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Human Papillomavirus Vaccine Coverage and Prevalence of Missed Opportunities for Vaccination in an Integrated Healthcare System

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Abstract

BACKGROUND: Human papillomavirus (HPV) vaccination has been recommended in the United States for female and male adolescents since 2006 and 2011, respectively. Coverage rates are lower than those for other adolescent vaccines. The objective of this study was to evaluate an assessment and feedback intervention designed to increase HPV vaccination coverage and quantify missed opportunities for HPV vaccine initiation at preventive care visits.

METHODS: We examined changes in HPV vaccination coverage and missed opportunities within the adolescent (11–17 years) population at 9 Oregon-based Kaiser Permanente Northwest outpatient clinics after an assessment and feedback intervention. Quarterly coverage rates were calculated for the adolescent populations at the clinics, according to age group (11–12 and 13–17 years), sex, and department (Pediatrics and Family Medicine). Comparison coverage assessments were calculated at 3 nonintervention (control) clinics. Missed opportunities for HPV vaccine

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initiation, defined as preventive care visits in which a patient eligible for HPV dose 1 remained unvaccinated, were examined according to sex and age group.

RESULTS: An average of 29,021 adolescents were included in coverage assessments. Before the intervention, 1-dose and 3-dose quarterly coverage rates were increasing at intervention as well as at control clinics in both age groups. Postimplementation quarterly trends in 1-dose or 3-dose coverage did not differ significantly between intervention and control clinics for either age group. One-dose coverage rates among adolescents with Pediatrics providers were significantly higher than those with Family Medicine providers (56% vs 41% for 11- to 12-year-old and 82% vs 69% for 13- to 17-year-old girls; 55% vs 40% for 11- to 12-year-old and 78% vs 62% for 13- to 17-year-old boys).

CONCLUSIONS: No significant differences in HPV vaccine coverage were identified at intervention clinics. However, coverage rates were increasing before the start of the intervention and might have been influenced by ongoing health system best practices. HPV vaccine coverage rates varied significantly according to department, which could allow for targeted improvement opportunities.

Keywords

adolescent; human papillomavirus vaccine; vaccine coverage; vaccine initiation

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THE ADVISORY COMMITTEE on Immunization Practices (ACIP) recommendation for human papillomavirus (HPV) vaccination has been in place since 2006 for girls and 2011 for boys; however, coverage rates have been substantially lower than rates for other adolescent-recommended vaccines. According to data from the 2015 National Immunization Survey-Teen, only 63% of 13- to 17-year-old girls and 50% of 13- to 17-year-old boys initiated the HPV vaccine series. In comparison, coverage for 2 other adolescent vaccines, tetanus-diphtheria-acellular pertussis (Tdap) and meningococcal conjugate vaccine (MenACWY), which were added to the adolescent vaccine schedule in 2005, has climbed to 87% and 81%, respectively.[1]

High Tdap vaccine coverage is generally attributed to the mandates for Tdap vaccine receipt before secondary school entry in most (47 of 50) states.[2] School mandates for MenACWY vaccination exist in 28 states; these mandates might have played a part in coverage rates for the vaccine reaching the Healthy People 2020 goal of 80%, although national estimates remain lower than those for Tdap.[3,4] Because of the prevalence of HPV infection in the US population, and the opportunity for reduction of HPV-related cancers, leading health organizations have made increasing HPV vaccination rates a priority and have produced and supported use of provider resources specifically focused on increasing HPV vaccination coverage.[3,5,6] Available resources focus on the importance of a strong provider recommendation for HPV vaccination at ages 11 or 12 years, and provide guidance on how to communicate effectively with vaccine-hesitant parents and teens. Also among the suggested strategies are assessment and feedback interventions, in which health educators engage with health care providers to discuss HPV vaccination rates specific to their patient population and identify opportunities for improving vaccine delivery practices.[7] Past efforts to use assessment and feedback have had some success within individual clinic settings.

However, little is known about its application and use in integrated health care delivery systems, which might have consistent standards and policies in place.[8,9]

Kaiser Permanente Northwest (KPNW), which serves approximately 570,000 patients in Oregon and southwest Washington, is an example of an integrated health care delivery system that uses a variety of evidence-based practices for improving adolescent vaccination rates. However, HPV initiation rates within KPNW are far lower than those for other adolescent vaccines. In an effort to examine the effect of assessment and feedback on HPV vaccination rates in the KPNW population, a quasiexperi-mental intervention study entitled 'Boosting Recommended Adolescent Vaccination in Oregon' (BRAVO) was implemented in select Oregon clinics in 2015 to 2016.

The primary study objective of BRAVO was to evaluate an assessment and feedback intervention designed to increase HPV vaccination coverage and reduce missed opportunities for HPV vaccine initiation at preventive care visits compared with standard of care. A secondary study objective was to assess the effect of the intervention according to clinical department (Pediatrics and Family Medicine).

Methods

All BRAVO protocols, materials, and study procedures were approved by the KPNW institutional review board.

Study Period And Population

Adolescents aged 11 to 17 years, with at least 6 months of continuous health plan enrollment and assigned to either a Pediatrics or Family Medicine provider at 1 of the participating clinics, were included in the study. Intervention clinics included the 9 largest KPNW clinics in the state of Oregon, which included approximately 150 physicians and their health care teams. Only Oregon-based clinics were included because of the partnership with the Oregon Immunization Program (OIP) whose jurisdiction was limited to Oregon. For comparison purposes, we included adolescent populations in 3 KPNW clinics in southwest Washington, which served as our nonrandomized convenience control sample. Intervention as well as control clinics had best practices in place at intervention onset: standing orders for vaccination if eligible, walk-in vaccination, electronic medical record prompts, vaccination reminder birthday letters, and vaccine coverage reports of Healthcare Effectiveness Data and Information Set measures.

The BRAVO intervention period lasted from April 2015 through June 2016. A baseline data collection period—April 2011 through March 2015—was included to evaluate trends in HPV vaccine coverage and missed opportunities at preventive care visits that predated the intervention period and draw conclusions regarding the effectiveness of the intervention.

Intervention

We implemented a provider-focused assessment and feedback intervention to promote HPV vaccination in our intervention clinics. In partnership with the Centers for Disease Control and Prevention, the OIP, and KPNW's health plan leadership, we developed a 30-minute

education session combining information on HPV infection, parental communication strategies,[10] and clinic-and department-specific coverage and missed opportunity data.

Baseline education sessions were presented to Family Medicine and Pediatrics departments in 9 KPNW clinics in April 2015; the content of the education sessions has been described elsewhere in detail.[11] Briefly, at each of these baseline education sessions a study team member paired with a health educator from the OIP to deliver the intervention. The study team member presented information on HPV disease and HPV vaccination using the Centers for Disease Control and Prevention-developed "You are the Key to Cancer Prevention" materials, as well as vaccine coverage and missed opportunity for HPV vaccine initiation at preventive care visit data tailored according to clinical department (Pediatrics and Family Medicine). The OIP health educator then led the health care teams (physicians, nurses, medical assistants, and department administrators) in participatory dialogue, reviewing communication strategies related to HPV vaccination and department-specific challenges to HPV vaccine communication.

The HPV vaccination data presented during the meetings, as well as provider-specific population reports, were distributed to the health care teams via paper copies after the meetings in the form of Assessment Reports; the provider- and clinical department-specific Assessment Reports were sent to the health care teams electronically and via paper copies on a quarterly basis for the duration of the study period. The Assessment Reports included: 1) HPV vaccine coverage rates for the 11- to 17-year-old populations paneled to the specific clinical department and provider, compared with rates of MenACWY and Tdap in the same populations, and 2) missed opportunities for HPV vaccination at vaccine-eligible preventive care visits. Calculation of coverage and missed opportunities are described in more detail under Data Assessments.

In January 2016, the research team returned to all clinical departments for follow-up visits to discuss new and remaining barriers to HPV vaccination within their patient populations, have staff share experiences using the communication strategies discussed at the baseline sessions, and present HPV coverage and rates of missed opportunities for HPV vaccine initiation at preventive care visits, with data plotted for the full 2015 calendar year.

Data Sources

Data were collected using quarterly, cross-sectional population assessments. All information on administered vaccines and preventive care visit dates were obtained from the KPNW electronic health record (EHR). KPNW has bidirectional data exchange with ALERT-IIS, the state of Oregon immunization information system (IIS), which captures data on vaccines given outside of the health plan.[12]

Data Assessments

Coverage was defined as the proportion of adolescents assigned to primary care providers at the specific clinic and department on the assessment date who had received the HPV vaccine as of that date. Coverage estimates were created for 2 age groups: 11 to 12 years and 13 to 17 years. Coverage was calculated for ≥1 dose (referred to as 1-dose coverage), and for ≥3 doses (referred to as 3-dose coverage); vaccine receipt was valid only if the ACIP

recommended timing elapsed between vaccine doses.[13] Coverage was calculated separately for boys and girls.

Missed opportunities for HPV vaccine initiation at preventive care visits were defined as any preventive care visit in the previous 3 months in which an adolescent was eligible for the first dose of HPV vaccine, but did not receive it. Anticipating differences according to age, missed opportunities were calculated for 2 age groups: 11 to 12 years and 13 to 17 years. Preventive care visits were identified using International Classification of Diseases-Ninth Revision codes for routine child health exam (V20.2), routine medical exam (V70.0), and other medical exam for administrative purposes (V70.3). Missed opportunities were restricted to preventive care visits on the basis of consistent, strong feedback from clinical staff.

Statistical Analysis

Primary analyses consisted of HPV vaccine coverage (1-dose and 3-dose) and rates of missed opportunities according to age group and sex. Secondary analyses explored differences in 1-dose HPV vaccine coverage according to Pediatrics and Family Medicine departments.

Using segmented regression to generate interrupted time series models,[14] we estimated the change in level and trend in the HPV vaccine coverage rates and missed opportunities after implementation of the intervention, while controlling for the secular trend in the preintervention time period. The study period was divided into 2 segments: preintervention period (March 2011–March 2015) and intervention period (April 2015–June 2016). The outcomes were aggregated and presented quarterly. Among boys, the first 4 quarters—before the ACIP recommendation for boys—were dropped from analysis because of low vaccine uptake rates.[13]

The Durbin–Watson statistic was used to test for serial autocorrelation of error terms in the regression model.[15] Because of the nature of the quarterly data, error terms of 4 quarters were evaluated for autocorrelation to account for seasonality. Stepwise autoregression, conducted using the maximum likelihood method with back step option, corrected for autocorrelation when detected. All final models had a Durbin–Watson statistic value close to the preferred value of 2. SAS version 9.4 (SAS Institute Inc, Cary, NC) was used for all analyses. A P value < .05 was considered significant.

Results

The adolescent patient populations of each intervention clinic ranged from 1600 to 6198 (as of June 2016 data collection). The average number of adolescents included in each cross-sectional quarterly vaccine coverage assessment was 29,021. Most adolescents (77%) had Pediatrics-based primary care providers, rather than Family Medicine providers.

Throughout the study period, there was a general upward trend in HPV vaccine coverage in both age groups and both sexes. At the conclusion of the BRAVO intervention period 1-dose HPV vaccine coverage was 53% and 52% among 11- to 12-year-old girls and boys at the

intervention clinics, respectively. At the same time point, 13- to 17-year-old 1-dose HPV vaccine coverage was 79% and 74% among girls and boys at the intervention clinics, respectively (Fig. 1).

One-dose HPV vaccine coverage varied significantly according to clinical department; at the conclusion of the BRAVO intervention, 1-dose coverage among 11- to 12- year-old girls was 56% and 41% according to department (Pediatrics compared with Family Medicine, $P < .001$; data not shown). One-dose coverage among 11- to 12-year-old boys was 55% and 40%, respectively (department comparison, $P < .001$). Patterns were similar among 13- to 17-year-old girls and boys, with statistically significantly higher 1-dose coverage rates in Pediatrics.

Although rates were lower, patterns for 3-dose HPV vaccine coverage were similar to those for 1-dose coverage. HPV vaccine 3-dose coverage at the conclusion of the BRAVO intervention period was 14% and 11% among 11- to 12-year-old girls and boys, respectively, and 57% and 46% among 13- to 17-year-old girls and boys, respectively (Fig. 2).

In our primary analysis, we observed statistically significant increasing coverage trends among girls and boys in the quarters preceding the BRAVO intervention, at intervention as well as control clinics; this increasing trend was present for 1-dose as well as 3-dose HPV vaccine coverage, and for 11- to 12- and 13- to 17-year-old age groups (Table 1). After implementation of the BRAVO intervention, the only statistically significant positive change in quarterly trend was seen among 11- to 12-year-old girls at intervention as well as control clinics, for 3-dose vaccine coverage (0.82% and 1.59% coverage increases on average per quarter, respectively, compared with the trend in the preintervention period). The change in trend was significantly greater at control clinics, compared with intervention clinics ($P = .002$). No other control versus intervention clinic comparisons of postintervention changes in trend were statistically significant. Among most age and sex groups, 1-dose as well as 3-dose HPV vaccine coverage was increasing at a greater rate at intervention clinics, compared with control clinics, before the BRAVO intervention (Table 1).

In secondary analyses, we compared trends in 1-dose HPV vaccine coverage across Pediatrics and Family Medicine departments. Among girls, coverage among 11- to 12- and 13- to 17-year-old girls with Pediatrics-based providers was 12 and 13 percentage points higher at baseline, respectively, compared with those with Family Medicine providers ($P < .001$ and $P < .001$). At baseline, 1-dose coverage was also higher among 11- to 12- and 13- to 17-year-old boys with Pediatrics providers, compared with those with Family Medicine providers, but the differences did not reach statistical significance (14 and 13 percentage points higher, respectively, $P = .056$ and $P = .163$, respectively). The differences in coverage rates remained consistent over the study period for both sexes. The difference in trends in 1-dose coverage did not vary between the 2 departments over the study period for either sex.

In primary analyses we examined rates of missed opportunities for HPV vaccine series initiation (ie, first dose HPV vaccination) according to age group and sex. We observed a decreasing trend in missed opportunities among 11- to 12-year-old boys and girls before the implementation of the BRAVO intervention (Table 2). Among the 13- to 17-year-old age group, the quarterly trend for missed opportunities was increasing before the intervention,

but only reached statistical significance among boys. After implementation of the BRAVO intervention, there was a statistically significant decrease in the quarterly trend of missed opportunities among 13- to 17-year-old girls, at intervention clinics compared with control clinics ($P = .019$). No additional intervention versus control clinic comparisons reached statistical significance (Table 2).

Discussion

The BRAVO project was an effort to examine the effect of assessment and feedback on HPV vaccination rates and vaccine initiation within an integrated health care delivery system. Over the study period, before as well as after the intervention, we identified significant increases in vaccination coverage across adolescent age groups. However, the intervention did not result in significantly different increases in HPV vaccine coverage at intervention clinics, compared with control clinics. After the intervention, there was a significant decrease in the rate of missed opportunities for vaccine initiation at preventive care visits among older female adolescents, significant changes were not identified in other age/gender groups.

Assessment and feedback has been effective at improving vaccination coverage in various settings and continues to be a recommended strategy for improving HPV vaccination rates.[7] Recent reviews have also mentioned that interventions to improve HPV vaccination coverage are most effective when implemented in combination with other recommended strategies, reinforcing the idea that multifaceted provider- and community-level engagement approaches have the greatest potential for increasing vaccine coverage.[16-18]

The BRAVO intervention was an effort to improve HPV vaccination coverage in an integrated health system, where immunization best practices are deeply embedded. From the use of an EHR, bidirectional exchange with the state IIS, reminder and recall systems generating letters to parents of children due for vaccinations, to the availability of walk-in vaccination opportunities, KPNW uses the full range of recommended clinic-based strategies.[6] KPNW HPV vaccination rates have been consistently trending upward since 2012, possibly because of the ongoing presence of these strategies, but this newly added intervention did not appear to contribute any added increase to that upward trend.

It is important to mention that HPV vaccination rates in this integrated health system were much higher than national averages; compared with 2015 national estimates,[1] KPNW had 16% and 24% higher HPV vaccine initiation rates among 13- to 17-year-old girls and boys, respectively. Additionally, our data show consistent significant increases in HPV vaccine coverage before implementation, and a slowing of that increase around the onset of the project. The lack of intervention effect might in fact be a result of health care system saturation, in that the breadth of immunization strategies in place at KPNW before the intervention had resulted in the highest HPV coverage rates possible in this setting, resulting in no effect from BRAVO. Furthermore, 1-dose HPV vaccination rates were lower than for the Tdap and MenACWY rates in the same population, yet the health system’s strategies already in place combined with this HPV-focused intervention were not sufficient to bring HPV vaccination rates on par with those for the other adolescent-recommended vaccines.

This suggests that the current recommended clinical strategies are not fully addressing the barriers to HPV vaccination present in the United States.[19] Attitudes toward HPV vaccination might be intrinsically different than those toward other adolescent-recommended vaccines, and might require novel recommendation approaches.

An interesting finding from this study was that HPV vaccination rates were significantly higher among Pediatrics populations, compared with Family Medicine populations, in this health care system. This finding is consistent with significantly higher rates of adolescent and HPV vaccine recommendations among pediatricians, compared with family physicians, published previously.[20-22] Although coverage in both clinical department types increased across our study period at similar rates, the significant difference in coverage rates remained. Policies and clinical priorities are the same across departments at KPNW, so whether this finding is attributable to differences among the adolescent populations, the parents who choose one provider type over another, or among the health care providers working in the respective departments is unknown. Oster and colleagues reported significant differences in sources of vaccine recommendations reported according to provider type,[20] but because the BRAVO intervention targeted both departments, and because KPNW policies and resources span departments, differences in resources should not have been a key factor in this provider population. Opportunities for additional interventions, targeted to specific departments or provider types, are worth examining more closely.

Missed opportunities for first-dose HPV vaccination were common, although this analysis was limited to preventive care visits. Our definition of a missed opportunity required access to EHR data, which is different than many other studies that publish rates of missed opportunities on the basis of vaccination data contained in IIS,[23] or in claims data.[24] Although there are limited data on missed opportunities using EHR data, one such study reported that approximately 60% of adolescents attending a preventive care visit have a missed opportunity for HPV vaccine.[25] This was consistent with our finding of a 67% missed opportunity rate among girls 13 to 17 years old. The slight downward trend in missed opportunities observed in the 13- to 17-year-old girls in intervention clinics might suggest that the tools provided in this intervention were helpful to providers in either initial vaccination of new female patients, or catch-up vaccination for those who had previously refused. However, this effect was not observed among younger girls or either of the male age groups. A recent study by Fiks et al enlisted pediatricians in a Maintenance of Certification program targeting HPV missed opportunities.[26] This study examined well as well as sick visits, and did not separate male and female visits. The authors reported an increase in first-dose HPV vaccine capture, relative to nonparticipating clinicians, at preventive care visits. Differences that might account for this finding, relative to the BRAVO results, might include the clinician buy-in created by the certification requirement and the collective identification of improvement goals. Health system differences and best practices, as well as differences in rates of missed vaccine opportunities at study onset could have also affected the difference in study findings. The study by Fiks et al as well as the BRAVO project show the utility of EHR data for timely feedback of missed opportunity data to clinicians.

A strength of the BRAVO project was the ability to examine vaccine initiation rates over time among 11- to 12-year-old patients, the age group for which vaccine initiation is

recommended, in addition to the older age group. The plateauing of 3-dose coverage among 11- to 12-year-old patients at 10% to 15% might indicate the need for enhanced strategies focusing on timely vaccine initiation. An additional study strength included the scalable nature of the project within the health system framework; partnering with health educators from the state health department and using existing clinical meeting times reduced the burden to study as well as clinical staff. The use of EHR data allowed for near real-time data collection and distribution.

An important limitation of this study includes that many active efforts to improve HPV vaccination were already in place before implementing this intervention, making it very difficult to tease out which factors might have been associated with the trend in increasing rates. Additionally, differences between intervention and control clinics might be in part because of differences at the state level, because our intervention and control sites were in different states, and not randomly assigned. However, because all clinics were part of the same health care system, with the same policies and practices around HPV vaccination, there is no expectation that this would lead to coverage differences. An additional limitation of the project was the restriction of the missed opportunity analysis to preventive care visits. Acute visits were excluded from this analysis a priori, on the basis of previous work in our population showing rates of missed opportunities in this population at these visits consistently near 100%. Feedback from clinician partners during planning indicated that this feedback would not be useful for providers, who are aware that vaccination does not take place at these visits, and do not believe that vaccination is appropriate at these visits. Rather, BRAVO decided to focus on preventive care visits, at which vaccination should take place. The authors believed that communicating missed opportunities at these visits exclusively was more meaningful for providers. Finally, some adolescents at each quarter might have only recently turned 11 years old, limiting the window for vaccination and possibly increasing the proportion unvaccinated in that age group.

In conclusion, HPV vaccine coverage was increasing in this integrated care system population before the start of this intervention, with no significant changes in quarterly trends after the intervention. Lack of significant coverage increases after this intervention is another example of the ongoing challenge of HPV vaccination in the United States. The modest coverage improvements observed in our study population, and the plateau in rates, reflect the national trend in HPV vaccine coverage, implying these challenges are a widespread issue.[1] Because of the multifaceted immunization strategies ongoing within the KPNW system, consistent with current recommended practice,[19] these results suggest that the desired increases in HPV vaccine coverage might require reaching parents before their HPV vaccination decision-making begins, or clinic-based interventions targeted to specific provider types.

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What's New

In a quasiexperimental study, conducted in a large health system, the effect of an intervention of assessment and feedback of human papillomavirus (HPV) vaccination coverage was compared with standard of care and no significant increase in HPV vaccination coverage was found in intervention clinics compared with control clinics; missed opportunities for vaccination during preventive care visits declined only for girls age 13 to 17 years. Increasing HPV vaccination coverage in a large health system with a history of implementing recommended best practices continues to be challenging.

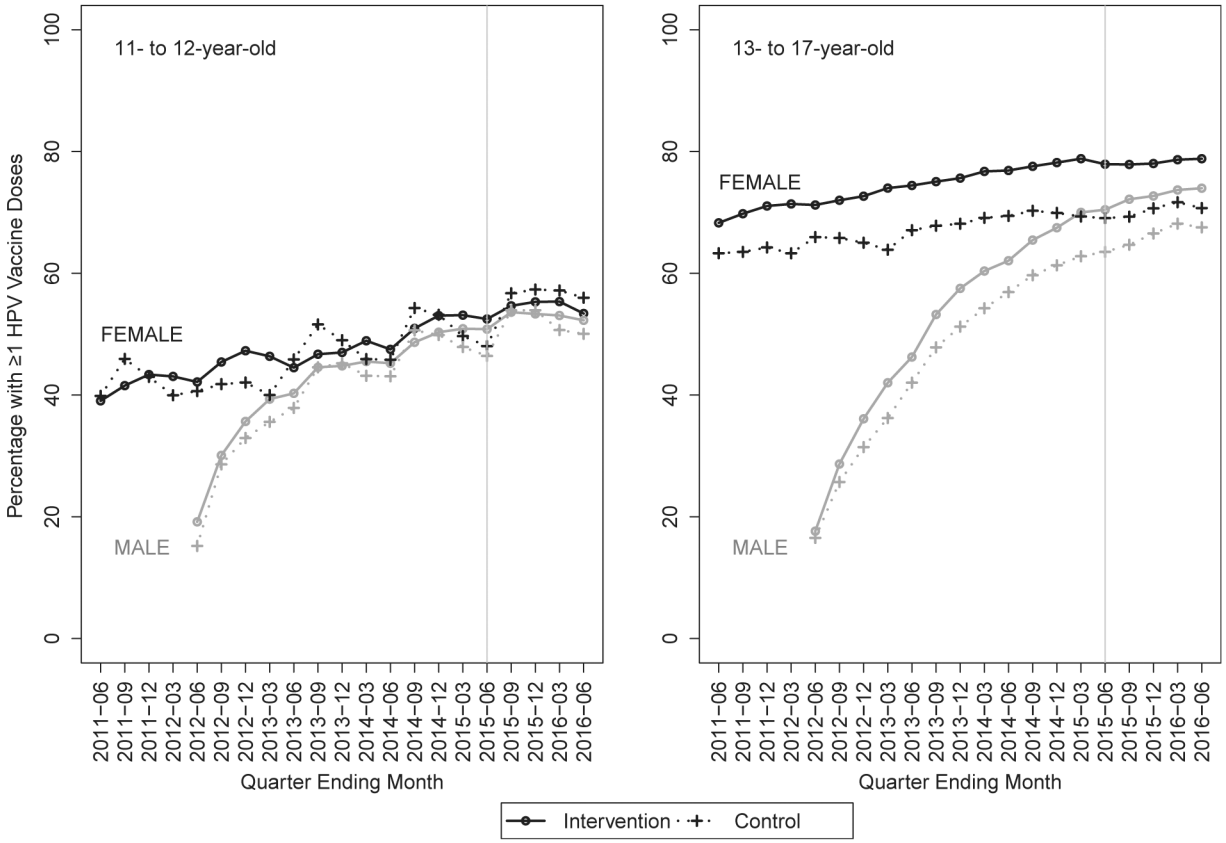

Figure 1.

One (≥7) dose human papillomavirus (HPV) vaccination coverage rates according to age group, sex, and clinic type (intervention or control). Vertical line marks start of Boosting Recommended Adolescent Vaccination in Oregon (BRAVO) intervention period.

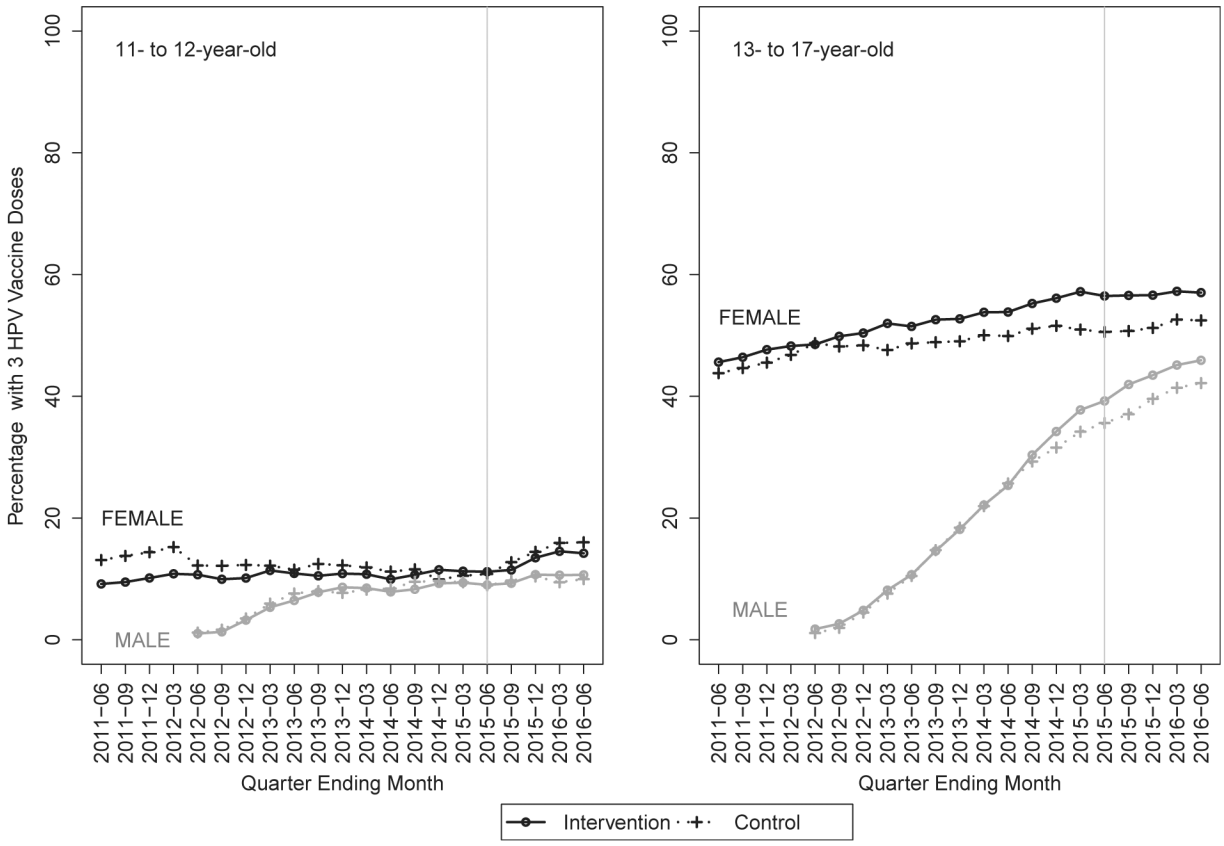

Figure 2.

Three (≥3) dose human papillomavirus (HPV) vaccination coverage rates according to age group, sex, and clinic type (intervention or control). Vertical line marks start of Boosting Recommended Adolescent Vaccination in Oregon (BRAVO) intervention period.

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Table 1.

Interrupted Time Series HPV Vaccine Coverage Trend Results: 11 to 12 and 13 to 17 Years Old, According to Sex

HPV Coverage Outcome	Baseline Coverage, %*	Preintervention Quarterly Trend (%)†	*P*	Change in Trend, %‡	*P*§	Control Versus Intervention, *P*‖
≥1 Dose, girls 11 to 12 years old						
Intervention clinics	39.55	0.79	<.001	−0.54	.251	.241
Control clinics	38.32	0.83	<.001	0.96	.288	
≥1 Dose, girls 13 to 17 years old						
Intervention clinics	68.32	0.67	<.001	−0.41	.002	.143
Control clinics	62.37	0.50	<.001	0.07	.825	
3 Doses, girls 11 to 12 years old						
Intervention clinics	9.76	0.09	.009	0.82	<.001	.002
Control clinics	14.27	−0.23	<.001	1.59	<.001	
3 Doses, girls 13 to 17 years old						
Intervention clinics	45.22	0.72	<.001	−0.54	<.001	.089
Control clinics	44.96	0.41	<.001	0.19	.399	
≥1 Dose, boys 11 to 12 years old						
Intervention clinics	26.04	2.33	<.001	−2.10	.092	.980
Control clinics	23.00	2.55	<.001	−2.14	.170	
≥1 Dose, boys 13 to 17 years old						
Intervention clinics	21.53	4.47	<.001	−3.61	.011	.758
Control clinics	18.90	4.09	<.001	−2.94	.014	
3 Doses, boys 11 to 12 years old						
Intervention clinics	1.08	0.77	<.001	−0.45	.326	.207
Control clinics	1.40	0.76	<.001	−0.65	.182	
3 Doses, boys 13 to 17 years old						
Intervention clinics	0.00	3.44	<.001	−1.78	.001	.620
Control clinics	0.00	3.26	<.001	−1.51	<.001	

HPV indicates human papillomavirus; and ACIP, Advisory Committee on Immunization Practices.

The first 3 rows show 1-dose HPV coverage results for the 11- to 12-year-old girls. Column 2 shows that the baseline (April 2011) coverage was similar, but slightly higher at intervention clinics. In columns 3 and 4, it is shown that before the intervention (April 2011–March 2015) 1-dose coverage was increasing significantly at intervention as well as at control clinics—0.79% and 0.83% increases in coverage per quarter on average, respectively. Column 5 shows the change in quarterly coverage trend after the intervention (April 2015–June 2016). In this group, the trend in coverage decreased (ie, the

rate of increase slowed) on average per quarter at intervention clinics, compared with the preintervention period. Column 6 shows the significance of the change in trend postintervention; in this group, the change in trend was not significant at either intervention or control clinics. The final column displays the statistical comparison between the control and intervention clinics, regarding the postintervention quarterly trend. Among the 11- to 12-year-old girls, the postintervention quarterly increase in 1-dose HPV coverage was not significantly different at intervention clinics, compared with control clinics.

[*] Baseline coverage was measured in June 2011 for girls and June 2012 for boys.

[†] Average percent change in coverage per quarter during the preintervention period. The preintervention period was April 2011 through March 2015—the first 4 quarters were excluded for boys because of timing of ACIP recommendation.

[‡] Percent change in vaccination coverage trend; comparison of the preintervention coverage trend with the coverage trend measured after intervention implementation (ie, change in slope of coverage rate line). The intervention period was April 2015 through June 2016.

[§] A measure of the significance of the change in vaccine coverage trend after intervention implementation, compared with the preintervention trend.

[‖] A measure of the significance of the postintervention quarterly trend; comparison of control and intervention clinics, controlling for the preintervention trend.

Table 2.

Interrupted Time Series HPV Vaccine Initiation Missed Opportunity Trend Results: 11 to 12 and 13 to 17 Years Old, According to Sex

Age/Sex Group	Baseline Missed Opportunity Rate, %*	Preintervention Quarterly Trend, %†	*P*	Change in Trend‡	*P*§	Control Versus Intervention *P*‖
Girls, 11 to 12 years old						
Intervention clinics	45.54	−0.67	**.006**	0.68	.595	.996
Control clinics	61.60	−1.06	**.027**	0.70	.792	
Girls, 13 to 17 years old						
Intervention clinics	67.44	0.26	.074	−1.39	.100	**.019**
Control clinics	75.96	0.01	.986	2.89	.262	
Boys, 11 to 12 years old						
Intervention clinics	45.54	−0.69	**.043**	0.27	.819	.969
Control clinics	56.06	−0.21	.541	−1.62	.354	
Boys, 13 to 17 years old						
Intervention clinics	38.09	2.38	<**.001**	−1.82	**.044**	.844
Control clinics	51.09	2.17	**.001**	−0.65	.746	

HPV indicates human papillomavirus; and ACIP, Advisory Committee on Immunization Practices.

Statistically significant *P* values are shown in bold.

*Baseline missed opportunity rate was measured June 2011 for girls and June 2012 for boys.

†Average percent change in rate of missed opportunities per quarter during the preintervention period. The preintervention period was April 2011 through March 2015; the first 4 quarters were excluded for boys because of timing of ACIP recommendation.

‡Percent change in missed opportunity trend; preintervention trend compared with the trend measured after intervention implementation. The intervention period was April 2015 through June 2016.

§A measure of the significance of the change in missed opportunity trend after intervention implementation, compared with the preintervention trend.

‖A measure of the significance of the change in quarterly missed opportunity trend after intervention implementation; comparison of control and intervention clinics, controlling for the preintervention trend.