

## School-based human papillomavirus vaccination program for increasing vaccine uptake in an underserved area in Texas

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### ABSTRACT

**Objective:** Compare the effectiveness of community-based HPV-related education and onsite school-based vaccination versus community-based education only for increasing HPV vaccine uptake in a rural, medically underserved area.

**Methods:** Our cohort included 2307 Rio Grande City Consolidated Independent School District (RGCCISD) middle school students from 3 schools enrolled in August 2016 and followed until April 2018. Using a quasi-experimental design, this study implemented an onsite school-based vaccination program and physician-led education on HPV and HPV vaccines for parents/guardians, school nurses/staff, and pediatric/family providers in the surrounding community (15-mile radius of RGCCISD) at 1 middle school (“intervention school”), and education-only for the remaining 2 schools (“comparison schools”). The Centers for Disease Control and Prevention’s HPV-related educational materials supplemented the education. HPV vaccine status was obtained from school immunization records and the project’s contracted vaccine vendor. HPV vaccine initiation and completion rates were compared pre and post intervention and between the intervention and comparison schools. Logistic regression was used to compare the odds of newly initiating/completing vaccination between the intervention and comparison schools.

**Results:** At baseline, the intervention school had lower HPV vaccine initiation and completion rates than the comparison schools (20.00% and 8.70% vs 28.97% and 14.56%). Post intervention, the intervention school had higher initiation and completion rates than the comparison schools (53.67% and 28.36% vs 41.56% and 20.53%). Students from the intervention school were over 3.6-times more likely to newly initiate/complete the HPV vaccinations than students from the comparison schools.

**Conclusion:** The school with on-site vaccination events and community-based education had a higher adolescent HPV vaccination rate compared to schools that received community-based education only.

### 1. Introduction

The human papillomavirus (HPV) vaccine is safe and effective and prevents morbidity and mortality associated with HPV-related diseases, including cervical, oropharyngeal, vaginal, vulvar, penile, and anal

cancers [1,2]. The US Advisory Committee on Immunization Practices (ACIP) recommends initiating the 9-valent HPV vaccine with a 2-dose schedule at age 11 or 12 (can be started as early as age 9), and a 3-dose schedule for those initiating between ages 13 and 26 and immunocompromised individuals [3,4]. Yet, the HPV vaccination rate

**Abbreviations:** ACIP, Advisory committee on immunization practices; CDC, Centers for disease control and prevention; CHIP, Children’s health insurance program; GMS, Grulla middle school; HPV, Human papillomavirus; RGV, Rio grande valley; RGCCISD, Rio grande city consolidated independent school district; RMS, Ringgold middle school; TDAP, Tetanus, Diphtheria (TD), Ortetanus, Diphtheria, And pertussis; U.S., United States; VFC, Vaccines for children; VMS, Veterans middle school

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continues to be low in the US. In 2017, only 65.5% of adolescents aged 13–17 years received  $\geq 1$  dose of HPV, with lower vaccine coverage in rural areas [5]. Compared to urban areas, the proportion of adolescents who received the first dose of the HPV vaccine was 11% points lower in rural areas [5]. The HPV vaccine is particularly important for rural, economically disadvantaged, and medically underserved US areas, such as the Rio Grande Valley (RGV) of Texas. The RGV consists of Cameron, Hidalgo, Starr, and Willacy Counties, which border Mexico. RGV residents are more likely to be uninsured and have limited access to primary care physicians and lower levels of health literacy compared with the rest of Texas [6–8]. Close to 95% of children in the RGV are of Hispanic/Latino ethnicity [9], and Latina women in the RGV are at significantly higher risks of cervical cancer incidence and mortality than Latina women in the US as a whole [10,11].

Historically, HPV vaccines in the US have been delivered in clinical settings, and significant knowledge and access barriers exist among providers and caregivers that are associated with lower utilization of these vaccines. Providers are often concerned about patients' insurance coverage or financial challenges, whereas caregivers often report needing more information on the HPV vaccine and its accessibility [12]. The Affordable Care Act now requires insurance companies to cover ACIP recommended vaccines without copays, and federal programs, such as the Vaccines for Children (VFC), provide free vaccines to Medicaid eligible, uninsured or underinsured, American Indian, or Alaskan Native children [1]. Further, very few US states (ie, Virginia, District of Columbia, and Rhode Island) have school-entry mandates for the HPV vaccine [1]. Rhode Island has the highest HPV vaccination rate in US and provides in-school HPV vaccines at no cost through their "Vaccinate Before You Graduate" program [1,13].

Research shows that no-cost, voluntary mass vaccinations in schools are well received and result in higher immunization rates, and that improving access to the HPV vaccine is associated with greater improvements in vaccine uptake than other interventions [14]. Schools have the highest reach to adolescents and demonstrate success in providing vaccines [14–16]. Introducing the HPV vaccine in a school-based setting provides a rare opportunity to build and strengthen school and adolescent health by offering preventive and curative health interventions and education [17]. This study addresses some of the known factors that affect HPV vaccine uptake (eg, social norms of behavior, knowledge, provider recommendations and risk perception, accessibility, work/school schedule, costs) [18–20]. The objective of this study is to compare the effectiveness of a community-based education and onsite school-based vaccination program, which was implemented at 1 RGV middle school ("intervention school"), and a community-based-education-only program, which was implemented at 2 similar middle schools ("comparison schools") in the RGV. Here we compare HPV vaccine uptake and completion rates before and after these interventions.

## 2. Material and methods

### 2.1. Study design and approach

Approval for this program was obtained from the University of Texas Medical Branch's Institutional Review Board and the Rio Grande City Consolidated Independent School District (RGCCISD) school board. This quasi-experimental study is part of a larger 3-year Cancer Prevention Research Institute of Texas (CPRIT)-funded study evaluating a school-based HPV vaccination program to increase vaccine uptake in the RGV. This study included 2 components: (1) physician-led educational events spanning 3 RGV counties, ie, Cameron, Hidalgo, and Starr (15-mile radius of RGCCISD), and (2) implementation of the first school-based HPV vaccination program in Texas. The school-based HPV vaccination program provided on-site vaccination for both females and males in the recommended age group and included an educational component, whereby physicians and project staff addressed an

audience of parents/guardians and school staff/nurses at school-related events. Instead of randomly allocating schools across interventions, we used a quasi-experimental design and designated the school with the highest enrollment of middle school students in RGCCISD (Veterans Middle School, VMS) as the intervention school. Comparison schools (that received community-based education only) were selected due to their geographic proximity to VMS and the similar sociodemographic composition of their student population. These were Grulla Middle School (GMS) and Ringgold Middle School (RMS).

The study timeframe for the current analysis includes the first 20 months of the program (August 2016 to April 2018). In 2016, we obtained information on baseline HPV vaccination rates among 6th-, 7th-, and 8th-grade students in these schools, including age and sex of students from the schools' data processing departments. This defined our student cohort for documenting baseline and follow-up vaccination rates. Data on follow-up vaccination rates were also acquired from the schools' data processing departments.

Prior to introducing the onsite vaccination program, we conducted a survey to assess parental knowledge and attitudes towards HPV vaccination in RGCCISD [20]. The results identified barriers to vaccine uptake and were used to develop strategies to implement the intervention [20]. Since we found that HPV vaccine uptake in the RGV remained low despite seemingly high levels of HPV awareness and knowledge and provider recommendation, we used our intervention to address accessibility, economic, and logistical barriers.

#### 2.1.1. Community-based educational program

Our educational program was uniformly delivered to stakeholders in the surrounding community of Cameron, Hidalgo, and Starr Counties, a 15-mile radius of RGCCISD. All 3 schools were exposed to the same community-based education program starting in 2016. The educational presentations occurred at school-based (eg, health fairs, vaccination days, back-to-school nights, Parent-Teacher Association [PTA], school board, and monthly nurse meetings) and community events (eg, health department events with Starr, Hidalgo, and Cameron; regional conferences; training sessions/workshops). The PowerPoint presentation included details on HPV (eg, what is HPV, how does it spread, incidence and burden of HPV, HPV vaccine guidelines etc.) and our funded project (eg, our program's focus on increasing HPV vaccination rates in RGCCISD and its significance, importance, components, and goals). The 30-min educational presentations were delivered by the study investigators (1 gynecologist and 1 oncologist) with time allotted for questions from the audience. A pediatrician was also present to answer questions. They emphasized the benefits of vaccination, the recommended age, and the importance of provider recommendations and distributed existing educational materials in English and Spanish from the Centers for Disease Control and Prevention (CDC) [21–25]. These educational materials were also delivered to pediatric and family health clinics located within a 15-mile radius of RGCCISD. When requested at school-based events, parents/guardians received one-on-one education by our study personnel. For school-based events, we posted educational flyers and fact sheets on the importance of getting students vaccinated against HPV. We also used social media (eg, RGCCISD's Facebook page), local radio stations, and newspapers to provide a description of our program and advertise events.

#### 2.1.2. Vaccination events at the intervention school

In August 2017, we piloted our school-based HPV vaccination event at the intervention school (VMS). Vaccination events were held in the nurse's office or conference room. The events were scheduled for the HPV vaccine series to be initiated and completed during the school year (ie, back-to-school events, progress report nights, and schedule preview events). Five HPV vaccination events were held between August 2017 and April 2018. Prior to these events, consent forms were sent home with students by school staff. At each vaccination event, 2 tables were set up—one with educational materials and another for the vendor that

was contracted by the project to administer on-site vaccinations at the school (ProCare Health Services). The vendor had the parents sign in and complete the consent form for the vaccinations as well as register their child with ImmTrac, the Texas Immunization Registry, to track and document vaccinations. For educational purposes, parents were required to be present when the first dose of the vaccine was administered. It usually took less than 10 min for students to get vaccinated. The HPV vaccine was bundled with other recommended vaccines (eg, flu, Meningococcal, Meningitis B, Tetanus, Diphtheria [TD], or Tetanus, Diphtheria, and Pertussis [TDAP] and Hepatitis A vaccines). The vendor's medical assistants administered the vaccines.

Before vaccination, the vendor screened the children for their health insurance coverage (ie, private health insurance, Medicaid, Children's Health Insurance Program [CHIP], Texas Vaccination Program) to bill for vaccine administration. Although uninsured children receive vaccines free of charge through the VFC program, there is a vaccine administration charge. According to county estimates, ~20% of the parents cannot afford to pay the \$10 admin fee. Our program covered the administrative fee if the child had no payer. If a child missed a dose, efforts were made to catch up through the supporting clinics and subsequent vaccination events. Our vaccine vendor also provided the student vaccination data, which supplemented the school immunization records. The vendor collected student vaccination data (vaccine, dose number) during the vaccine administration. All records were refreshed quarterly by the vendor and school.

## 2.2. Outcomes

The primary outcomes of the analysis were HPV vaccine initiation (proportion of eligible students who received at least 1 dose) and completion rates (proportion of eligible students who completed 2 doses for those aged < 15 years and 3 doses for those who initiated at age ≥ 15 years or those with immunocompromising conditions).

## 2.3. Statistical analyses

Summary statistics for sex and age were computed. Proportions between intervention and comparison schools were compared using chi-square tests and means using *t* tests. HPV initiation and completion rates at baseline (8/31/2016) and at 3 follow-up dates (12 months [8/23/2017], 18 months [2/8/2018], and 20 months [4/25/2018]) were computed and stratified by intervention group and sex. Each of these follow-up dates was preceded by one or more vaccination events at the intervention school. Rates at baseline and follow-up were compared using *t*-tests. We also computed the proportion of students who were vaccinated onsite at the intervention school vs those who received their doses elsewhere. We observed no statistically significant differences in vaccination rates between the 2 comparison schools (GMS and RMS) at 5% level of significance (Appendix Table 1). Therefore, data for these 2 schools were combined to create a comparison group for our statistical analyses.

Logistic regressions were estimated for vaccine uptake to test for differences in odds of being vaccinated between the intervention and comparison schools after adjusting for students' sex and age. The dependent variables in these models included indicators for newly initiated and completed students, ie, students who initiated/completed the HPV vaccine during our program period. The independent variables included whether the student was from the intervention or comparison schools and students' age and sex (HPV vaccination rates differ by children's sex in the US [5,26]). All analyses were conducted using SAS version 9.4 (SAS Inc., Cary, NC). Statistical significance was considered at alpha = 0.05 level (2-sided).

## 3. Results

### 3.1. Overview of study cohort and educational events

At baseline, the total enrollment of 6th-, 7th-, and 8th-grade students at the intervention school (onsite vaccination events and community-based education) was  $n = 885$  and  $n = 1422$  at the comparison schools (community-based education only). The intervention school had a higher percentage of females than the comparison schools ( $n = 456, 51.53\%$  vs  $n = 665, 46.77\%$ ;  $p$ -value = .03). The mean age of students at the intervention school was similar to that of the comparison schools (12.23 years  $\pm$  0.90, range = 9.9–14.4 vs 12.18 years  $\pm$  0.91, range = 9.94–14.22, respectively). At the intervention school, students who initiated during our onsite vaccination events received their first HPV vaccine dose before they turned 15 years old.

By April 2018, our program conducted 411 educational events (262 professional and 149 public events). We educated 8558 professionals and 15,528 public individuals directly and distributed 38,307 educational materials. During the first 20 months of this program, a total of 197 HPV vaccine doses were administered to 145 students at the intervention school, of which 94% (185/197 doses) were covered through the VFC program.

### 3.2. HPV vaccination rates

Fig. 1 shows the overall HPV vaccine initiation and completion rates for our intervention and comparison schools. The baseline initiation rate was lower at the intervention school than the comparison schools (20.00% vs 28.97%,  $p$ -value < .001). The initiation rate increased to 53.67% and 41.56% for intervention and comparison schools, respectively, at the follow-up date of 4/25/2018 ( $p$ -value < .001). The completion rate for the intervention school was also lower at baseline than the comparison schools (8.70% vs 14.56%,  $p$ -value < .001). However, the completion rate rose to 28.36% at the intervention school and 20.53% for the comparison schools at the 4/25/2018 follow-up ( $p$ -value < .001).

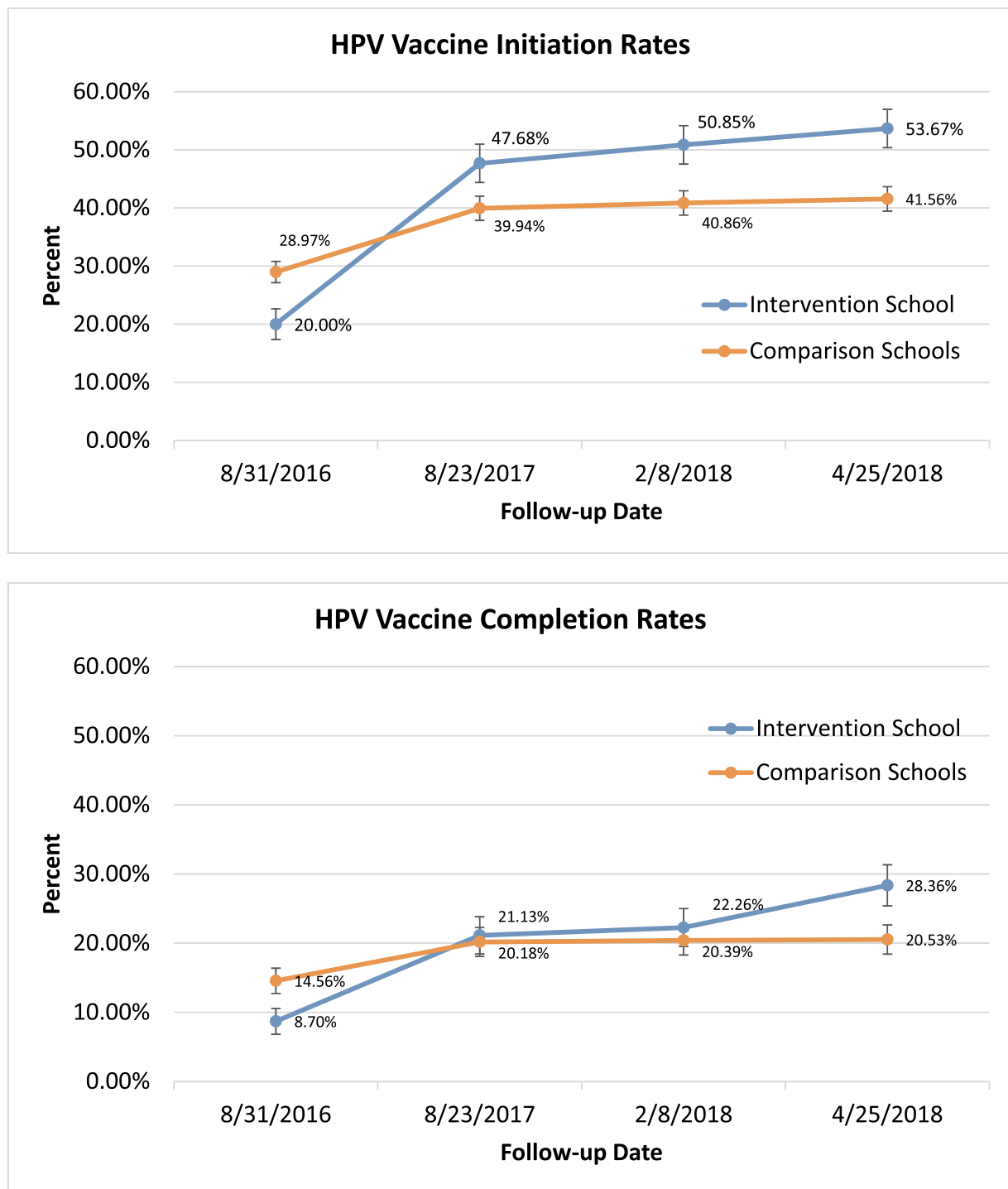
Table 1 reports the initiation and completion rates for the intervention and comparison schools by sex. At baseline, vaccination rates were lower at the intervention school than at the comparison schools, for both males (initiation: 19.11% vs 26.02%,  $p$ -value = .007; completion: 9.09% vs 10.57%) and females (initiation: 20.83% vs 32.33%,  $p$ -value < .001; completion: 8.55% vs 19.10%,  $p$ -value < .001). By April 25, 2018, initiation rates for males (49.18% vs 38.57%,  $p$ -value < .001) and females (57.89% vs 44.96%,  $p$ -value < .001) increased significantly, with rates higher for the intervention school than the comparison schools. Similar results were observed for the completion rates.

In terms of overall changes from baseline to 4/25/2018 (Appendix Table 2), we observed a 34% increase in the proportion of students who newly initiated the vaccine series at the intervention school vs 13% at the comparison schools ( $p$ -value < .001). The proportion of students who newly completed the vaccine series increased by 20% for the intervention school vs 6% for the comparison schools ( $p$ -value < .001).

Appendix Table 3 reports the percentage of newly vaccinated students at the intervention school during our onsite vaccination events. By the first follow-up, nearly a quarter of students were vaccinated onsite, and this rose to 63% and 43% at the second and third follow-ups, respectively.

### 3.3. Logistic regression results

After adjusting for sex and age, students from our intervention school who received both onsite vaccinations and community-based education had almost 4-times higher odds of newly initiating (Table 2, odds ratio [OR] = 3.63, 95% CI = 2.94–4.50) and completing the



**Fig. 1.** HPV Vaccination Rates for Intervention and Comparison Schools<sup>1</sup>.

<sup>1</sup> We report vaccine initiation and completion rates along with the 95% confidence intervals. Except for completion rates at 8/23/2017 (p-value = .58) and 2/8/2018 (p-value = .28), all rates were significantly different between the intervention and comparison schools at p-value < .001 level.

vaccine series (OR = 3.82, 95% CI = 2.90–5.03) compared to those from the comparison schools who received community-based education only.

**4. Discussion**

Our data support the findings of a previous US study that documented that educating parents, school staff, and health care professionals greatly increased HPV and HPV vaccine knowledge [27]. Our

study provides further evidence on the feasibility and effectiveness of a school-based HPV vaccination and education program and suggests that HPV vaccinations outside traditional healthcare settings (ie, school-based mass vaccination programs) can boost vaccine uptake in medically underserved areas [28,29]. Our study addresses many of research gaps highlighted by Reiter et al. [30], including improving vaccine confidence, accessibility, HPV uptake through social media and public health campaigns, and health care provider recommendations.

While school-based HPV programs have been evaluated in the US

**Table 1**  
HPV vaccination rates by sex for the intervention and comparison schools.

	Intervention school <sup>a</sup> : onsite vaccination events and community-based education total students <sup>b</sup> = 885	Comparison schools <sup>a</sup> : community-based education total students <sup>b</sup> = 1422	p-value
	n(%)	n(%)	
<b>Baseline 8/31/2016</b>			
<b>Initiation</b>			
Males	82 (19.11)	197 (26.02)	.007
Females	95 (20.83)	215 (32.33)	< .001
<b>Completion</b>			
Males	39 (9.09)	80 (10.57)	.42
Females	39 (8.55)	127 (19.1)	< .001
<b>Follow-up 8/23/2017<sup>c</sup></b>			
<b>Initiation</b>			
Males	185 (43.12)	276 (36.46)	.02
Females	237 (51.97)	292 (43.91)	.008
<b>Completion</b>			
Males	82 (19.11)	119 (15.72)	.14
Females	105 (23.03)	168 (25.26)	.39
<b>Follow-up 2/8/2018</b>			
<b>Initiation</b>			
Males	199 (46.39)	286 (37.78)	.004
Females	251 (55.04)	295 (44.36)	< .001
<b>Completion</b>			
Males	89 (20.75)	121 (15.98)	.04
Females	108 (23.68)	169 (25.41)	.51
<b>Follow-up 4/25/2018</b>			
<b>Initiation</b>			
Males	211 (49.18)	292 (38.57)	< .001
Females	264 (57.89)	299 (44.96)	< .001
<b>Completion</b>			
Males	112 (26.11)	122 (16.12)	< .001
Females	139 (30.48)	170 (25.56)	.07

<sup>a</sup> The intervention school (VMS) had onsite vaccination events and community-based education while the comparison schools (GMS and RMS) received community-based education only. Community-based education occurred at school-based and community events throughout Cameron, Hidalgo and Starr counties. The school-based events included health fairs, vaccination days, back-to-school nights, and PTA meetings, while community events included county health department events, regional conferences, and individual/group training sessions/workshops.

<sup>b</sup> This table reports the number and percent of males and females who received at least one HPV dose (initiation) and completed all doses. Total number of eligible students at the intervention school were 429 males and 456 females. Total number of eligible students at the comparison schools were 757 males and 665 females.

<sup>c</sup> First onsite vaccination event at the intervention school was held on 8/23/2017. The other vaccination events included 2 additional vaccination days on 2/8/2018 and 2/28/2018 (we only report 2/8/2018 rates here because of the closeness in these dates), and onsite clinic on 4/25/2018.

[31], this study is the first to implement this program in an economically disadvantaged, medically underserved area with a high proportion of minority children. In our study, HPV vaccine uptake was higher among middle school students who received both community-based education and onsite vaccinations than those who received education only. Initiation and completion rates at the intervention school almost doubled to 53.67% and 28.36%, respectively, by April 2018 (roughly 20 months after project implementation). The increase in HPV vaccine initiation and completion rates was lower at the comparison schools that received education only (41.56% and 20.53%, respectively). Our regression results demonstrated that the students at the intervention school had > 3.6 times higher odds of newly initiating and completing HPV vaccination compared with students from comparison schools. The majority of the HPV vaccines delivered at our vaccination events at the intervention school were covered by the VFC program. Nationwide, boys are at a higher risk for not completing HPV vaccines [26], and our program demonstrates success in improving vaccine rates among

**Table 2**  
Logistic regression models for newly initiated and newly completed students.

	Newly initiated		Newly completed	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age <sup>a</sup>	0.70 (0.62–0.79)	< .001	0.86 (0.74–0.99)	.04
Sex				
Male	ref			
Female	1.17 (0.95–1.45)	.14	1.28 (0.98–1.67)	.07
School				
Comparison schools: <sup>b</sup> community-based education	ref			
Intervention school: <sup>b</sup> onsite vaccination and community-based education	3.63 (2.94–4.50)	< .001	3.82 (2.90–5.03)	< .001

<sup>a</sup> Included as a continuous variable and computed using baseline data.

<sup>b</sup> The intervention school (VMS) had onsite vaccination events and community-based education while the comparison schools (GMS and RMS) received community-based education only. Community-based education occurred at school-based and community events throughout Cameron, Hidalgo and Starr counties. The school-based events included health fairs, vaccination days, back-to-school nights, and PTA meetings, while community events included county health department events, regional conferences, and individual/group training sessions/workshops.

middle school boys. Notably, the completion rates for boys at our intervention school reached 26.1% in April 2018 (vs 16.1% at comparison schools).

Barriers to HPV vaccination services include limited HPV/HPV vaccine knowledge, access barriers, lack of insurance coverage, logistical problems (cost and shortage of alternative settings), and no provider recommendation [12]. Our study focuses on improving accessibility and addressing system-level barriers. Parents reported significant difficulty for vaccine series initiation and completion because of work/school schedule conflicts [20]. Our program targeted these barriers by educating and creating awareness of HPV vaccines among not only the parents/guardians but also among school staff and local health care providers. Although our program is ongoing (continuing educational awareness and expanding free vaccinations to all middle schools) and we expect higher rates for all 3 middle schools, our results demonstrate that school-based free HPV vaccines significantly supplemented our physician-led educational/awareness program in increasing HPV initiation and completion rates. These results are crucial for meeting the *Healthy People 2020* goal of having 80% HPV coverage among 13–15-year-olds [32]. Increasing vaccination coverage to 80% may prevent 53,000 more cervical cancer cases over the lifetime of those ≤ 12 years [33,34].

#### 4.1. Strengths and limitations

As we learned, schools are champions for improving HPV vaccine uptake. With the appropriate resources and partnerships, schools can carry out vaccination-related activities from educating students, parents, and communities to developing policies supporting vaccination, providing vaccines, or serving as the site where vendors administer vaccines [35]. Our success is attributable to the strong support of the RGCCISD Superintendent, School Board, and school principals.

Despite the successes, we faced some challenges. A key challenge in offering HPV vaccines in schools is creating the demand for the vaccination services among parents, school staff, and the community [28]. Voluntary mass vaccination programs in schools require partnerships between providers and community members. The significant RGCCISD staff turnover between 2016 and 2017 served as major barrier in



maintaining partnerships. To overcome this, we repeated the initial educational presentations during a teacher in-service training day before the start of the 2017 academic year and repeated presentations for new nursing staff. Moreover, we did not include student education in our program because of the lack of evidence of whether it alters vaccination behaviors. Previous studies show that education can change students' (young adolescents aged 12–16 or those in college) intention or attitude to vaccinate [36], which should be explored as an area for future research. Further, there could be other factors (eg, insurance coverage of students) that could have impacted vaccination rates at our comparison schools which were not addressed.

Our study has its limitations. Limited information was collected on students and parents, ie, students' race, ethnicity, and other socioeconomic status; and parents' education, income levels, country of birth, or knowledge and confidence in the HPV vaccines. Therefore, examination of rates by these important characteristics cannot be undertaken. We do not have complete information on students' insurance, which may be important for examining access to care. Bundling of the HPV vaccine with other ACIP recommended vaccines could have accentuated the impact of our program [37,38]; however, we do not have complete data on these other vaccines, but this could be an important future extension of our study. Some students may change schools during our study time; however, for simplification, we followed our baseline cohort through the study. Some students may have received the HPV vaccine outside the school settings through their local providers. If parents failed to report the HPV vaccine status to the schools, we would be unable to account for those in our study. The vendor and schools shared updated information, but it may not capture all vaccines received. We suspect that the increased HPV vaccine uptake at the intervention school may be due to more motivation to share updated records because of the onsite vaccination events, more exposure to study personnel, and better access to vaccinations. Future studies should explore issues, such as inadequate school-based health centers and vaccine billing, as barriers for school-based HPV programs [29].

## 5. Conclusions

School-based onsite vaccinations and community-based education increased adolescent HPV vaccination rates more than education alone.

## Appendix U. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pvr.2019.100189>.

## Appendix

Table 1  
HPV Vaccine Uptake Rates for the Comparison Schools

Initiation	Grulla Middle School	Ringgold Middle School	p-value <sup>a</sup>
	Mean (standard deviation)		
Baseline	0.31 (0.46)	0.27 (0.44)	0.07
8/23/2017	0.39 (0.49)	0.40 (0.49)	0.73
2/8/2018	0.41 (0.49)	0.41 (0.49)	0.80
4/25/2018	0.41 (0.49)	0.43 (0.49)	0.44
<b>Completion</b>			
Baseline	0.15 (0.36)	0.14(0.35)	0.56
8/23/17	0.2 (0.4)	0.20 (0.4)	0.79
2/8/2018	0.2 (0.4)	0.21 (0.41)	0.75
4/25/2018	0.2 (0.4)	0.21 (0.41)	0.65

<sup>a</sup>p-values computed using independent t-tests.

Per our experience, environmental interventions, such as school-based vaccination programs, have 2 major advantages over informational and behavioral interventions. First, it increases access to the HPV vaccine. Second, it could reach a large, diverse population regardless of individual access to healthcare. In summary, it is important to bundle HPV vaccines with other required vaccines, and educating parents, local providers, school board members, and school staff can result in sustained HPV vaccine uptake.

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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**Table 2**  
Increase in Newly Vaccinated Students at Intervention and Comparison Schools

	Intervention School: Onsite Vaccination and Community-Based Education		Comparison Schools: Community-Based Education		p-value <sup>a</sup>	
	Initiation	Completion	Initiation	Completion		
	Mean (standard deviation)					
Baseline to 8/23/2017	0.28 (0.45)	0.12 (0.33)	0.11 (0.31)	0.06 (0.23)	< .001	< .001
8/23/2017 to 2/8/2018	0.03 (0.18)	0.01 (0.11)	0.01 (0.10)	0.00 (0.05)	< .001	.01
2/8/2018 to 4/25/2018	0.03 (0.17)	0.06 (0.24)	0.01 (0.08)	0.00 (0.04)	< .001	< .001
Baseline to 4/25/2018	0.34 (0.47)	0.20 (0.40)	0.13 (0.33)	0.06 (0.24)	< .001	< .001

<sup>a</sup>p-values computed using independent t-tests.

**Table 3**  
Students from the Intervention Schools Vaccinated at School vs. Outside School

	Number of Students Newly Vaccinated at School	Number of Students Newly Vaccinated Outside	Newly Vaccinated Student at School (%) <sup>a</sup>
Baseline to 8/23/2017	87	267	24.6%
8/23/2017 to 2/8/2018	24	14	63.2%
2/8/2018 to 4/25/2018	34	45	43.0%
Overall	145	326	30.8%

<sup>a</sup>Calculated as the number of students newly vaccinated at school\*100/number of students newly vaccinated at school or outside school.

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