HPV Vaccination in the Virginia Context: Demographic Disparities, Patient-Provider Gender Concordance and the Impact of Changing Recommendations

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Abstract

Objective: Despite its effectiveness in preventing several cancers, there are marked disparities in HPV vaccination initiation and series completion. The present study sought to understand disparities in HPV vaccinations among patients in northern Virginia (ages 9-26) and the impact of patient and provider gender concordance, in lieu of CDC's vaccine recommendation changes in 2016, which reduced the recommended doses from three to two, in this population.
Design: Analyses of electronic medical records collected from 2012 to 2017.
Setting: A large health care system in Northern Virginia.
Participants: A total of 37,427 patients, ages 9 to 26, were included in analyses.
Main outcome measures: We examined odds of initiating vaccination, completing vaccination at 6 months, completing vaccination at 12 months and clinical completion. We examined if patient and provider characteristics were associated with initiating vaccination and vaccination completion at different durations.
Results: Racial minorities had higher odds of getting vaccinated, relative to non-Latino whites. Each additional year between the patient's first and last visit was associated with higher odds of initiating vaccination, completing vaccination at both 6 and 12 months, and clinical completion. Compared to female patients who were 19 years and older, female patients aged 9-18 years had higher odds of initiating vaccination and clinical completion. Compared to male patients who were 19 years and older, female patients aged 9-18 years had higher odds of clinical completion Female and male patients had better outcomes when seen by female primary care providers than male primary care providers.
Conclusions and Relevance: Further research should investigate the observed benefit of female providers and to understand the long-term impact of changes in CDC recommendations.

Introduction

Globally, human papillomavirus (HPV) accounts for 690,000 incident cancer cases a year, with cervical, anogenital and oropharyngeal cancers comprising the majority of cases.[1, 2] In 2018, in North America, this amounts to 39,000 cases annually.[2] HPV vaccines are effective at preventing several cancers caused by HPV infections, including cervical,[3-5] vaginal,[6] and anal[7] cancers. Since the vaccine recommendations targeting adolescents were introduced in the United States in 2006, the prevalence of HPV types targeted by the vaccine has dropped by more than half in teenage women from 2003-2006 to 2007-2010.[8] Additionally, the prevalence of oral HPV infections was 88.2% among young adults who reported receipt of at least one dose of HPV vaccine compared to unvaccinated individuals.[9] Despite the demonstrated benefits, in 2015, among adolescents aged 13-15 years, only 37.1% girls and 27.1% of boys, respectively, had completed the three-dose HPV vaccine series.[10]

Prior studies have demonstrated that disparities exist in HPV vaccine series initiation. In general, those that are older, non-Latino-white (relative to other races) and those with private health insurance (relative to those who have publicly funded coverage) are more likely to initiate the vaccine series.[11-13] However, these associations vary by study, suggesting that differences in the population under examination are important. Disparities by medical department and health care provider specialty have also been documented, with family medicine practices showing higher rates of vaccine initiation, relative to general medicine or obstetrics and gynecology (OBGYN).[11]

Emerging research has also shown that provider characteristics, like provider gender, may influence HPV vaccination rates. Female providers are more likely to deliver adolescent vaccines than their male counterparts.[14] Providers are also more likely to recommend the vaccine to female patients than male patients.[15, 16] Furthermore, female patients report being more likely to get the vaccine if recommended by a female health care provider.[17] In all, studies highlight a complex interplay of patient and provider gender in determining vaccine recommendations and administration, however, examinations of the interaction between patient and provider gender are limited.

In Virginia, beginning October 1, 2008, all doses of the HPV vaccine series are mandatory for females attending all schools, with the 1st dose required to be administered before the start of 6th grade.[18] However, unlike other vaccines, parents can opt out of their children getting vaccinated against HPV because of its non-communicable nature in a school setting.[19] Parental barriers to HPV vaccination for their children include lack of physician recommendation for the vaccine, need for more information about the vaccine, low perceived risk of HPV infection, potential effect on sexual behavior, social influences, and vaccine cost. Of note, one barrier to completing all the doses of the HPV vaccination series is the lack of awareness or forgetfulness among parents that HPV vaccine is administered via multiple doses.[20]

Parents and guardians in Virginia are encouraged to submit the HPV immunization documents when their child starts school.[19, 21] According to the 2016 National Immunization Survey, in the state of Virginia, 41.1% of female and 37.4% of male adolescents aged 13-17 years had ≥3 HPV vaccine doses, including 2 doses received before 15 years of age. HPV immunization rates for

Virginia were similar to the national data from the same survey, where 49.5% of female and 37.5% of male adolescents aged 13-17 years in the United States received ≥3 HPV doses.[22]

Recent factors may make it easier to ensure compliance with HPV vaccine recommendations in the US and could potentially reduce existing disparities. Based on updated efficacy and effectiveness data, the Center for Disease Control and Prevention (CDC) Advisory Committee on Immunization Practices (ACIP) altered the vaccination schedule recommendations for children ages 9-14, by recommending a two-dose vaccination series in late October 2016.[23] Individuals 15-26 years of age were still advised to complete the previously recommended three-dose series. Thus, those who initiate the vaccine at a younger age now have fewer vaccine doses to complete, and consequently could facilitate vaccine schedule adherence. However, the impact of this policy on vaccine initiation and completion has not been examined extensively.

This study examined how disparities in HPV vaccination manifest in the state of Virginia, which has lower HPV vaccination rates than most states,[24] in spite of being one of only three states or territories mandating the HPV vaccine for school attendance.[25] In particular, given the change in ACIP vaccine recommendations, we examined how patient and provider factors are associated with initiation, partial completion, and full completion of the vaccination series.

Methods

Data

Data for this study come from electronic medical records of patients from a large healthcare system located in Northern Virginia. Data represented 41 health system practices, including 21 Family Medicine, 8 Internal Medicine, 8 Obstetrics and Gynecology (OBGYN) and 4 Pediatric that served low-income communities. Records for patients who were ages 9-26 at any point between 1/1/2012 and 7/31/2017 and had an office visit were included. Patients with a diagnosis of HPV via DNA test, or history of an abnormal PAP smear were excluded. This represented a total of 103,664 patient visits made by 37,427 patients. Records were coded to include reason for visit and if the patient received an HPV vaccine during their visit. Data use for this study was approved by both the health system and the University of Virginia Institutional Review Boards. Because this study involved a secondary analysis of de-identified data, informed consent was not required.

Variables

There were four dependent variables of interest: initiation of vaccination (i.e. receiving at least 1 vaccine dose), completion of vaccination series in 6 months, completion of vaccination series in 12 months, and clinical completion (i.e. completion of vaccination series within 3 years).

Several patient characteristics were examined as independent variables in analyses. These were: gender, race/ethnicity (White, Asian, Black, Latino, Middle Eastern, Multiracial, other race or unknown race), average age across all visits (9-10, 11-12, 13-18 and 19+), insurance coverage (public, private, other or unknown) and years between first and last visit (measured as a continuous variable). Two primary care provider characteristics were also examined: gender and department (primary care, family medicine, internal medicine, OBGYN and other providers). The "other provider" category included pediatricians, nurse practitioners, dermatologists and subspecialists managing a variety of clinics where eligible patients were seen.

According to the ACIP recommendations for HPV vaccination, the following criteria were applied for vaccination completion within 6 months:
a) For age groups more than 15 years, 3 shots should be given within 6 months;
b) For age groups less than 15 years, adolescents who have received 1 shot before April 2016, 3 shots be given within 6 months; and
c) For age groups less than 15 years, adolescents who have received 1 shot after April 2016, 2 shots be given within 6 months.

The same criteria were applied to vaccination completion within 12 months and clinical completion (i.e. completion of vaccination within 3 years), respectively. These definitions allow for the concurrent examination of both the older three-dose and newer two-dose vaccination recommendations.

Analyses

Data were analyzed using SAS 9.4. Sample characteristics were tabulated by the dependent variables. Because the outcome of interest was binary, logistic regression models, limited to the 33,150 cases with complete data, were used to estimate odds of the 4 different outcomes. Marginally standardized probabilities were also calculated.[26] These probabilities were created by scoring the data with model-based predicted probabilities assuming all the patients received the level of a variable (regardless of observed level). The sample average of the predicted probabilities was then used to get the marginally standardized probabilities. The probabilities can then be compared after eliminating biases due to different confounder distributions between levels.[26]

Results

Table 1 shows the sample characteristics. In general, vaccination initiation (47.83%), 6 months completion (1.22%), 12 months completion (2.53%) and clinical completion rates (5.79%) were highest among those who were 11-12 years of age. Latinos demonstrated the highest initiation (27.99%), 6 months completion (0.35%), 12 months completion (1.04%) and completion rates (3.21%), when compared to other racial/ethnic minority groups. Males and females saw similar rates of vaccine series initiation, 6 months completion, 12 months completion and clinical completion rates. Those with public insurance coverage saw higher rates of HPV vaccination initiation (23.12%), 6 months completion (0.35%), 12 months completion (0.86%) and clinical completion rates (2.31%); relative to other insurance types. Patients whose primary care provider was a female had higher rates of vaccination initiation (11.29%), 6 months completion (0.19%), 12 months completion (0.45%) and clinical completion (0.85%) compared to those who had a male primary care provider. Patients who had a primary care provider in "other" departments had the highest rates of vaccination initiation (42.95%), 6 months completion (0.67%), 12 months completion (1.56%) and clinical completion (5.43%).

Table 2 shows the results of the binary logistic regression model for the four dependent variables. Asian (OR=1.56; 95% CI= 1.34, 1.81), Black (OR=1.51; 95% CI= 1.31, 1.73), Latino (OR=1.67; 95% CI= 1.44, 1.93), other race (OR=1.63; 95% CI= 1.40, 1.88) and multiracial (OR=1.70; 95% CI= 1.29, 2.21) patients had higher odds of initiating at least one dose of HPV vaccination, relative to white patients. Each additional year between the patient's first and last visit was associated with higher odds of initiating vaccination (OR=1.63; 95% CI= 1.58, 1.68), completing vaccinations in 6 months (OR=1.46; 95% CI= 1.20, 1.78), completing vaccinations in 12 months (OR=1.71; 95% CI= 1.51, 1.94), and clinical completion (OR=1.92; 95% CI= 1.76,

2.10). Those that were 11-12 years of age had almost ten times the odds of initiating vaccination (OR=9.17; 95% CI= 8.03, 10.48), 6 months completion (OR=22.62; 95% CI= 9.19, 62.62), 12 months completion (OR=14.16; 95% CI= 7.86, 26.41) and clinical completion (OR=11.81; 95% CI= 7.39, 19.27), relative to patients who were 19 years or older. Those that were 13-18 years of age had more than three times the odds of initiating vaccination (OR=3.39; 95% CI= 3.06, 3.76), 6 months completion (OR=4.14; 95% CI= 1.65, 11.49), 12 months completion (OR=3.83; 95% CI= 2.17, 7.01) and clinical completion (OR=4.02; 95% CI= 2.60, 6.40), relative to patients who were 19 years or older. Patients with female primary care providers had higher odds of initiating vaccination(OR=1.51; 95% CI= 1.37, 1.66) , 6 months completion (OR=2.27; 95% CI= 1.16, 4.83), 12 months completion (OR=1.95; 95% CI= 1.25, 3.14) and clinical completion (OR=1.35; 95% CI= 1.01, 1.81), relative to those with male primary care providers. Patients with primary care providers from other departments had higher odds of initiating vaccination (OR=2.99; 95% CI= 2.53, 3.54), and clinical completion (OR=2.06; 95% CI= 1.28, 3.35), relative to patients with providers in the primary care department.

Table 3 shows the results of binary logistic regression models in female patients. Asian (OR=1.72; 95% CI= 1.42, 2.07), Black (OR=1.70; 95% CI= 1.43, 2.01), Latino (OR=1.68; 95% CI= 1.39, 2.03), other race (OR=1.75; 95% CI= 1.46, 2.09), unknown race (OR=1.39; 95% CI=1.11, 1.72), and multiracial (OR=1.80; 95% CI=1.28, 2.47) female patients had higher odds of initiating HPV vaccination, relative to white female patients. Each additional year between the female patient's first and last visit was associated with higher odds of initiating vaccination (OR=1.59; 95% CI=1.53,1.65), completing vaccinations in 6 months (OR=1.44; 95% CI=1.10,1.87), completing vaccinations in 12 months (OR=1.74; 95% CI=1.48, 2.05), and clinical completion (OR=2.02; 95% CI=1.79, 2.28). Female patients that were 9-10 years of age had more than ten times the odds of completing vaccination in 6 months (OR=13.23; 95% CI=1.92, 92.39), and more than four times the odds of clinical completion (OR=4.35; 95% CI=1.77, 9.82), relative to female patients who were 19 years or older. Female patients that were 11-12 years of age had higher odds of initiating vaccination (OR=9.87; 95% CI=8.31, 11.72), 6 months completion (OR=45.88; 95% CI=12.26, 253.53), 12 months completion (OR=16.36; 95% CI=7.82, 35.89) and clinical completion (OR=13.15; 95% CI=7.44, 23.74), relative to female patients who were 19 years or older. Female patients that were 13-18 years of age had higher odds of initiating vaccination (OR=2.97; 95% CI=2.61, 3.36), 6 months completion (OR=8.83; 95% CI=3.37, 47.92), 12 months completion (OR=3.90; 95% CI=1.90, 8.39) and clinical completion (OR=3.20; 95% CI=1.86, 5.63), relative to female patients who were 19 years or older. Female patients visiting female primary care providers had higher odds of initiating vaccination (OR=1.54; 95% CI=1.35, 1.75), and clinical completion (OR=1.63; 95% CI=1.05, 2.61), relative to those visiting male primary care providers. Female patients with primary care providers from other departments (OR=2.30; 95% CI=1.84, 2.89) and obstetrician and gynecology department (OR=1.96; 95% CI=1.57, 2.43) had higher odds of initiating vaccination, relative to female patients with providers in the primary care department.

Table 4 shows the results of binary logistic regression models in male patients. Latino (OR=1.58; 95% CI= 1.25, 1.99) and other race (OR=1.44; 95% CI= 1.12, 1.83) male patients had higher odds of initiating HPV vaccination relative to white male patients. Each additional year between the male patient's first and last visit was associated with higher odds of initiating vaccination (OR=1.67; 95% CI=1.59, 1.75), completing vaccinations in 6 months (OR=1.48;

95% CI=1.10,1.95), completing vaccinations in 12 months (OR=1.65; 95% CI=1.36, 1.99), and clinical completion (OR=1.81; 95% CI=1.59, 2.07). Male patients that were 9-10 years of age had higher odds of clinical completion (OR=5.08; 95% CI=1.83, 14.78), relative to male patients who were 19 years or older. Male patients that were 11-12 years of age had almost ten times the odds of initiating vaccination (OR=9.36; 95% CI=7.51, 11.68), 6 months completion (OR=9.79; 95% CI=2.98, 36.08), 12 months completion (OR=10.32; 95% CI=4.04, 29.21) and clinical completion (OR=12.60; 95% CI=5.55, 32.35), relative to male patients who were 19 years or older. Male patients that were 13-18 years of age had higher odds of initiating vaccination (OR=4.46; 95% CI=3.72, 5.35), 12 months completion (OR=3.36; 95% CI=1.39, 9.17), and clinical completion (OR=5.81; 95% CI=2.69, 14.40), relative to male patients who were 19 years or older. Male patients visiting female primary care providers had higher odds of initiating vaccination (OR=1.46; 95% CI=1.27, 1.69), 6 months completion (OR=3.91; 95% CI=1.49, 12.68) and clinical completion (OR=1.74; 95% CI=1.48, 5.82), relative to those visiting male primary care providers. Male patients with primary care providers from other departments had higher odds of initiating vaccination (OR=3.94; 95% CI=3.05, 5.09) and clinical completion (OR=3.54; 95% CI=1.73, 7.36), relative to male patients with providers in the primary care department.

Discussion

Results showed that most non-white patients had higher odds of initiating or completing the HPV vaccine series in this study population. This differs from much of the existing literature showing that minority populations have lower rates of initiation and ultimate completion of the HPV vaccination schedule.[27-29] Racial minorities are also less likely to be insured or utilize preventive health care than non-Latino whites.[30, 31] Even though, the present study is limited to people who live in a racially diverse part of the United States, the higher income nature of the Northern Virginia area may help explain some of the disparities observed. Specifically, previous research has shown that parents with higher socio-economic status and parents who are white are less likely to hold pro-social views about the HPV vaccine (i.e. seeing the vaccine as beneficial to society and not just the recipient)[29] and that anti-vaccine attitudes are more common in more affluent areas.[32]

While two-dose HPV vaccination is now common practice for 9-14-year-olds in the United States, this study indicates that vaccine initiation is still a major hurdle in this population. Among the 9-10-year-olds that initiated HPV vaccination, they had more time to achieve clinical completion compared to the older cohort. It may also indicate more frequent health care visits and thus more opportunities to get educated about HPV vaccination schedule.[33] The geographic area of Northern Virginia served by the study health system is a highly affluent region that likely serves parents with higher educational levels compared to some of the rural parts of Virginia. It is possible that parents residing in the area are more informed about HPV vaccination, more likely to follow the Virginia mandate, and thus are proponents of its completion within the intended time period.[34]
However, this population had higher odds of achieving clinical completion compared to 19+-year-olds. We also found that 11-18-year-olds had higher odds of vaccine initiation, which is similar to previous research looking at the age duration of HPV vaccine initiation.[35] Furthermore, those previously eligible for the vaccine, who had not yet initiated the vaccination series, may

represent a "hard-to-reach" population whose likelihood to vaccinate is driven by factors that cannot be accounted for in medical record data. HPV vaccination is covered under public insurance programs such as Medicaid, vaccines for children program, children's health insurance program, and immunization grant program.[36] Research also shows that parents are more accepting of HPV vaccination if they have public insurance or pay out-of-pocket.[37] This is in support with the findings of our study that shows higher odds of vaccine initiation among the overall study population whose parents were covered by public insurance.

The rates of vaccination initiation for patients seeing internal medicine providers were lower when compared to other primary care providers. This may be due to the age range of the study population. Also, internal medicine physicians generally cater to adults rather than children whereas family medicine physicians or pediatricians often cater to both children and adults. Previous research has shown that a majority of physicians that cater to vaccinated children and children that are exempt from vaccination are pediatricians (53.7%), followed by family medicine (44.4%) and internal medicine (7.4%).[38] Compared to family medicine physicians, internal medicine physicians also tend to stock less vaccinations [39] and do not perceive the need to stock vaccinations due to the age of their patient population.[21]

Also, our findings showed a significant relationship between patient and provider gender in HPV vaccinations. Our study suggests that regardless of patient gender, vaccination schedule adherence was higher when patients saw female primary care providers. In particular, female patients were more likely to achieve clinical completion whereas male patients were more likely to complete vaccination within 12 months. Generally, gender concordant care has shown limited benefit in most contexts.[40, 41] However, studies have also shown that compared to male primary care providers, female primary care providers tend to have longer visits, gather more information from patients, have higher information exchange with the patients and have a better rapport with both male and female patients. [42,43] While children prefer physicians of the same gender, parents tend to prefer female providers. [43] As such, patients and their guardians may benefit from having the option to choose the gender of their primary care providers, so as to provide gender-concordant care to those who desire it. Furthermore, findings suggest that efforts must be taken to both understand and improve the vaccine recommendation and administration practices of male primary care providers. Doing so may help increase HPV vaccination uptake and reduce gender disparities.

Several limitations must be considered when interpreting findings. First, data represent patients seen at one healthcare system in Northern Virginia and thus may not generalize to other populations. Second, the nature of the data only allows us to control for a limited set of confounders, thus ignoring factors like household income and education. Third, because patients can enter or exit the Inova healthcare system at any time (i.e. an open population), it is impossible to know if patients initiated or completed the vaccination series outside of the health care system. Thus, the number of doses completed within the Inova healthcare system can only be a proxy of the actual number of doses completed. However, accounting for years between first and last visit should mitigate some of this impact. Finally, among the study sample, there may be individuals who were outside of the population for whom HPV vaccination was recommended. In particular, during the study inclusion period, HPV vaccination was only recommended through age 26 for men who are gay, bisexual or who have sex with men. For all other men, the

HPV vaccine was only recommended through age 21. As a result, the results for men may be biased to the null.

Despite limitations, this study expands existing knowledge of disparities in HPV vaccination in the United States in important ways. We showed that provider characteristics can interact with patient characteristics to improve adherence to the HPV vaccination schedule. As a result, future work must improve the vaccination behaviors of male primary care providers.

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Table 1: Patient and Characteristics, by HPV Vaccine Series Dose Completion (N=33,150)

	All		Vaccination Initiation		6 months completion		12 months completion		Clinical completion	
	N	%	N	%	N	%	N	%	N	%
Patient Race										
Asian	2818	8.5	273	9.69	3	0.11	9	0.32	16	0.57
Black	3699	11.16	366	9.89	5	0.14	8	0.22	25	0.68
Latino	3462	10.44	969	27.99	12	0.35	36	1.04	111	3.21
Middle Eastern	462	1.39	53	11.47	1	0.22	1	0.22	2	0.43

Multiracial	640	1.93	85	13.28	0	0	1	0.16	1	0.16
Other Race	3001	9.05	363	12.1	6	0.2	12	0.4	26	0.87
Unknown Race	2428	7.32	172	7.08	2	0.08	4	0.16	6	0.25
White	16640	50.2	1041	6.26	19	0.11	45	0.27	65	0.39
Patient Gender										
Female	20144	60.77	1946	9.66	26	0.13	68	0.34	132	0.66
Male	13006	39.23	1376	10.58	22	0.17	48	0.37	120	0.92
Patient Age										
9-10	2097	6.33	99	4.72	2	0.1	6	0.29	18	0.86
11-12	2210	6.67	1057	47.83	27	1.22	56	2.53	128	5.79
13 -18	7415	22.37	1304	17.59	13	0.18	37	0.5	77	1.04
19+	21428	64.64	862	4.02	6	0.03	17	0.08	29	0.14
Insurance Type										
Other	460	1.39	42	9.13	0	0	0	0	2	0.43
Private	26653	80.4	2004	7.52	29	0.11	70	0.26	125	0.47
Public	5368	16.19	1241	23.12	19	0.35	46	0.86	124	2.31
Unknown	669	2.02	35	5.23	0	0	0	0	1	0.15
Years Between First and Last Visit										
0	19847	59.87	895	4.51	6	0.03	10	0.05	10	0.05
1	6950	20.97	678	9.76	15	0.22	26	0.37	38	0.55
2	3189	9.62	590	18.5	8	0.25	19	0.6	39	1.22
3	1719	5.19	476	27.69	9	0.52	31	1.8	64	3.72
4	947	2.86	417	44.03	5	0.53	16	1.69	59	6.23
5	498	1.5	266	53.41	5	1	14	2.81	42	8.43
Primary Care Provider Gender										
Female	20182	60.88	2279	11.29	38	0.19	91	0.45	172	0.85
Male	12968	39.12	1043	8.04	10	0.08	25	0.19	80	0.62
Primary Care Provider Department										
Family Medicine	6417	19.36	743	11.58	8	0.12	29	0.45	48	0.75
Internal Medicine	5115	15.43	165	3.23	0	0	0	0	3	0.06
OBGYN	1597	4.82	115	7.2	1	0.06	1	0.06	2	0.13
Other	2375	7.16	1020	42.95	16	0.67	37	1.56	129	5.43
General medicine	17646	53.23	1279	7.25	23	0.13	49	0.28	70	0.4

Table 2: Odds of completing immunizations by different durations (N=33,150)								
	Starting vaccination		**6 months completion**		**12 months completion**		**Clinical completion**	
	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability
Patient Race								33,150
White								
Asian	**1.56 [1.34-1.81]**	11.47%	0.92 [0.24-2.58]	0.20%	1.10 [0.51-2.14]	0.46%	1.23 [0.68-2.10]	0.91%
Black	**1.51 [1.31-1.73]**	11.20%	1.05 [0.36-2.62]	0.23%	0.75 [0.33-1.51]	0.32%	1.38 [0.84-2.21]	1.00%
Latino	**1.67**	11.93%	0.48	0.11%	0.82	0.34%	1.02	0.77%

	[1.44-1.93]		[0.18-1.25]		[0.44-1.49]		[0.66-1.59]	
Middle Eastern	1.17 [0.82-1.63]	9.42%	1.48 [0.16-6.33]	0.32%	0.70 [0.08-2.76]	0.30%	0.54 [0.11-1.69]	0.43%
Multiracial	**1.70 [1.29-2.21]**	12.12%	0.37 [0.00-2.78]	0.08%	0.49 [0.06-1.86]	0.21%	0.27 [0.03-1.04]	0.22%
Other Race	**1.63 [1.40-1.88]**	11.79%	1.29 [0.46-3.16]	0.28%	1.28 [0.64-2.40]	0.53%	1.52 [0.91-2.47]	1.09%
Unknown Race	1.16 [0.97-1.39]	9.40%	0.79 [0.16-2.51]	0.17%	0.65 [0.21-1.56]	0.27%	0.69 [0.27-1.45]	0.53%
Estimated follow up in years	**1.63 [1.58-1.68]**	18.90%	**1.46 [1.20-1.78]**	0.31%	**1.71 [1.51-1.94]**	0.76%	**1.92 [1.76-2.10]**	1.52%
Patient Gender								
Male								
Female	1.07 [0.98-1.17]	10.21%	0.91 [0.51-1.63]	0.17%	1.13 [0.77-1.66]	0.40%	0.96 [0.74-1.26]	0.78%
Patient Age								
19+								
9-10	**0.51 [0.40-0.65]**	3.21%	3.53 [0.63-14.51]	0.15%	3.47 [1.27-8.44]	0.38%	**4.36 [2.28-8.14]**	0.88%
11-12	**9.17 [8.03-10.48]**	29.30%	**22.62 [9.19-62.62]**	0.95%	**14.16 [7.86-26.41]**	1.49%	**11.81 [7.39-19.27]**	2.25%
13-18	**3.39 [3.06-3.76]**	15.02%	**4.14 [1.65-11.49]**	0.18%	**3.83 [2.17-7.01]**	0.42%	**4.02 [2.60-6.40]**	0.82%
Insurance Type								
Private								
Other	**0.90 [0.62-1.27]**	9.17%	0.87 [0.01-6.43]	0.16%	0.35 [0.00-2.47]	0.14%	0.83 [0.17-2.46]	0.72%
Public	**1.15 [1.03-1.29]**	9.87%	0.96 [0.44-2.02]	0.18%	1.03 [0.63-1.68]	0.38%	0.85 [0.60-1.20]	0.85%
Unknown	**0.54 [0.37-0.78]**	6.51%	0.72 [0.01-5.67]	0.13%	0.44 [0.00-3.17]	0.17%	0.57 [0.06-2.16]	0.51%
Primary Care Provider Gender								
Male								
Female	**1.51 [1.37-1.66]**	10.80%	**2.27 [1.16-4.83]**	0.22%	**1.95 [1.25-3.14]**	0.44%	**1.35 [1.01-1.81]**	0.82%
Primary Care Provider Department								
General medicine								
Family Medicine	**1.34 [1.21-1.49]**	1.49%	0.72 [0.30-1.54]	0.13%	1.19 [0.73-1.89]	0.47%	1.41 [0.96-2.05]	0.79%
Internal Medicine	**0.69 [0.58-0.82]**	0.82%	0.17 [0.00-1.34]	0.03%	0.08 [0.00-0.54]	0.03%	0.38 [0.10-1.00]	0.23%
OBGYN	**2.01 [1.62-2.47]**	2.47%	2.14 [0.23-8.98]	0.38%	0.97 [0.11-3.72]	0.39%	1.22 [0.25-3.64]	0.69%
Other	**2.99 [2.53-3.54]**	3.54%	1.25 [0.43-3.60]	0.23%	0.87 [0.43-1.77]	0.35%	**2.06 [1.28-3.35]**	1.13%

Table 3: Odds of completing vaccinations by different durations for females (N=20,144)								
	Starting vaccination		**6 months completion**		**12 months completion**		**Clinical completion**	
	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability
Patient Race								
White								
Asian	**1.72 [1.42-2.07]**	11.63%	1.40 [0.27-4.97]	0.20%	0.92 [0.29-2.32]	0.33%	1.52 [0.73-2.92]	0.93%
Black	**1.70 [1.43-2.01]**	11.51%	1.13 [0.21-4.05]	0.17%	0.91 [0.32-2.16]	0.33%	1.49 [0.77-2.74]	0.92%

Latino	**1.68 [1.39-2.03]**	11.44%	1.27 [0.36-4.25]	0.19%	1.16 [0.52-2.50]	0.41%	0.94 [0.51-1.72]	0.61%
Middle Eastern	1.10 [0.69-1.70]	8.43%	1.22 [0.01-10.52]	0.18%	0.43 [0.00-3.33]	0.16%	0.52 [0.06-2.25]	0.35%
Multiracial	**1.80 [1.28-2.47]**	11.98%	0.76 [0.01-6.11]	0.11%	0.87 [0.10-3.45]	0.31%	0.50 [0.05-1.99]	0.34%
Other Race	**1.75 [1.46-2.09]**	11.76%	2.83 [0.87-8.32]	0.41%	2.11 [0.95-4.38]	0.73%	**2.05 [1.09-3.72]**	1.21%
Unknown Race	**1.39 [1.11-1.72]**	9.98%	0.31 [0.00-2.45]	0.05%	0.62 [0.12-1.92]	0.22%	0.75 [0.24-1.84]	0.49%
Estimated follow up in years ǂ	**1.59 [1.53-1.65]**	18.60%	**1.44 [1.10-1.87]**	0.31%	**1.74 [1.48-2.05]**	0.80%	**2.02 [1.79-2.28]**	1.54%
Patient Age								
19+								
9-10	**0.67 [0.49-0.91]**	4.11%	**13.23 [1.92-92.39]**	0.36%	3.61 [0.89-11.36]	0.41%	**4.35 [1.77-9.82]**	0.95%
11-12	**9.87 [8.31-11.72]**	32.89%	**45.88 [12.26-253.53]**	1.23%	**16.36 [7.82-35.89]**	1.78%	**13.15 [7.44-23.74]**	2.67%
13-18	**2.97 [2.61-3.36]**	14.38%	**8.83 [2.37-47.92]**	0.24%	**3.90 [1.90-8.39]**	0.44%	**3.20 [1.86-5.63]**	0.71%
Insurance Type								
Private								
Other	1.17 [0.76-1.73]	10.67%	1.42 [0.01-11.50]	0.26%	0.58 [0.01-4.25]	0.22%	0.91 [0.10-3.50]	0.62%
Public	1.11 [0.95-1.28]	9.56%	0.91 [0.33-2.35]	0.18%	1.13 [0.06-2.08]	0.37%	1.10 [0.68-1.75]	0.68%
Unknown	**0.62 [0.38-0.97]**	6.76%	1.02 [0.01-8.66]	0.19%	0.68 [0.01-5.11]	0.26%	0.39 [0.00-2.85]	0.28%
Primary Care Provider Gender								
Male								
Female	**1.54 [1.35-1.75]**	10.33%	1.28 [0.53-3.50]	0.19%	1.41 [0.78-2.70]	0.40%	**1.63 [1.05-2.61]**	0.74%
Primary Care Provider Department								
General medicine								
Family Medicine	**1.35 [1.18-1.54]**	10.58%	1.23 [0.43-3.24]	0.23%	1.66 [0.91-2.99]	0.65%	1.48 [0.91-2.37]	0.89%
Internal Medicine	**0.76 [0.62-0.93]**	6.86%	0.50 [0.00-4.57]	0.09%	0.14 [0.00-1.01]	0.06%	0.36 [0.07-1.11]	0.23%
OBGYN	**1.96 [1.57-2.43]**	13.80%	2.48 [0.26-11.69]	0.45%	1.06 [0.12-4.31]	0.43%	1.31 [0.26-4.07]	0.80%
Other	**2.30 [1.84-2.89]**	15.44%	0.74 [0.19-2.88]	0.14%	0.68 [0.27-1.67]	0.28%	1.24 [0.65-2.40]	0.76%

ǂ Marginal probabilities are projected rates if patient is followed for 4 years.

Table 4: Odds of completing vaccinations by different durations for males (N=13,006)								
	Starting vaccination		**6 months completion**		**12 months completion**		**Clinical completion**	
	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability	OR [95% CI]	Marginal Probability
Patient Race								
White								
Asian	1.27 [0.97-1.65]	11.08%	0.66 [0.07-2.91]	0.31%	1.41 [0.49-3.46]	0.83%	0.92 [0.32-2.21]	0.93%
Black	1.20 [0.94-1.52]	10.67%	0.89 [0.19-3.14]	0.41%	0.60 [0.15-1.73]	0.36%	1.25 [0.57-2.58]	1.23%
Latino	**1.58**	12.61%	**0.15**	0.07%	0.48	0.29%	0.99	0.99%

	[1.25-1.99]		**[0.03-0.63]**		[0.18-1.24]		[0.51-1.91]	
Middle Eastern	1.37 [0.80-2.26]	11.60%	3.00 [0.30-14.54]	1.21%	1.74 [0.19-7.30]	1.01%	0.85 [0.09-3.65]	0.87%
Multiracial	1.57 [0.97-2.46]	12.56%	0.49 [0.00-4.87]	0.23%	0.34 [0.00-2.72]	0.21%	0.21 [0.00-1.66]	0.24%
Other Race	**1.44 [1.12-1.83]**	11.91%	0.40 [0.04-1.96]	0.19%	0.50 [0.10-1.66]	0.31%	0.97 [0.39-2.17]	0.98%
Unknown Race	0.83 [0.59-1.13]	8.49%	1.73 [0.33-6.19]	0.75	0.90 [0.18-2.87]	0.54%	0.69 [0.14-2.13]	0.72%
Estimated follow up in years	**1.67 [1.59-1.75]**	19.07%	**1.48 [1.10-1.95]**	0.42%	**1.65 [1.36-1.99]**	0.84%	**1.81 [1.59-2.07]**	1.67%
Patient Age								
19+								
9-10	**0.42 [0.28-0.61]**	2.62%	0.58 [0.00-5.79]	0.06%	3.04 [0.69-11.27]	0.41%	**5.08 [1.83-14.78]**	0.93%
11-12	**9.36 [7.51-11.68]**	25.37%	**9.79 [2.98-36.08]**	0.98%	**10.32 [4.04-29.21]**	1.34%	**12.60 [5.55-32.35]**	2.17%
13-18	**4.46 [3.72-5.35]**	15.86%	1.68 [0.46-6.42]	0.17%	**3.36 [1.39-9.17]**	0.45%	**5.81 [2.69-14.40]**	1.06%
Insurance Type								
Private								
Other	0.53 [0.24-1.04]	7.02%	2.51 [0.02-19.35]	0.57%	0.85 [0.01-6.54]	6.54%	1.27 [0.14-5.15]	1.47%
Public	**1.22 [1.01-1.45]**	10.38%	0.97 [0.27-3.19]	0.24%	0.89 [0.39-1.97]	1.97%	0.66 [0.40-1.10]	1.20%
Unknown	**0.46 [0.23-0.84]**	6.43%	1.59 [0.01-15.45]	0.37%	1.06 [0.01-8.41]	8.41%	1.05 [0.11-4.30]	1.25%
Primary Care Provider Gender								
Male								
Female	**1.46 [1.27-1.69]**	11.53%	**3.91 [1.49-12.68]**	0.37%	**2.83 [1.48-5.82]**	0.61%	1.18 [0.80-1.75]	1.02%
Primary Care Provider Department								
General medicine								
Family Medicine	**1.34 [1.13-1.59]**	10.67%	0.37 [0.07-1.27]	0.09%	0.72 [0.30-1.55]	0.32%	1.23 [0.63-2.28]	0.68%
Internal Medicine	**0.55 [0.38-0.77]**	5.61%	0.21 [0.00-1.85]	0.05%	0.17 [0.00-1.36]	0.08%	0.60 [0.06-2.51]	0.34%
Other	**3.94 [3.05-5.09]**	20.93%	2.53 [0.48-13.28]	0.62%	1.41 [0.45-4.42]	0.62%	**3.54 [1.73-7.36]**	1.83%