



Published in final edited form as:

*Vaccine*. 2023 November 22; 41(48): 7138–7146. doi:10.1016/j.vaccine.2023.10.023.

## Influenza vaccination coverage among persons ages six months and older in the Vaccine Safety Datalink in the 2017–18 through 2022–23 influenza seasons

Stephanie A. Irving<sup>a,\*</sup>, Holly C. Groom<sup>a</sup>, Edward A. Belongia<sup>b</sup>, Bradley Crane<sup>a</sup>, Matthew F. Daley<sup>c</sup>, Kristin Goddard<sup>d</sup>, Lisa A. Jackson<sup>e</sup>, Tia L. Kauffman<sup>a</sup>, Tat'Yana A. Kenigsberg<sup>f</sup>, Leslie Kuckler<sup>g</sup>, Allison L. Naleway<sup>a</sup>, Suchita A. Patel<sup>h</sup>, Hung Fu Tseng<sup>i</sup>, Josh T.B. Williams<sup>j</sup>, Eric S. Weintraub<sup>f</sup>

<sup>a</sup>Kaiser Permanente Center for Health Research, Portland OR, USA

<sup>b</sup>Marshfield Clinic Research Institute, Marshfield WI, USA

<sup>c</sup>Institute for Health Research, Kaiser Permanente Colorado, Denver CO, USA

<sup>d</sup>Vaccine Study Center, Kaiser Permanente Northern California, Oakland CA, USA

<sup>e</sup>Kaiser Permanente Washington Health Research Institute, Seattle WA, USA

<sup>f</sup>Immunization Safety Office, Centers for Disease Control and Prevention, Atlanta GA, USA

<sup>g</sup>HealthPartners Institute, Minneapolis MN, USA

<sup>h</sup>Immunization Services Division, Centers for Disease Control and Prevention, Atlanta GA, USA

<sup>i</sup>Kaiser Permanente Southern California, Pasadena CA, USA

<sup>j</sup>Denver Health, Denver CO, USA

### Abstract

**Background:** In the United States, annual vaccination against seasonal influenza is recommended for all people ages ≥ 6 months. Vaccination coverage assessments can identify populations less protected from influenza morbidity and mortality and help to tailor vaccination efforts. Within the Vaccine Safety Datalink population ages ≥ 6 months, we report influenza vaccination coverage for the 2017–18 through 2022–23 seasons.

**Methods:** Across eight health systems, we identified influenza vaccines administered from August 1 through March 31 for each season using electronic health records linked to immunization registries. Crude vaccination coverage was described for each season, overall and by self-reported sex; age group; self-reported race and ethnicity; and number of separate categories of diagnoses associated with increased risk of severe illness and complications from influenza (hereafter

\*Corresponding author at: Kaiser Permanente Center for Health Research, 3800 N Interstate Ave, Portland, OR 97227 USA. Stephanie.A.Irving@kpchr.org (S.A. Irving).

Authorship

All authors attest they meet the ICMJE criteria for authorship.

Appendix A. Supplementary material

Supplementary material to this article can be found online at <https://doi.org/10.1016/j.vaccine.2023.10.023>.

referred to as high-risk conditions). High-risk conditions were assessed using ICD-10-CM diagnosis codes assigned in the year preceding each influenza season.

**Results:** Among individual cohorts of more than 12 million individuals each season, overall influenza vaccination coverage increased from 41.9 % in the 2017–18 season to a peak of 46.2 % in 2019–20, prior to declaration of the COVID-19 pandemic. Coverage declined over the next three seasons, coincident with widespread SARS-CoV-2 circulation, to a low of 40.3 % in the 2022–23 season. In each of the six seasons, coverage was lowest among males, 18–49-year-olds, non-Hispanic Black people, and those with no high-risk conditions. While decreases in coverage were present in all age groups, the declines were most substantial among children: 2022–23 season coverage for children ages six months through 8 years and 9–17 years was 24.5 % and 22.4 % (14 and 10 absolute percentage points), respectively, less than peak coverage achieved in the 2019–20 season.

**Conclusions:** Crude influenza vaccination coverage increased from 2017 to 18 through 2019–20, then decreased to the lowest level in the 2022–23 season. In this insured population, we identified persistent disparities in influenza vaccination coverage by sex, age, and race and ethnicity. The overall low coverage, disparities in coverage, and recent decreases in coverage are significant public health concerns.

## Keywords

Influenza; Vaccination; Vaccination coverage; Vaccine uptake

---

## 1. Introduction

Influenza is a contagious viral respiratory disease that can lead to serious illness, hospitalization, and death. Vaccination is one of the most effective measures to prevent influenza illness and resulting complications.[1] Annual vaccination against seasonal influenza is recommended for all persons in the United States ages 6 months, except when medically contraindicated.[2].

Nationally, influenza vaccination coverage has fluctuated over time, with considerable variability seen across age groups and differences by race and ethnicity.[3] In national survey data, consistently lower coverage estimates are seen among younger adults and Black, non-Hispanic people.[4] For this reason, close monitoring of influenza vaccination coverage is important both for determining progress with the universal influenza vaccination program to protect people from influenza and to inform strategies for eliminating disparities coverage.

There are limited data on the impact of the COVID-19 pandemic on influenza vaccination coverage. There is some evidence of declining coverage from the 2020–21 to 2021–22 influenza season,[5,6] but few coverage estimates for the 2022–23 season are available. Using data from a large, representative population,[7,8] the current study aims to fill an important gap in the existing literature by examining trends in influenza vaccination coverage over time, including seasons prior to and during the COVID-19 pandemic.

In this paper, using a descriptive analysis we report crude influenza vaccination coverage among individuals ages 6 months within the Vaccine Safety Datalink (VSD) during the 2017–18 through 2022–23 influenza seasons and describe coverage by pre-specified demographic and clinical factors.

## 2. Methods

### 2.1. Setting

The VSD is a longstanding collaborative effort between the CDC’s Immunization Safety Office and several integrated health care systems (sites) across the United States.[9] VSD sites create standardized, deidentified data files from electronic health records and claims data, which allows linkage of select demographics, medical event information, and vaccination history. This descriptive, retrospective study utilized data obtained from VSD’s influenza vaccine rapid cycle analysis (RCA) surveillance.[10] Eight VSD sites (HealthPartners, Marshfield Clinic, Denver Health, and the Colorado, Northern California, Northwest, Southern California, and Washington regions of Kaiser Permanente) in six US states (California, Colorado, Minnesota, Oregon, Washington, and Wisconsin) contributed data to this analysis.

This research was reviewed and approved by the institutional review boards of the participating eight VSD sites and granted a waiver of informed consent. In addition, the research was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy (see e.g., 45C.F.R. part 46, 21C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C.; 44 U.S.C. §3501 et seq.).

### 2.2. Influenza seasons of interest

Influenza vaccination coverage was evaluated retrospectively for six influenza seasons: 2017–18 through 2022–23. Annual influenza seasons were defined as August 1 through March 31 for each year.

### 2.3. Study population

The source population for each influenza season consisted of all people ages 6 months of age with any amount of respective VSD site health plan membership in the August 1-March 31 period. Infants who reached six months of age during the August 1-March 31 period were included in that season’s analyses.

### 2.4. Ascertainment of vaccination status

All influenza vaccines administered in the eligible study population were identified from standardized VSD files (Supplemental Table 1). The VSD vaccine files include data from electronic health records and insurance claims and are supplemented through bidirectional communication with regional or state immunization information systems.[11] The VSD employs standardized data quality checks and de-duplication of vaccines from multiple sources. All influenza vaccines administered between August 1 and March 31 were included in the season-specific analyses. Data were extracted on May 30, 2023, to allow for lag time for more complete vaccination capture of the 2022–23 vaccines within the VSD data.

## 2.5. Measures

For each season, crude overall influenza vaccination coverage was calculated by dividing the number of people vaccinated from August 1 through March 31 by the total number of people in the VSD population, as defined above. Each season, crude coverage was also calculated by self-reported sex; age group (six months through 8 years, 9–17, 18–49, 50–64, and ≥ 65 years); self-reported race and ethnicity (Hispanic, all races; Asian, non-Hispanic; Black, non-Hispanic; multiple races, non-Hispanic; White, non-Hispanic; another race, non-Hispanic; unknown or missing); and number of separate categories of diagnoses associated with increased risk of severe illness and complications from influenza (0, 1, 2, 3, 4, ≥ 5 high-risk categories; Supplemental Table 2). Age was defined as of the vaccination date among those vaccinated; for those who remained unvaccinated, age was calculated as of March 31 of the season of interest. All coverage estimates are limited to receipt of a single dose in the season of interest and pediatric estimates do not represent two-dose coverage among infants and young children requiring two doses. High-risk conditions were assessed using ICD-10-CM diagnosis codes assigned in the year preceding each influenza season (e.g., August 2021 through July 2022 for the 2022–23 influenza season).

*Post hoc*, we examined vaccination coverage among more granular pediatric age groups (6–11 months, 12–23 months, <2 years) in addition to the primary pediatric age groups listed above (6 months–8 years and 9–17 years). Among children, in addition to annual coverage estimates, we described the change in coverage from the highest estimates observed in the study period (peak) to the lowest estimates (low point). Both absolute (percentage point change from peak to low point) and proportional (percentage point change from peak to low point, as a proportion of peak coverage) changes were assessed, by pediatric age group.

Patterns of influenza vaccine uptake, defined as the number of doses administered in the VSD population by week, were also examined and compared across the six seasons. Weekly and cumulative doses were described, through Morbidity and Mortality Weekly Report (MMWR) week 13 (approximately through the end of March) each season.[12].

Data for this paper were collected and summarized using SAS software, version 9.4 (Cary, NC).

## 3. Results

Across the 2017–18 through 2022–23 influenza seasons, the number of people ages 6 months in the VSD population averaged 12,451,352 (range 12,263,777—12,570,303 people; Table 1). Demographic and clinical characteristics of the population were consistent across seasons. In each of the six seasons, 51.7 % of the population self-reported as female. Eighteen to 49-year-olds made up the largest age group each influenza season (45.4–45.7 %), and 18.8–20.1 % of each season’s population was 6 months through 17 years old. Approximately one quarter (25.1–26.3 %) of each season’s population was Hispanic and 37.8–42.9 % was non-Hispanic White; race and ethnicity data were missing for 8.9–12.1 % of the population each season, with more missing data in later seasons. Each season, 29.0–31.4 % of the population had ≥ 1 diagnosis within a category associated with increased risk for severe illness and complications from influenza.

Overall influenza vaccination coverage was 41.9 % in the 2017–18 season and increased to 46.2 % in the 2019–20 season before declining over the next three seasons, to a low of 40.3 % in the 2022–23 season (Table 1).

### 3.1. Influenza vaccination coverage by demographic and clinical characteristics

In all six seasons, influenza vaccination coverage was 7.4–8.1 percentage points higher among females than males (Fig. 1). In every season, higher coverage estimates were seen among people ages 65 years than the other age groups; among people ages 65 years, coverage ranged from 69.5 to 73.3 % each season. Coverage estimates were lowest among people ages 18–49 years in every season, ranging from 28.7 to 34.7 %. Among children ages 6 months through 8 years, adolescents ages 9–17 years, and adults ages 18–49 years, vaccination coverage was highest in the 2019–20 season; the highest coverage estimates among the 50–64 and 65-year age groups were observed in the 2020–21 season (Fig. 2). When examining more granular pediatric age groups, high influenza vaccination coverage estimates were identified among children ages < 2 years, with the highest pediatric coverage among infants ages 6–11 months. All pediatric age groups experienced decreases in coverage in the later seasons examined, with absolute changes in coverage ranging from 9.5 to 15.2 percentage points from peak coverage in 2019–20 to the 2022–23 season (Table 2).

By race and ethnicity, influenza vaccination coverage estimates were highest among non-Hispanic Asian people in all seasons, ranging from 50.1 to 58.1 % each season. Among those with known race and ethnicity, coverage estimates were lowest in all seasons among non-Hispanic Black people, ranging from 31.5 to 36.5 % each season (Fig. 3).

In each season, we identified higher coverage estimates with increasing numbers of high-risk categories captured by electronic diagnoses. The sub-population with diagnoses spanning 5 high-risk categories had the highest coverage estimates in every season, ranging from 73.5 to 79.5 %. Those with diagnoses in four, three, two, and one category, respectively, had progressively lower coverage estimates, with coverage in the sub-population with diagnoses in only one high-risk category ranging from 48.8 to 55.1 % each season. All coverage estimates among sub-populations with diagnoses in 1 high-risk category were higher than the overall population estimates, while all coverage estimates in the sub-population with no diagnoses in high-risk categories were lower than overall population estimates (Fig. 4).

### 3.2. Trends in influenza vaccine uptake

Across the six seasons examined, there was a consistent pattern of uptake of influenza vaccines across each study period. Calendar (MMWR) weeks 39 or 40, corresponding with the last week in September and the first week in October, saw the most weekly doses administered in each of the six seasons. The 2021–22 and 2022–23 seasons saw the lowest weekly uptake peaks across the six seasons, with 2022–23 peaking at 440,774 doses in week 40, relative to the 2020–21 peak of 633,414 doses (week 40; Fig. 5). Cumulative influenza vaccine uptake was highest in the 2019–20 season and lowest in the 2022–23 season (Fig. 6).

## 4. Discussion

This large retrospective study found that influenza vaccination coverage increased in the VSD population from the 2017–18 through 2019–20 influenza seasons, peaking at an overall coverage of 46.2 % in 2019–20. However, we identified decreases in coverage over the 2020–21 through 2022–23 seasons, to a low of 40.3 % overall; the declines in coverage were observed in both sexes, and for all age, race and ethnicity, and high-risk groups. We also identified differences in coverage across demographic and clinical characteristics, with the lowest coverage estimates in every season among males, 9–17 and 18–49-year-olds, non-Hispanic Black people, and those with no diagnoses associated with increased risk of severe illness and complications from influenza identified in their electronic medical record.

Similar patterns in disparities in vaccination status have been reported in national estimates of influenza coverage. The Behavioral Risk Factor Surveillance System (BRFSS) reported consistently higher coverage among White, non-Hispanic adults, compared to Hispanic or Black, non-Hispanic adults in the 2010–11 through 2021–22 seasons.[6] The highest VSD estimates were seen among Asians, who also had the highest coverage in the 2021–22 BRFSS data, though the confidence intervals overlapped with those of White adults.[6] The persistent disparities in influenza vaccination coverage seen by race and ethnicity in the VSD population are well-established in the literature.[13–16] Unfortunately, the VSD data show that these disparities persist in the 2022–23 influenza season.

Declines in influenza vaccination coverage during the COVID-19 pandemic have been reported previously. CDC’s national and state survey-based final estimates based on the National Immunization Survey-Flu (NIS-Flu) for children and BRFSS for adults identified declines in coverage among persons aged 6 months and older and some sub-groups from the 2020–21 to 2021–22 influenza season.[6] However, preliminary estimates for the 2022–23 season based on the NIS-Flu indicate the overall coverage estimate for children is similar to the 2021–22 season.[17] Preliminary adult coverage estimates for 2022–23, based on the National Immunization Survey – Adult COVID Module (NIS-ACM), which included questions about influenza vaccination, are higher compared to 2021–22, and include a significant (3.7 percentage point) increase in coverage for those aged 65 years.[18] Without additional sources and published analyses of 2022–23 influenza season data for comparison, it is difficult to determine if the decreases seen in the VSD are present in other populations, and why the VSD and NIS coverage trends may differ for the 2022–23 influenza season.

In the 2022–23 season, the NIS-ACM and NIS-Flu reported higher coverage than that identified in the VSD data across all age groups; [17–18] the magnitude of this difference is especially notable among children aged 6 month–17 years, where NIS-Flu reported a coverage estimate of 55.1 %, compared to 37.3 % in the VSD data (absolute difference 17.8 percentage points).[17] Similarly, the 2021–22 season influenza vaccination coverage identified in the VSD population is substantially lower than estimates from published national survey estimates.[6] This finding is similar to a report of pediatric influenza vaccination coverage in an insured population between 2010 and 2017, which reported significantly lower pediatric coverage compared to NIS-Flu estimates over the same period.



Specifically, the annual coverage reported by Gates, et al. (33.4 % for all children < 18 years) [19] was even lower than the VSD estimates, which ranged from 37.3 % (2022–23) to 48.9 % (2019–20). Annual NIS-Flu influenza coverage estimates averaged 56.5 % during the same period examined by Gates, reflecting a difference of more than 22 percentage points (NIS-Flu compared to Gates, et al).[6,19] The 2021–22 NIS estimate for children ages 6 months through 17 years was 57.8 %, compared to our finding of 39.8 % (absolute difference 18 percentage points).[6] Differences in coverage estimates between national and state-level surveys and other populations have been reported in the literature and may be due in part to population differences and overestimation of vaccine receipt obtained by self-report within the NIS survey population.[20–22] Factors related to the COVID-19 pandemic may have contributed to coverage differences between VSD, national and state-level surveys, and other sources; possibilities include changes in health care-seeking behaviors (e.g., fewer medical visits), healthcare system changes such as prioritizing covid vaccinations services, and increased influenza vaccinations in pharmacy or retail settings.

In each influenza season, we found lower influenza vaccination coverage in older children (9–17 years) compared to younger children (6 months–8 years). Absolute differences between the two age groups ranged from 9.3 to 14.0 percentage points by season. However, when we examined the younger age group with more granularity, we saw more dramatic differences: influenza vaccination coverage among children ages 6–11 months peaked at a high of 77.6 % (2019–20), compared to the peak of 42.5 % (2019–20) among children ages 9–17 years. Similar differences in pediatric age subgroups have been reported earlier. In line with NIS-Flu pediatric coverage estimates from 2010 to 11 through 2021–22,[6] Gates, et al. also reported higher estimates among children ages < 4 years and lowest estimates among children ages 13–17 years in an insured population between 2010 and 2017.[19].

We identified a decrease in coverage across all pediatric age groups during the seasons overlapping with the COVID-19 pandemic. Within the VSD, pediatric age groups had absolute decreases in coverage from 9.5 to 15.2 percentage points. Day and colleagues reported similar declines in pediatric coverage between the 2020–21 and 2021–22 seasons, with more substantial decreases in older and Black children.[5] While we did not examine changes in pediatric coverage by race and ethnicity, we saw consistent crude decreases across pediatric age subgroups, with decreases of 24.5 % (ages 6 months–8 years) and 22.4 % (ages 9–17 years) of the peak coverage identified in 2019–20. These decreases were not identified by NIS-Flu, which found no significant declines in coverage for children ages 6 months to 4 years, 5–12 years, or 13–17 years from the 2020–21 to 2021–22 season.[6].

This study is subject to several limitations. First, the findings may not be generalizable to all populations in the United States, with the possibility that the VSD members may have fewer barriers to care and/or more access to vaccination; however, the VSD population has been shown to be generalizable to the United States population, and representative of the specific communities served by the participating sites, on important factors such as sex, age, education, and race and ethnicity. [7–8] Second, vaccination status may be misclassified in the VSD if individuals receive vaccines outside the participating delivery systems or immunization information systems catchment area;[11] if that capture changed over time

it would potentially bias the trends observed here. While it is possible that the COVID-19 pandemic led to an increase in the administration of influenza vaccines outside of the VSD health systems, the VSD capture of vaccination through immunization information systems and claims is robust.[11] Third, it is possible that demographic or clinical characteristics may be misclassified within the electronic medical record. Fourth, individuals ages 6 months with any VSD membership were included in the study population; it is possible that vaccination was under-ascertained among those with shorter membership intervals, lowering our coverage estimates.

## 5. Conclusions

Our findings provide insights into recent trends in influenza vaccination coverage in a large, generally insured United States population, and include estimates by sex, age group, race and ethnicity, and presence of high-risk conditions for severe disease from influenza. The coverage estimates are lower than national targets, and previously identified disparities by sex, age, and race and ethnicity are also observed here. Influenza vaccines provide protection from influenza illness and related complications, and the overall low coverage, disparities in coverage, and decreases in coverage in recent seasons identified here all have important public health ramifications. Continued efforts to increase vaccination coverage, especially in specific sub-populations such as adolescents and younger adults and non-Hispanic Black people, are essential to meet vaccination targets and improve public health.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgements

The authors wish to acknowledge the contributions of the Data Managers at participating Vaccine Safety Datalink sites, and Jim Singleton for his review of the draft manuscript.

## Funding

This work was supported by the U.S. Centers for Disease Control and Prevention (Contract 75D30122D15425). The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

## Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: [Allison Naleway reports financial support was provided by Centers for Disease Control and Prevention. Lisa Jackson reports a relationship with Pfizer that includes: funding grants.].

## Data availability

The authors do not have permission to share data.

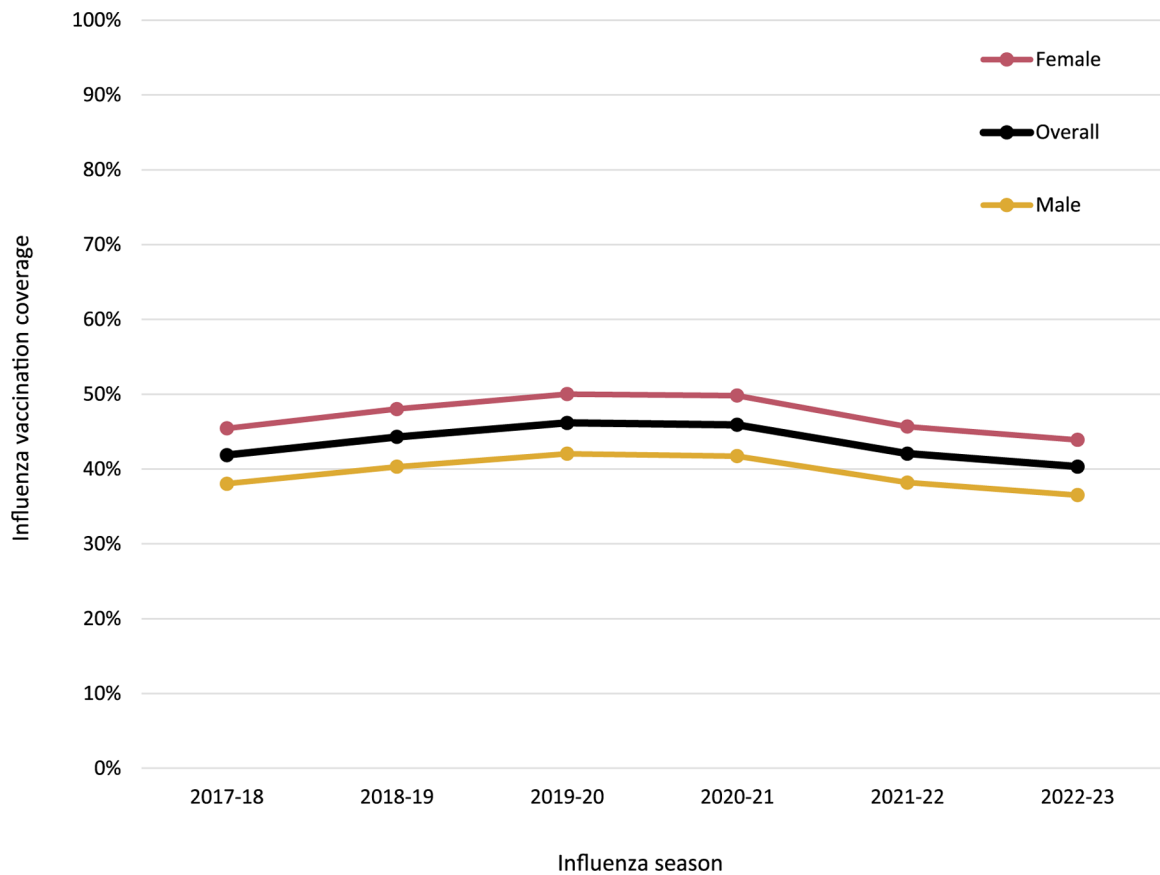
## References

- [1]. Nogareda F, Gharpure R, Contreras M, Velandia M, Lucia Pacis C, Elena Chevez A, et al. Seasonal influenza vaccination in the Americas: Progress and challenges during the COVID-19 pandemic. *Vaccine* 2023 Jul 12;41(31):4554–60. [PubMed: 37328348]

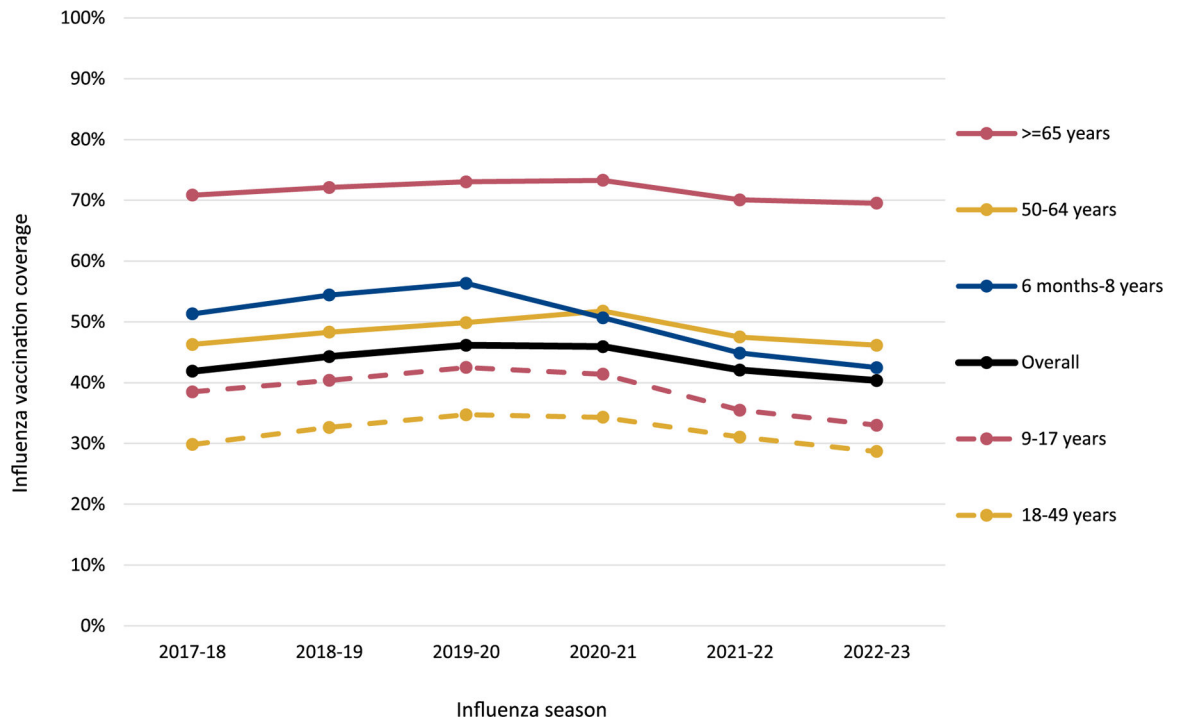


- [2]. Grohskopf LA, Blanton LH, Ferdinands JM, Chung JR, Broder KR, et al. Prevention and Control of Seasonal Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices – United States, 2022–23 Influenza Season. *MMWR - Recommendations and Reports* 2022 Aug 26;71(1):1–28. 10.15585/mmwr.r7101a1.
- [3]. Kini A, Morgan R, Kuo H, Shea P, Shapiro J, Leng SX, Pekosz A, Klein SL. Differences and disparities in seasonal influenza vaccine, acceptance, adverse reactions, and coverage by age, sex, gender, and race. *Vaccine*. 2022 Mar 8;40(11): 1643–1654. doi: 10.1016/j.vaccine.2021.04.013. Epub 2021 Apr 28. [PubMed: 33933316]
- [4]. Centers for Disease Control and Prevention. Influenza Vaccination Coverage for Persons 6 Months and Older. Accessed October 6, 2023. <https://www.cdc.gov/flu/fluvoxview/interactive-general-population.htm>.
- [5]. Day ME, Klein M, Sucharew H, Carol Burkhardt M, Reyner A, et al. Declining influenza vaccination rates in an underserved pediatric primary care center during the COVID-19 pandemic. *Vaccine*. 2022 Oct 19;40(44):6391–6396. Doi: 10.1016/j.vaccine.2022.09.016. Epub 2022 Sep 12. [PubMed: 36182616]
- [6]. Centers for Disease Control and Prevention. Flu Vaccination Coverage, United States, 2021–22 Influenza Season. Accessed June 16, 2023. <https://www.cdc.gov/flu/fluvoxview/coverage-2022estimates.htm>.
- [7]. Sukumaran L, McCarthy NL, Li R, Weintraub ES, Jacobsen SJ, et al. Demographic characteristics of members of the Vaccine Safety Datalink (VSD): A comparison with the United States population. *Vaccine*. 2015 Aug 26;33(36):4446–50. Doi: 10.1016/j.vaccine.2015.07.037. Epub 2015 Jul 23. [PubMed: 26209836]
- [8]. Davis AC, Voelkel JL, Remmers CL, Adams JL, McGlynn EA. Comparing Kaiser Permanente Members to the General Population: Implications for Generalizability of Research. *Perm J* 2023;22.172.
- [9]. Baggs J, Gee J, Lewis E, Fowler G, Benson P, et al. The Vaccine Safety Datalink: a model for monitoring immunization safety. *Pediatrics* 2011 May;127(Suppl 1): S45–53. 10.1542/peds.2010-1722H. [PubMed: 21502240]
- [10]. Lee GM, Greene SK, Weintraub ES, Baggs J, Kulldorff M, Fireman BH, et al. Vaccine Safety Datalink Project. H1N1 and seasonal influenza vaccine safety in the vaccine safety datalink project. *American Journal of Preventive Medicine* 2011 Aug;41(2): 121–8. 10.1016/j.amepre.2011.04.004. [PubMed: 21767718]
- [11]. Groom HC, Crane B, Naleway AL, et al. Monitoring vaccine safety using the vaccine safety Datalink: Assessing capacity to integrate data from Immunization Information systems. *Vaccine* 2022;40(5):752–6. [PubMed: 34980508]
- [12]. Centers for Disease Control and Prevention. CDC Stacks: MMWR Weeks. Accessed March 13, 2023. <https://stacks.cdc.gov/view/cdc/22305>.
- [13]. Grohskopf LA, Liburd LC, Redfield RR. Addressing Influenza Vaccination Disparities During the COVID-19 Pandemic. *Journal of the American Medical Association* 2020 Sep 15;324(11):1029–30. 10.1001/jama.2020.15845. [PubMed: 32930764]
- [14]. Lu PJ, Singleton JA, Euler GL, Williams WW, Bridges CB. Seasonal influenza vaccination coverage among adult populations in the United States, 2005–2011. *Am J Epidemiol*. 2013 Nov 1;178(9):1478–87. Doi: 10.1093/aje/kwt158. Epub 2013 Sep 5. [PubMed: 24008912]
- [15]. Almario CV, May FP, Maxwell AE, Ren W, Ponce NA, Spiegel BM. Persistent racial and ethnic disparities in flu vaccination coverage: Results from a population-based study. *American Journal of Infection Control* 2016 Sep 1;44(9):1004–9. 10.1016/j.ajic.2016.03.064. Epub 2016 Jun 29 [PubMed: 27372226]
- [16]. Black CL, O'Halloran A, Hung M, et al. Vital Signs: Influenza Hospitalizations and Vaccination Coverage by Race and Ethnicity—United States, 2009–10 Through 2021–22 Influenza Seasons. *MMWR. Morbidity and Mortality Weekly Report* 2022; 71:1366–73. [PubMed: 36302226]
- [17]. Centers for Disease Control and Prevention. Influenza Vaccination Coverage, Children 6 months through 17 years, United States. Accessed June 16, 2023. <https://www.cdc.gov/flu/fluvoxview/dashboard/vaccination-coverage-race.html>.

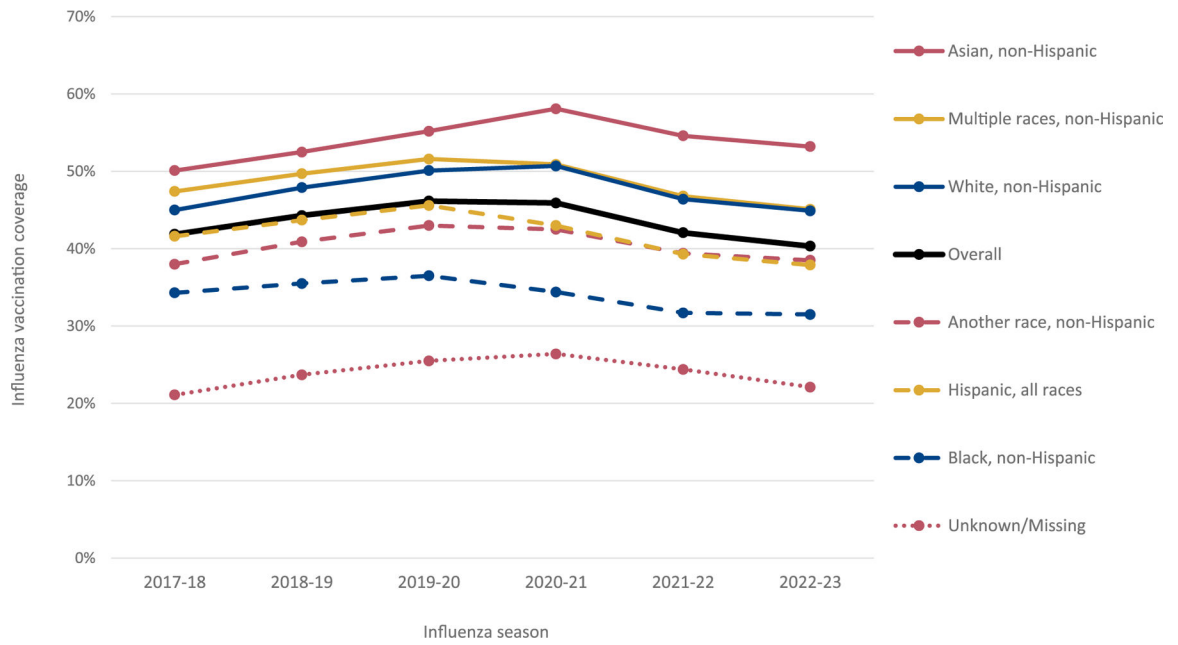
- [18]. Centers for Disease Control and Prevention. Influenza Vaccination Coverage, Adults. Accessed June 1, 2023. <https://www.cdc.gov/flu/fluview/dashboard/vaccination-adult-coverage.html>.
- [19]. Gates DM, Cohen SA, Orr K, Caffrey AR. Pediatric influenza vaccination rates lower than previous estimates in the United States. *Vaccine* 2022 Oct 19;40(44):6337–43. 10.1016/j.vaccine.2022.09.053. Epub 2022 Sep 24 [PubMed: 36167694]
- [20]. Santibanez TA, Srivastav A, Zhai Y, Singleton JA. Trends in Childhood Influenza Vaccination Coverage, United States, 2012–2019. *Public Health Rep.* 2020 Sep/Oct;135(5):640–649. Doi: 10.1177/0033354920944867. Epub 2020 Aug 12. [PubMed: 32783780]
- [21]. Centers for Disease Control and Prevention (CDC). Interim results: state-specific seasonal influenza vaccination coverage – United States, August 2009-January 2010. *MMWR Morb Mortal Wkly Rep.* 2010 Apr 30;59(16):477–84. Erratum in: *MMWR Morb Mortal Wkly Rep.* 2010 May 14;59(18):561. [PubMed: 20431523]
- [22]. Centers for Disease Control and Prevention (CDC). Seasonal influenza vaccination coverage among children aged 6 months-18 years — eight immunization information system sentinel sites, United States, 2009–10 influenza season. *MMWR Morb Mortal Wkly Rep.* 2010 Oct 8;59(39):1266–9. [PubMed: 20930704]



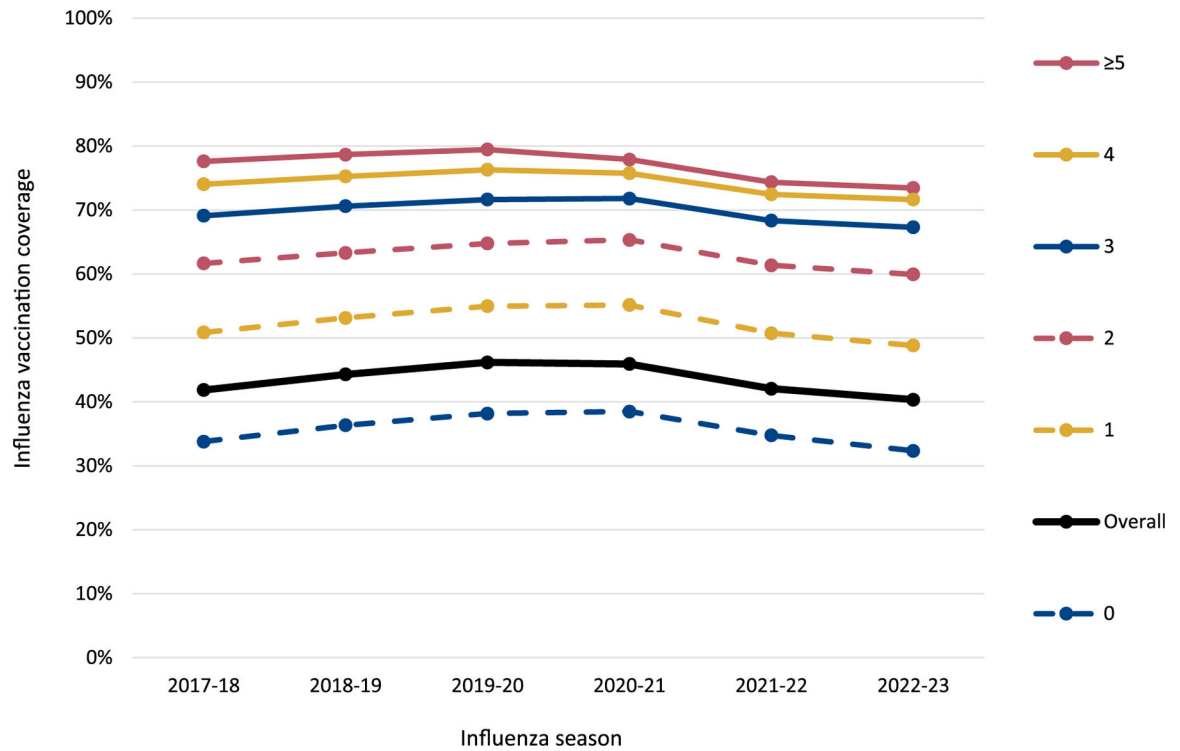
**Fig. 1.** Influenza vaccination coverage in the Vaccine Safety Datalink, overall and by sex – 2017–18 through 2022–23 influenza seasons. Legend: Influenza vaccination coverage among people ages 6 months in the Vaccine Safety Datalink, overall and stratified by sex. All same-season influenza vaccines administered between August 1 through March 31 were included in coverage estimates.



**Fig. 2.** Influenza vaccination coverage in the Vaccine Safety Datalink, by age group – 2017–18 through 2022–23 influenza seasons. Legend: Influenza vaccination coverage among people ages 6 months in the Vaccine Safety Datalink, overall and stratified by age group. All same-season influenza vaccines administered between August 1 through March 31 were included in coverage estimates. Age was determined as of the vaccination date among those vaccinated and as of March 31st each season among those unvaccinated.

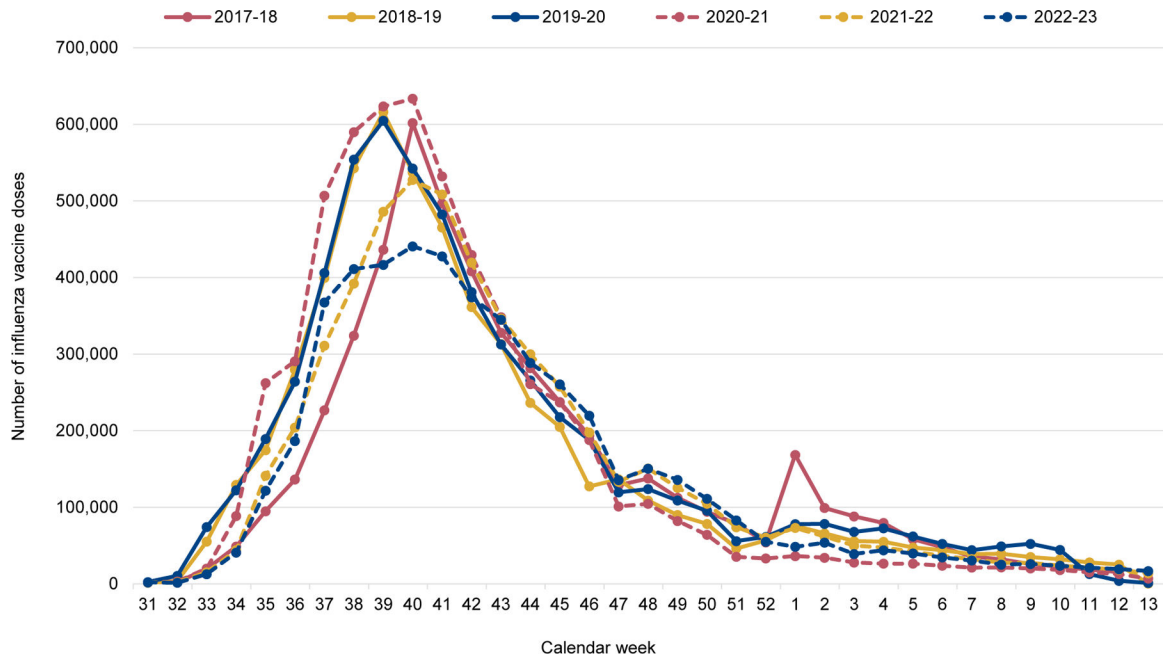


**Fig. 3.** Influenza vaccination coverage in the Vaccine Safety Datalink, by race and ethnicity – 2017–18 through 2022–23 influenza seasons. Legend: Influenza vaccination coverage among people ages 6 months in the Vaccine Safety Datalink, overall and stratified by race and ethnicity. All same-season influenza vaccines administered between August 1 through March 31 were included in coverage estimates.

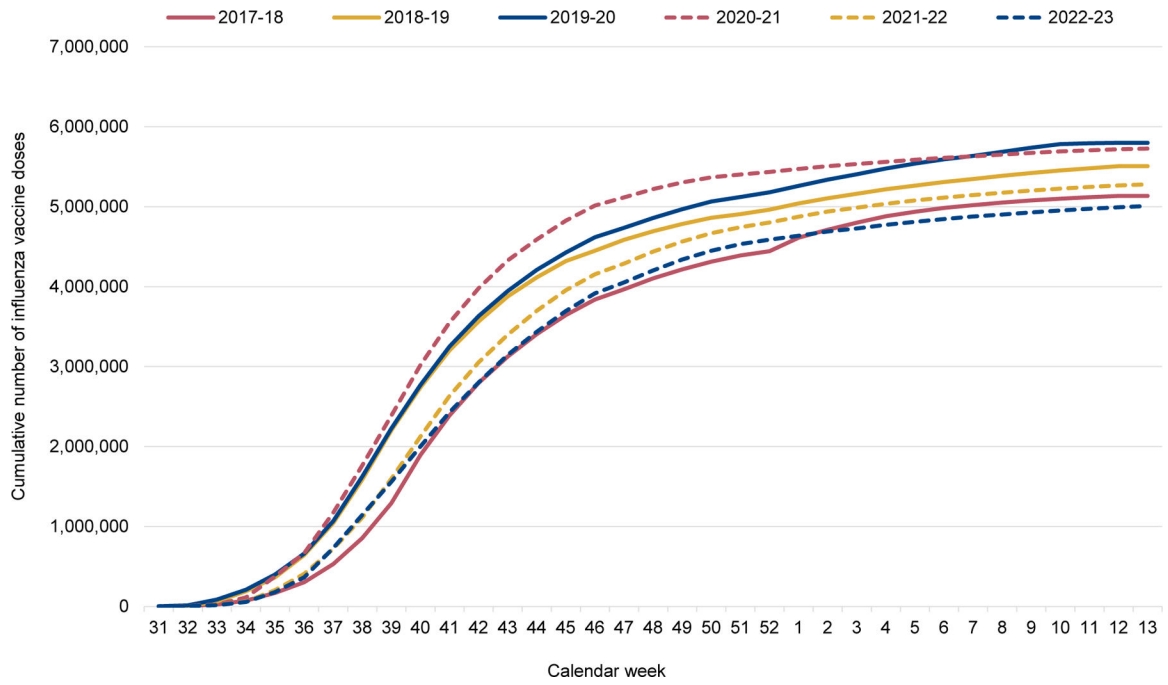


**Fig. 4.** Influenza vaccination coverage in the Vaccine Safety Datalink, by number of high-risk condition categories – 2017–18 through 2022–23 influenza seasons. Legend: Influenza vaccination coverage among people ages ≥ 6 months in the Vaccine Safety Datalink, overall and stratified by the number of high-risk condition categories. All same-season influenza vaccines administered between August 1 and March 31 were included in coverage estimates. Pre-defined conditions associated with increased risk of severe illness and complication from influenza were identified using ICD-10-CM diagnoses in the electronic health record during the period of August 1 through July 31 preceding the season of interest and are defined in Supplemental Table 2.





**Fig. 5.** Influenza vaccine doses administered by week in the Vaccine Safety Datalink – 2017–18 through 2022–23 influenza seasons.



**Fig. 6.** Cumulative influenza vaccine doses administered by week in the Vaccine Safety Datalink – 2017–18 through 2022–23 influenza seasons.

**Table 1**  
Demographic and clinical characteristics and influenza vaccination status of individuals within the Vaccine Safety Datalink in the 2017–18 through 2022–23 influenza seasons.

	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Total individuals, n <sup>*</sup>	12,263,777	12,436,192	12,570,303	12,472,364	12,548,380	12,417,097
Sex, n (col %) / Female	6,342,885 (51.7)	6,435,033 (51.7)	6,503,653 (51.7)	6,456,709 (51.8)	6,490,472 (51.7)	6,420,733 (51.7)
Male	5,920,892 (48.3)	6,001,159 (48.3)	6,066,650 (48.3)	6,015,655 (48.2)	6,057,908 (48.3)	5,996,364 (48.3)
Age group, n (col. %) <sup>^</sup>						
6 months – 8 years	1,138,001 (9.3)	1,143,269 (9.2)	1,143,259 (9.1)	1,111,497 (8.9)	1,090,149 (8.7)	1,061,645 (8.5)
9–17 years	1,322,673 (10.8)	1,324,837 (10.7)	1,329,982 (10.6)	1,303,853 (10.5)	1,293,225 (10.3)	1,274,750 (10.3)
18–49 years	5,591,344 (45.6)	5,679,462 (45.7)	5,740,592 (45.7)	5,670,841 (45.5)	5,721,857 (45.6)	5,638,182 (45.4)
50–64 years	2,483,993 (20.3)	2,495,784 (20.1)	2,508,982 (20.0)	2,488,608 (20.0)	2,477,621 (19.7)	2,431,315 (19.6)
>=65 years	1,727,764 (14.1)	1,792,836 (14.4)	1,847,479 (14.7)	1,897,549 (15.2)	1,965,523 (15.7)	2,011,195 (16.2)
Race and ethnicity, n (col. %)						
Asian, non-Hispanic	1,449,154 (11.8)	1,502,702 (12.1)	1,541,698 (12.3)	1,548,117 (12.4)	1,571,610 (12.5)	1,550,390 (12.5)
Black, non-Hispanic	821,933 (6.7)	830,161 (6.7)	832,047 (6.6)	824,722 (6.6)	829,879 (6.6)	815,162 (6.6)
Hispanic, all races	3,081,892 (25.1)	3,156,498 (25.4)	3,223,019 (25.6)	3,221,875 (25.8)	3,275,807 (26.1)	3,265,462 (26.3)
Multiple races, non-Hispanic	341,023 (2.8)	344,691 (2.8)	345,393 (2.7)	345,208 (2.8)	348,611 (2.8)	341,002 (2.7)
White, non-Hispanic	5,257,211 (42.9)	5,240,284 (42.1)	5,158,536 (41.0)	5,022,978 (40.3)	4,904,163 (39.1)	4,693,086 (37.8)
Another race, non-Hispanic	221,660 (1.8)	232,888 (1.9)	240,894 (1.9)	242,515 (1.9)	248,735 (2.0)	247,727 (2.0)
Unknown/Missing	1,090,904 (8.9)	1,128,968 (9.1)	1,228,716 (9.8)	1,266,949 (10.2)	1,369,575 (10.9)	1,504,268 (12.1)
High-risk condition categories, n (col. %) <sup>**</sup>						
0	8,502,924 (69.3)	8,579,014 (69.0)	8,625,458 (68.6)	8,760,693 (70.2)	8,906,244 (71.0)	8,577,355 (69.1)
1	1,766,703 (14.4)	1,812,182 (14.6)	1,834,767 (14.6)	1,757,254 (14.1)	1,640,753 (13.1)	1,773,251 (14.3)
2	838,329 (6.8)	852,523 (6.9)	868,309 (6.9)	807,271 (6.5)	806,474 (6.4)	847,517 (6.8)
3	477,964 (3.9)	483,732 (3.9)	495,819 (3.9)	456,236 (3.7)	467,381 (3.7)	478,818 (3.9)
4	281,731 (2.3)	288,530 (2.3)	300,060 (2.4)	275,428 (2.2)	287,896 (2.3)	292,631 (2.4)
5	396,126 (3.2)	420,211 (3.4)	445,890 (3.5)	415,482 (3.3)	439,632 (3.5)	447,525 (3.6)
Influenza vaccine receipt, n (col. %) <sup>^A</sup>						
Yes	5,134,230 (41.9)	5,508,488 (44.3)	5,802,462 (46.2)	5,727,266 (45.9)	5,278,453 (42.1)	5,008,528 (40.3)

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

\* Total individuals 6 months of age within the Vaccine Safety Datalink population as of August 1 each season, or with any population membership in the August 1-March 31 period of interest, if not a member on August 1, including those born during an influenza season who turned 6 months of age by March 31.

^ Age as of vaccination, among those vaccinated, or as of March 31 among those unvaccinated. Age is missing for the following numbers of people in the 2017–18 through 2022–23 seasons, respectively: 2, 4. Due to these missing data, totals for this category do not match the overall totals.

\*\* Number of separate, pre-defined categories in which a person had an electronic diagnosis associated with increased risk of severe illness and complications from influenza were identified using ICD-10-CM diagnoses in the electronic health record in the August 1-July 31 period prior to the season of interest (Supplemental Table 2).

^^ Any influenza vaccine received in the August 1-March 31 period each season.

**Table 2**

Influenza vaccination coverage among children in the Vaccine Safety Datalink in the 2017–18 through 2022–23 influenza seasons and difference in coverage between peak season\* and 2022–23.

	<b>2017–18 (%)</b>	<b>2018–19 (%)</b>	<b>2019–20 (%)</b>	<b>2020–21 (%)</b>	<b>2021–22 (%)</b>	<b>2022–23 (%)</b>	<b>Absolute percentage point change, peak season to 2022–23<sup>^</sup></b>	<b>Proportional change, peak season to 2022–23<sup>#</sup> (%)</b>
6–11 months	73.6	76.8	77.6	71.7	67.9	64.6	-13.0	-16.8
12–23 months	69.5	72.3	73.9	68.6	64.6	58.7	-15.2	-20.6
<2 years	71.3	74.3	75.5	69.9	65.8	61.2	-14.3	-18.9
6 months-8 years	51.3	54.4	56.3	50.7	44.9	42.5	-13.8	-24.5
9–17 years	38.5	40.4	42.5	41.4	35.5	33.0	-9.5	-22.4
6 months-17 years	44.4	46.9	48.9	45.7	39.8	37.3	-11.6	-23.7

\* Peak season is defined as the influenza season with the highest coverage estimate for that age group and is shown in bold.

<sup>^</sup> Percentage point change from the season with highest coverage to the 2022–23 coverage estimate.

<sup>#</sup> Percentage point change from the season with highest coverage to the 2022–23 coverage estimate, as a proportion of the highest coverage.