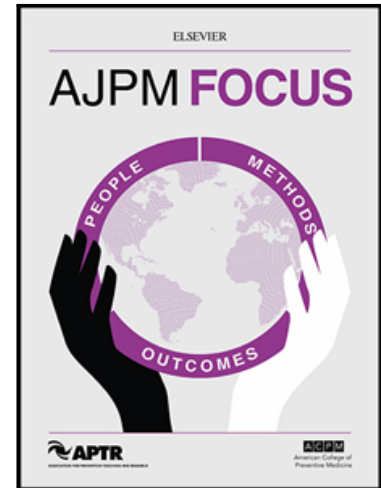


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Disparities and Trends in Routine Adult Vaccination Rates Among Disaggregated Asian American Subgroups, NHIS 2006-2018

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**Section:**Research Article

## **Disparities and Trends in Routine Adult Vaccination Rates Among Disaggregated Asian American Subgroups, NHIS 2006-2018**

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**Ziqing Wang:** Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing - original draft, Writing - review & editing. **Armaan Jamal:** Conceptualization, Methodology, Writing-original draft, Writing - review & editing, Visualization. **Ryan Wang:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Visualization. **Shozen Dan:** Conceptualization, Methodology, Visualization. **Shanthi Kappagoda:** Conceptualization, Supervision, Writing - review & editing. **Gloria Kim:** Funding Acquisition, Writing - review & editing. **Latha Palaniappan:** Funding Acquisition, Resources, Supervision, Writing - review & editing. **Jin Long:** Methodology, Supervision. **Jaiveer Singh:** Project administration, Resources. **Malathi Srinivasan:** Conceptualization, Methodology, Resources, Supervision, Writing - review & editing.

### **Highlights**

Routine vaccination rates in the U.S. are below Healthy People 2030 goals.

Asian Americans have lower rates in some routine vaccines than non-Hispanic Whites.

Routine vaccination rates differ among disaggregated Asian American subgroups.

Foreign-born Asian Americans have lower vaccination rates than their U.S.-born counterparts.

Culturally targeted public health interventions may improve vaccination rates.

### **Abstract**

**Introduction:** Vaccination rates may be improved through culturally tailored messages, but little is known about them among disaggregated Asian-American subgroups. We assessed vaccination rates for key vaccines among these subgroups.

**Methods:** Using the National Health Interview Survey (NHIS), we analyzed recent vaccination rates (2015-2018, n=188,250) and trends (2006-2018) among Asians (Chinese [n=3165], Asian Indian [n=3525], Filipino [n=3656], other Asian [n=5819]), and non-Hispanic White (NHW) adults [n=172,085] for six vaccines (the Human Papillomavirus [HPV], hepatitis B, pneumococcal, influenza, tetanus-diphtheria [tetanus], and shingles vaccines). We controlled demographic, socioeconomic, and health-related variables in multivariable logistic regression and predicted marginal modeling analyses. We also computed vaccination rates among Asian-American subgroups on the 2015-2018 NHIS data stratified by foreign-born and US-born status. We used Joinpoint regression to analyze trends of vaccination rates. All analyses were conducted in 2021 and 2022.

**Results:** Among Asians, shingles (29.2%, 95% CI = [26.6%-32.0%]), tetanus (53.7%, 95% CI = [51.8%-55.6%]), and pneumococcal (53.8%, 95% CI = [50.1%-57.4%]) vaccination rates were lower than NHWs. Influenza (47.9%, 95% CI = [46.2%-49.6%]) and hepatitis B (40.5%, 95% CI = [39.0%-42.7%]) vaccination rates were similar or higher than NHWs (48.4%, 95% CI = [47.9%-48.9%]) and 30.7%, 95% CI = [30.1%-31.3%], respectively). Among Asians, we found substantial variations in vaccination rates and trends. For example, Asian Indian women had lower HPV vaccination rates (12.9%, 95% CI = [9.1%-18.0%]) than all other Asian subgroups (Chinese: 37.9%, 95% CI = [31.1%-45.2%]; Filipinos: 38.7%, 95% CI = [29.9%-48.3%]; Other Asians: 30.4%, 95% CI = [24.8%-36.7%]), and non-Hispanic whites (36.1%, 95% CI = [34.8%-37.5%]).

Being male, lower education attainment and income, no health insurance or covered by public health insurance only, and lower frequency of doctor visits were generally associated with lower vaccine uptakes. Foreign-born Asian aggregate had lower vaccination rates than US-born Asian

aggregate for all vaccines except influenza. We also found subgroup-level differences in vaccination rates between foreign-born and US-born Asians. Compared to their respective US-born counterparts, (a) foreign-born Chinese, Asian Indians, and other Asians had lower HPV and hepatitis B vaccination rates, (b) foreign-born Chinese and Filipinos had lower pneumococcal vaccination rates, (c) foreign-born Chinese and Asian Indians had lower influenza vaccination rates, and (d) all foreign-born Asian subgroups had lower tetanus vaccination rates.

**Conclusion:** Vaccination rates and trends differed among Asian-American subgroups. Culturally tailored messaging and interventions may improve vaccine uptakes.

**Keywords:**

- ◁ Asian American
- ◁ Vaccination
- ◁ National Health Interview Survey
- ◁ Health disparities
- ◁ Disaggregation

**Introduction**

Vaccine-preventable diseases cause thousands of hospitalizations and deaths in the US every year.<sup>1-3</sup> Reducing vaccine-preventable diseases and other disparities in preventive health care is a major goal of Healthy People 2030.<sup>4</sup> However, racial and ethnic minorities have lower vaccination rates than White Americans.<sup>5</sup> Although some vaccine-preventable diseases such as hepatitis B disproportionately impact Asian Americans, vaccination rates in the United States among Asian Americans are low.<sup>1,6,7</sup>

To date, most US vaccination research aggregates data on Asian Americans, despite differences in vaccination rates, health behaviors, and health outcomes between Asian American subgroups.<sup>8-10</sup> Literature on vaccination rates among disaggregated Asian American subgroups are few and far between. One study on influenza vaccination rates has shown large disparities among Asian American subgroups.<sup>11</sup> One recent study found that most Asian American subgroups have higher COVID vaccination rates than NHW and other racial/ethnic minority groups, with variations in the Asian subgroups.<sup>12</sup> However, disaggregated studies on uptakes of other vaccines among Asian Americans are scarce.

Using the National Health Interview Survey (NHIS) from 2006-2018, we assessed rates for six routinely recommended vaccines: influenza, pneumococcal (including both polysaccharide and conjugate vaccines), herpes zoster (shingles), hepatitis B, tetanus-diphtheria (tetanus), and human papillomavirus among disaggregated Asian-American subgroups, and compared rates with non-Hispanic whites (NHWs). Understanding which groups have higher or lower vaccination rates can inform public health policies and clinical practices to reduce healthcare disparities in the US and help public health practitioners who work in corresponding communities focus on the most relevant interventions.

## **Methods**

### **Study Sample**

The NHIS is a continuous, cross-sectional interview survey that targets the non-institutionalized civilian population in the US. Data on socio-demographic information, access to healthcare, and health behaviors are gathered by trained interviewers from the US Census Bureau. To ensure that the sample is representative of the targeted population, NHIS uses a multistage area probability sampling design with stratification and clustering.<sup>13,14</sup> Our study used publicly available NHIS data harmonized by the Integrated Public Use Microdata Service (IPUMS).<sup>15</sup> We included individuals aged 19 or older who belong to one of the following racial/ethnic groups: NHW, Chinese, Filipino, Asian Indian, and Other Asian (OA). Vaccination rate trends by race were analyzed using data from 2006 to 2018 (n=572,961). Racial disparities in vaccination rates were analyzed using pooled data from 2015 to 2018 to achieve relatively up-to-date estimations and sufficient sample sizes in NHWs (n=172,085) and Asian subgroups (Chinese: n=3,165; Filipino: n=3,656; Asian Indian: n=3,525; Other Asian: 5,819).

## Measures

We analyzed six CDC recommended vaccines: the human papillomavirus (HPV), hepatitis B, pneumococcal, influenza, tetanus (tetanus), and shingles vaccines.<sup>16</sup> Participants were asked whether they have ever received each vaccine within the recommended time frame. Participants responded to prompts for universal vaccines: "Have you ever received the hepatitis B vaccine?" For shingles, participants 50 and older were asked whether they had received the Zostavax vaccine status only. Starting from 2018, they were asked whether they had either of the Zostavax vaccine or the new Shingrix vaccine. Since we used pooled data from 2015 to 2018 and that Zostavax was not routinely recommended for adults aged 50-59, we

examined the shingles vaccination rates among those 60 and older.<sup>17</sup> HPV-eligible female adults (aged 12-26 when vaccine became available in the US) "Have you ever received an HPV shot or vaccine?"

Race/ethnicity was measured by self-identification. We examined vaccination rates of Asians and NHWs in publicly available NHIS adult data.

Our study included demographic, socioeconomic, and health-related covariates. The demographic variables included age (grouped into 19-26 years old, 27-49 years old, 50-64 years old, 65+ years old and controlled for in universally recommended vaccines; in unit of year and controlled for in age-specific vaccines within their respective recommended age ranges), sex (female, male), marital status (currently married, not currently married), and nativity (US-born, foreign-born and  $\geq 10$  years in the US, foreign-born and lived  $< 10$  years in the US).

Socioeconomic variables included family annual income ( $\leq \$34,999$ ,  $\$35,000$ -\$96,999,  $\geq \$97,000$ ), education level (less than high school, high school graduate/GED/some college, and type of health insurance coverage (public insurance only, private insurance only, both public and private insurance, and not covered). Health-related covariates included self-reported health status (excellent/very good, good, fair/poor) and the number of physician visits (0-3 visits, 4-7 visits, 8 or more visits).

### **Statistical analysis**

For each racial/ethnic group, we calculated weighted vaccination rates and their 95% confidence intervals. We used sampling weights stored in the NHIS data set. These weights represent the



inverse probability of an observation being selected into the sample, adjusted for non-response and complex sampling designs. For each year, these weights sum to the total number of non-institutionalized civilian population in the US in that year. We computed the weighted rates instead of the raw, unweighted rates to produce nationally representative estimates. T-tests were used to compare weighted rates between NHWs and Asian subgroups. Chi-square tests were used to compare proportions of participants in NHW and Asian subgroups in categories of included population characteristics.

Multivariable logistic regression models were fitted for each vaccination outcome to identify independently associated factors. Wald tests were used to determine statistical significance of regression coefficients. Predictive marginal models were used to calculate adjusted vaccination rates, which are predictive means of vaccination rates stratified by race/ethnicity while controlling for all covariates in the multivariable logistic regression models. Each adjusted rate was calculated as a probability-weighted average of the fitted probabilities of receiving the vaccine calculated from the regression model over a new, standardized population. In this population, all observations were set to each race/ethnicity respectively while holding other covariates at their respective probability-weighted means. T-tests were used to compare adjusted vaccination rates between NHWs and Asian subgroups.

Joinpoint version 4.9.0.0 was used in 2021 to analyze trends in adult vaccination rates from 2006 to 2018.<sup>18</sup> The Joinpoint statistical software fits the simplest joinpoint model allowable by data inputs and uses a Monte Carlo Permutation method to incrementally test for statistically significant joinpoints.<sup>19</sup> Detecting a joinpoint means that the model favors the alternative

hypothesis that there is a change in trend at the time corresponding to the joinpoint. Therefore, the software tests statistical significance of changes in trend and visualizes the fitted models as different line segments connected by joinpoints.<sup>18,19</sup> For HPV, shingles, and tetanus vaccines, data from 2008 (instead of 2006) to 2018 were used in joinpoint analyses, because they were unavailable in NHIS until 2008. Two measures were used to characterize trends: the APC (Annual Percent Change) is the percentage change in vaccination rate compared to the previous year within the same time segment (between the starting time point and the first joinpoint, between two consecutive joinpoints, or between the last joinpoint and the ending time point). The AAPC (Average Annual Percent Change) is the weighted average of all APCs, where each weight is the length of the time segment over which each APC was computed<sup>18</sup>. If no joinpoint was detected, the two measures are equal.

We conducted additional analyses on the 2015-2018 data stratified by US-born vs. foreign-born status, where we calculated the weighted and adjusted vaccination rates among US-born Asian subgroups and foreign-born Asian subgroups, separately.

All statistical analyses except Joinpoint regression were performed in 2021 and 2022 using R version 4.1.0.<sup>20</sup> This study was considered not human subject research by Stanford Institutional Review Board (protocol #61782).

## **Results**

From 2015 to 2018, we included 16,165 Asian respondents (3,165 Chinese, 3,656 Filipinos, 3,525 Asian Indians, and 5,819 other Asians). In this population, weighted vaccination rates were 28.4% (95% CI: 25.1%-31.8%) for HPV vaccines among age-eligible females, 40.5% (95% CI: 39.0%-42.2%) for hepatitis B vaccines, 53.8% (95% CI: 50.1%-57.4%) for pneumococcal vaccines among those 65 or older, 47.9% (95% CI: 46.2%-49.6%) for influenza vaccines, 53.7% (95% CI: 51.8%-55.6%) for tetanus vaccines, and 29.2% (95% CI: 26.6%-32.0%) for shingles vaccines among those 60 or older (Table 1). Figure 1 visualizes the vaccination rate trends (Appendix Table 1, 4, 7, 10, 13, 16, 19).

### **Human Papillomavirus Vaccine**

While the estimated HPV vaccination rate for age-eligible adult females was significantly lower among aggregated Asians (28.4%) than NHWs (36.1%), it is not significantly different for Chinese (37.9%), Filipinos (38.7%), and other Asians (30.4%) from NHWs. Notably, age-eligible adult Asian Indian females (12.9%) had significantly lower vaccination rates than all included groups (Table 1). Adjusted HPV vaccination rates were 38.4% for Chinese, 44.9% for Filipinos, and 36.1% for other Asians, all similar or higher than that for NHWs (35.6%). However, the adjusted HPV vaccination rate in age-eligible adult Asian Indian females (23.1%) remained lowest (Table 2).

HPV vaccination rates increased for all groups from 2008 to 2018 at similar rates (Appendix Table 3) for Chinese (AAPC=11.7, 95% CI=6.1, 17.5), Filipinos (AAPC=13.5, 95% CI=8.0, 19.2), Asian Indians (AAPC=10.1, 95% CI=2.7, 18.1), other Asians (AAPC=12.5, 95% CI=7.2, 18.1), and NHWs (AAPC=11.3, 95% CI=8.3, 14.3).

## **Hepatitis B Vaccine**

The estimated hepatitis B adult vaccination rates were 38.5% for Chinese, 42.3% for Filipinos, 41.2% for Asian Indians, and 40.4% for other Asians, all significantly higher than NHWs (30.7%) (Table 1). The adjusted hepatitis B vaccination rates for Chinese (36.0%) and Asian Indians (35.6%) were not significantly different from NHWs (34.0%), while Filipinos (45.0%) and other Asians (42.3%) had higher rates than NHWs (Table 2).

From 2006 to 2018, the hepatitis B vaccination rate remained stable (Appendix Table 6) for Chinese (AAPC=1.6, 95% CI=-1.7, 4.9), Filipinos (AAPC=1.0, 95% CI=-0.7, 2.7), and Asian Indians (AAPC=0.9, 95% CI=-5.4, 7.6). It moderately increased for other Asians (AAPC=5.2, 95% CI=1.9, 8.5) and NHWs (AAPC=2.2, 95% CI=0.9, 3.6). Chinese (APC=6.7, 95% CI=0.8, 12.8) and NHW (APC=3.5, 95% CI=1.4, 5.7) had increasing trends in the hepatitis B vaccination rate from 2006 to 2012 and 2011, respectively. Other Asians (APC=19.1, 95% CI=1.5, 39.6) and NHW (APC=9.7, 95% CI=1.6, 18.5) had increasing trends from 2016 to 2018. Chinese (APC=-3.3, 95% CI=-8.1, 1.8), Asian Indians (APC=-9.5, 95% CI=-31.2, 18.9), other Asians (APC=-3.5, 1.6), and NHW (APC=-1.9, 95% CI=-4.3, 0.4) had negative, although statistically insignificant, point estimates of APC for hepatitis B vaccination rates from 2006 to 2018, 2015, 2016, and 2016, respectively (Appendix Table 5).

## **Pneumococcal Vaccine**

The estimated pneumococcal vaccination rates among adults 65 or older were 48.7% for Chinese, 62.8% for Filipinos, 57.7% for Asian Indians, and 48.4% for other Asians, all significantly lower than NHWs (71.1%) (Table 1). Chinese (64.8%) and other Asians (66.8%) had lower point estimates for adjusted pneumococcal vaccination rates than NHWs (70.5%). Filipinos (77.4%)

and Asian Indians (75.5%) had higher point estimates for adjusted vaccination rates than NHWs (Table 2). However, these differences were not statistically significant.

From 2006 to 2018, pneumococcal vaccination rates significantly increased for Filipinos (AAPC=4.4, 95% CI=2.5, 6.3) and NHWs (AAPC=1.3, 95% CI=0.9, 1.8) and displayed non-significant upward trends for Chinese (AAPC=3.2, 95% CI=-0.4, 6.9), Asian Indians (AAPC=1.5, 95% CI=-2.0, 5.2), and other Asians (AAPC=1.4, 95% CI=-1.6, 4.5). No joinpoint was detected (Appendix Table 9).

### **Influenza Vaccine**

Although the estimated adult influenza vaccination rate was not statistically significantly different for aggregated Asians (47.9%) than NHWs (48.4%), it is significantly higher in Filipinos (53.0%) and significantly lower in Chinese (43.1%) than NHWs (Table 1). The adjusted influenza vaccination rates for all Asian subgroups were higher than NHWs  $\hat{=}$  49.7% for Chinese, 56.8% for Filipinos, 55.1% for Asian Indians, 56.0% for other Asians, and 44.5% for NHWs (Table 2).

Influenza vaccination rates increased for all groups from 2006 to 2018 (Appendix Table 12).

Influenza vaccination rates overall increased at similar or faster pace in Chinese (AAPC=4.2, 95% CI=1.8-6.6), Filipinos (AAPC=4.0, 95% CI=2.1-5.9), Asian Indians (AAPC=4.6, 95% CI=4.6, 14.8), and other Asians (AAPC=4.2, 95% CI 2.9-5.6) than NHWs (AAPC=3.0, 95% CI=2.1-4.0).

However, the influenza vaccination leveled off for several Asian groups (Appendix Table 11).

For example, the influenza vaccination rate in Chinese increased from 2006 to 2010 (APC=10.1,



















































