for Substance Use Research, Victoria, British Columbia, Canada.

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***** https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/unhealthy-alcohol-use-in-adolescents-and-adults-screening-and-behavioral-counseling-interventions

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Progress Toward Rubella and Congenital Rubella Syndrome Elimination — Worldwide, 2012–2022

Alan C. Ou, MD[1]; Laura A. Zimmerman, MPH[1]; James P. Alexander, Jr., MD[1]; Natasha S. Crowcroft, MD[2]; Patrick M. O'Connor, MD[2]; Jennifer K. Knapp, PhD[1]

Abstract

Rubella virus is a leading cause of vaccine-preventable birth defects. Infection during pregnancy can result in miscarriage, fetal death, stillbirth, or a constellation of birth defects, including cataracts, deafness, heart defects, and developmental delay, known as congenital rubella syndrome (CRS). A single dose of rubella-containing vaccine can provide lifelong protection against rubella. The Global Vaccine Action Plan 2011–2020 included a target to achieve elimination of rubella in at least five of the six World Health Organization (WHO) regions by 2020, and rubella elimination is a critical goal of the Immunization Agenda 2030. This report updates a previous report and describes progress toward rubella and CRS elimination during 2012–2022. During 2012–2022, among 194 WHO countries, the number that included rubella-containing vaccine (RCV) in their immunization schedules increased from 132 (68%) to 175 (90%) and the percentage of the world's infants vaccinated against rubella increased from 40% to 68%. Reported rubella cases declined 81%, from 93,816 in 2012 to 17,407 in 2022. Verification of rubella elimination was achieved in 98 (51%) of 194 countries by 2022, an increase from 84 (43%) countries in 2019. Despite significant progress in the introduction of RCV into routine immunization programs worldwide, approximately 25 million infants annually still do not have access to RCV. Nevertheless, even in complex settings, the increasing number of countries that have achieved and sustained rubella elimination demonstrates progress toward global rubella elimination.

Introduction

Rubella virus is a leading cause of vaccine-preventable birth defects and can cause epidemics. Rubella virus infection usually produces a mild febrile rash illness in children and adults. However, infection during pregnancy, especially during the first trimester, can result in miscarriage, fetal death, stillbirth, or a constellation of birth defects known as congenital rubella syndrome (CRS). A single dose of rubella-containing vaccine (RCV) can provide lifelong protection against rubella (*1*). The Global Vaccine Action Plan 2011–2020 (GVAP) included a target to achieve elimination of rubella in at least five of the six World Health Organization (WHO) regions by 2020 (*2*), and WHO recommended capitalizing on the accelerated measles elimination activities as an opportunity to introduce RCV (*1*). In 2020, the Measles and Rubella Strategic Framework (MRSF) 2021–2030 (*3*) was developed under the Immunization Agenda 2030 (IA2030) (*4*), which includes rubella elimination as a critical impact goal. MRSF includes guidance at the country, regional, and global levels for planning and implementing more effective measles and rubella elimination efforts. This report updates a previous report (*5*) and summarizes global progress toward elimination of rubella and CRS from 2012 (when accelerated rubella control activities were initiated) through 2022.

Methods

Immunization Activities

The WHO-recommended strategy for introducing RCV into national immunization programs is through an initial catch-up vaccination campaign targeting persons who might not have been naturally exposed to rubella (usually children and adolescents aged ≤14 years) (*1*). WHO recommends that countries then achieve and maintain at least 80% coverage with ≥1 dose of RCV delivered through routine services or campaigns (*1*).

Each year, countries report immunization data to WHO and UNICEF using the electronic Joint Reporting Form (eJRF).* This form includes information on immunization schedules and the number of vaccine doses administered through routine immunization services and vaccination campaigns. WHO and UNICEF estimate coverage with the first and second RCV doses delivered through routine immunization services† for all countries, using annual administrative coverage data, national coverage estimates, and vaccination coverage surveys. For this report, 2012–2022 eJRF data were analyzed, with a focus on data from 2012 (the new phase of rubella vaccine introduction and elimination), 2020 (the beginning of the COVID-19 pandemic), and 2022 (the most recent data available). Because RCV first became available in high-income countries, World Bank income groupings for 2022 were used to evaluate

* https://www.who.int/teams/immunization-vaccines-and-biologicals/immunization-analysis-and-insights/global-monitoring/who-unicef-joint-reporting-process

† Calculated for the first dose of RCV (RCV1), among children aged 1 year or, if RCV1 is given at age ≥1 year, among children aged 24 months. Calculated for the second dose of RCV (RCV2) among children at the recommended age for the administration of RCV2, per the national immunization schedule. https://immunizationdata.who.int/

income-related disparities in RCV introduction and coverage at the national level.[§]

Surveillance Activities and Reported Rubella and CRS Incidence

Rubella and CRS surveillance data are reported through eJRF using standard case definitions (*5*). Rubella surveillance relies on the measles surveillance system to detect cases of febrile rash illness. CRS cases are detected through separate surveillance systems, often using a few sentinel sites that might not be nationally representative (*6*). The Global Measles and Rubella Laboratory Network comprises 743 laboratories that conduct measles and rubella case confirmation through serologic and molecular testing. For this report, rubella and CRS surveillance data were reviewed, including the distribution of rubella virus genotypes. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[¶]

Monitoring of Progress Toward Elimination

Progress toward regional goals is measured by the number of countries introducing RCV and the number verified as having eliminated rubella and CRS. The interruption of endemic rubella virus transmission is defined as no ongoing local rubella transmission for ≥12 months. When interruption of transmission is sustained for 36 months, an independent regional verification commission verifies countries as having eliminated rubella (*7*). Data on verification of elimination are available in the Regional Verification Commission reports.[**,††,§§,¶¶,***]

Results

Immunization Activities

In 2022, RCV had been introduced in 175 (90%) of 194 countries,[†††] a 33% increase compared with the 132 (68%) countries that offered RCV in 2012 (Figure 1). All countries in the Region of the Americas (AMR), the European Region (EUR), the South-East Asia Region (SEAR), and the Western Pacific Region (WPR) have introduced RCV. In the two remaining regions, RCV has been introduced in 32 (68%) of 47 countries in the African Region (AFR) and 17 (81%) of 21 countries in the Eastern Mediterranean Region (EMR) (Table).

[§] World Bank publishes annual gross national income classification cutoffs per capita in U.S. dollars. The 2023 fiscal year provides classification data through 2022: high income ≥$13,846; upper-middle income = $4,466–$13,845; lower-middle income = $1,136–$4,465; and low income ≤$1,135. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

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

[**] https://applications.emro.who.int/docs/WHOEMEPI362E-eng.pdf

[††] https://www.who.int/europe/publications/i/item/WHO-EURO-2023-7719-47486-69809

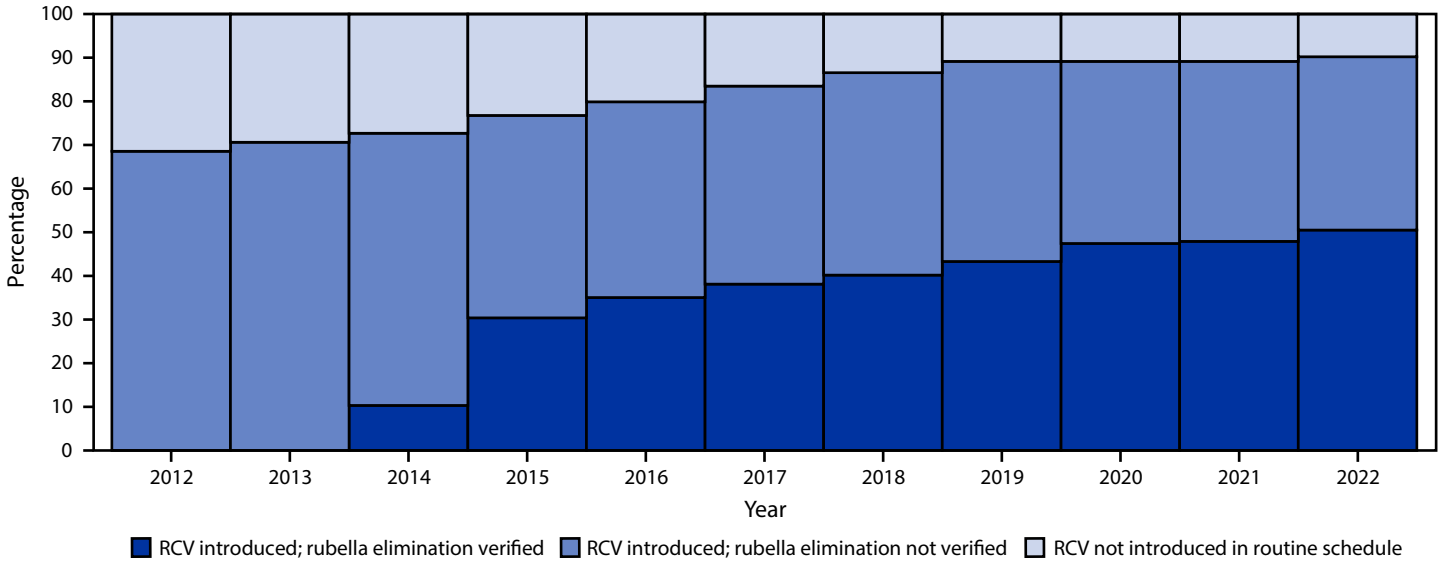
[§§] https://iris.who.int/handle/10665/370787

[¶¶] https://iris.who.int/handle/10665/365590

[***] https://www.paho.org/en/news/29-4-2015-americas-region-declared-worlds-first-eliminate-rubella

[†††] Among the 19 countries that have not yet introduced RCV, four are in EMR (Afghanistan, Djibouti, Somalia, and Sudan) and 15 are in AFR (Central African Republic, Chad, Democratic Republic of the Congo, Equatorial Guinea, Ethiopia, Gabon, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Niger, Nigeria, South Africa, and South Sudan).

FIGURE 1. Percentage of World Health Organization countries that introduced rubella-containing vaccine into the routine immunization schedule and the percentage with verified rubella elimination, by year (N = 194) — worldwide, 2012–2022



Abbreviation: RCV = rubella-containing vaccine.

TABLE. Progress toward control and elimination of rubella and congenital rubella syndrome, by World Health Organization region — worldwide, 2012, 2019, and 2022

Characteristic	WHO region (no. of countries)						
	AFR (47)	AMR (35)	EMR (21)	EUR (53)	SEAR (11)	WPR (27)	Worldwide (194)
Regional rubella or CRS target	Elimination in 80% of countries	Regional elimination	None	Regional elimination	Regional elimination	Regional elimination	**None**
Countries verified eliminated, no. (%)*							
2012	NA	NA	NA	NA	NA	NA	**NA**
2019	NA	35 (100)	NA	45 (91)	NA	4 (15)	**84 (43)**
2022	NA	35 (100)	4 (19)	50 (94)	4 (36)	5 (19)	**98 (51)**
Countries with RCV in schedule, no. (%)							
2012	3 (6)	35 (100)	14 (67)	53 (100)	5 (45)	22 (81)	**132 (68)**
2019	31 (66)	35 (100)	16 (76)	53 (100)	11 (100)	27 (100)	**173 (89)**
2022	32 (68)	35 (100)	17 (81)	53 (100)	11 (100)	27 (100)	**175 (90)**
Regional rubella vaccination coverage, %†							
2012	0	94	36	95	5	86	**40**
2019	32	87	43	96	93	94	**69**
2022	36	84	42	93	92	92	**68**
Countries reporting rubella cases, no. (%)							
2012	38 (81)	34 (97)	18 (86)	45 (85)	11 (100)	20 (74)	**166 (86)**
2019	42 (89)	33 (94)	18 (86)	47 (89)	10 (91)	19 (70)	**169 (87)**
2022	41 (87)	27 (77)	16 (76)	41 (77)	11 (100)	13 (48)	**149 (77)**
Reported rubella cases, no.							
2012	10,751	15	1,490	30,535	6,877	44,148	**93,816**
2019	5,981	25	2,322	627	4,537	35,067	**48,559**
2022	10,021	0	2,678	29	3,728	951	**17,407**
Countries reporting CRS cases, no. (%)							
2012	18 (38)	34 (97)	9 (43)	41 (77)	6 (55)	15 (56)	**123 (63)**
2019	16 (34)	31 (89)	12(57)	40 (75)	7 (64)	17 (63)	**123 (63)**
2022	20 (43)	31 (89)	16 (76)	42 (79)	10 (91)	14 (52)	**133 (69)**
Reported CRS cases, no.							
2012	69	3	20	62	14	133	**301**
2019	9	0	21	8	358	22	**418**
2022	5	0	933	2	554	33	**1,527**

Abbreviations: AFR = African Region; AMR = Region of the Americas; CRS = congenital rubella syndrome; EMR = Eastern Mediterranean Region; EUR = European Region; NA = not available; RCV = rubella-containing vaccine; SEAR = South-East Asia Region; WHO = World Health Organization; WPR = Western Pacific Region.
* Established regional verification commissions verify achievement of elimination in five regions (AMR, EMR, EUR, SEAR, and WPR).
† RCV coverage estimates are determined by WHO and UNICEF Estimates of National Immunization Coverage.

The introduction of RCV within low- and lower-middle–income countries has increased steadily over time (Figure 2). In 2012, RCV had been introduced in only 11% of 36 low-income countries and 50% of 46 lower-middle–income countries; however, by 2022, RCV introduction had increased to include 13 (50%) of 26 low-income countries and 51 (94%) of 54 lower-middle–income countries.

According to the WHO/UNICEF Estimates of National Immunization Coverage, coverage with the first dose of RCV globally among infants increased from 40% in 2012 to 68% in 2022, with wide regional variation (range = 36% [AFR]–93% [EUR]) (Table). In 2022, rubella vaccination coverage was 27% in low-income countries, 70% in lower-middle–income countries, 88% in upper-middle–income countries, and 93% in high-income countries. Excluding those countries that have not yet introduced RCV, 2022 coverage was 82% in low-income countries, 81% in lower-middle–income countries, 86% in upper-middle–income countries, and 94% in high-income countries.

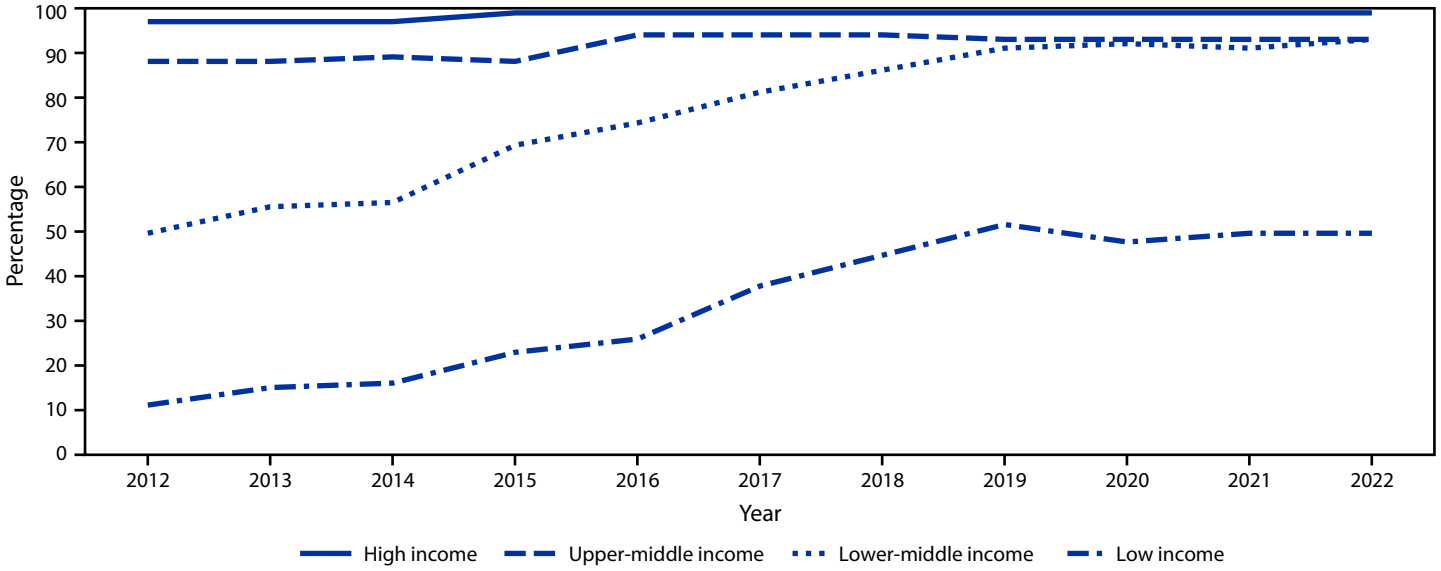
Surveillance Activities and Reported Rubella and CRS Incidence

The number of countries reporting rubella cases, including the reporting of zero cases, increased from 166 (86%) in 2012 to 169 (87%) in 2019. During the COVID-19 pandemic, the number of countries reporting cases declined to 144 (74%) in 2020, and then increased slightly to 149 (77%) in 2022, but overall, remained below 2012 levels (Table). The number of countries reporting CRS cases remained constant at 123 (63%) in 2012 and 2019 but increased to 133 (69%) in 2022.

Compared with the 93,816 rubella cases reported in 2012, reported rubella cases declined 48%, to 48,559 in 2019, and decreased further to 17,407 in 2022 (Table). Reported CRS cases increased from 301 in 2012 to 418 in 2019 and 1,527 in 2022, primarily as the result of initiation of CRS surveillance and reporting in several populous countries (Afghanistan, Bangladesh, India, Indonesia, and Pakistan) since 2012.

During 2012–2022, a total of 5,722 rubella sequences from 45 countries were reported to the Rubella Virus Nucleotide

FIGURE 2. Percentage of World Health Organization countries that have introduced rubella-containing vaccine into the routine immunization schedule, by historical World Bank income group* and year (N = 194) — worldwide, 2012–2022†



* Gross national income per capita in U.S. dollars for 2022: high income ≥$13,846; upper-middle income = $4,466–$13,845; lower-middle income = $1,136–$4,465; and low income ≤$1,135. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups
† In 2022, there were 59 high-income, 49 upper-middle–income, 51 lower-middle–income, 13 low-income, and 22 unclassified countries.

Surveillance database in the Global Measles Rubella Laboratory Network. Among these, 3,295 (58%) were genotype 1E, and 2,395 (42%) were genotype 2B. However, 67% and 24% of the sequences were from China and Japan, respectively, highlighting the need to enhance global virologic surveillance for rubella (Min-hsin Chen, CDC, personal communication, 2024).

Progress Toward Elimination

Five WHO regions now have rubella and CRS regional elimination goals; AFR established a goal in 2021 (*8*). Although EMR has yet to set an elimination goal, the region has committed to achieving elimination (*4*). The AMR commission verified that the entire region had eliminated rubella and CRS in 2015; verification commissions in AFR, EMR, EUR, SEAR, and WPR assess rubella elimination status on a country-by-country basis. The number of countries in which elimination of endemic rubella has been verified has increased from 84 in 2019 to 98 countries in 2022: none in AFR, 35 (100%) in AMR, four (19%) of 21 in EMR, 50 (94%) of 53 in EUR, four (36%) of 11 in SEAR, and five (19%) of 27 in WPR.

Discussion

Rubella elimination has accelerated since 2012; by 2022, elimination had been verified in 51% of the world's countries. During 2019–2022, despite COVID-19 disruptions, 15 countries were verified as having achieved elimination. In addition, rubella elimination has been verified in nearly 25% of lower-middle–income countries, illustrating that rubella can be eliminated in complex socioeconomic circumstances. Furthermore, endemic transmission has not been reestablished in any country that has been verified to have achieved elimination, likely attributable to high vaccine efficacy and lifelong immunity conferred by a single dose of the vaccine and to sustained immunization coverage at levels necessary for herd immunity *(1)*. The increased commitment by countries, regions, and other international stakeholders to eliminate rubella has driven this considerable progress.

Since the onset of the intensified efforts to eliminate rubella in 2012, the number of countries that have introduced RCV and the coverage achieved have both increased substantially.[§§§] From 2012 to 2022, the number of countries that have introduced RCV increased by approximately one third, from 132 to 175, and global RCV immunization coverage increased from 40% to 68%. The pace of vaccine introduction slowed during the COVID-19 pandemic, with only Comoros and Pakistan introducing RCV in 2021. Although the number of low-income and lower-middle–income countries introducing RCV has increased, and the overall number of reported rubella cases has declined 81% during 2012–2022, approximately 25 million infants annually still lack access to RCV, more than one half of them living in low-income, conflict-affected areas.

The increase in reported CRS cases since 2012 reflects an increase in the number of countries conducting CRS surveillance in 2022. Because surveillance for CRS is limited in scope

[§§§] https://doi.org/10.1016/j.ijid.2023.10.012

Summary

What is already known about this topic?

Rubella virus infection during early pregnancy can result in miscarriage, fetal death, or live births with a myriad of physical defects (congenital rubella syndrome). Countries can eliminate rubella.

What is added by this report?

During 2012–2022, the percentage of World Health Organization countries including rubella vaccines in their vaccination schedule increased from 68% to 90%, and the percentage of the world's infants vaccinated against rubella increased from 40% to 68%. From 2013 to 2021, global rubella incidence declined 81%. Enhanced surveillance for congenital rubella syndrome has resulted in increased detection of cases.

What are the implications for public health practice?

Substantial global progress toward rubella elimination has accelerated since 2012; however, the universal introduction of the rubella vaccine is essential in all countries to accelerate progress toward elimination.

within countries and many countries do not conduct CRS surveillance, the number reported in 2022 represents a vast underestimate of the actual number of CRS cases globally. Though modeled estimates of CRS demonstrated a two-thirds reduction in the global burden during 2010–2019, more than 32,000 infants are born with CRS each year, primarily in countries that have not introduced RCV (*9*). With intensified investments, countries that have introduced RCV are likely to eliminate rubella. However, the threat of reintroduction remains until every country has introduced the vaccine (*10*). Therefore, it is essential that every country introduces RCV to achieve global rubella elimination.

Limitations

The findings in this report are subject to at least three limitations. First, ascertaining the accuracy and reliability of surveillance and immunization data remains a challenge, limiting the ability to identify immunity gaps, focus on immunization-strengthening activities, and demonstrate the interruption of rubella virus transmission. Second, during the COVID-19 pandemic, decreased reporting by countries and the quality of surveillance data reported limited the ability to monitor progress during the previous 3 years. Finally, because many countries do not conduct CRS surveillance and because sentinel surveillance only identifies those infants who have access to specialty hospitals for diagnosis and treatment, CRS surveillance is limited in its accuracy.

Implications for Public Health Practice

The 19 countries that have yet to introduce rubella vaccine include approximately 25 million infants, mostly living in settings classified by the World Bank as conflict-affected and low-income.¶¶¶ To redress this equity gap, these countries need support in introducing rubella vaccine. Because of extensive disruptions to routine immunization programs during the COVID-19 pandemic, ensuring all children are up to date with rubella vaccination is essential, especially those who missed vaccination during the pandemic. Additional strategies to immunize adolescents and adults are needed to protect against rubella infection throughout the life course to ensure adults of childbearing age are protected from the risk of having an infant with CRS.

¶¶¶ https://thedocs.worldbank.org/en/doc/608a53dd83f21ef6712b5dfef050b00b-0090082023/original/FCSListFY24-final.pdf

Acknowledgment

Min-hsin Chen, Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, CDC.

Corresponding author: Alan C. Ou, alan.ou@cdc.gov.

[1]Global Immunization Division, Global Health Center, CDC; [2]Department of Immunization, Vaccines, and Biologicals, World Health Organization, Geneva, Switzerland.

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Interim Estimates of 2023–24 Seasonal Influenza Vaccine Effectiveness — United States

Aaron M. Frutos, PhD[1,2]; Ashley M. Price, MPH[1]; Elizabeth Harker, MPH[1]; Emily L. Reeves, MPH[1]; Haris M. Ahmad, MPH[1]; Vel Murugan, PhD[3]; Emily T. Martin, PhD[4]; Stacey House, MD, PhD[5]; Elie A. Saade, MD[6]; Richard K. Zimmerman, MD[7]; Manjusha Gaglani, MBBS[8,9,10]; Karen J. Wernli, PhD[11,12]; Emmanuel B. Walter, MD[13]; Marian G. Michaels, MD[7,14]; Mary A. Staat, MD[15,16]; Geoffrey A. Weinberg, MD[17]; Rangaraj Selvarangan, PhD[18,19]; Julie A. Boom, MD[20,21]; Eileen J. Klein, MD[22]; Natasha B. Halasa, MD[23]; Adit A. Ginde, MD[24]; Kevin W. Gibbs, MD[25]; Yuwei Zhu, MD[23]; Wesley H. Self, MD[23]; Sara Y. Tartof, PhD[12,26]; Nicola P. Klein, MD, PhD[27]; Kristin Dascomb, MD, PhD[28]; Malini B. DeSilva, MD[29]; Zachary A. Weber, PhD[30]; Duck-Hye Yang, PhD[30]; Sarah W. Ball, ScD[30]; Diya Surie, MD[31]; Jennifer DeCuir, MD, PhD[31]; Fatimah S. Dawood, MD[31]; Heidi L. Moline, MD[31]; Ariana P. Toepfer, MPH[31]; Benjamin R. Clopper, MPH[31]; Ruth Link-Gelles, PhD[31]; Amanda B. Payne, PhD[31]; Jessie R. Chung, MPH[1]; Brendan Flannery, PhD[1]; Nathaniel M. Lewis, PhD[1]; Samantha M. Olson, MPH[1]; Katherine Adams, MPH[1]; Mark W. Tenforde, MD, PhD[1]; Shikha Garg, MD[1]; Lisa A. Grohskopf, MD[1]; Carrie Reed, DSc[1]; Sascha Ellington, PhD[1]; CDC Influenza Vaccine Effectiveness Collaborators

Abstract

In the United States, annual influenza vaccination is recommended for all persons aged ≥6 months. Using data from four vaccine effectiveness (VE) networks during the 2023-24 influenza season, interim influenza VE was estimated among patients aged ≥6 months with acute respiratory illness–associated medical encounters using a test-negative case-control study design. Among children and adolescents aged 6 months–17 years, VE against influenza-associated outpatient visits ranged from 59% to 67% and against influenza-associated hospitalization ranged from 52% to 61%. Among adults aged ≥18 years, VE against influenza-associated outpatient visits ranged from 33% to 49% and against hospitalization from 41% to 44%. VE against influenza A ranged from 46% to 59% for children and adolescents and from 27% to 46% for adults across settings. VE against influenza B ranged from 64% to 89% for pediatric patients in outpatient settings and from 60% to 78% for all adults across settings. These findings demonstrate that the 2023–24 seasonal influenza vaccine is effective at reducing the risk for medically attended influenza virus infection. CDC recommends that all persons aged ≥6 months who have not yet been vaccinated this season get vaccinated while influenza circulates locally.

Introduction

CDC's Advisory Committee on Immunization Practices recommends annual influenza vaccination for all persons aged ≥6 months (*1*). During previous influenza seasons, influenza vaccination prevented hundreds of thousands of outpatient medical visits, tens of thousands of hospitalizations, and thousands of deaths from influenza.* During the current influenza season, most influenza viruses detected were influenza A(H1N1)pdm09 viruses with cocirculation of influenza B/Victoria and influenza A(H3N2).† Because circulating seasonal influenza viruses change continuously, influenza vaccines are reviewed biannually and updated as needed. CDC has monitored the effectiveness of annual influenza vaccines against circulating influenza strains since 2004.§ This report provides interim estimates of 2023–24 seasonal influenza vaccine effectiveness (VE) against laboratory-confirmed influenza for children, adolescents, and adults in the outpatient and inpatient settings from active and passive surveillance systems in 22 U.S. states.

Methods

Data Collection

Four analyses including patients who received medical care (outpatient or hospitalization) for acute respiratory illness (ARI) during the 2023–24¶ season were conducted using data from four CDC-affiliated VE networks: 1) Investigating Respiratory Viruses in the Acutely Ill (IVY), 2) New Vaccine Surveillance Network (NVSN), 3) U.S. Flu Vaccine Effectiveness (US Flu VE), and 4) Virtual SARS-CoV-2, Influenza, and Other respiratory viruses Network (VISION). These networks have been previously described (*2*–*5*).

IVY enrolled adult patients admitted to the hospital (Box). NVSN enrolled pediatric patients who received outpatient care** (outpatient clinics, urgent care, and emergency departments), and those admitted to the hospital. US Flu VE enrolled pediatric and adult patients who received outpatient care (outpatient clinics, urgent care, and emergency departments). VISION included pediatric and adult patients who received outpatient care (urgent care and emergency departments), and those admitted to the hospital.

* https://www.cdc.gov/flu/vaccines-work/past-burden-prevented-est.html
† https://www.cdc.gov/flu/weekly/
§ https://www.cdc.gov/flu/vaccines-work/past-seasons-estimates.html
¶ Inclusion dates by network: IVY: September 1, 2023–January 31, 2024; NVSN: October 1, 2023–February 2, 2024; US Flu VE: October 10, 2023–January 24, 2024; VISION: October 15, 2023–January 15, 2024.
** Patients enrolled as outpatients in NVSN might have progressed to a more acute level of care, and those data might not be reflected in this analysis.

BOX. Influenza vaccine effectiveness network characteristics — United States, 2023–2024 influenza season

IVY Network

- **Population:** Adults aged ≥18 years
- **Settings**: No outpatient, inpatient only
- **Type of surveillance**: Active
- **Medical centers included (state)**: Baylor Scott & White Med. Ctr. – Temple (Texas), Baylor Scott & White Health, Baylor Univ. Med. Ctr. (Texas), Baystate Med. Ctr. (Massachusetts), Beth Israel Deaconess Med. Ctr. (Massachusetts), Cleveland Clinic (Ohio), Emory Univ. Med. Ctr. (Georgia), Hennepin County Med. Ctr. (Minnesota), Henry Ford Health (Michigan), Intermountain Med. Ctr. (Utah), Johns Hopkins Hospital (Maryland), Montefiore Med. Ctr. (New York), The Ohio State Univ. Wexner Med. Ctr. (Ohio), Oregon Health & Science Univ. Hospital (Oregon), Stanford Univ. Med. Ctr. (California), UCLA Med. Ctr. (California), Univ. of Colorado Hospital (Colorado), Univ. of Iowa Hospitals (Iowa), Univ. of Miami Med. Ctr. (Florida), Univ. of Michigan Hospital (Michigan), Univ. of Washington (Washington), Vanderbilt Univ. Med. Ctr. (Tennessee), Wake Forest Univ. Baptist Med. Ctr. (North Carolina), Barnes-Jewish Hospital (Missouri), Univ. of Arizona Med. Ctr. (Arizona), and Yale Univ. (Connecticut)
- **Determination of vaccination status**: According primarily to vaccination registries or medical records (i.e., source documentation) and secondarily by self-report (if no source documentation available [<10% of cases])
- **ARI definition**: One or more of the following signs or symptoms: fever, cough, shortness of breath, new hypoxemia, or new pulmonary findings on chest imaging consistent with pneumonia

NVSN

- **Population:** Children and adolescents (aged 6 months–17 years)
- **Settings**: Inpatient and outpatient clinics, urgent care clinics, and EDs
- **Type of surveillance**: Active and passive
- **Medical centers included (state)**: Vanderbilt Univ. Med. Ctr. (Tennessee), Univ. of Rochester Med. Ctr. (New York), Cincinnati Children's Hospital Med. Ctr. (Ohio), Texas Children's Hospital (Texas), Seattle Children's Hospital (Washington), Children's Mercy Hospital (Missouri), and Children's Hospital of Pittsburgh (Pennsylvania)
- **Determination of vaccination status**: State immunization registries, medical records or self-report.
- **ARI definition**: Signs and symptoms of acute respiratory illness (including cough, fever, or other symptoms) within 14 days of illness onset

US Flu VE

- **Population:** Children and adolescents aged 6 months –17 years; adults aged ≥18 years
- **Settings**: Outpatient clinics, urgent care clinics, and EDs; no inpatient
- **Type of surveillance**: Active
- **Medical centers included (state)**: Arizona State Univ. Tempe, Phoenix Children's Hospital, Valleywise Health Med. Ctr. (Arizona), Univ. of Michigan and Henry Ford Health (Michigan), Washington Univ. in St. Louis (Missouri), Univ. Hospitals of Cleveland and Louis Stokes Cleveland Department of Veterans Affairs Med. Ctr. (Ohio), Univ. of Pittsburgh, Univ. of Pittsburgh Med. Ctr. (Pennsylvania), Baylor Scott & White Health – Temple (Texas), and Kaiser Permanente Washington (Washington)
- **Determination of vaccination status**: Medical records or state immunization registries and self-report (Michigan, Missouri, Ohio, Pennsylvania, Texas, and Washington sites); self-report only (Arizona site)
- **ARI definition**: Illness ≤7 days duration with new or worsening cough

VISION

- **Population:** Children and adolescents aged 6 months–17 years; adults aged ≥18 years
- **Inpatient versus outpatient settings**: Inpatient, urgent care clinics, and EDs
- **Type of surveillance**: Passive
- **Medical centers included (state)**: HealthPartners (Minnesota and Wisconsin), Intermountain Health (Utah), Kaiser Permanente Northern California (California), Kaiser Permanente Southern California (California)
- **Determination of vaccination status**: Immunization information systems, electronic health records, claims data
- **ARI definition**: Acute respiratory clinical diagnoses or respiratory signs or symptoms based on ICD-10 codes

Abbreviations: ARI = acute respiratory illness; Ctr. = Center; ED = emergency department; ICD-10 = *International Classification of Diseases, Tenth Revision*; IVY = Investigating Respiratory Viruses in the Acutely Ill Network; Med. = Medical; NVSN = New Vaccine Surveillance Network; Univ. = University; US Flu VE = United States Influenza Vaccine Effectiveness Network; VISION = Virtual SARS-CoV-2, Influenza, and Other respiratory viruses Network.

Data Analysis

Influenza VE was estimated based on a test-negative case-control design using multivariable logistic regression as (1 – adjusted odds ratio) × 100%. Case-patients were those with ARI who received a positive[††] influenza molecular assay test result. Control patients were those with ARI who received a negative influenza molecular assay test result. Patients were considered vaccinated[§§] if they had received ≥1 dose of 2023–24 influenza vaccine ≥14 days before an index date.[¶¶] Patients were excluded[***] if they were vaccinated within 13 days of the index date or received a positive SARS-CoV-2 test result (*6*). VE estimates were calculated for influenza A subtypes A(H1N1)pdm09 and A(H3N2) when possible. If more than one network had a VE estimate for the same age group, influenza type, and setting, VE was reported in the text as a range, from lowest VE point estimate to highest, without CIs.

Logistic regression models were adjusted for geographic region, age, calendar time of illness,[†††] and other prespecified confounders.[§§§] SAS software (version 9.4; SAS Institute) and R (version 4.3; R Foundation) were used to conduct the analyses. IVY, NVSN, and US Flu VE activities were reviewed by CDC, deemed not research, and were conducted consistent with applicable federal law and CDC policy.[¶¶¶] VISION activities were reviewed and approved by the Kaiser Permanente Northern California, Kaiser Permanente Southern California, and Westat institutional review boards.[****]

Results

Vaccination Status Among Control Patients

During the 2023–24 influenza season, the proportion of patients with medically attended ARI who had received influenza vaccine varied by VE network, patient age, and setting. Among pediatric patients, the proportion of vaccinated control patients within the VE networks ranged from 25% to 31% in outpatient settings and from 32% to 41% in the inpatient setting. Among adult control patients aged 18–64 years, 28% to 37% in outpatient and 30% to 34% in inpatient settings were vaccinated; among control patients aged ≥65 years, 62%–68% in outpatient and 48%–60% in inpatient settings were vaccinated.

Pediatric VE

VE against any influenza-associated ARI for children and adolescents aged 6 months–17 years ranged from 59% to 67% in outpatient settings and from 52% to 61% against any influenza-associated hospitalization (Table 1). VE against influenza A ranged from 46% to 59% in outpatient settings and from 46% to 56% against influenza-associated hospitalization. VE against influenza A(H1N1)pdm09 ranged from 54% to 61% in outpatient settings and against influenza-associated hospitalization was 60%. VE against A(H3N2) was 55% in outpatient settings. VE against influenza B ranged from 64% to 89% in outpatient settings.

Adult VE

VE against any influenza-associated ARI for all adults aged ≥18 years ranged from 33% to 49% in outpatient settings and from 41% to 44% against any influenza-associated hospitalization (Table 2). VE against influenza A ranged from 27% to 46% in outpatient settings and from 40% to 42% against influenza-associated hospitalization. VE against influenza A(H1N1)pdm09 was 25% in outpatient settings and 50% against influenza-associated hospitalization. VE against influenza A(H3N2) was 54% in outpatient settings. VE against influenza B was 78% in two networks in outpatient settings and was 60% against influenza-associated hospitalization.

VE against any influenza-associated ARI for adults aged 18–64 years ranged from 25% to 52% in outpatient settings and from 40% to 49% against any influenza-associated hospitalization. VE against any influenza A ranged from 13% to 49% in outpatient settings and from 38% to 42% against influenza-associated hospitalization. VE against influenza B ranged from 75% to 79% in outpatient settings and was 50% against influenza-associated hospitalization.

VE against any influenza-associated ARI for adults aged ≥65 years ranged from 41% to 51% in outpatient settings and in two networks was 42% against any influenza-associated hospitalization. VE against influenza A ranged from 40% to 52% in outpatient settings and from 42% to 47% against influenza-associated hospitalization. VE against influenza B was 69% in outpatient settings.

[††] All influenza case-patients received a positive reverse transcription–polymerase chain reaction test result from a clinical or surveillance respiratory laboratory specimen for IVY, NVSN, and US Flu VE. For VISION, influenza case-patients received a positive molecular assay result from a clinical respiratory laboratory specimen.

[§§] Vaccination status was self- or parent- or guardian-reported or abstracted from medical records, immunization information systems, or claims data.

[¶¶] Index date for IVY, NVSN, and US Flu VE was date of ARI onset. Index date for VISION was the earlier of outpatient visit, hospital admission date, or influenza clinical testing date.

[***] Patients with a positive SARS-CoV-2 test result were excluded in all networks because of the potential for bias from correlated vaccination probabilities. VISION participants with an influenza *International Classification of Diseases, Tenth Revision* (ICD-10) code but without a confirmatory laboratory test result or with COVID-19-related ICD-10 code even in the absence of a positive SARS-CoV-2 test were also excluded.

[†††] IVY used biweekly period of hospital admission. NVSN used month of patient enrollment in the hospital or outpatient setting. US Flu VE used month of illness onset. VISION used calendar date as a natural cubic spline.

[§§§] IVY, US Flu VE, and VISION also adjusted for sex and race and ethnicity. US Flu VE also adjusted for days between illness onset and enrollment and self-reported general health status.

[¶¶¶] 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.

[****] 45 C.F.R. part 46.101(c); 21 C.F.R. part 56.

Discussion

These interim estimates indicate that receipt of 2023–24 influenza vaccination reduced the risk for medically attended influenza-associated outpatient visits and hospitalization among children and adolescents and among adults, including those aged ≥65 years, consistent with results from previous years.[††††] Influenza vaccination was effective against both influenza A (mostly subtype A(H1N1)pdm09) and B (lineage Victoria) viruses that have circulated so far this season, consistent with recent findings from Canada and Europe (*7*,*8*). VE estimates among adults ≥65 years, a group at increased risk for severe illness (*1*), were similar to those among adults aged 18–64 years. These findings support continuing efforts to increase influenza vaccination coverage to prevent influenza

TABLE 1. Number and percentage of children and adolescents aged 6 months–17 years receiving seasonal influenza vaccine, number and percentage with a positive or negative influenza test result, and vaccine effectiveness,* by influenza type† and subtype§ — three networks, United States, 2023–24 influenza season

Network (setting)	Influenza test result by influenza vaccination status, no. vaccinated/No. total (%)		VE (95% CI)¶
	Positive	Negative	
Any influenza			
NVSN** (outpatient††)	123/622 (20)	793/2,577 (31)	59 (48–67)
US Flu VE (outpatient)	29/283 (10)	182/736 (25)	67 (48–80)
VISION (outpatient)	961/6,068 (16)	4,579/15,274 (30)	60 (57–64)
NVSN (inpatient)	29/128 (23)	543/1,321 (41)	61 (40–75)
VISION (inpatient)	21/113 (19)	299/921 (32)	52 (16–72)
Any influenza A			
NVSN (outpatient)	84/411 (20)	793/2,577 (31)	55 (41–66)
US Flu VE (outpatient)	27/212 (13)	182/736 (25)	46 (15–67)
VISION (outpatient)	920/5,524 (17)	4,579/15,274 (30)	59 (55–62)
NVSN (inpatient)	25/102 (25)	543/1,321 (41)	56 (30–73)
VISION (inpatient)	21/105 (20)	299/921 (32)	46 (7–69)
Influenza A(H1N1)pdm09			
NVSN (outpatient)	61/298 (20)	793/2,577 (31)	54 (37–66)
US Flu VE (outpatient)	11/120 (9)	182/736 (25)	61 (26–81)
NVSN (inpatient)	18/79 (23)	543/1,321 (41)	60 (32–77)
Influenza A(H3N2)			
NVSN (outpatient)	19/87 (22)	793/2,577 (31)	55 (20–74)
US Flu VE (outpatient)	2/17 (12)	182/736 (25)	—
NVSN (inpatient)	4/10 (40)	543/1,321 (41)	—
Influenza B			
NVSN (outpatient)	39/216 (18)	793/2,577 (31)	64 (47–75)
US Flu VE (outpatient)	3/76 (4)	182/736 (25)	89 (70–97)
VISION (outpatient)	45/571 (8)	4,579/15,274 (30)	79 (71–85)
NVSN (inpatient)	4/27 (15)	543/1,321 (41)	—
VISION (inpatient)	0/10 (—)	299/921 (32)	—

Abbreviations: NVSN = New Vaccine Surveillance Network; OR = odds ratio; US Flu VE = U.S. Flu Vaccine Effectiveness network; VE = vaccine effectiveness; VISION = Virtual SARS-CoV-2, Influenza, and Other respiratory viruses Network.

* VE was estimated using the test-negative case-control design comparing vaccination odds among persons who had positive test results for influenza with vaccination odds among persons who had negative test results for any influenza and SARS-CoV-2. Calculated as (1 − adjusted OR) × 100%; ORs were estimated using logistic regression. Firth logistic regression was used for NVSN's inpatient estimates.

† Influenza A and B coinfections were included in both influenza A and influenza B VE estimates.

§ Influenza A subtype estimates were not calculated for VISION because of limited subtype data.

¶ All networks adjusted for geographic region, age, and calendar time. US Flu VE and VISION adjusted for sex and race and ethnicity. US Flu VE also adjusted for time since illness onset and self-reported health status. VE estimates with fewer than 50 cases or from models that did not converge are not presented and are indicated with a dash.

** Patients enrolled as outpatients in NVSN might have progressed to a more acute level of care, and those data might not be reflected in this analysis.

†† For NVSN and US Flu VE, outpatient setting is defined as outpatient clinics, urgent care, and emergency departments; for VISION, an outpatient setting is defined as urgent care and emergency departments.

†††† https://www.cdc.gov/flu/vaccines-work/effectiveness-studies.htm

TABLE 2. Number and percentage of adults aged ≥18 years receiving seasonal influenza vaccine, number and percentage with a positive or negative influenza test result, and vaccine effectiveness,* by influenza type† and subtype§ — three networks, United States, 2023–24 influenza season

Network (setting)	Influenza test result by influenza vaccination status, no. vaccinated/No. total (%)		VE (95% CI)¶
	Positive	Negative	
All adults (aged ≥18 years)			
Any influenza			
US Flu VE (outpatient**)	177/568 (31)	803/1,807 (44)	33 (16–47)
VISION (outpatient)	4,501/18,385 (24)	21,356/52,657 (41)	49 (47–51)
IVY (inpatient)	200/632 (32)	1,517/3,872 (39)	44 (32–54)
VISION (inpatient)	728/1,839 (40)	7,425/14,168 (52)	41 (34–47)
Any influenza A			
US Flu VE (outpatient)	168/495 (34)	803/1,807 (44)	27 (9–43)
VISION (outpatient)	4,343/15,896 (27)	21,356/52,657 (41)	46 (44–48)
IVY (inpatient)	80/264 (30)	1,517/3,872 (39)	42 (23–57)
VISION (inpatient)	713/1,742 (41)	7,425/14,168 (52)	40 (33–47)
Influenza A(H1N1)pdm09			
US Flu VE (outpatient)	111/308 (36)	803/1,807 (44)	25 (1–43)
IVY (inpatient)	58/209 (28)	1,517/3,872 (39)	50 (30–64)
Influenza A(H3N2)			
US Flu VE (outpatient)	14/67 (21)	803/1,807 (44)	54 (11–77)
IVY (inpatient)	18/45 (40)	1,517/3,872 (39)	—
Influenza B			
US Flu VE (outpatient)	9/76 (12)	803/1,807 (44)	78 (57–90)
VISION (outpatient)	164/2,530 (6)	21,356/52,657 (41)	78 (74–81)
IVY (inpatient)	5/21 (24)	1,517/3,872 (39)	—
VISION (inpatient)	18/103 (17)	7,425/14,168 (52)	60 (30–77)
Adults (aged 18–64 years)			
Any influenza			
US Flu VE (outpatient)	136/489 (28)	503/1,368 (37)	25 (3–42)
VISION (outpatient)	2,557/14,698 (17)	9,194/33,086 (28)	52 (50–55)
IVY (inpatient)	87/383 (23)	579/1,927 (30)	49 (33–61)
VISION (inpatient)	197/773 (25)	1,367/4,050 (34)	40 (28–50)
Any influenza A			
US Flu VE (outpatient)	128/417 (31)	503/1,368 (37)	13 (−13–34)
VISION (outpatient)	2,425/12,294 (20)	9,194/33,086 (28)	49 (46–51)
IVY (inpatient)	37/156 (24)	579/1,927 (30)	42 (13–61)
VISION (inpatient)	187/694 (27)	1,367/4,050 (34)	38 (24–48)
Influenza B			
US Flu VE (outpatient)	8/75 (11)	503/1,368 (37)	75 (50–89)
VISION (outpatient)	135/2,433 (6)	9,194/33,086 (28)	79 (75–82)
IVY (inpatient)	2/16 (13)	579/1,927 (30)	—
VISION (inpatient)	13/83 (16)	1,367/4,050 (34)	50 (5–74)

See table footnotes on the next page.

TABLE 2. (*Continued*) Number and percentage of adults aged ≥18 years receiving seasonal influenza vaccine, number and percentage with a positive or negative influenza test result, and vaccine effectiveness* by influenza type† and subtype§ — three networks, United States, 2023–24 influenza season

Network (setting)	Influenza test result by influenza vaccination status, no. vaccinated/No. total (%)		VE (95% CI)¶
	Positive	Negative	
Older adults (aged ≥65 years)			
Any influenza			
US Flu VE (outpatient)	41/79 (52)	300/439 (68)	51 (14–72)
VISION (outpatient)	1,944/3,687 (53)	12,162/19,571 (62)	41 (36–45)
IVY (inpatient)	113/249 (45)	938/1,945 (48)	42 (23–56)
VISION (inpatient)	531/1,066 (50)	6,058/10,118 (60)	42 (34–50)
Any influenza A			
US Flu VE (outpatient)	40/78 (51)	300/439 (68)	52 (16–73)
VISION (outpatient)	1,918/3,602 (53)	12,162/19,571 (62)	40 (36–45)
IVY (inpatient)	43/108 (40)	938/1,945 (48)	47 (19–65)
VISION (inpatient)	526/1,048 (50)	6,058/10,118 (60)	42 (34–49)
Influenza B			
US Flu VE (outpatient)	1/1 (100)	300/439 (68)	—
VISION (outpatient)	29/97 (30)	12,162/19,571 (62)	69 (51–80)
IVY (inpatient)	3/5 (60)	938/1,945 (48)	—
VISION (inpatient)	5/20 (25)	6,058/10,118 (60)	—

Abbreviations: IVY = Investigating Respiratory Viruses in the Acutely Ill network; OR = odds ratio; US Flu VE = U.S. Flu Vaccine Effectiveness network; VE = vaccine effectiveness; VISION = Virtual SARS-CoV-2, Influenza, and Other respiratory viruses Network.

* VE was estimated using the test-negative case-control design comparing vaccination odds among persons who had positive test results for influenza with vaccination odds among persons who had negative test results for any influenza and SARS-CoV-2. Calculated as (1 − adjusted OR) × 100%; ORs were estimated using logistic regression.

† Influenza A and B coinfections were included in both influenza A and influenza B VE estimates.

§ Influenza A subtype estimates were not calculated for VISION because of limited subtype data.

¶ All networks adjusted for geographic region, age, and calendar time. IVY, US Flu VE, and VISION, adjusted for sex and race and ethnicity. US Flu VE also adjusted for time since illness onset and self-reported health status. VE estimates with fewer than 50 cases or from models that did not converge are not presented and are indicated with a dash.

** For US Flu VE, outpatient setting is defined as outpatient clinics, urgent care, and emergency departments; for VISION, an outpatient setting is defined as urgent care and emergency departments.

illness and associated hospitalization. Vaccination of persons aged ≥6 months who have not yet been vaccinated this season should continue while influenza viruses are circulating locally.

Influenza vaccination coverage in the United States has been lower this season than in the previous season and also lower than coverage before the COVID-19 pandemic.[§§§§] In the current analyses, fewer than one half of test-negative control patients had received influenza vaccine in all VE networks and among enrollees of most age groups. The public health benefit of annual influenza vaccination depends on both vaccine effectiveness and vaccination coverage. Increased vaccination coverage will maximize prevention of influenza-associated illness, reducing both outpatient visits and hospitalization (*9*,*10*).

This is the first time interim pediatric and adult influenza VE estimates from four major networks have been presented together. Whereas previous interim VE estimates were for outpatient settings only, these analyses include estimates of VE among children and adolescents and among adults across a spectrum of illness severity. These findings are further strengthened by the geographic diversity of the networks, representing patients in 22 U.S. states.

Limitations

The findings in this report are subject to at least four limitations. First, small sample sizes prevented estimation of VE for some age groups and settings. For example, an estimate of VE against influenza A(H3N2) was only possible in outpatient settings. Second, although models were adjusted for potential confounders, the potential for unmeasured confounding remained, such as underlying medical conditions or prior vaccination status. Third, there might be misclassification of vaccination status for networks that used self-reported vaccination data or if vaccine was administered outside of the medical system. Finally, in these analyses, patients who received ≥1 dose of 2023–24 influenza vaccine were considered vaccinated. However, to be considered fully vaccinated for the season, children aged 6 months–8 years are recommended to receive 2 influenza vaccine doses if they have not been previously vaccinated (*1*). Thus, some children classified as vaccinated might have only been partially vaccinated.

Implications for Public Health Practice

Influenza vaccination remains the best way to prevent influenza. These findings provide further evidence of the importance of influenza vaccination in reducing medically attended influenza illness in outpatient and inpatient settings among all age groups. Last year alone, CDC estimates that influenza vaccination prevented about 6 million illnesses, 65,000 hospitalizations, and 3,700 deaths.[¶¶¶¶] These findings support the recommendation for all persons aged ≥6 months to be vaccinated against influenza (*1*).

CDC Influenza Vaccine Effectiveness Collaborators

Adam S. Lauring, University of Michigan; Julie Arndorfer, Intermountain Medical Center; Daniel Bride, Intermountain Medical Center; Ithan D. Peltan, Intermountain Medical Center; Nicholas M. Mohr, University of Iowa; David N. Hager, Johns Hopkins University; Matthew Prekker, Hennepin County Medical Center; Amira Mohamed, Montefiore Medical Center; Nicholas Johnson, University of Washington; Jay Steingrub, Baystate Medical Center; Akram Khan, Oregon Health and Science University; Laurence W. Busse, Emory University; Abhijit Duggal, Cleveland Clinic; Jennifer G. Wilson,

§§§§ https://emergency.cdc.gov/han/2023/han00503.asp

¶¶¶¶ https://www.cdc.gov/flu/about/burden-prevented/2022-2023.htm

Summary

What is already known about this topic?

Influenza vaccines are reviewed biannually and updated as needed. In the United States, annual influenza vaccination is currently recommended for all persons aged ≥6 months.

What is added by this report?

Analysis of data from four vaccine effectiveness (VE) networks estimated interim pediatric influenza VE was 59%–67% in outpatient settings and 52%–61% against influenza-associated hospitalization. Interim adult influenza VE was 33%–49% in outpatient settings and 41%–44% against influenza-associated hospitalization.

What are the implications for public health practice?

These findings indicate that the 2023–24 seasonal influenza vaccine is effective at reducing the risk of influenza-associated outpatient visits and hospitalization. All eligible persons aged ≥6 months should receive annual influenza vaccination.

Stanford University; Nida Qadir, University of California Los Angeles; Christopher Mallow, University of Miami; Jennie H. Kwon, Washington University in St. Louis; Matthew C. Exline, Ohio State University; Nathan I. Shapiro, Beth Israel Deaconess Medical Center; Cristie Columbus, Baylor Scott & White Health and Texas A&M University School of Medicine; Ivana A. Vaughan, Henry Ford Health; Jarrod M. Mosier, University of Arizona; Basmah Safdar, Yale University; Estelle S. Harris, University of Utah; James D. Chappell, Vanderbilt University Medical Center; Laura S. Stewart, Vanderbilt University Medical Center; Sydney A. Swan, Vanderbilt University Medical Center; Pedro A. Piedra, Texas Children's Hospital and Baylor College of Medicine; Leila C. Sahni, Texas Children's Hospital and Baylor College of Medicine; Janet A. Englund, Seattle Children's Research Institute; Danielle M. Zerr, Seattle Children's Research Institute; Robert W. Hickey, UPMC Children's Hospital of Pittsburgh and University of Pittsburgh School of Medicine; John V. Williams, UPMC Children's Hospital of Pittsburgh and University of Pittsburgh School of Medicine; Chelsea Rohlfs, Cincinnati Children's Hospital Medical Center and University of Cincinnati College of Medicine; Elizabeth P. Schlaudecker, Cincinnati Children's Hospital Medical Center and University of Cincinnati College of Medicine; Dinah Dosdos, Children's Mercy Hospital and University of Missouri-Kansas City School of Medicine; Mary E. Moffatt, Children's Mercy Hospital and University of Missouri-Kansas City School of Medicine; Jennifer E. Schuster, Children's Mercy Hospital and University of Missouri-Kansas City School of Medicine; Kirsten Weltmer, Children's Mercy Hospital and University of Missouri-Kansas City School of Medicine; Peter G. Szilagyi, University of Rochester School of Medicine and Dentistry; Tara Curley, Washington University School of Medicine in St. Louis; Jamie Mills, Washington University School of Medicine in St. Louis; Kiran Faryar, University Hospitals of Cleveland; Robert A. Salata, University Hospitals of Cleveland; Krissy Moehling Geffel, University of Pittsburgh School of Medicine; Mary Patricia Nowalk, University of Pittsburgh School of Medicine; Kempapura Murthy, Baylor Scott & White Health; Spencer Rose, Baylor Scott & White Health; Michael E. Smith, Baylor Scott & White Health; Brianna Wickersham, Kaiser Permanente Washington Health Research Institute; Brian D. Williamson, Kaiser Permanente Washington Health Research Institute; Natalie A.B. Bontrager, Duke Human Vaccine Institute; Olivia L. Williams, Duke Human Vaccine Institute; Joanna L. Kramer, Phoenix Children's Hospital; Lora Nordstrom, Valleywise Health Medical Center; Arnold S. Monto, University of Michigan School of Public Health; Ivana A. Vaughn, Henry Ford Health; Monica Dickerson, CDC; Callie McLean, CDC; Emma K. Noble, CDC; Caitlin Ray, CDC; Kelsey Sumner, CDC; Inih Essien, HealthPartners; Linda Fletcher, HealthPartners; Phillip Heaton, HealthPartners; Sheryl Kane, HealthPartners; Charlene McEvoy, HealthPartners; Sunita Thapa, HealthPartners; Gabriela Vazquez-Benitez, HealthPartners; Cassandra Bezi, Kaiser Permanente Southern California; Richard Contreras, Kaiser Permanente Southern California; Gregg S. Davis, Kaiser Permanente Southern California; Bruno J. Lewin, Kaiser Permanente Southern California; Parag Mahale, Kaiser Permanente Southern California; Rudy Patrick, Kaiser Permanente Southern California; Lei Qian, Kaiser Permanente Southern California; Emily Rayens, Kaiser Permanente Southern California; Iris Anne C. Reyes, Kaiser Permanente Southern California; Denison S. Ryan, Kaiser Permanente Southern California; S. Bianca Salas, Kaiser Permanente Southern California; Lina S. Sy, Kaiser Permanente Southern California; Meiyu Yeh, Kaiser Permanente Southern California; Xi Zeng, Kaiser Permanente Southern California; Bruce Fireman, Kaiser Permanente Northern California; Kristin Goddard, Kaiser Permanente Northern California; John Hansen, Kaiser Permanente Northern California; Karen B. Jacobson, Kaiser Permanente Northern California; Julius Timbol, Kaiser Permanente Northern California; Ousseny Zerbo, Kaiser Permanente Northern California; Margaret Dunne; Westat; Yan Zhuang, Westat.

Corresponding author: Aaron M. Frutos, AFrutos@cdc.gov.

[1]Influenza Division, National Center for Immunization and Respiratory Diseases, CDC; [2]Epidemic Intelligence Service, CDC; [3]Biodesign Center for Personalized Diagnostics, Arizona State University, Tempe, Arizona; [4]University of Michigan School of Public Health, Ann Arbor, Michigan; [5]Washington University School of Medicine in St. Louis, St. Louis, Missouri; [6]University Hospitals of Cleveland, Cleveland, Ohio; [7]University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania; [8]Baylor Scott & White Health, Temple, Texas; [9]Baylor College of Medicine, Temple, Texas; [10]Texas A&M University College of Medicine, Temple, Texas; [11]Kaiser Permanente Washington Health Research Institute, Seattle, Washington; [12]Kaiser Permanente Bernard J. Tyson School of Medicine, Pasadena, California; [13]Duke Human Vaccine Institute, Duke University School of Medicine, Durham, North Carolina; [14]UPMC Children's Hospital of Pittsburgh, Pittsburgh, Pennsylvania; [15]University of Cincinnati College of Medicine, Cincinnati, Ohio; [16]Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; [17]University of Rochester School of Medicine and Dentistry, Rochester, New York; [18]University of Missouri-Kansas City School of Medicine, Kansas City, Missouri; [19]Children's Mercy Hospital, Kansas City, Missouri; [20]Baylor College of Medicine, Houston, Texas; [21]Texas Children's Hospital, Houston, Texas; [22]Seattle Children's Research Institute, Seattle, Washington; [23]Vanderbilt University Medical Center, Nashville, Tennessee; [24]University of Colorado School of Medicine, Aurora, Colorado; [25]Wake Forest University School of Medicine, Winston-Salem, North Carolina; [26]Kaiser Permanente Department of Research & Evaluation, Pasadena, California; [27]Kaiser Permanente Vaccine Study Center, Kaiser Permanente Northern California Division of Research, Oakland, California; [28]Division of Infectious Diseases and Clinical Epidemiology, Intermountain Health, Salt Lake City, Utah; [29]HealthPartners Institute, Minneapolis, Minnesota; [30]Westat, Rockville, Maryland; [31]Coronavirus and Other Respiratory Viruses Division, National Center for Immunization and Respiratory Diseases, CDC.

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Interim Influenza Vaccine Effectiveness Against Laboratory-Confirmed Influenza — California, October 2023–January 2024

Sophie Zhu, PhD[1,2]; Joshua Quint, PhD[2]; Tomás M. León, PhD[2]; Monica Sun, MPH[2]; Nancy J. Li, MS[2]; Mark W. Tenforde, MD, PhD[3]; Seema Jain, MD[2]; Robert Schechter, MD[2]; Cora Hoover, MD[2]; Erin L. Murray, PhD[2]

Abstract

Surveillance data can provide rapid, within-season influenza vaccine effectiveness (VE) estimates to guide public health recommendations. Mandatory reporting of influenza vaccine administration to California's immunization information registry began January 1, 2023, and mandatory reporting of all influenza laboratory test results, including negative results, was instituted in California on June 15, 2023. These data, collected by the California Department of Public Health during October 1, 2023–January 31, 2024, were used to calculate interim influenza VE against laboratory-confirmed influenza by comparing the odds of vaccination among case-patients (persons who received a positive influenza laboratory test result) and control patients (those who received a negative influenza laboratory test result). VE was calculated as 1 – adjusted odds ratio using mixed-effects logistic regression, with age, race, and ethnicity as fixed effects and specimen collection week and county as random effects. Overall, during October 1, 2023–January 31, 2024, estimated VE was 45% among persons aged ≥6 months, 56% among children and adolescents aged 6 months–17 years, 48% among adults aged 18–49 years, 36% among those aged 50–64 years, and 30% among those aged ≥65 years. Consistent with some previous influenza seasons, influenza vaccination provided moderate protection against laboratory-confirmed influenza among infants, children, adolescents, and adults. All persons aged ≥6 months without a contraindication to vaccination should receive annual influenza vaccination to reduce influenza illness, severe influenza, and strain on health care resources. Influenza vaccination remains the best way to prevent influenza.

Introduction

Each year in the United States, influenza virus is estimated to cause approximately 9–41 million infections, 140,000–710,000 hospitalizations, and 12,000–52,000 deaths (*1*). Vaccination protects against illness, hospitalization, and death associated with influenza (*2*), and annual influenza vaccination is recommended for all persons aged ≥6 months (*3*). However, effectiveness of seasonal influenza vaccines varies by influenza season, the recipient's age, and other factors (*4*). Mandatory reporting of administration of all influenza vaccine doses to California's immunization information system (IIS) began January 1, 2023. Positive influenza laboratory test results first became reportable in California on October 1, 2019, and negative results became reportable on June 15, 2023.* The California Department of Public Health (CDPH) used these data sources to estimate early influenza season vaccine effectiveness (VE) against laboratory-confirmed influenza during October 2023–January 2024, including by age and influenza type.

Methods

VE against laboratory-confirmed influenza was estimated using a case-control design by comparing the odds of current season influenza vaccination among persons who received a positive influenza test result (test-positive case-patients) and persons who received a negative influenza test result (test-negative control patients). All persons who received testing for influenza using molecular nucleic acid amplification tests at laboratory, hospital, pharmacy, ambulatory, or community-based testing facilities in California during October 1, 2023–January 31, 2024, were eligible for inclusion. Testing and vaccination records were linked using fuzzy matching†; a person who received two influenza laboratory results ≥1 day apart was considered to have had repeat testing. The earliest positive test result was used to identify influenza case-patients, and the earliest negative test result (among persons who never received a positive test result) was used to identify control patients. Results from laboratories that reported predominantly positive influenza test results (≥50%) on a weekly basis were excluded because negative results were considered likely to be underreported. These excluded results represented approximately 5% of total laboratory reports. A person was considered vaccinated if immunization records from California's IIS documented receipt of ≥1 dose of seasonal influenza vaccine ≥14 days before testing during August 1, 2023–January 31, 2024. Persons who were vaccinated <13 days before the test date were excluded. VE against laboratory-confirmed influenza was calculated as 100% × (1 – adjusted odds ratio [aOR]), where the aOR is the odds ratio of vaccination among test-positive case-patients compared with

* https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/Laboratory_Reporting_Letter_COVID_Influenza_RSC_Sept2023_Final.pdf

† California influenza testing and immunization registries were matched using a probabilistic algorithm with exact match for date of birth and fuzzy match with a 95% cutoff on first name, last name, and county of residence.

TABLE 1. Characteristics of persons with and without laboratory-confirmed influenza — California, October 2023–January 2024

Characteristic	Influenza test result, no. (%)		
	Total	Positive	Negative
Total (row %)	**678,422 (100.0)**	77,501 (11.4)	600,921 (88.6)
Median age, yrs (IQR)	**42 (17–66)**	31 (10–52)	44 (19–68)
Race*			
American Indian or Alaska Native	**2,919 (0.4)**	326 (0.4)	2,593 (0.5)
Asian	**53,419 (7.9)**	6,252 (8.1)	47,167 (7.8)
Black or African American	**40,069 (5.9)**	4,033 (5.2)	36,036 (6.0)
Native Hawaiian or other Pacific Islander	**2,878 (0.4)**	300 (0.4)	2,578 (0.4)
White	**301,779 (44.5)**	29,908 (38.5)	271,871 (45.2)
Multiple races	**1,381 (0.2)**	130 (0.2)	1,251 (0.2)
Other	**131,284 (19.4)**	16,098 (20.8)	115,186 (19.2)
Unknown	**144,693 (21.3)**	20,454 (26.4)	124,239 (20.7)
Ethnicity*			
Hispanic or Latino	**159,676 (23.6)**	21,309 (27.4)	138,367 (23.1)
Not Hispanic or Latino	**386,200 (56.9)**	38,653 (49.9)	347,547 (57.8)
Unknown	**132,546 (19.5)**	17,539 (22.7)	115,007 (19.1)
Sex			
Female	**376,814 (55.5)**	41,321 (53.3)	335,493 (55.8)
Male	**301,187 (44.4)**	36,147 (46.7)	265,040 (44.1)
Other	**85 (0)**	2 (0)	83 (0)
Unknown	**336 (0.1)**	31 (0)	305 (0.1)
Influenza type			
A	—	68,716 (88.7)	—
B	—	7,160 (9.2)	—
Unknown	—	1,625 (2.1)	—
Month vaccinated			
Received influenza vaccination	**190,313 (28.1)**	**13,905 (17.9)**	**176,408 (29.3)**
By month of influenza test result			
Oct	**11,073 (13.1)**	93 (6.5)	10,980 (13.2)
Nov	**39,497 (25.3)**	1,357 (12.5)	38,140 (26.3)
Dec	**69,884 (30.1)**	7,104 (17.6)	62,780 (32.7)
Jan	**69,859 (33.9)**	5,351 (21.4)	64,508 (35.6)
Median no. of days from vaccination to test result (IQR)	**68 (43–93)**	76 (54–98)	67 (42–92)
Received high-dose, adjuvanted, or recombinant vaccine, among those aged ≥65 yrs†			
Yes	**74,085 (88.8)**	3,510 (87.4)	70,575 (88.8)
No	**9,408 (11.2)**	503 (12.6)	8,905 (11.2)

* Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic; all racial groups are non-Hispanic.
† CDC's Advisory Committee on Immunization Practices recommends that adults aged ≥65 years receive a high-dose, adjuvanted, or recombinant influenza vaccine.
https://dx.doi.org/10.15585/mmwr.rr7202a1

test-negative control patients, adjusted for potential confounders. Using mixed-effects logistic regression, estimates were adjusted for age, race, and ethnicity as fixed effects; specimen collection week and county of residence were random effects. Separate analyses were conducted to estimate VE by influenza type (A or B) and by age group. All analyses were performed using R software (version 4.3.1; R Foundation). This activity was reviewed by CDPH and CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[§]

Results

During October 1, 2023–January 31, 2024, a total of 678,422 influenza laboratory test results meeting study inclusion criteria were reported to CDPH, including 77,501 (11%) positive and 600,921 (89%) negative test results. The median ages of persons who did and did not receive a positive influenza test result were 31 years (IQR = 10–52 years) and 44 years (IQR = 19–68), respectively (Table 1). Among positive influenza test results, 68,716 (89%) were influenza type A, 7,160 (9%) were type B, and results for 1,625 (2%) specimens were unknown or pending. Overall, 190,313 (28%) persons had documented receipt of the 2023–24 influenza vaccine, including 13,905 (18%) persons who received a positive test result and 176,408 (29%) who received a negative result. Most (74,085 of 83,493; 89%) vaccinated adults aged ≥65 years received a preferentially recommended high-dose, adjuvanted, or recombinant vaccine[¶] (*3*).

[§] 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.

[¶] CDC's Advisory Committee on Immunization Practices recommends that adults aged ≥65 years receive a high-dose, adjuvanted, or recombinant influenza vaccine.

Overall, adjusted VE was 45% against receiving either a positive influenza A or B test result, 42% against receiving a positive influenza A test result, and 76% against receiving a positive influenza B test result (Table 2). VE exhibited an age gradient and was highest among persons aged <18 years (56%), 48% among adults aged 18–49 years, 36% among those aged 50–64 years, and was lowest among adults aged ≥65 years (30%). An age gradient was noted for both influenza A and B, although the VE for persons aged ≥65 years for influenza B (54%) was notably higher than for influenza A (29%).

Discussion

Analysis of state-level California surveillance data from influenza vaccination and laboratory reporting systems indicates that influenza vaccination provided moderate protection against laboratory-confirmed influenza across all age groups during October 2023–January 2024. Influenza immunization has been demonstrated to avert complications and severe outcomes associated with influenza, including illness, hospitalization, and death (*2*,*5*); therefore, annual influenza vaccination is recommended for all persons aged ≥6 months (*3*). Measured influenza VE in this analysis was highest among children and adolescents and lowest among older adults, a finding that has been observed in previous seasons (*6*). This finding suggests that influenza vaccination for adults aged ≥50 years is less effective than among other age groups. Vaccination of adults aged ≥50 years remains a high priority given their increased risk for severe influenza, even if estimated VE is lower for older adults compared with younger persons (*6*).

Influenza vaccination and laboratory reporting requirements allowed for early season California VE estimates using routine surveillance data. Although the outcome of interest in this analysis (positive influenza laboratory test result) is not one used by CDC VE platforms, the results of this study can be interpreted alongside those from established platforms to broaden characterization of VE. In addition, these VE estimates are consistent with current CDC VE estimates and previous season VE calculations of 40%–60% when influenza viruses are well matched to influenza vaccine components.** Integrated community influenza surveillance and immunization data were used to calculate early season VE estimates during the current (2023–24) influenza season in Canada, and this approach might be feasible for jurisdictions that have similar availability of immunization and laboratory surveillance data (*7*).

In-season early VE estimates that reflect protection against any positive influenza test result can complement established methods that estimate VE against other outcomes or in other settings (*8*). For example, during a year when mismatched influenza viruses predominate, knowledge of low VE might support communication surrounding additional protective and treatment measures against influenza (e.g., social distancing, promoting proper cleaning and disinfection procedures, and use of antivirals) when indicated. Preparations in response to low VE might be especially important in hospitals and long-term care facilities, including measures such as active

** https://www.cdc.gov/flu/vaccines-work/vaccineeffect.htm

TABLE 2. Effectiveness of influenza vaccine against laboratory-confirmed influenza — California, October, 2023–January 2024

	Positive		Negative		VE	
Influenza type/Age group, yrs	**Total**	**No. (%) vaccinated**	**Total**	**No. (%) vaccinated**	**Unadjusted % (95% CI)**	**Adjusted* % (95% CI)**
Influenza A and B†						
Total	**75,876**	**13,629 (18)**	**600,921**	**176,408 (29)**	**47 (46–48)**	**45 (44–46)**
<18	**28,914**	3,744 (13)	147,047	32,791 (22)	48 (46–50)	56 (54–57)
18–49	**26,435**	3,334 (13)	189,129	36,171 (19)	39 (36–41)	48 (46–50)
50–64	**10,861**	2,575 (24)	96,148	28,579 (30)	27 (23–30)	36 (33–39)
≥65	**9,666**	3,976 (41)	168,597	78,867 (47)	21 (18–24)	30 (27–33)
Influenza A						
Total	**68,716**	**13,118 (19)**	**600,921**	**176,408 (29)**	**43 (42–44)**	**42 (41–43)**
<18	**25,393**	3,517 (14)	147,047	32,791 (22)	44 (42–46)	52 (51–53)
18–49	**23,257**	3,136 (14)	189,129	36,171 (19)	34 (31–36)	44 (42–46)
50–64	**10,546**	2,532 (24)	96,148	28,579 (30)	25 (22–29)	35 (32–38)
≥65	**9,520**	3,933 (41)	168,597	78,867 (47)	20 (17–24)	29 (26–32)
Influenza B						
Total	**7,160**	**511 (7)**	**600,921**	**176,408 (29)**	**82 (80–83)**	**76 (73–78)**
<18	**3,521**	227 (6)	147,047	32,791 (22)	76 (73–79)	79 (76–82)
18–49	**3,178**	198 (6)	189,129	36,171 (19)	72 (68–76)	75 (71–75)
50–64	**315**	43 (14)	96,148	28,579 (30)	63 (49–73)	67 (55–76)
≥65	**146**	43 (29)	168,597	78,867 (47)	53 (33–67)	54 (34–67)

Abbreviation: VE = vaccine effectiveness.

* Adjusted for age (using natural cubic spline interpolation), race, and ethnicity as fixed effects and specimen collection week and county of residence as random effects, using mixed effects logistic regression.

† VE for unknown influenza types was not calculated because of small sample size, and unknown influenza type results were excluded from overall influenza A and B VE estimation.

Summary

What is already known about this topic?

Influenza vaccine effectiveness (VE) is determined using multiple platforms and varies from year to year.

What is added by this report?

Using timely surveillance data from mandatory influenza laboratory surveillance and the immunization registry in California, investigators estimated that VE for laboratory-confirmed influenza during October 2023–January 2024 was 45%. VE was highest among persons aged <18 years (56%) and declined with age to 30% among adults aged ≥65 years.

What are the implications for public health practice?

Mandatory reporting requirements of laboratory surveillance and vaccination data allow for early season VE estimates while seasonal influenza viruses are circulating. Influenza vaccination remains the best way to prevent influenza, and vaccination is recommended for all persons aged ≥6 months.

surveillance for acute respiratory illness among residents and limiting personal contact (*9*). Earlier interim VE estimates might also help guide midseason disease forecasting by providing timely updates of a critical modeling parameter.

Limitations

The findings in this report are subject to at least seven limitations. First, 2023 was the first year during which reporting of negative influenza test results to CDPH and influenza vaccination to a centralized IIS was mandated. This limitation might have resulted in incomplete reporting and potential bias in observed VE. Second, it was not possible to determine whether infants and children aged <9 years, for whom 2 doses of seasonal influenza vaccine are recommended during their first influenza season (*5*), were fully or partially vaccinated. Third, accompanying symptom information was not available for any influenza laboratory results to differentiate VE against asymptomatic infection or symptomatic illness. Estimates might be biased if characteristics of persons who were tested and those who were not differ. Fourth, information on testing setting (e.g., outpatient, inpatient, or intensive care unit) and illness severity was not available to measure VE for specific outcomes (e.g., hospitalization or death). Fifth, these findings are limited to California and might not be generalizable across the entire United States; multiple influenza viruses circulate, and the proportion of circulating viruses and testing practices by area might differ, as might VE against each influenza virus type or subtype. Sixth, subtype information was not available to estimate VE against influenza A(H1N1)pdm09 and A(H3N2) viruses, though >80% of influenza A strains characterized this season at California public health laboratories are H1N1(pdm09), similar to national data.[††] Finally, other sources of confounding and bias were not assessed, including the presence of preexisting conditions in the study population that might affect the likelihood of severe influenza, propensity to seek health care and influenza testing, or influenza vaccination behaviors that are differential with respect to infection status (*10*).

Implications for Public Health Practice

Surveillance data can be used to calculate interim VE quickly and efficiently at the state level. Early VE estimates might allow for more timely public health action for influenza prevention and treatment recommendations. Interim VE estimates from this analysis indicate that the current seasonal influenza vaccine protects against receipt of a positive influenza laboratory test result among persons aged ≥6 months. Annual influenza vaccination is recommended for all persons aged ≥6 months to prevent illness and adverse complications associated with influenza. Influenza vaccination remains the best way to prevent influenza.

[††] https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/Immunization/Week2023-2407_FINALReport.pdf

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Timothy Lo, Celeste Romano, California Department of Public Health Immunization Branch; Jessie Chung, Sascha Ellington, National Center for Immunization and Respiratory Diseases, CDC.

Corresponding author: Sophie Zhu, uri0@cdc.gov.

[1]Epidemic Intelligence Service, CDC; [2]California Department of Public Health; [3]Influenza Division, National Center for Immunization and Respiratory Diseases, CDC.

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Interim Effectiveness of Updated 2023–2024 (Monovalent XBB.1.5) COVID-19 Vaccines Against COVID-19–Associated Emergency Department and Urgent Care Encounters and Hospitalization Among Immunocompetent Adults Aged ≥18 Years — VISION and IVY Networks, September 2023–January 2024

Jennifer DeCuir, MD, PhD[1]; Amanda B. Payne, PhD[1]; Wesley H. Self, MD[2]; Elizabeth A.K. Rowley, DrPH[3]; Kristin Dascomb, MD, PhD[4]; Malini B. DeSilva, MD[5]; Stephanie A. Irving, MHS[6]; Shaun J. Grannis, MD[7,8]; Toan C. Ong, PhD[9]; Nicola P. Klein, MD, PhD[10]; Zachary A. Weber, PhD[3]; Sarah E. Reese, PhD[3]; Sarah W. Ball, ScD[3]; Michelle A. Barron[9]; Allison L. Naleway, PhD[6]; Brian E. Dixon, PhD[7,8]; Inih Essien, OD[5]; Daniel Bride, MS[4]; Karthik Natarajan, PhD[11,12]; Bruce Fireman[10]; Ami B. Shah, MPH[1,13]; Erica Okwuazi, MSc[1,13]; Ryan Wiegand, PhD[1]; Yuwei Zhu, MD[2]; Adam S. Lauring, MD, PhD[14]; Emily T. Martin, PhD[14]; Manjusha Gaglani, MBBS[15,16]; Ithan D. Peltan, MD[17,18]; Samuel M. Brown, MD[17,18]; Adit A. Ginde, MD[9]; Nicholas M. Mohr, MD[19]; Kevin W. Gibbs, MD[20]; David N. Hager, MD, PhD[21]; Matthew Prekker, MD[22]; Amira Mohamed, MD[23]; Vasisht Srinivasan, MD[24]; Jay S. Steingrub, MD[25]; Akram Khan, MD[26]; Laurence W. Busse, MD[27]; Abhijit Duggal, MD[28]; Jennifer G. Wilson, MD[29]; Steven Y. Chang, MD, PhD[30]; Christopher Mallow, MD[31]; Jennie H. Kwon, DO[32]; Matthew C. Exline, MD[33]; Cristie Columbus, MD[15,34]; Ivana A. Vaughn, PhD[35]; Basmah Safdar, MD[36]; Jarrod M. Mosier, MD[37]; Estelle S. Harris, MD[18]; Jonathan D. Casey, MD[2]; James D. Chappell, MD, PhD[2]; Carlos G. Grijalva, MD[2]; Sydney A. Swan[2]; Cassandra Johnson, MS[2]; Nathaniel M. Lewis, PhD[38]; Sascha Ellington, PhD[38]; Katherine Adams, MPH[38]; Mark W. Tenforde, MD, PhD[38]; Clinton R. Paden, PhD[1]; Fatimah S. Dawood, MD[1]; Katherine E. Fleming-Dutra, MD[1]; Diya Surie, MD[1]; Ruth Link-Gelles, PhD[1]; CDC COVID-19 Vaccine Effectiveness Collaborators

Abstract

In September 2023, CDC's Advisory Committee on Immunization Practices recommended updated 2023–2024 (monovalent XBB.1.5) COVID-19 vaccination for all persons aged ≥6 months to prevent COVID-19, including severe disease. However, few estimates of updated vaccine effectiveness (VE) against medically attended illness are available. This analysis evaluated VE of an updated COVID-19 vaccine dose against COVID-19–associated emergency department (ED) or urgent care (UC) encounters and hospitalization among immunocompetent adults aged ≥18 years during September 2023–January 2024 using a test-negative, case-control design with data from two CDC VE networks. VE against COVID-19–associated ED/UC encounters was 51% (95% CI = 47%–54%) during the first 7–59 days after an updated dose and 39% (95% CI = 33%–45%) during the 60–119 days after an updated dose. VE estimates against COVID-19–associated hospitalization from two CDC VE networks were 52% (95% CI = 47%–57%) and 43% (95% CI = 27%–56%), with a median interval from updated dose of 42 and 47 days, respectively. Updated COVID-19 vaccine provided increased protection against COVID-19–associated ED/UC encounters and hospitalization among immunocompetent adults. These results support CDC recommendations for updated 2023–2024 COVID-19 vaccination. All persons aged ≥6 months should receive updated 2023–2024 COVID-19 vaccine.

Introduction

On September 12, 2023, CDC's Advisory Committee on Immunization Practices recommended updated 2023–2024 COVID-19 vaccination with a monovalent XBB.1.5–derived vaccine for all persons aged ≥6 months to prevent COVID-19, including severe disease (*1*). Although 1 updated vaccine dose is recommended for most persons aged ≥5 years, vaccination coverage with updated vaccines has remained low,* including among those at highest risk for severe disease, such as adults aged ≥65 years. Thousands of persons in the United States continue to be hospitalized with COVID-19 each week, including approximately 31,000 during January 7–13, 2024, despite endemicity and increased population immunity to SARS-CoV-2.† This analysis estimated updated COVID-19 vaccine effectiveness (VE) during September 2023–January 2024§ among immunocompetent adults aged ≥18 years against COVID-19–associated emergency department (ED) or urgent care (UC) encounters in one CDC VE network and VE against COVID-19–associated hospitalization in two CDC VE networks.

Methods

Data Collection

Methods for Virtual SARS-CoV-2, Influenza, and Other respiratory viruses Network (VISION) and Investigating Respiratory Viruses in the Acutely Ill (IVY) VE analyses have been described (*2*,*3*). VISION is a multisite, electronic health records (EHR)–based network including 369 EDs and UCs and 229 hospitals in eight states¶ that uses a test-negative,

* https://www.cdc.gov/vaccines/imz-managers/coverage/covidvaxview/interactive/adult-coverage-vaccination.html

† https://covid.cdc.gov/covid-data-tracker/#datatracker-home (Accessed February 13, 2024).

§ The VISION analysis included ED/UC encounters and hospitalizations during September 21, 2023–January 9, 2024. The IVY analysis included hospitalized patients admitted during September 21, 2023–January 31, 2024.

¶ Sites from the CDC-funded VISION network that contributed data for this analysis were HealthPartners (Minnesota and Wisconsin), Intermountain Healthcare (Utah), Kaiser Permanente Northern California (California), Kaiser Permanente Northwest (Oregon and Washington), Regenstrief Institute (Indiana), and University of Colorado (Colorado).

case-control design to estimate COVID-19 VE. Eligible patients must receive molecular testing (e.g., real-time reverse transcription–polymerase chain reaction [RT-PCR] testing) for SARS-CoV-2 during the 10 days preceding or up to 72 hours after a COVID-19–associated ED/UC encounter or hospital admission.** COVID-19 vaccination history is ascertained from state or jurisdictional registries, EHRs, and, in a subset of sites, medical claims data.

IVY is a multisite, inpatient network including 26 hospitals in 20 U.S. states†† that uses a test-negative, case-control design to prospectively enroll patients with COVID-19–like illness (CLI)§§ who receive testing for SARS-CoV-2 within 10 days of illness onset and 3 days of hospital admission. Nasal swabs are collected for central RT-PCR testing for SARS-CoV-2 at Vanderbilt University Medical Center (Nashville, Tennessee), and SARS-CoV-2–positive specimens are sent to the University of Michigan (Ann Arbor, Michigan) for whole genome sequencing to identify SARS-CoV-2 lineages. Demographic and clinical data are collected through EHR review and patient or proxy interview. COVID-19 vaccination history is ascertained from state or jurisdictional registries, EHRs, and self-report.

Data Analysis

The VISION and IVY networks conducted separate VE analyses. In both analyses, immunocompetent adults aged ≥18 years who 1) had a medical encounter at an ED/UC (VISION only) or 2) were hospitalized (VISION and IVY) at a participating facility with CLI were included. Case-patients were those who received a positive SARS-CoV-2 molecular test result, and control patients were those who received a negative SARS-CoV-2 test result.¶¶ Participants were excluded if they 1) received a COVID-19 vaccine dose <7 days before their eligible ED/UC encounter or hospitalization; 2) received an updated COVID-19 vaccine dose <2 months after receiving a previous COVID-19 vaccine dose (to align with current Advisory Committee on Immunization Practices recommendations); 3) received a bivalent COVID-19 vaccine dose after September 10, 2023; 4) received an updated COVID-19 vaccine dose before September 13, 2023; or 5) received >1 updated COVID-19 vaccine dose.*** Case-patients were also excluded if they had received a positive influenza or respiratory syncytial virus (RSV) molecular test result at the time of their CLI encounter.††† Because of potential confounding caused by the association between COVID-19 and influenza vaccination behaviors, control patients who received positive or indeterminant influenza test results were excluded from the primary analysis§§§ (*4*). A sensitivity analysis including these control patients was also conducted.

Odds ratios (ORs) and 95% CIs were estimated using multivariable logistic regression comparing persons who received an updated COVID-19 vaccine dose with those who did not, irrespective of the number of previous original or bivalent COVID-19 vaccine doses received (if any), among case-patients and control patients. VE models were adjusted

** COVID-19–like illness diagnoses were obtained from *International Classification of Diseases, Tenth Revision* (ICD-10) discharge codes. The specific codes used were COVID-19 pneumonia: J12.81 and J12.82; influenza pneumonia: J09.X1, J10.0, J10.00, J10.01, J10.08, J11.0, J11.00, and J11.08; other viral pneumonia: J12*; bacterial and other pneumonia: J13, J14, J15*, J16*, J17, and J18*; influenza disease: J09*, J10.1, J10.2, J10.8*, J11.1, J11.2, and J11.8*; acute respiratory distress syndrome: J80; chronic obstructive pulmonary disease with acute exacerbation: J44.1; asthma acute exacerbation: J45.21, J45.22, J45.31, J45.32, J45.41, J45.42, J45.51, J45.52, J45.901, and J45.902; respiratory failure: J96.0*, J96.2*, and R09.2; other acute lower respiratory tract infections: J20*, J21*, J22, J40, J44.0, J41*, J42, J43*, J47*, J85, J85.0, J85.1, J85.2, J85.3, and J86*; acute and chronic sinusitis: J01* and J32*; acute upper respiratory tract infections: J00*, J02*, J03*, J04*, J05*, and J06*; acute respiratory illness signs and symptoms: R04.2, R05, R05.1, R05.2, R05.4, R05.8, R05.9, R06.00, R06.02, R06.03, R06.1, R06.2, R06.8, R06.81, R06.82, R06.89, R07.1, R09.0*, R09.1, R09.2, R09.3, and R09.8*; acute febrile illness signs and symptoms: R50*, R50.81, and R68.83; acute nonrespiratory illness signs and symptoms: M79.10, M79.18, R10.0, R10.1*, R10.2, R10.3*, R10.81*, R10.84, R10.9, R11.0, R11.10, R11.11, R11.15, R11.2, R19.7, R21*, R40.0, R40.1,R41.82, R43*, R51.9, R53.1, R53.81, R53.83, R57.9, and R65*; respiratory failure, unspecified: J96.9*; febrile convulsions: R56.0; viral and respiratory diseases complicating pregnancy, childbirth, and puerperium: O98.5*, O98.8*, O98.9*, and O99.5*. All ICD-10 codes with * include all child codes under the specific parent code. One VISION site, representing 19% of case-patients from VISION analyses, did not include the following codes in its definition: J96.9*, O98.5*, O98.8*, O98.9*, O99.5*, and R56.0.

†† Sites from the CDC-funded IVY network that contributed data for this analysis were Barnes-Jewish Hospital (St. Louis, Missouri), Baylor Scott & White Medical Center (Temple, Texas), Baylor University Medical Center (Dallas, Texas), Baystate Medical Center (Springfield, Massachusetts), Beth Israel Deaconess Medical Center (Boston, Massachusetts), Cleveland Clinic (Cleveland, Ohio), Emory University Medical Center (Atlanta, Georgia), Hennepin County Medical Center (Minneapolis, Minnesota), Henry Ford Health (Detroit, Michigan), Intermountain Medical Center (Murray, Utah), Johns Hopkins Hospital (Baltimore, Maryland), Montefiore Medical Center (New York, New York), Oregon Health & Science University Hospital (Portland, Oregon), Ronald Reagan UCLA Medical Center (Los Angeles, California), Stanford University Medical Center (Stanford, California), The Ohio State University Wexner Medical Center (Columbus, Ohio), UCHealth University of Colorado Hospital (Aurora, Colorado), University of Arizona Medical Center (Tucson, Arizona), University of Iowa Hospitals (Iowa City, Iowa), University of Miami Medical Center (Miami, Florida), University of Michigan Hospital (Ann Arbor, Michigan), University of Utah (Salt Lake City, Utah), University of Washington (Seattle, Washington), Vanderbilt University Medical Center (Nashville, Tennessee), Wake Forest University Baptist Medical Center (Winston-Salem, North Carolina), and Yale University (New Haven, Connecticut).

§§ In the IVY analysis, CLI was defined as one or more of the following signs and symptoms: fever, cough, shortness of breath, new or worsening findings on chest imaging consistent with pneumonia, or hypoxemia defined as SpO2 <92% on room air or supplemental oxygen to maintain SpO2 ≥92%. For patients on chronic oxygen therapy, hypoxemia was defined as SpO2 below baseline or an escalation of supplemental oxygen to maintain a baseline SpO2.

¶¶ In the IVY analysis, patients were also classified as case-patients if they received a positive SARS-CoV-2 antigen test result.

*** In the IVY analysis, patients were also excluded if they experienced illness onset after hospital admission or withdrew.

††† One VISION site, representing 19% of case-patients from VISION analyses, did not provide RSV test results; therefore, RSV coinfections could not be excluded from this site.

§§§ In the IVY analysis, patients with missing influenza test results were also excluded.

for age, sex, race and ethnicity, calendar time, and geographic region.¶¶¶ VE was calculated as (1 – adjusted OR) × 100%. In the VISION network, VE was estimated for adults aged ≥18 years and by age group (18–64 and ≥65 years). In the IVY network, statistical power was limited among younger adults because of lower vaccination coverage and fewer COVID-19–associated hospitalizations among persons aged 18–64 years; therefore, VE against hospitalization was estimated only for adults aged ≥18 years and ≥65 years.

Analyses were conducted using R software (version 4.3.2; R Foundation) for the VISION analysis and SAS software (version 9.4; SAS Institute) for the IVY analysis. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.**** This activity was reviewed and approved as a research activity by one VISION site.

Results

Updated COVID-19 VE Against COVID-19–Associated ED/UC Encounters, VISION Network

Among adults aged ≥18 years in the VISION network, 128,825 ED/UC encounters met inclusion criteria, including 17,229 case-patients and 111,596 control patients (Table 1). A total of 1,297 (8%) case-patients and 13,378 (12%) control patients had received an updated COVID-19 vaccine dose. VE against COVID-19–associated ED/UC encounters was 51% (95% CI = 47%–54%) in the first 7–59 days after an updated dose (median interval since updated dose = 33 days) and 39% (95% CI = 33%–45%) in the 60–119 days after an updated dose (median interval since updated dose = 74 days) (Table 2). Among adults aged 18-64 years, VE against COVID-19–associated ED/UC encounters was 52% (95% CI = 45%–58%) in the first 7–59 days after an updated dose (median interval since updated dose = 31 days) and 45% (95% CI = 34%–55%) in the 60–119 days after an updated dose (median interval since updated dose = 73 days). Among adults aged ≥65 years, VE against COVID-19–associated ED/UC encounters was 49% (95% CI = 44%–54%) in the first 7–59 days after an updated dose (median interval since updated dose = 33 days) and 37% (95% CI = 29%–44%) in the 60–119 days after an updated dose (median interval since updated dose = 74 days).

¶¶¶ VISION regression models were adjusted for age, sex, race and ethnicity, calendar day, and geographic region with age and calendar day included as natural cubic splines. IVY regression models were adjusted for age, sex, race and ethnicity, calendar time in biweekly intervals, and U.S. Department of Health and Human Services region.

**** 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.

Updated COVID-19 VE Against COVID-19–Associated Hospitalization, VISION and IVY Networks

VISION network. Among adults aged ≥18 years in the VISION network, 37,503 hospitalizations met criteria for inclusion in analyses, including 4,589 case-patients and 32,914 control patients (Table 3). A total of 395 (9%) case-patients and 4,199 (13%) control patients had received an updated COVID-19 vaccine dose. VE against COVID-19–associated hospitalization was 53% (95% CI = 46%–59%) in the first 7–59 days after an updated dose (median interval since updated dose = 32 days) and 50% (95% CI = 40%–59%) in the 60–119 days after an updated dose (median interval since updated dose = 73 days). Among patients aged ≥65 years, VE against COVID-19–associated hospitalization was 54% (95% CI = 47%–60%) in the first 7–59 days after an updated dose (median interval since updated dose = 32 days) and 50% (95% CI = 39%–59%) in the 60–119 days after an updated dose (median interval since updated dose = 73 days).

IVY network. Among adults aged ≥18 years in the IVY network, 4,117 met criteria for inclusion in analyses, including 1,194 case-patients and 2,923 control patients. A total of 94 (8%) case-patients and 353 (12%) control patients had received an updated COVID-19 vaccine dose. VE of an updated dose against COVID-19–associated hospitalization was 43% (95% CI = 27%–56%, median interval since updated dose = 47 days) among adults aged ≥18 years and 48% (95% CI = 31%–61%, median interval since updated dose = 48 days) among adults aged ≥65 years.

Including control patients who received positive or indeterminant influenza test results added 1,819 control patients to the VISION hospitalization analysis and including control patients who received positive or indeterminant influenza test results or had missing influenza test results added 511 control patients to the IVY hospitalization analysis (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/148434). VE estimates in supplementary analyses including control patients who received positive or indeterminant influenza test results did not differ meaningfully from those in the main analyses for ED/UC encounters (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/148435) or hospitalization (Supplementary Table 3, https://stacks.cdc.gov/view/cdc/148436).

Whole genome sequencing data were available for SARS-CoV-2–positive specimens collected in the IVY network during September 21–December 15, 2023. Among 952 sequenced specimens, 154 (16%) had XBB.1.5–like spike proteins, 550 (58%) had EG.5–like spike proteins with an F456L substitution compared with XBB.1.5, 189 (20%)

TABLE 1. Characteristics of emergency department or urgent care encounters and hospitalizations among immunocompetent adults aged ≥18 years with COVID-19–like illness, by SARS-CoV-2 test result status and CDC vaccine effectiveness network — VISION and IVY networks, September 2023–January 2024

Characteristic	VE network, no. (column %)					
	VISION			IVY		
	Total no. of patients	COVID-19 case-patients	COVID-19 control patients	Total no. of patients	COVID-19 case-patients	COVID-19 control patients
All ED/UC encounters	**128,825**	**17,229**	**111,596**	—	—	—
COVID-19 vaccination status						
No updated dose*	**114,150 (89)**	15,932 (92)	98,218 (88)	—	—	—
Updated dose, ≥7 days earlier	**14,675 (11)**	1,297 (8)	13,378 (12)	—	—	—
Updated dose, 7–59 days earlier	**10,197 (8)**	825 (5)	9,372 (8)	—	—	—
Updated dose, 60–119 days earlier	**4,478 (3)**	472 (3)	4,006 (4)	—	—	—
Median age, yrs (IQR)	**52 (34–71)**	54 (35–72)	52 (33–70)	—	—	—
Age group, yrs						
18–64	**85,121 (66)**	10,959 (64)	74,162 (66)	—	—	—
≥65	**43,704 (34)**	6,270 (36)	37,434 (34)	—	—	—
Female sex	**78,702 (61)**	10,292 (60)	68,410 (61)	—	—	—
Race and ethnicity						
Black or African American, NH	**13,252 (10)**	1,425 (8)	11,827 (11)	—	—	—
White, NH	**81,818 (64)**	11,594 (67)	70,224 (63)	—	—	—
Hispanic or Latino, any race	**18,664 (14)**	2,316 (13)	16,348 (15)	—	—	—
Other, NH†	**12,782 (10)**	1,590 (9)	11,192 (10)	—	—	—
Unknown§	**2,309 (2)**	304 (2)	2,005 (2)	—	—	—
HHS region¶						
1	**0 (—)**	0 (—)	0 (—)	—	—	—
2	**0 (—)**	0 (—)	0 (—)	—	—	—
3	**0 (—)**	0 (—)	0 (—)	—	—	—
4	**0 (—)**	0 (—)	0 (—)	—	—	—
5	**45,232 (35)**	5,907 (34)	39,325 (35)	—	—	—
6	**0 (—)**	0 (—)	0 (—)	—	—	—
7	**0 (—)**	0 (—)	0 (—)	—	—	—
8	**37,173 (29)**	7,466 (43)	29,707 (27)	—	—	—
9	**37,346 (29)**	2,829 (16)	34,517 (31)	—	—	—
10	**9,074 (7)**	1,027 (6)	8,047 (7)	—	—	—
No. of chronic medical condition categories**						
0	**93,347 (72)**	13,540 (79)	79,807 (72)	—	—	—
1	**25,509 (20)**	2,542 (15)	22,967 (21)	—	—	—
2	**6,619 (5)**	814 (5)	5,805 (5)	—	—	—
3	**2,439 (2)**	230 (1)	2,209 (2)	—	—	—
4	**720 (1)**	84 (<1)	636 (1)	—	—	—
≥5	**191 (<1)**	19 (<1)	172 (<1)	—	—	—
Month of COVID-19–associated ED/UC encounter						
Sep 2023	**9,787 (8)**	1,222 (7)	8,565 (8)	—	—	—
Oct 2023	**29,836 (23)**	3,521 (20)	26,315 (24)	—	—	—
Nov 2023	**33,988 (26)**	4,487 (26)	29,501 (26)	—	—	—
Dec 2023	**42,403 (33)**	6,289 (37)	36,114 (32)	—	—	—
Jan 2024	**12,811 (10)**	1,710 (10)	11,101 (10)	—	—	—
SARS-CoV-2 JN.1 lineage predominant period††	**24,923 (19)**	3,597 (21)	21,326 (19)	—	—	—
All hospitalizations	**37,503**	**4,589**	**32,914**	**4,117**	**1,194**	**2,923**
COVID-19 vaccination status						
No updated dose*	**32,909 (88)**	4,194 (91)	28,715 (87)	**3,670 (89)**	1,100 (92)	2,570 (88)
Updated dose, ≥7 days earlier	**4,594 (12)**	395 (9)	4,199 (13)	**447 (11)**	94 (8)	353 (12)
Updated dose, 7–59 days earlier	**3,326 (9)**	270 (6)	3,056 (9)	**283 (7)**	57 (5)	226 (8)
Updated dose, 60–119 days earlier	**1,268 (3)**	125 (3)	1,143 (3)	**164 (4)**	37 (3)	127 (4)
Median age, yrs (IQR)	**71 (59–81)**	77 (67–84)	71 (58–81)	**68 (55–78)**	73 (61–82)	66 (53–76)
Age group, yrs						
18–64	**12,975 (35)**	976 (21)	11,999 (36)	**1,765 (43)**	371 (31)	1,394 (48)
≥65	**24,528 (65)**	3,613 (79)	20,915 (64)	**2,352 (57)**	823 (69)	1,529 (52)
Female sex	**20,083 (54)**	2,365 (52)	17,718 (54)	**2,127 (52)**	623 (52)	1,504 (51)

See table footnotes on the next page.

TABLE 1. (*Continued*) Characteristics of emergency department or urgent care encounters and hospitalization among immunocompetent adults aged ≥18 years with COVID-19-like illness, by SARS-CoV-2 test result status and CDC vaccine effectiveness network — VISION and IVY networks, September 2023–January 2024

Characteristic	VE network, no. (column %)					
	VISION			IVY		
	Total no. of patients	COVID-19 case-patients	COVID-19 control patients	Total no. of patients	COVID-19 case-patients	COVID-19 control patients
Race and ethnicity						
Black or African American, NH	**3,979 (11)**	346 (8)	3,633 (11)	**929 (23)**	226 (19)	703 (24)
White, NH	**26,499 (71)**	3,479 (76)	23,020 (70)	**2,358 (57)**	752 (63)	1,606 (55)
Hispanic or Latino, any race	**3,510 (9)**	354 (8)	3,156 (10)	**540 (13)**	133 (11)	407 (14)
Other, NH†	**3,112 (8)**	373 (8)	2,739 (8)	**153 (4)**	40 (3)	113 (4)
Unknown§	**403 (1)**	37 (1)	366 (1)	**137 (3)**	43 (4)	94 (3)
HHS region¶						
1	**0 (—)**	0 (—)	0 (—)	**892 (22)**	330 (28)	562 (19)
2	**0 (—)**	0 (—)	0 (—)	**291 (7)**	62 (5)	229 (8)
3	**0 (—)**	0 (—)	0 (—)	**41 (1)**	14 (1)	27 (1)
4	**0 (—)**	0 (—)	0 (—)	**525 (13)**	125 (10)	400 (14)
5	**17,479 (47)**	2,154 (47)	15,325 (47)	**484 (12)**	160 (13)	324 (11)
6	**0 (—)**	0 (—)	0 (—)	**518 (13)**	129 (11)	389 (13)
7	**0 (—)**	0 (—)	0 (—)	**138 (3)**	36 (3)	102 (3)
8	**6,982 (19)**	1,061 (23)	5,921 (18)	**759 (18)**	194 (16)	565 (19)
9	**11,252 (30)**	1,211 (26)	10,041 (31)	**323 (8)**	101 (8)	222 (8)
10	**1,790 (5)**	163 (4)	1,627 (5)	**146 (4)**	43 (4)	103 (4)
No. of chronic medical condition categories**						
0	**5,113 (14)**	643 (14)	4,470 (14)	**389 (9)**	98 (8)	291 (10)
1	**6,316 (17)**	624 (14)	5,692 (17)	**807 (20)**	237 (20)	570 (20)
2	**7,234 (19)**	847 (18)	6,387 (19)	**1,171 (28)**	340 (28)	831 (28)
3	**9,230 (25)**	1,255 (27)	7,975 (24)	**975 (24)**	290 (24)	685 (23)
4	**6,545 (17)**	830 (18)	5,715 (17)	**521 (13)**	156 (13)	365 (12)
≥5	**3,065 (8)**	390 (8)	2,675 (8)	**254 (6)**	73 (6)	181 (6)
Month of COVID-19–associated hospitalization						
Sep 2023	**2,960 (8)**	270 (6)	2,690 (8)	**322 (8)**	126 (11)	196 (7)
Oct 2023	**9,789 (26)**	1,011 (22)	8,778 (27)	**1,081 (26)**	352 (29)	729 (25)
Nov 2023	**10,439 (28)**	1,283 (28)	9,156 (28)	**1,021 (25)**	300 (25)	721 (25)
Dec 2023	**11,791 (31)**	1,674 (36)	10,117 (31)	**949 (23)**	230 (19)	719 (25)
Jan 2024	**2,524 (7)**	351 (8)	2,173 (7)	**744 (18)**	186 (16)	558 (19)
SARS-CoV-2 JN.1 lineage predominant period††	**5,486 (15)**	807 (18)	4,679 (14)	**901 (22)**	231 (19)	670 (23)

Abbreviations: ED = emergency department; HHS = U.S. Department of Health and Human Services; IVY = Investigating Respiratory Viruses in the Acutely Ill; NH = non-Hispanic; UC = urgent care; VE = vaccine effectiveness; VISION = Virtual SARS-CoV-2, Influenza, and Other respiratory viruses Network.

* The "no updated dose" group included all eligible persons who did not receive an updated (2023–2024) COVID-19 vaccine dose, regardless of number of previous (i.e., original monovalent and bivalent) doses (if any) received.

† For VISION, "Other, NH" race includes persons reporting NH ethnicity and any of the following for race: American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, other races not listed, and multiple races; because of small numbers, these categories were combined. For IVY, "Other, NH" race includes Asian, Native American or Alaska Native, and Native Hawaiian or other Pacific Islander; because of small numbers, these categories were combined.

§ For VISION, "Unknown" includes persons with missing race and ethnicity in their electronic health records. For IVY, "Unknown" includes patients who self-reported their race and ethnicity as "Other" and those for whom race and ethnicity were unknown.

¶ Regions are defined by HHS. States included in each region are available at https://www.hhs.gov/about/agencies/iea/regional-offices/index.html. VISION network sites included were located as follows. *Region 5*: HealthPartners (Minnesota and Wisconsin) and Regenstrief Institute (Indiana); *Region 8*: Intermountain Healthcare (Utah) and University of Colorado (Colorado); *Region 9*: Kaiser Permanente Northern California (California); and *Region 10*: Kaiser Permanente Northwest (Oregon and Washington). IVY network sites were located as follows: *Region 1*: Baystate Medical Center (Springfield, Massachusetts), Beth Israel Deaconess Medical Center (Boston, Massachusetts), and Yale University (New Haven, Connecticut); *Region 2*: Montefiore Medical Center (New York, New York); *Region 3*: Johns Hopkins Hospital (Baltimore, Maryland); *Region 4*: Emory University Medical Center (Atlanta, Georgia), University of Miami Medical Center (Miami, Florida), Vanderbilt University Medical Center (Nashville, Tennessee), and Wake Forest University Baptist Medical Center (Winston-Salem, North Carolina); *Region 5*: Cleveland Clinic (Cleveland, Ohio), Hennepin County Medical Center (Minneapolis, Minnesota), Henry Ford Health (Detroit, Michigan), The Ohio State University Wexner Medical Center (Columbus, Ohio), and University of Michigan Hospital (Ann Arbor, Michigan); *Region 6*: Baylor Scott & White Medical Center (Temple, Texas) and Baylor University Medical Center (Dallas, Texas); *Region 7*: Barnes-Jewish Hospital (St. Louis, Missouri) and University of Iowa Hospitals (Iowa City, Iowa); *Region 8*: Intermountain Medical Center (Murray, Utah), UCHealth University of Colorado Hospital (Aurora, Colorado), and University of Utah (Salt Lake City, Utah); *Region 9*: Stanford University Medical Center (Stanford, California), Ronald Reagan UCLA Medical Center (Los Angeles, California), and University of Arizona Medical Center (Tucson, Arizona); and *Region 10*: Oregon Health & Science University Hospital (Portland, Oregon) and University of Washington (Seattle, Washington).

** VISION underlying condition categories included pulmonary, cardiovascular, cerebrovascular, musculoskeletal, neurologic, hematologic, endocrine, renal, and gastrointestinal. IVY underlying condition categories included pulmonary, cardiovascular, neurologic, hematologic, endocrine, renal, gastrointestinal, and autoimmune.

†† The JN.1 predominant period was considered to have started December 24, 2023.

TABLE 2. Effectiveness of updated 2023–2024 (monovalent XBB.1.5) COVID-19 vaccination against laboratory-confirmed COVID-19–associated emergency department or urgent care encounters, by age group — VISION network, September 2023–January 2024

Age group, yrs/ COVID-19 vaccination dosage pattern	No. (column %) COVID-19 case-patients	COVID-19 control patients	Median interval since last dose for vaccinated persons, days (IQR)	VE %* (95% CI)
≥18				
No updated dose† (Ref)	15,932 (92)	98,218 (88)	669 (403–792)	Ref
Received updated dose	1,297 (8)	13,378 (12)	44 (26–64)	47 (44–50)
7–59 days earlier	825 (5)	9,372 (8)	33 (20–46)	51 (47–54)
60–119 days earlier	472 (3)	4,006 (4)	74 (66–83)	39 (33–45)
18–64				
No updated dose† (Ref)	10,582 (97)	69,423 (94)	697 (480–832)	Ref
Received updated dose	377 (3)	4,739 (6)	42 (24–62)	50 (44–55)
7–59 days earlier	259 (2)	3,457 (5)	31 (19–45)	52 (45–58)
60–119 days earlier	118 (1)	1,282 (2)	73 (66–83)	45 (34–55)
≥65				
No updated dose† (Ref)	5,350 (85)	28,795 (77)	509 (362–733)	Ref
Received updated dose	920 (15)	8,639 (23)	46 (27–66)	45 (41–49)
7–59 days earlier	566 (9)	5,915 (16)	33 (21–46)	49 (44–54)
60–119 days earlier	354 (6)	2,724 (7)	74 (66–83)	37 (29–44)

Abbreviations: Ref = referent group; VE = vaccine effectiveness; VISION = Virtual SARS-CoV-2, Influenza, and Other respiratory viruses Network.

* VE was calculated as (1 − odds ratio) × 100% with odds ratios calculated using multivariable logistic regression. For VISION, the odds ratio was adjusted for age, sex, race and ethnicity, geographic region, and calendar time (days since January 1, 2021).

† The "no updated dose" group included all eligible persons who did not receive an updated (2023–2024) COVID-19 vaccine dose, regardless of number of previous (i.e., original monovalent and bivalent) doses (if any) received.

TABLE 3. Effectiveness of updated 2023–2024 (monovalent XBB.1.5) COVID-19 vaccination against laboratory-confirmed COVID-19–associated hospitalization among adults aged ≥18 years — VISION and IVY networks, September 2023–January 2024

VE network/Age group, yrs/COVID-19 vaccination dosage pattern	No. (column %) COVID-19 case-patients	COVID-19 control patients	Median interval since last dose for vaccinated persons, days (IQR)	VE %* (95% CI)
VISION (4,589 case-patients and 32,914 control patients)				
≥18				
No updated dose† (Ref)	4,194 (91)	28,715 (87)	627 (383 to 765)	Ref
Received updated dose	395 (9)	4,199 (13)	42 (24 to 62)	52 (47 to 57)
7–59 days earlier	270 (6)	3,056 (9)	32 (19 to 45)	53 (46 to 59)
60–119 days earlier	125 (3)	1,143 (3)	73 (66 to 81)	50 (40 to 59)
18–64				
No updated dose† (Ref)	938 (96)	11,342 (95)	685 (447 to 829)	Ref
Received updated dose	38 (4)	657 (5)	38 (22 to 58)	43 (20 to 59)
7–59 days earlier	28 (3)	503 (4)	30 (19 to 44)	42 (14 to 61)
60–119 days earlier	10 (1)	154 (1)	74 (67 to 81)	45 (–6 to 71)§
≥65				
No updated dose† (Ref)	3,256 (90)	17,373 (83)	549 (370 to 745)	Ref
Received updated dose	357 (10)	3,542 (17)	43 (25 to 62)	53 (47 to 58)
7–59 days earlier	242 (7)	2,553 (12)	32 (19 to 46)	54 (47 to 60)
60–119 days earlier	115 (3)	989 (5)	73 (66 to 81)	50 (39 to 59)
IVY (1,194 case-patients and 2,923 control patients)				
≥18				
No updated dose† (Ref)	1,100 (92)	2,570 (88)	645 (387 to 781)	Ref
Received updated dose	94 (8)	353 (12)	47 (25 to 71)	43 (27 to 56)
7–59 days earlier	—	—	—	—
60–119 days earlier	—	—	—	—
≥65				
No updated dose† (Ref)	747 (91)	1,284 (84)	573 (375 to 752)	Ref
Received updated dose	76 (9)	245 (16)	48 (26 to 72)	48 (31 to 61)
7–59 days earlier	—	—	—	—
60–119 days earlier	—	—	—	—

Abbreviations: IVY = Investigating Respiratory Viruses in the Acutely Ill; Ref = referent group; VE = vaccine effectiveness; VISION = Virtual SARS-CoV-2, Influenza, and Other respiratory viruses Network.

* VE was calculated as (1 − odds ratio) × 100% with odds ratios calculated using multivariable logistic regression. For VISION, the odds ratio was adjusted for age, sex, race and ethnicity, geographic region, and calendar time (days since January 1, 2021). For IVY, the odds ratio was adjusted for age, sex, race and ethnicity, calendar time in biweekly intervals, and U.S. Department of Health and Human Services region.

† The "no updated dose" group included all eligible persons who did not receive an updated (2023–2024) COVID-19 vaccine dose, regardless of number of previous (i.e., original monovalent and bivalent) doses (if any) received.

§ Some estimates are imprecise, which might be due to a relatively small number of persons in each level of vaccination or case status. This imprecision indicates that the actual VE could be substantially different from the point estimate shown, and estimates should therefore be interpreted with caution. Additional data accrual could increase precision and allow more precise interpretation.

had HK.3–like spike proteins with L455F and F456L substitutions compared with XBB.1.5, 57 (6%) had JN.1–like spike proteins with more than30 substitutions compared with XBB.1.5, and two (<1%) had other spike proteins.†††† Similarly, among 18,316 SARS-CoV-2–positive specimens collected during the same period and sequenced by CDC as part of national genomic surveillance,§§§§ 2,624 (14%) had XBB.1.5–like spike proteins, 9,649 (53%) had EG.5–like spike proteins, 3,700 (20%) had HK.3–like spike proteins, 2,302 (13%) had JN.1–like spike proteins, and 41 (<1%) had other spike proteins.

Discussion

During September 2023–January 2024, in two multisite VE networks, updated 2023–2024 COVID-19 vaccination provided significant protection against COVID-19–associated ED/UC encounters and hospitalization among immunocompetent adults, compared with not receiving an updated vaccine. The comparison group included both unvaccinated persons and persons who had received original monovalent or bivalent doses only; thus, these results support current CDC recommendations for updated COVID-19 vaccination, including among persons who have previously received original monovalent or bivalent COVID-19 vaccines and those who have never been vaccinated, irrespective of previous infection history (*1*).

†††† Sequences were grouped by spike amino acid sequence similarity to SARS-CoV-2 lineages circulating during fall 2023. XBB.1.5–like, EG.5–like, and HK.3–like spike sequences are similar to the XBB.1.5 spike sequence used in updated 2023–2024 COVID-19 vaccines, with EG.5–like spikes having the additional F456L substitution, and HK.3–like spikes having additional L455F and F456L substitutions. JN.1 represents viruses in the JN.1 Pango lineage. "Other" represents non-XBB.1.5–derived, non-JN.1 viruses detected during September 21–December 15, 2023.

§§§§ CDC national SARS-CoV-2 genomic surveillance includes samples sequenced by CDC and national testing laboratories contracted by CDC.

Summary

What is already known about this topic?

In September 2023, CDC's Advisory Committee on Immunization Practices recommended updated 2023–2024 (monovalent XBB.1.5) COVID-19 vaccination for all persons aged ≥6 months to prevent COVID-19, including severe disease. Few estimates of updated 2023–2024 vaccine effectiveness against medically attended COVID-19 are available.

What is added by this report?

Receipt of an updated COVID-19 vaccine dose provided increased protection against COVID-19–associated emergency department and urgent care encounters and hospitalization compared with no receipt of an updated vaccine dose among immunocompetent U.S. adults during a period of multiple cocirculating SARS-CoV-2 Omicron lineages.

What are the implications for public health practice?

These findings support CDC recommendations for updated 2023–2024 COVID-19 vaccination. All persons aged ≥6 months should receive updated 2023–2024 COVID-19 vaccine.

Updated COVID-19 vaccines contain the spike antigen from the SARS-CoV-2 Omicron XBB.1.5 virus, which was the predominant variant circulating in the United States during the first half of 2023. Many other XBB lineages cocirculated during fall 2023 that had amino acid substitutions associated with increased escape from neutralizing antibodies, such as EG.5 and HK.3 (*5*). The JN.1 lineage, a descendent of Omicron BA.2.86, was first detected in the United States in September 2023[¶¶¶¶] and accounted for approximately 65% of circulating lineages by the 2-week period ending January 6, 2024.[*****] As noted, JN.1 contains more than 30 substitutions in the spike protein compared with XBB.1.5, some of which might be associated with immune escape (*5*). Although studies have found that updated COVID-19 vaccines elicit broadly cross-protective neutralizing antibodies, including against XBB lineages and JN.1 (*5*–*7*), the pace and frequency with which new SARS-CoV-2 lineages have displaced predecessors underscores the need for ongoing monitoring of COVID-19 VE and for periodic COVID-19 vaccine antigen updates. These analyses include periods when XBB lineages and JN.1 cocirculated to varying degrees in the United States, indicating that receipt of updated vaccines provided protection against COVID-19–associated ED/UC encounters and hospitalization due to the variants cocirculating during this period.

Despite different populations, methods, and outcomes, estimates of the effectiveness of updated COVID-19 vaccines were aligned across the VISION and IVY analyses. VE estimates were also similar to those recently published from another CDC VE platform, which measured VE against symptomatic SARS-CoV-2 infection (*8*), and to a United Kingdom report,[†††††] which measured VE against hospitalization among patients aged ≥65 years. Earlier estimates of the effectiveness of updated COVID-19 vaccines against hospitalization in older adults from Denmark (*9*) and the Netherlands (*10*) were somewhat higher than those observed in this analysis; however, this is likely due to a shorter interval since updated dose receipt among patients included in the European studies or to differences in study methods. Whereas the maximum interval since receipt of an updated dose was 25 days in the Danish report and 2 months in the Dutch report, persons in the VISION and IVY analyses could have received an updated dose up to 4 months earlier.

In the VISION analysis, there was evidence of waning effectiveness of updated COVID-19 vaccines against ED/UC encounters; however, COVID-19–associated hospitalization rates during the analysis period were relatively low compared with previous years, limiting the evaluation of waning VE against hospitalization and precluding estimation of VE against critical illness. Analyses from VISION and IVY during 2022–2023 showed substantial waning of COVID-19 VE against ED/UC encounters and hospitalization, with VE not significantly different from zero in some strata by 6 months after vaccination, although VE was more sustained against critical illness (*2*,*3*) (defined as receipt of invasive mechanical ventilation, intensive care unit admission, or death), with protection lasting well over 1 year after the most recent dose. Continued monitoring of the effectiveness of updated COVID-19 vaccines for expected waning against hospitalization and to determine the durability of VE against critical illness is needed.

Limitations

The findings in this report are subject to at least five limitations. First, although case-patients were required to meet a CLI definition and to receive a positive SARS-CoV-2 test result, they might have visited EDs or UCs or been hospitalized for reasons other than COVID-19, which could have lowered VE estimates. Second, misclassification of vaccination status was possible, because state registries, EHRs, medical claims data, and self-report might not identify all updated COVID-19 vaccine doses administered, which would likely result in underestimation of VE. Third, analyses did not account for previous SARS-CoV-2 infection, which might provide protection against future COVID-19. VE should therefore be interpreted as the incremental benefit of an updated dose in a population

[¶¶¶¶] https://www.cdc.gov/respiratory-viruses/whats-new/SARS-CoV-2-variant-JN.1.html

[*****] https://covid.cdc.gov/covid-data-tracker/#variant-proportions

[†††††] https://assets.publishing.service.gov.uk/media/65b3c8a3c5aacc000da683d3/vaccine-surveillance-report-2024-week-4.pdf

with high levels of infection-induced immunity, vaccine-induced immunity, or both. Fourth, although analyses were adjusted for relevant confounders, residual confounding from other factors, including behavioral modifications to prevent SARS-CoV-2 exposure and outpatient antiviral treatment for COVID-19, is possible. Finally, sample size limitations precluded estimation of lineage-specific VE and stratification of VE by interval since updated dose receipt in the IVY analysis.

Implications for Public Health Practice

In this analysis of the effectiveness of updated COVID-19 vaccines, receipt of an updated COVID-19 vaccine dose provided protection against COVID-19–associated ED/UC encounters and hospitalization among immunocompetent adults. CDC will continue monitoring VE of updated COVID-19 vaccines. These results support CDC recommendations for updated 2023–2024 COVID-19 vaccination. All persons aged ≥6 months should receive updated 2023–2024 COVID-19 vaccine.

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CDC COVID-19 Vaccine Effectiveness Collaborators

Shekhar Ghamande, Baylor Scott & White Health; Robert Gottlieb, Baylor Scott & White Health; Tresa McNeal, Baylor Scott & White Health; Catherine Raver, Baylor Scott & White Health; William Bender, Emory University; Linda Fletcher, HealthPartners; Phillip Heaton, HealthPartners; Sheryl Kane, HealthPartners; Charlene McEvoy, HealthPartners; Sunita Thapa, HealthPartners; Gabriela Vazquez-Benitez, HealthPartners; Anne Frosch, Hennepin County Medical Center; Lois E Lamerato, Henry Ford Health; Mayur Ramesh, Henry Ford Health; Julie Arnofer, Intermountain Healthcare; Harith Ali, Johns Hopkins; Bradley Crane, Kaiser Permanente Center for Health Research; Padma Dandamudi, Kaiser Permanente Center for Health Research; Kristin Goddard, Kaiser Permanente Northern California; John Hansen, Kaiser Permanente Northern California; Julius Timbol, Kaiser Permanente Northern California; Ousseny Zerbo, Kaiser Permanente Northern California; Katie Allen, Regenstrief Institute; Thomas Duszynski, Regenstrief Institute; William Fadel, Regenstrief Institute; Colin Rogerson, Regenstrief Institute; Nida Qadir, University of California, Los Angeles; Catia Chavez, University of Colorado; Bryant Doyle, University of Colorado; David Mayer, University of Colorado; Suchitra Rao, University of Colorado; Carolina Rivas, University of Miami; Nicholas J. Johnson, University of Washington; Adrienne Baughman, Vanderbilt University Medical Center; Cara T. Lwin, Vanderbilt University Medical Center; Jillian P. Rhoads, Vanderbilt University Medical Center; Kelsey N. Womack, Vanderbilt University Medical Center; Margaret Dunne, Westat; Allison Ciesla, CDC; Josephine Mak, CDC; Morgan Najdowski, CDC; Caitlin Ray, CDC.

Corresponding author: Jennifer DeCuir, media@cdc.gov.

[1]Coronavirus and Other Respiratory Viruses Division, National Center for Immunization and Respiratory Diseases, CDC; [2]Vanderbilt University Medical Center, Nashville, Tennessee; [3]Westat, Rockville, Maryland; [4]Division of Infectious Diseases and Clinical Epidemiology, Intermountain Healthcare, Salt Lake City, Utah; [5]HealthPartners Institute, Minneapolis, Minnesota; [6]Kaiser Permanente Center for Health Research, Portland, Oregon; [7]Indiana University School of Medicine, Indianapolis, Indiana; [8]Regenstrief Institute Center for Biomedical Informatics, Indianapolis, Indiana; [9]University of Colorado School of Medicine, Aurora, Colorado; [10]Kaiser Permanente Vaccine Study Center, Kaiser Permanente Northern California Division of Research, Oakland, California; [11]Department of Biomedical Informatics, Columbia University Irving Medical Center, New York, New York; [12]New York-Presbyterian Hospital, New York, New York; [13]General Dynamics Information Technology, Falls Church, Virginia; [14]University of Michigan, Ann Arbor, Michigan; [15]Baylor Scott & White Health, Texas; [16]Baylor College of Medicine, Temple, Texas; [17]Intermountain Medical Center, Murray, Utah; [18]University of Utah, Salt Lake City, Utah; [19]University of Iowa, Iowa City, Iowa; [20]Wake Forest School of Medicine, Winston-Salem, North Carolina; [21]Johns Hopkins University School of Medicine, Baltimore, Maryland; [22]Hennepin County Medical Center, Minneapolis, Minnesota; [23]Montefiore Medical Center, Albert Einstein College of Medicine, New York, New York; [24]University of Washington, Seattle, Washington; [25]Baystate Medical Center, Springfield, Massachusetts; [26]Oregon Health & Science University, Portland, Oregon; [27]Emory University, Atlanta, Georgia; [28]Cleveland Clinic, Cleveland, Ohio; [29]Stanford University School of Medicine, Stanford, California; [30]Ronald Reagan UCLA Medical Center, Los Angeles, California; [31]University of Miami, Miami, Florida; [32]Washington University in St. Louis, St. Louis, Missouri; [33]The Ohio State University, Columbus, Ohio; [34]Texas A&M University College of Medicine, Dallas, Texas; [35]Henry Ford Health, Detroit, Michigan; [36]Yale University School of Medicine, New Haven, Connecticut; [37]University of Arizona, Tucson, Arizona; [38]Influenza Division, National Center for Immunization and Respiratory Diseases, CDC.

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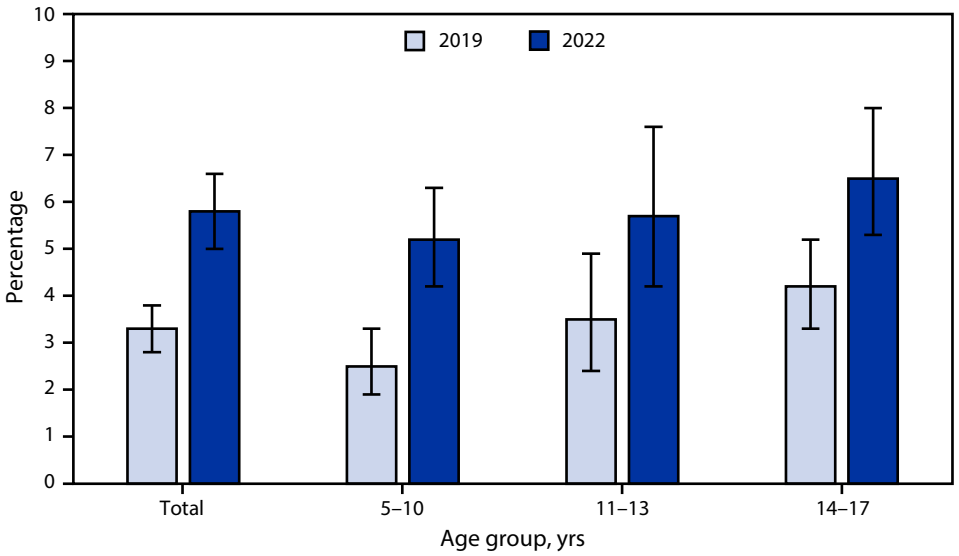
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Children and Adolescents Aged 5–17 Years Who Had Chronic School Absenteeism Due to Illness, Injury, or Disability During the Past 12 Months,† by Age Group and Year — National Health Interview Survey,§ United States, 2019 and 2022



* With 95% CIs indicated by error bars.
† Based on a response of ≥15 days to the survey question, "During the past 12 months, about how many days of school did (Sample Child) miss school because they had an illness, injury, or disability?"
§ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population.

The percentage of children and adolescents aged 5–17 years who had chronic school absenteeism during the past 12 months was higher in 2022 (5.8%) than in 2019 (3.3%). From 2019 to 2022, the percentage of children who had chronic school absenteeism increased for each age group. The percentage of children who had chronic school absenteeism increased with increasing age in 2019; no significant differences by age occurred in 2022.

Source: National Health Interview Survey, 2019 and 2022. https://www.cdc.gov/nchs/nhis.htm

Reported by: Lindsey I. Black, MPH, lblack1@cdc.gov; Nazik Elgaddal, MS.

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