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SHORT REPORT

Missed opportunities for human papillomavirus vaccine series initiation in a large, rural U.S. state

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ABSTRACT

Human papillomavirus (HPV) vaccination rates are lower in rural versus urban areas of the United States. Our objective was to identify the types of vaccination clinic settings where missed opportunities for HPV vaccine series initiation most frequently occurred in Montana, a large, primary rural U.S. state. We analyzed a limited dataset from Montana's immunization information system for adolescents who turned 11 years old in 2014–2017. Vaccination visits where the HPV vaccine was due but not administered were missed opportunities. We compared missed opportunities across six types of clinic settings, and calculated adjusted relative risks (RR) using a generalized estimating equation model. Among n = 47,622 adolescents, 53.9% of 71,447 vaccination visits were missed opportunities. After adjusting for sex, age, and rurality of clinic location, receiving vaccines in public health departments was significantly associated with higher risk of missed opportunities (aRR = 1.25, 95% confidence interval = 1.22–1.27, vs. private clinics). Receipt of vaccines in Indian Health Services and Tribal clinics was associated with fewer missed opportunities (aRR = 0.72, 95% CI: 0.69–0.75, vs. private clinics). Our results indicate the need for interventions to promote HPV vaccine uptake in public health departments, which are a critical source of immunization services in rural and medically underserved areas of the U.S.

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Introduction

Human papillomavirus (HPV) infections are a leading cause of cervical, oropharyngeal, and other cancers, as well as related diseases, including condyloma.[1] Since 2011, the U.S. Advisory Committee on Immunization Practices (ACIP) has recommended all adolescents ages 11–12 years initiate HPV vaccine series.[2] If the first dose is received before the 15th birthday then two vaccine doses are needed to complete the series; otherwise, three doses are needed for series completion.[3] In 2019, 71.5% of U.S. adolescents ages 13–17 years had received at least one dose of the HPV vaccine.[4] However, series initiation was 9.6 percentage points lower for adolescents living in rural as compared with urban areas.[4] Private clinics are the most common setting for adolescent vaccinations in the U.S.; however, rural adolescents are more likely than urban adolescents to be vaccinated in other types of settings, including public health departments.[5]

In Montana, a large and primarily rural U.S. state, the Centers for Disease Control and Prevention's 2019 National Immunization Survey-Teen reported that 63.7% of adolescents had initiated HPV vaccination.[4] In contrast, 90.1% had received a tetanus-diphtheria-acellular pertussis (Tdap) vaccine,[4] which is required in Montana prior to attending 7th grade. This discrepancy signals that missed opportunities to vaccinate against HPV are occurring when adolescents present for other vaccines. In their 2018 report, the U.S. President's Cancer Panel concluded that reducing missed opportunities to recommend and administer the HPV vaccine when adolescents present for other preventive care services is a top national priority for accelerating vaccine uptake.[6]

Our aims were to quantify the prevalence of missed opportunities to vaccinate adolescents against HPV when they presented for other vaccines, and to determine whether the risk of missed opportunities differed by the types of vaccination clinic settings accessed. We achieved these aims through an analysis of data from Montana's centralized immunization information system (IIS), ImMTrax.

Materials and methods

We used a retrospective cohort design to analyze a limited dataset from ImMTrax. U.S. states' IIS allow for providers to report and obtain patients' vaccination records, which are maintained in a centralized database. IIS data are also used for population-based analyses to target initiatives for increasing vaccine uptake.[7,8] In Montana, vaccination providers voluntarily participate in ImMTrax. However, providers that participate in the federal Vaccines for Children (VFC) program, which provides free vaccines for uninsured, underinsured, Medicaid-enrolled and otherwise eligible children and adolescents, use ImMTrax for VFC

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vaccine ordering and reporting. Over 90% of clinics that provide immunization services to children and adolescents in Montana participate in VFC and in ImMTrax.

Our study cohort included Montana adolescents who turned 11 years old in 2014–2017 with at least one immunization recorded in ImMTrax between ages 9–17 years. The ImMTrax dataset for this cohort was first accessed in November 2020 and analyses were conducted in December 2020-May 2021. We focused on adolescents who turned 11 years old in 2014–2017 in order to have at least three years of vaccination histories for cohort members. Although HPV vaccines can be given after the 9th birthday, the ACIP recommends initiating the series at ages 11–12 years;[3] therefore, we excluded individuals who received an HPV vaccine before their 11th birthday. Starting at the 11th birthday, we examined unique dates of all vaccinations that are routinely recommended to adolescents by the ACIP (Tdap, meningococcal, HPV, and influenza vaccines) and determined whether the HPV vaccine had been administered on each date. If the HPV vaccine was not administered, then the vaccination visit was a missed opportunity. During the study period, Montana children ages 10 years and older could receive influenza, but not other vaccines, in pharmacies; therefore, we excluded vaccinations in pharmacies from analyses. For each adolescent, vaccination visits were examined until the HPV vaccine was received or end of study period (10/29/2020), whichever was first.

We reported the overall percentage of vaccination visits that were missed opportunities to initiate the HPV vaccine series, and the percentage of adolescents with at least one missed opportunity. We reported the number and percentage of vaccination visits that were missed opportunities to vaccinate against HPV by rurality of clinic location, using U.S. Census Bureau categories for metropolitan statistical area (MSA) (i.e., urban), micropolitan statistical area (smaller and less dense communities with a distinct center), or non-MSA (i.e., rural).[9] For visits that were missed opportunities to vaccinate against HPV, we described which other vaccines were given at those visits.

We used chi-square tests to compare the percentage of vaccination visits that were missed opportunities across six types of clinic settings: private clinics, public health departments, rural health clinics, Indian Health Service (IHS)-affiliated and Tribal clinics, federally qualified health centers (FQHCs) and community health centers, or other settings. In Montana, the majority of counties have their own public health departments. Some very rural counties share a regional health department, and in some more populated counties the public health department offers immunization services in multiple locations. Rural health clinic is a designation provided by the U.S. Centers for Medicare and Medicaid Services for clinics in rural and medically underserved areas that meet certain eligibility criteria.[10] In Montana, approximately 6.2% of the population is American Indian or Alaska Native, which is the largest minority racial or ethnic group in the state.[11] The IHS and Tribal clinics category included Tribal clinics on reservations, Urban Indian Health Centers, and other IHS clinics.[12] The Other category included vaccines administered in hospitals, urgent care settings, migrant health centers, school-based health centers, and unknown or unidentifiable locations.

Using a generalized estimating equation model to account for adolescents' multiple vaccination visits, we calculated unadjusted and adjusted relative risks (RRs) and 95% confidence intervals (CIs) for missed opportunities by clinic setting, age and gender of adolescent, and rurality of clinic location (MSA, micropolitan statistical area, or non-MSA). We also reported the percentage of cohort members who ultimately initiated the HPV vaccine series.

All analyses were conducted using SAS 9.4®. The University of Montana Institutional Review Board approved this study under the exempt category of review.

Results

Our cohort included 47,622 adolescents. Within this study cohort, 53.9% (n = 38,513) of 71,447 vaccination visits on or after the 11th birthday were missed opportunities to initiate HPV vaccination. About 56.3% (n = 26,788) of adolescents had at least one missed opportunity to be vaccinated against HPV when presenting for another vaccine on or after their 11th birthday. Approximately 50.0% (n = 12,955) of 25,900 vaccination visits in MSAs were missed opportunities, while 54.4% (n = 11,074) of 20,348 visits in micropolitan statistical areas and 57.5% (n = 14,484) of 25,199 visits in non-MSAs were missed opportunities. Overall, across the 38,513 vaccination visits where missed opportunities to vaccinate against HPV occurred, 34.6% (n = 13,335) were visits where only the Tdap vaccine was administered, 35.6% (n = 13,692) were visits where only the influenza vaccine was administered, 18.8% (n = 7,251) were visits with both Tdap and meningococcal vaccines, and 11.0% (n = 4,235) were visits where other combinations of vaccines were administered.

The most common settings where adolescents received vaccinations were private clinics (38,144 visits) and public health departments (17,441 visits) (Table 1). Missed opportunities occurred most frequently in public health departments (64.9% of visits) as compared with other types of clinic settings ($p < .001$, Table 1), with the exception of the "Other" category, which had the smallest overall number of visits and included hospitals and urgent care settings (1,996 visits, 69.1% were missed opportunities). IHS and Tribal clinics had the lowest prevalence of missed opportunities (4,330 visits, 37.7% were missed opportunities) (Table 1).

After adjusting for age and gender, as well as rurality of clinic location, adolescents who received vaccinations at public health departments were 1.25 times as likely to have a missed opportunity as compared to adolescents receiving vaccinations at private clinics (95% CI: 1.22–1.27) (Table 2). Adolescents who received vaccines in IHS and Tribal clinics were significantly less likely to experience missed opportunities to be vaccinated against HPV than adolescents who received vaccines in private clinics (adjusted RR = 0.72, 95% CI: 0.69–0.75), as were adolescents who received vaccines in FQHCs or community health centers (adjusted RR = 0.93, 95% CI: 0.89–0.96). Ultimately, 69.2% of adolescents in our study cohort initiated the HPV vaccine series.

Table 1. Immunization visits that were missed opportunities for initiating the human papillomavirus vaccine series for adolescents ages 11–17 years by clinic setting, Montana, 2014–2020.

Clinic setting	Private clinics	Public health departments	Rural health clinics	Indian health service and tribal clinics	Federally qualified health centers and community health centers	Other[a]	Chi-square *P* value
Total HPV vaccine-eligible immunization visits, No.	38,144	17,441	5,471	4,330	4,065	1,996	
Missed opportunities for HPV vaccination, No.	18,956	11,315	3,295	1,633	1,934	1,380	<0.001
%	49.7%	64.9%	60.2%	37.7%	47.6%	69.1%	
(95% CI)	(49.2%-50.2%)	(64.2%-65.6%)	(58.9%-61.5%)	(36.3%-39.2%)	(46.0%-49.1%)	(67.1%-71.2%)	

HPV, human papillomavirus; CI, confidence interval.
[a]Other settings included hospitals, urgent care settings, migrant health centers, school-based health centers, and unknown or unidentifiable locations.

Table 2. Associations between clinic setting, age, sex, and rurality with missed opportunities for initiating the human papillomavirus vaccine series for adolescents ages 11–17 years, Montana, 2014–2020.

	Total HPV vaccine-eligible immunization visits, N = 71,447 n (column %)	Unadjusted relative risk (95% confidence interval)[a]	Adjusted relative risk (95% confidence interval)[a]
Clinic setting			
Public health departments	17,441 (24.41%)	1.29 (1.27–1.31)	1.25 (1.22–1.27)
Rural health clinics	5,471 (7.66%)	1.21 (1.18–1.23)	1.12 (1.09–1.15)
Federally Qualified Health Centers and Community Health Centers	4,065 (5.69%)	0.96 (0.92–0.99)	0.93 (0.89–0.96)
Indian Health Services and Tribal clinics	4,330 (6.06%)	0.76 (0.73–0.79)	0.72 (0.69–0.75)
Other	1,996 (2.79%)	1.38 (1.34–1.42)	1.33 (1.29–1.38)
Private clinics	38,144 (53.39%)	[Reference]	[Reference]
Age of adolescent at visit			
13–17 years	17,231 (24.12%)	1.38 (1.16–1.64)	1.04 (1.03–1.06)
11–12 years	54,216 (75.88%)	[Reference]	[Reference]
Gender of adolescent[b]			
Female	34,039 (47.64%)	0.93 (0.92–0.94)	0.93 (0.92–0.95)
Male	36,475 (51.05%)	[Reference]	[Reference]
Clinic rurality			
Non-metropolitan statistical area	25,199 (35.27%)	1.14 (1.12–1.16)	1.12 (1.09–1.14)
Micropolitan statistical area	20,348 (28.48%)	1.08 (1.07–1.10)	1.09 (1.07–1.11)
Metropolitan statistical area	25,900 (36.25%)	[Reference]	[Reference]

[a]A generalized estimating equation model was used to account for multiple immunization visits by adolescents. In this study, there were 71,447 immunization visits among 47,622 adolescents.
[b]Gender was "unknown" or "other" for 761 individuals who were excluded from this model, resulting in a total of 70,514 visits examined in this unadjusted model, as well as in the adjusted model.

Discussion

In this analysis of Montana's IIS data, we found that missed opportunities to vaccinate adolescents against HPV were common in public health departments, which play a critical role in immunization services delivery in rural and medically underserved areas. After accounting for rurality and other factors, vaccination visits in public health departments were significantly more likely to be missed opportunities to vaccinate against HPV as compared to visits in private clinics. Promoting HPV vaccination in a public clinic setting presents unique challenges relative to other settings like private clinics, where older children and adolescents receive a range of routine preventive health services from primary care providers.[13] For example, such primary care settings have distinct patient populations for targeting outreach and reminder-recall efforts.[14,15] In contrast, public clinics are open to all, often for walk-in services, and are typically used for episodic primary care services, like vaccinations. Notably, across the six types of clinic settings that we examined, missed opportunities to vaccinate against HPV were lowest at IHS and Tribal clinics. Future work should seek to learn from current adolescent immunization delivery practices in IHS and Tribal settings. It may be that streamlined clinical operations, effective provider-family communication or other factors are facilitators of HPV vaccine uptake in Montana's Tribal communities.

In this study, we demonstrated an effective application of state IIS data for identifying opportunities to increase vaccine uptake on a population level. Previous studies have also used state IIS for investigating missed opportunities to vaccinate adolescents against HPV.[16–18] One IIS-based study in the U.S. state of Washington reported that 32.9% and 38.7% of vaccination visits among adolescent females and males, respectively, were missed opportunities to vaccinate against HPV.[16] Another study of females ages 11–26 years in Utah found that 43.9% of vaccination visits were missed opportunities to vaccinate against HPV.[17] Our finding that 53.9% of adolescents' vaccination visits in Montana were missed opportunities to be vaccinated against HPV was higher than those previous studies; however, an analysis of IIS data in the U.S. state of Indiana reported that 60% of adolescents' vaccination visits were missed opportunities to vaccinate against HPV.[18] While

these previous state-level analyses examined individual or county-level factors associated with missed opportunities for HPV vaccination, differences across types of clinic settings were not examined. Our novel investigation of missed opportunities by type of clinic setting adds to the current literature, and aids in pinpointing settings for improving HPV vaccine uptake, particularly in rural areas of the U.S.

Identifying interventions to increase HPV vaccination rates in rural populations has been identified as a top adolescent immunization services research priority in the U.S.[19] Nationally, prior work has largely focused on the role of primary care physicians in delivering effective recommendations for HPV vaccination.[20,21] However, in public clinic settings, patients' and families' vaccine-related interactions may primarily be with nurses working under providers' standing orders.[22] Our study's results illuminate the need for modified or new communication and outreach strategies that nurses can use to promote vaccine uptake in public health department settings. Given the importance of public clinics in providing vaccine services in rural areas, decreasing missed opportunities for HPV vaccination in these settings is a necessary step toward eliminating rural-urban vaccination disparities in the U.S.

Our study had some limitations. Our analyses were limited to one U.S. state, Montana, which may limit generalizability regarding missed opportunities for HPV vaccination in other states. This study represents one of the few examinations of missed opportunities in a primarily rural area of the U.S., and included novel analyses of missed opportunities stratified by clinic setting, which could be replicated with other states' IIS. In this study, the reasons for missed opportunities were unknown, and may have included adolescents not being offered the HPV vaccine, parents/guardians not receiving a strong recommendation to vaccinate their child, or parental vaccine hesitancy.[23,24] However, knowing the specific reasons for missed opportunities to vaccinate against HPV are not necessarily needed to inform interventions. Multi-level interventions at the clinic and provider levels, such as training providers to routinely offer and to strongly recommend the vaccine, are effective across these multiple barriers to HPV vaccination.[21,25] Finally, potential misclassification of vaccination status due to missing records may be an issue in studies utilizing electronic vaccination data sources, including IIS. However, annual estimates of HPV vaccine coverage from ImMTrax have largely aligned with those from NIS-Teen, which is considered the gold standard for measuring adolescent vaccination coverage in the U.S.[4]

As demonstrated in this study, population-level investigations using IIS data collected by states or other jurisdictions can be a valuable tool for identifying areas of need and for informing interventions to increase vaccine uptake. Our results point to the need for initiatives to promote HPV vaccination when Montana adolescents present for other vaccines, particularly in public health department settings.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Prior presentation

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