Preventive Medicine 121 (2019) 115–120

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Tiempo de Vacunarte (time to get vaccinated): Outcomes of an intervention to improve HPV vaccination rates in a predominantly Hispanic community

J. Molokwu[a,*,1], A. Dwivedi[b,1], I. Mallawaarachchi[b,1], A. Hernandez[c,1], N. Shokar[d,e,f,2]

[a] Department of Family and Community Medicine, Texas Tech University Health Sciences Center El Paso, 9849 Kenworthy Street, El Paso, TX 79924, USA
[b] Department of Biostatistics and Epidemiology, Graduate School of Biomedical Sciences, Texas Tech University Health Sciences Center El Paso, El Paso, TX, USA
[c] Department of Family and Community Medicine, Texas Tech University Health Sciences Center El Paso, El Paso, TX, USA
[d] Department of Family and Community Medicine & Biomedical Sciences, Texas Tech University Health Sciences Center El Paso, El Paso, TX, USA
[e] Department of Family and Community Medicine, Paul l. Foster School of Medicine, Texas Tech University Health Sciences Center El Paso, 9849 Kenworthy Street, El Paso, TX 79924, USA
[f] Department of Biomedical Sciences, Paul l. Foster School of Medicine, Texas Tech University Health Sciences Center El Paso, Medical Science Building, 5001 El Paso Drive, El Paso, TX 79905, USA.

ARTICLE INFO

Keywords:
HPV vaccination completion
Promontora
HPV education
HPV prevention
Hispanic population

ABSTRACT

The purpose of this study was to evaluate effects of a culturally tailored evidence-based HPV vaccine educational intervention on psychosocial factors and vaccine completion in a largely low-income Hispanic population.

Our study is a prospective community based intervention utilizing a prepost design. We recruited individual's dwelling in a border community aged 18–26 years or parents/guardians of children aged 9–17 years who had not completed the HPV vaccine series.

We recruited 2380 participants between June 2015 and February 2018. We included 1796 participants in the final analysis. Mean age of the sample was 22.8 years (SD2.60). Majority of participants 63.99 were female and self-identified as Hispanic (97.4%). A total of 3192 vaccines were administered with an overall vaccine completion rate of 39.8%; 31.6% among adult participants compared to 48.7% among children. The Intervention significantly improved HPV knowledge by 61.66%, HPV awareness by 19.45%, Intention to vaccinate by 13.85%. For both adults and children being born in Mexico significantly improved the odds of vaccine completion (AOR: 2.154 95% CI: 1.439–3.224), while for adults only pre-intervention perceived benefits remained significant (AOR 1.101, CI: 1.002–1.210) and in children the main factor was parental perceived susceptibility of their child (AOR: 1.257 CI: 1.001–1.578).

A Community based multicomponent HPV vaccine intervention significantly improved HPV immunization rates in a largely Hispanic population. Factors that affect completion of the HPV series are different among adults and children.

Human Papilloma Virus (HPV) is the most common sexually transmitted infection in the United States (US) (Satterwhite et al., 2013) with a prevalence of 45.2% in adults aged 18–59 year (McQuillan et al., n.d.). High-risk strains of the HPV have been implicated in the causal pathway of cancers of the vulva, vagina, cervix, penis, throat and anogenital region (Li et al., 2011; de Sanjose et al., 2010). The Centers for Disease Control and Prevention (CDC) estimate that HPV accounts for over 30,000 new cancers annually (Viens et al., 2016). Although rates of cervical cancer have continued to decline in the US, there remains a racial/ethnic disparity in incidence (Siegel et al., 2011).

Women of Hispanic origin continue to be diagnosed with cervical cancer at rates higher than their White non-Hispanic counterparts, and currently, have the highest incidence rates in the US at 9.9/100,000 population compared to 7.0/100,000 population among non-Hispanic Whites (*Cancer Facts and Figures 2017,* 2017). Also, Hispanic women living along the US Mexico border have higher rates of cervical cancer diagnosis when compared to non-border dwelling Hispanics (Coughlin et al., 2008). A similar trend is also seen for penile cancer in the US, where males of Hispanic origin have higher rates than non-Hispanic Whites (1.9 per 100,000 compared to 1.1 per 100,000) (Society AC,

* Corresponding author.
E-mail addresses: jennifer.molokwu@ttuhsc.edu (J. Molokwu), alok.dwivedi@ttuhsc.edu (A. Dwivedi), amir.hernandez@ttuhsc.edu (A. Hernandez), navkiran.shokar@ttuhsc.edu (N. Shokar).

[1] Conflict of Interest: This author declares that he has no potential conflict of interest.
[2] Conflict of Interest: This author declares that she has no potential conflict of interest.

https://doi.org/10.1016/j.ypmed.2019.02.004
Received 16 July 2018; Received in revised form 31 January 2019; Accepted 6 February 2019
Available online 15 February 2019
0091-7435/

2017).

Despite the proven efficacy of HPV vaccines in the prevention of persistent HPV infection and cervical cancer (Pomfret et al., 2011; Lehtinen et al., 2012), rates of vaccine initiation and completion in the US have remained low (Reagan-Steiner et al., 2016). HPV vaccination rates continue to lag behind many adolescent vaccines such as tetanus-diphtheria-acellular pertussis (Tdap) and meningococcal vaccine (Reagan-Steiner et al., 2016). Rates of HPV vaccination among adolescents aged 13 to 17 years are approximately 41.9% compared with rates for Tdap at 86.4% (Reagan-Steiner et al., 2016). Racial/ethnic disparities also exist in the initiation of the HPV vaccine. While some community studies report that Hispanics are less likely to have initiated the vaccine series compared with their non–Hispanic White counterparts (Gelman et al., 2013), NIS-teen data shows completion rates for Hispanic teens aged 13 to 17 at 41.5% vs non-Hispanic whites at 34.8% (Reagan-Steiner et al., 2016).

Numerous factors are reported as barriers to the receipt of the HPV vaccine. The most frequently reported barrier is cost (Rambout et al., 2014). With an average series cost of approximately $390 which is covered by insurance but may be a deterrent among uninsured and underinsured individuals. Reported deterrents to HPV vaccine uptake can be broken down into systemic barriers such as lack of knowledge, lack of health care provider recommendation, insurance status and practical barriers such as transportation, booking appointments and the need for additional office visits (Rambout et al., 2014; Reiter et al., 2011; Rand et al., 2007). These systemic barriers are often higher in minority populations (De and Budhwani, 2017). Other factors include concerns about vaccine safety and side effects, the perception of low susceptibility to HPV infection, perceived low access to the vaccine, societal norms, religious background, perception that the vaccine is unnecessary, and fear of needles (Rambout et al., 2014; Rand et al., 2007).

Most previous HPV vaccine intervention studies have focused on assessing the effects of educational interventions on HPV vaccine knowledge or intent (Reiter et al., 2011; Rand et al., 2007; Lechuga et al., 2011; Askelson et al., 2010). Very few studies have assessed the impact of interventions on vaccine initiation and completion (Rickert et al., 2015; Parra-Medina et al., 2015). There was one study which used a multi-component approach (education and navigation) to increase self-reported vaccination rates in mothers with non-successfully vaccinated daughters (Parra-Medina et al., 2015). We aim to expand on this by evaluating the effect of a multicomponent (education, navigation and access provision) culturally tailored and evidence-based HPV intervention on actual vaccine completion rates in a predominantly low-income Hispanic community. The secondary aims are to evaluate changes in psychosocial factors after the intervention and assess predictors of vaccine completion.

1. Methods

Our program was a multicomponent intervention that consisted of outreach, education, navigation to services and reduction of access barriers with the provision of no-cost vaccines. This approach was used based on evidence of the efficacy of these components in other cancer prevention programs in similar populations (Shokar et al., 2016).

Institutional Review Board approval was obtained before study implementation.

1.1. Study design

For the evaluation, we embedded a prospective study into our program utilizing a pre-post design. Our program was implemented from June 2015 to February 2018. Participants were recruited into the program throughout the study period. For the evaluation study, we invited the first 150 participants to complete a comprehensive questionnaire that included validated measures of knowledge, awareness, intention to vaccinate, susceptibility, perceived benefits, perceived barriers and social norms (the psychosocial survey group). These participants received pre-post education surveys to evaluate the effect of the intervention on psychosocial measures. The comprehensive survey was limited to the first 150 participants due to the length of time required to complete these surveys, and to limit the effect of survey burden on the willingness of participants to receive services. All other program participants completed a short survey on knowledge, awareness and intention to get the vaccine. Participants completed surveys at recruitment, immediately post education and at seven months post recruitment. Individuals in the psychosocial survey group received a $22 gift card for completing the full survey.

1.2. Study setting and recruitment

This intervention was conducted in El Paso County, Texas which is located on the US-Mexico border with a population of approximately 840,000 (Elpaso County, 2015). A majority (82.2%) of the population is Hispanic American of Mexican descent (Bureau USC, 2010–2014). This population is socioeconomically challenged with a high poverty rate, low educational attainment and low rates of health coverage (36% without health insurance, compared to 25.2% in Texas and 14.7% in the US) (Bureau USC, 2017). Participants were approached and recruited from multiple community sites with the aid of our community partners. Sites included but were not limited to community centers, food banks, health fairs, community colleges, trade schools, school districts and churches.

1.3. Eligibility

Individuals were eligible to participate in the program if they were adults aged 18–26 years or parents/guardians of children (POC: parents of children) aged 9–17 years who had not previously completed the three-dose vaccine series. Eligibility criteria for receipt of no-cost HPV vaccine through our program were age 9–26 years, uninsured, underinsured and having a Texas address (this was a requirement of the grant-funding agency). We determined age criteria using the Advisory Committee on Immunization Practices (ACIP) recommendations for HPV vaccination (ACIP, 2014).

1.4. Intervention

Our intervention targeted individuals with access to care barriers. The intervention consisted of outreach, education, navigation and provision of vaccine to eligible individuals.

The development of the educational material for the program was guided by the Health Belief Model (HBM) and was informed by findings of focus groups previously conducted in the community (Penaranda et al., 2014). The focus groups identified cultural concerns, barriers and knowledge gap specific to this community, and this informed our adaptation of available material on the CDC website (*Prevention. CfDCa. Human Papilloma Virus (HPV)*, 2015). The educational materials were culturally tailored and available in Spanish and English and included information on cervical cancer, HPV transmission, HPV vaccine indications, schedule, contraindications and adverse reactions. The materials addressed constructs that are associated with increased intention to vaccinate such as perceived susceptibility to HPV infection, perceived health benefits (Rickert et al., 2014; Patel et al., 2012), and normative beliefs (Dempsey et al., 2006). The education was pilot-tested in a small group to ensure that information was accurately conveyed in a comprehensible manner. We developed the educational sessions to be presented verbally with an audiovisual aid which are strategies that have been shown to improve knowledge in a similar low-income Hispanic community (Chan et al., 2015). The sessions were delivered by bilingual community health workers also known as promotoras to further address cultural and language barriers.

The *navigation* component was delivered by program navigators who helped participants with community resources, scheduling, transportation assistance, and also performed tracking and reminders. Reminder phone calls occurred at 2, 6, and 12 months. After three unsuccessful phone contact attempts, navigators sent participants a letter with program contact information, and no further attempts to contact them were made. If a participant reported receiving HPV vaccine outside the program during the follow-up period, this was verified through the state immunization registry where possible.

Access to the vaccine was provided after the education was delivered. Eligibility criteria for receipt of no-cost HPV vaccine through our program were age 9–26 years, uninsured, underinsured and having a Texas address (this was a requirement of the grant-funding agency). For those eligible for the no-cost vaccine, a certified medical assistant provided the vaccine at the site of recruitment or scheduled a vaccine administration appointment at the participant's home or a collaborating community site. For those who qualified for immunization through their insurance, we referred them to their providers for vaccination.

1.5. Measures

We collected demographic information including age, gender (self-defined by the participant or parent/guardian), level of education, race, ethnicity, country of birth, household income and length of residence in the US. Psychosocial measures included knowledge (7 items), awareness and intention to vaccinate. Individuals in the "psychosocial survey" group completed additional questions covering HBM constructs obtained from validated surveys which included knowledge, susceptibility (3 items, Cronbach's alpha = 0.94), perceived severity (4 items, Cronbach's alpha 0.9), perceived benefits (4 items, Cronbach's alpha = 0.86), barriers (3 items, Cronbach's alpha = 0.9), and subjective norms (3 items not validated) (Gerend and Magloire, 2008; Gerend et al., 2013; Caskey et al., 2009). In cases where parents had more than one eligible child or if both a parent and their child were eligible, only one survey was completed. For the surveys, we used the child's information for age, gender, having a regular doctor, county of birth, ethnicity and length of time living in the US and the parent's characteristics for other survey items.

1.6. Statistical analysis

The primary outcome of our study was vaccine completion, while secondary outcomes were changes in psychosocial measures after the intervention and predictors of vaccine completion. We defined vaccine completion as receipt of two doses of vaccine at least six months apart for individuals aged 9 to 15 and receipt of three doses of the vaccine over six months for those aged 16 to 26 (ACIP, 2014). We summarized quantitative data using mean and standard deviation (SD) and reported categorical data using frequencies and proportions. We reported summary statistics for the entire cohort and separately for adults and POC. We reported vaccine initiation and completion rates along with their 95% confidence interval (CI) using the binomial distribution. We compared psychosocial scores pre-intervention with respective scores after intervention using a two-sided paired *t*-test. We summarized the effect size using mean change in scores along with the 95% CI and p-value. We also quantified the percent relative change for each score. We obtained p-values to assess significant differences in absolute mean changes between pre and post intervention. We used McNemar's test to compare HPV vaccine awareness pre and post-intervention. We determined the adjusted and unadjusted factors associated with vaccine completion using logistic regression analysis for adults while we used hierarchical logistic regression analyses with two-levels for children. The multilevel model was used due to the hierarchical structure in the dataset (multiple children from the same family). We considered the subject level covariates as level one factors and household factors as level II factors (Tables 3 and 4). We included factors present in the unadjusted analysis at 15% level of significance in the multivariable regression analysis. We only retained factors significant at 5% in the multivariable analysis (Table 4). We conducted our statistical analyses using SAS 9.4.

Table 1
Characteristics of participants in the study.

Variable	Overall (N = 1796)		Adults (N = 937)		Child (N = 859)	
	Mean	SD	Mean	SD	Mean	SD
Age	17.94	5.77	22.83	2.60	12.59	2.74
US years	12.56	7.38	15.09	8.64	9.80	4.22
	N	%	N	%	N	%
Gender						
Female	1148	63.99	679	72.47	469	54.73
Male	646	36.01	258	27.53	388	45.27
Regular doctor						
No	1156	64.73	811	86.92	345	40.45
Yes	630	35.27	122	13.08	508	59.55
Country of birth						
US	1245	69.55	606	64.67	639	74.91
Mexico	517	28.88	316	33.72	201	23.56
Other	28	1.6	15	1.6	13	1.5
	Overall (N = 1553)		Adults (N = 937)		POC (N = 616)	
Hispanic						
No	40	2.58	29	3.09	11	1.79
Yes	1512	97.42	908	96.91	604	98.21
Partner						
No	832	53.68	643	68.62	189	30.83
Yes	718	46.32	294	31.38	424	69.17
Education						
Grade school	103	6.69	6	0.64	97	16.03
Middle school	171	11.1	43	4.6	128	21.16
High school	520	33.77	353	37.75	167	27.6
College or higher	746	48.44	533	57.01	213	35.21
Income						
< 20 k	587	37.87	281	30.05	306	49.76
20–35 k	168	10.84	89	9.52	79	12.85
> 35 k	83	5.35	37	3.96	46	7.48
Don't know or refused	712	45.9	528	56.5	184	29.9

2. Results

In the study period (June 2015–February 2018), 12,645 participants were approached and offered the intervention. Of these 2,380 participants were eligible and recruited into the program. A total of 1796 unique surveys were included in the analysis (numbers are different due to multiple participants from the same family having only one survey completed). Of the final surveys analyzed, 937 (52%) were adult participants with an average age of 22.8 years (SD: 2.6), and 859 (48%) were children with an average age of 12.7 years (SD: 2.7). Table 1 shows the socio-demographic characteristics of participants for the entire cohort and separately for adults and children/POC in the study. The majority of the participants in the cohort were female (63.9), born in the US (69.5%), Hispanic (97.4%), had a greater than high school education (82.2%), income less than $20,000 (37.8%) and did not have a regular doctor (64.7%). There were some demographic differences in adults recruited to the study when compared with children/POC; adult participants were more likely to be female (72.4% vs 54.7%), less likely to have a regular physician (86.9% vs 40.4% reporting no regular physician). Adult participants were also less likely to be born in the US (64.6% vs 74.9%), more likely to have a college or higher education (57% vs 35.2%) and less likely to report income < 20,000(30.1% vs 49.8%).

Overall our final HPV vaccine initiation and vaccine completion

Table 2
Effect of the education intervention on psychosocial factors among participants.

Variable	Pre		Post		Change			% mean change
	Mean	SD	Mean	SD	Mean	95% CI		
Overall								
HPV awareness-Y (N, %)	1102	71.1	1131	90.6	19.45			
Knowledge	6.47	3.27	10.46	1.62	4.15	3.96	4.34	61.66
Susceptibility	16.17	4.68	17.93	4.50	1.78	1.14	2.41	10.89
Severity	19.46	2.88	19.74	2.76	0.32	−0.04	0.68	1.40
Benefits	24.82	4.56	26.25	3.45	1.46	0.84	2.08	5.76
Barriers	15.90	4.30	14.09	5.27	−1.76	−2.32	−1.20	−11.34
Subjective norms	11.73	4.87	12.24	5.23	0.27	−0.25	0.79	4.30
Self-efficacy	18.58	3.23	19.17	2.77	0.64	0.23	1.06	3.20
Intention	29.31	9.14	33.31	4.58	4.13	3.65	4.61	13.65
Adult participants								
HPV awareness-Y (N, %)	577	61.7	686	87.6	25.9			
Knowledge	6.30	3.33	10.33	1.62	4.13	3.89	4.37	64.01
Susceptibility	14.37	4.85	16.62	5.10	2.05	1.14	2.96	15.67
Severity	19.01	3.36	19.19	3.42	0.32	−0.31	0.95	0.95
Benefits	23.41	4.68	25.52	4.04	1.91	1.03	2.80	9.03
Barriers	15.11	3.80	13.21	5.25	−1.77	−2.65	−0.90	−12.61
Subjective norms	11.65	4.47	12.14	4.94	0.52	−0.11	1.14	4.21
Self-efficacy	17.93	3.26	18.29	3.20	0.33	−0.16	0.82	2.00
Intention	29.08	8.85	32.77	5.13	3.58	3.03	4.14	12.71
Parents of children (POC)								
HPV awareness-Y (N, %)	525	85.4	445	95.5	10.1			
Knowledge	6.74	3.15	10.69	1.59	4.18	3.87	4.49	58.63
Susceptibility	18.04	3.66	19.40	3.14	1.47	0.57	2.37	7.51
Severity	19.94	2.19	20.35	1.57	0.32	0.02	0.62	2.07
Benefits	26.30	3.93	27.08	2.41	0.96	0.08	1.83	2.96
Barriers	16.71	4.64	15.09	5.14	−1.75	−2.45	−1.04	−9.73
Subjective norms	11.82	5.27	12.35	5.56	−0.01	−0.87	0.85	4.47
Self-efficacy	19.24	3.07	20.15	1.73	0.99	0.30	1.68	4.72
Intention	29.66	9.56	34.21	3.26	5.04	4.15	5.93	15.33

rates were 67.1% (95%CI: 64.8%, 69.2%) and 39.8% (95%CI: 37.5%, 42.1%) respectively (figure not included in tables). The vaccine initiation rate was significantly higher among adults 77.4% (95%CI: 74.6%, 80.0%) compared to children 55.8% (95%CI: 52.4.6%, 59.1%). The vaccine completion rate was quite low 31.6% (95%CI: 28.6%, 34.7%) among adult participants compared to 48.7% (95%CI: 45.3%, 52.1%) among children. Approximately 90% of the participants received at least one dose of vaccine (some participants were recruited having already initiated but not completed) with over half (55.5%) of all participants receiving at least two doses of the vaccine.

Among adult participants, HPV awareness improved significantly from 61.7% to 87.6%. HPV awareness also increased in POC (85.1% to 95.5%). The effect of the educational intervention on psychosocial scores in the psychosocial survey group is reported in Table 2. Both groups (adults versus POC), showed a statistically significant improvement in most psychosocial factors compared to their baseline values. Knowledge increased 64% in adults, $p < 0.001$ and 58.6% in POC $p < 0.001$; susceptibility increased 15.7%, $p < 0.001$ in adults and 7.5% in POC, $p = 0.002$; benefits increased 9%, $p < 0.001$ in adults and 2.9%, $p = 0.033$ in POC; barriers decreased −12.6%, $p < 0.001$ in adults, and −9.7%, $p < 0.001$ in POC; and vaccine intention increased 12.7%, $p < 0.001$ in adults and 15.3%, $p < 0.001$ in POC following our intervention. In addition to these factors, the POC group also showed a significant improvement in self-efficacy (4.7%, $p = 0.005$) as well as perceived severity (2.07%, $p = 0.037$). Subjective norms were not significantly different after the intervention in either group. The extent of improvement after the intervention was found to be larger for adult participants on all scores except for intention when compared to the POC.

Tables 3 and 4 show unadjusted and adjusted factors associated with vaccine completion. In the unadjusted analysis for adult participants, we found male gender and being born in the US conferred reduced odds of vaccine completion while pre-intervention perceived benefits were significantly associated with increased odds of vaccine completion. In children, however, the unadjusted analysis showed increasing age, being Hispanic and having the parent living with a partner increased the odds of vaccine completion. Being born in the US, a higher pre-intervention susceptibility score and higher pre-intervention intention to vaccinate conferred decreased odds of vaccine completion. Following adjustment, the odds of vaccine completion remained significantly lower in both adults and children born in the US, while a higher pre-intervention perceived benefits score remained significantly predicted vaccine completion in the young adult population and the pre-intervention susceptibility score predicted vaccine completion in children.

3. Discussion

Vaccine initiation and completion rates have been reported to be quite low among Hispanics compared to other ethnic groups. This intervention resulted in an overall initiation rate of 67.1% and a completion rate of 39.8%. While this is slightly higher than the national average for receipt of at least one dose of the vaccine (60.4%) (Walker et al., 2017), it still falls significantly short of the Healthy People 2020 target of 80% vaccine coverage. Overall we found that the odds of vaccine completion remained significantly lower in both adults and children born in the US. While pre-intervention perceived benefits in the young adult population and pre-intervention susceptibility remained significant in children.

Our multicomponent program was a promotora-led intervention that comprised education, navigation services and provision of no-cost vaccines. The use of promotoras has been shown to improve uptake in cancer screening programs in mostly Hispanic populations (Hansen et al., 2005; Nuno et al., 2011; O'Brien et al., 2010). A 2015 study which reviewed the effect of promotora-led outreach, education and navigation support were similarly effective in increasing initiation and

Table 3
Unadjusted factors associated with vaccine completion for adults and children.[a]

Variable	Adults	Children[b]
	OR (95% CI)	OR (95% CI)
Age	0.962 (0.913, 1.015)	1.137 (1.442, 4.080)
US years	0.988 (0.972, 1.004)	1.014 (0.951, 1.082)
Gender - M	0.727 (0.529, 1.000)	0.589 (1.568, −0.160)
Regular doctor - Y	0.672 (0.434, 1.041)	0.454 (1.386, −0.810)
Country of birth - US	0.662 (0.498, 0.879)	0.223 (0.748, −2.900)
Hispanic - Y	1.467 (0.620, 3.474)	1.391 (198.9, 2.220)
Partner - Y	0.873 (0.647, 1.178)	1.328 (4.785, 2.830)
Education		
Grade school	Reference	
Middle school	0.972 (0.098, 9.645)	0.256 (1.633, −0.920)
High school	1.949 (0.225, 16.891)	0.203 (1.200, −1.560)
College or higher	2.747 (0.319, 23.686)	0.215 (1.193, −1.560)
Income		
< 20 k	Reference	
20–35 k	1.418 (0.867, 2.319)	0.322 (1.863, −0.570)
> 35 k	0.883 (0.418, 1.866)	0.258 (2.447, −0.400)
Don't know or refused	0.892 (0.653, 1.218)	0.402 (1.496, −0.760)
Knowledge_Pre	1.025 (0.983, 1.068)	0.913 (1.094, −0.010)
Susceptibility_Pre	1.059 (0.976, 1.149)	1.005 (1.538, 2.010)
Severity_Pre	1.019 (0.909, 1.143)	0.824 (1.554, 0.770)
Benefits_Pre	1.099 (1.002, 1.205)	0.885 (1.262, 0.610)
Barriers_Pre	0.985 (0.895, 1.085)	0.929 (1.256, 1.000)
Subjective norms_Pre	1.071 (0.985, 1.164)	0.895 (1.168, 0.330)
Self-efficacy_Pre	1.041 (0.924, 1.172)	0.885 (1.425, 0.960)
Intention_Pre	0.997 (0.982, 1.013)	0.934 (0.991, −2.520)
HPV awareness_Pre - Y	1.244 (0.934, 1.658)	0.729 (3.644, 1.190)

[a] OR: odds ratio; CI: confidence interval; HPV: human papillomavirus.
[b] For Children: We used Information from the child for the variables: age, gender, regular doctor, county of birth, ethnicity and length of time living in the US. Family (parents) characteristics were used for survey items; living with a partner, education, income and psychosocial variables such as knowledge, perceived susceptibility, severity, barriers, subjective norms, self-efficacy, intention and HPV awareness. We used logistic regression analysis for modeling vaccine completion among adult participants while two level logistic regression analyses (children were nested in family) were used for modeling vaccine completion among child participants.

Table 4
Final adjusted analysis for vaccine completion.[a]

Variable	OR	95% CI	
Adult-Y	0.276	0.177	0.430
Country of birth			
USA	Reference		
MX	2.154	1.439	3.224
Other	2.452	0.567	10.608
Hispanic - Y	3.167	0.900	11.139
HPV awareness_Pre-Y (N, %)	1.478	0.970	2.252
Intention_Pre	0.981	0.962	1.000
Country of birth - US	0.346	0.160	0.750
Benefits - Pre	1.101	1.002	1.210
Country of birth - US	0.117	0.017	0.814
Susceptibility - Pre	1.257	1.001	1.578

Ordinary logistic regression analysis was used for modeling vaccine completion among adult participants while two level logistic regression analyses (children were nested in family) were carried out for modeling vaccine completion among child participants. Regression model for adults included gender, living in US, regular doctor, and country of birth, Hispanics, knowledge, and HPV awareness. Regression model for children included age, country of birth, Hispanics, partner, education, income, intention and HPV awareness.
[a] OR: odds ratio; CI: confidence interval; HPV: human papillomavirus.

completion rates in Hispanic females aged 11–17 (Parra-Medina et al., 2015). To our knowledge; no similar studies have reported the effect of a promotora-led intervention for improving HPV vaccine uptake in both males and females.

In the unadjusted analysis for young adults (aged 18 to 26 years), we found that males and those born in the US were less likely to complete the HPV vaccination series. This finding is consistent with national data from the CDC's 2016 report in which among adolescents aged 13–17 years, males were less likely to complete HPV vaccine series than females (28.8% vs 44.2%) (Reagan-Steiner et al., 2016).

We did find that the odds of completing the vaccine series were significantly lower among individuals born in the US. We hypothesize that this increased odds among immigrants may be due to higher vaccine acceptability because of their positive experiences with vaccine-preventable diseases (Perkins et al., 2010).

In children (9 to 17 years of age) we found the factors most associated with HPV vaccine series completion were older age of the child, a parent living with a partner and higher baseline parental HPV awareness, while a higher parental intention to vaccinate at baseline and higher levels of education were associated with lower odds of completion of vaccination series. While not reported in our data, we did not find any association between intention and initiation of the HPV vaccine series. Our findings are similar to those of Rickert et al. who evaluated the effects of two brief health interventions on HPV vaccine uptake and completion in adolescents aged 11 to 15 and found no association between parental intention to vaccinate and uptake or completion of vaccine series (Rickert et al., 2015). It has been suggested in the literature that intention to vaccinate may serve as a mediator in the pathway between psychosocial factors and vaccination receipt rather than as a direct association (Rickert et al., 2014). Studies among young adults have found younger age to be associated with increased initiation (Wilson et al., 2016); these studies tend to evaluate predictors in young adults rather than in children. In studies evaluating age as a predictor in younger adolescents, older age is associated with improved vaccine coverage which is similar to our finding (Donahue et al., 2015).

Our findings shed some light on differences between predictors of HPV vaccine completion between young adults and parents of vaccine-eligible children in a predominantly low income and Hispanic (mostly Mexican origin) population. Our findings highlight the importance of adapting interventions to fit the needs of the population served. The adjusted analysis showed that pre-intervention perceived benefits were an essential factor in vaccine completion in adults, while for parents of vaccine-eligible children, baseline perceived susceptibility was important. Surprisingly, perceived barriers and perceived self-efficacy did not affect the odds of vaccine completion in either group. Although other studies have found similar associations between these psychosocial factors and vaccination, they primarily studied intention to vaccinate as opposed to the actual behaviour of vaccine completion (Reiter et al., 2011; Lechuga et al., 2011; Askelson et al., 2010; Patel et al., 2012).

3.1. Limitations

One of the limitations of this study is that we utilized a pragmatic design that did not include a parallel control group to establish the exact effect of the intervention on psychosocial factors. Further, comprehensive psychosocial factors were only collected on a sub-group of individuals which may have affected our ability to detect more differences. This limitation was a result of attempting to reduce the effect of long survey burden on participants' willingness to receive vaccines. The results of this study may not be generalizable to other ethnic groups as this study was conducted in a community on the US Mexico border, and findings may differ in non-border dwelling Hispanics. Approximately 97% of our study population self-identified as Hispanic which is much higher than many studies reporting effects on Hispanic populations. However, although this limits generalizability, it is also a strength as it provides much-needed information about health promotion interventions in this underrepresented group. Despite these limitations, our study has some unique strengths. Ours is the first community-based study to assess the effect of a multifaceted intervention on both HPV vaccine-eligible adults and children in a predominantly underserved

Hispanic population on the US Mexico border. In addition to using promotoras to provide education and navigation, we were able to deliver vaccination to individuals in their local community centers and homes. Finally, this study assessed the effectiveness of the intervention on actual vaccine uptake and completion as opposed to an intention to vaccinate. In the study population, the intervention program was found to be effective on collective outcomes.

4. Conclusion

Our study findings suggest that a comprehensive intervention improves HPV vaccine uptake and completion in both adults and children, and significantly improves HPV awareness, knowledge, and intention to receive vaccinations, perceived susceptibility and perceived barriers. To address disparities in HPV vaccination, culturally tailored multicomponent programs delivered by trained promotoras should be explored in populations with lower vaccination rates. Further studies are needed to evaluate the cost-effectiveness of this approach in communities with low HPV vaccination rates.

Financial disclosures

J Molokwu: Has no financial disclosures.
A Dwivedi: Has no financial disclosures.
I Mallawaarachchi: Has no financial disclosures.
A Hernandez: Has no financial disclosures.
N Shokar: Has no financial disclosures.

Acknowledgments

Funding: This work was supported by a Cancer prevention program grant from the Cancer Prevention Research Institute of Texas (CPRIT) (Grant number: 140211). The funding agency did not participate in the study design, data collection, and analysis, interpretation of data, writing of report or the decision to submit the article for publication.

References

ACIP, 2014. Human Papillomavirus Vaccination: Recommendations of the Advisory Committee on Immunization Practices (ACIP). Available from: http://www.immunize.org/acip/.
Askelson, N.M., Campo, S., Lowe, J.B., Smith, S., Dennis, L.K., Andsager, J., 2010. Using the theory of planned behavior to predict mothers' intentions to vaccinate their daughters against HPV. J. Sch. Nurs. 26 (3), 194–202.
Bureau USC, 2010–2014. Race and Hispanic or Latino Origin. Available from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF.
Bureau USC, 2017. Health insurance coverage status. 2008–2012 American Community survey 5 - year estimates. 2010–2014. [cited; Available from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_5YR_S2701&prodType=table.
Cancer Facts & Figures 2017. [cited 2017 8/1/2017]; Available from: https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/annual-cancer-facts-and-figures/2017/cancer-facts-and-figures-2017.pdf.
Caskey, R., Lindau, S.T., Alexander, G.C., 2009. Knowledge and early adoption of the HPV vaccine among girls and young women: results of a national survey. J. Adolesc. Health 45 (5), 453–462.
Chan, A., Brown, B., Sepulveda, E., Teran-Clayton, L., 2015. Evaluation of fotonovela to increase human papillomavirus vaccine knowledge, attitudes, and intentions in a low-income Hispanic community. BMC. Res. Notes 8, 615.
Coughlin, S.S., Richards, T.B., Nasseri, K., Weiss, N.S., Wiggins, C.L., Saraiya, M., et al., 2008. Cervical cancer incidence in the United States in the US-Mexico border region, 1998–2003. Cancer 113 (10 Suppl), 2964–2973.
De, P., Budhwani, H., 2017. Human papillomavirus (HPV) vaccine initiation in minority Americans. Public Health 144, 86–91.
de Sanjose, S., Quint, W.G., Alemany, L., Geraets, D.T., Klaustermeier, J.E., Lloveras, B., et al., 2010. Human papillomavirus genotype attribution in invasive cervical cancer: a retrospective cross-sectional worldwide study. Lancet Oncol. 11 (11), 1048–1056.
Dempsey, A.F., Zimet, G.D., Davis, R.L., Koutsky, L., 2006. Factors that are associated with parental acceptance of human papillomavirus vaccines: a randomized intervention study of written information about HPV. Pediatrics 117 (5), 1486–1493.
Donahue, K.L., Hendrix, K.S., Sturm, L.A., Zimet, G.D., 2015. Human Papillomavirus vaccine initiation among 9–13-year-olds in the United States. Prev. Med. Rep. 2, 892–898.
Elpaso County, 2015. Texas quick facts, United States Census Bureau. [cited 2016 4/19/2016]; Available from: http://www.census.gov/quickfacts/table/PST045215/48141.
Gelman, A., Miller, E., Schwarz, E.B., Akers, A.Y., Jeong, K., Borrero, S., 2013. Racial disparities in human papillomavirus vaccination: does access matter? J. Adolesc. Health 53 (6), 756–762.
Gerend, M.A., Magloire, Z.F., 2008. Awareness, knowledge, and beliefs about human papillomavirus in a racially diverse sample of young adults. J. Adolesc. Health 42 (3), 237–242.
Gerend, M.A., Shepherd, M.A., Lustria, M.L., 2013. Increasing human papillomavirus vaccine acceptability by tailoring messages to young adult women's perceived barriers. Sex. Transm. Dis. 40 (5), 401–405.
Hansen, L.K., Feigl, P., Modiano, M.R., Lopez, J.A., Escobedo Sluder, S., Moinpour, C.M., et al., 2005. An educational program to increase cervical and breast cancer screening in Hispanic women: a southwest oncology group study. Cancer Nurs. 28 (1), 47–53.
Lechuga, J., Swain, G.R., Weinhardt, L.S., 2011. The cross-cultural variation of predictors of human papillomavirus vaccination intentions. J. Women's Health (Larchmt) 20 (2), 225–230.
Lehtinen, M., Paavonen, J., Wheeler, C.M., Jaisamrarn, U., Garland, S.M., Castellsagué, X., et al., 2012. Overall efficacy of HPV-16/18 AS04-adjuvanted vaccine against grade 3 or greater cervical intraepithelial neoplasia: 4-year end-of-study analysis of the randomised, double-blind PATRICIA trial. Lancet Oncol. 13 (1), 89–99.
Li, N., Franceschi, S., Howell-Jones, R., Snijders, P.J., Clifford, G.M., 2011. Human papillomavirus type distribution in 30,848 invasive cervical cancers worldwide: variation by geographical region, histological type and year of publication. Int. J. Cancer 128 (4), 927–935.
McQuillan, G.Kruszon-Moran, DMarkowitz, L.E.Unger, E.R.Paulose-Ram, R. Prevalence of HPV in adults aged 18–69: United States, 2011–2014. NCHS data brief 2017 April 6 2017 [cited 2017 July 13]; no 280. Available from. https://www.cdc.gov/nchs/products/databriefs/db280.htm.
Nuno, T., Martinez, M.E., Harris, R., Garcia, F.A., 2011. Promotora-administered group education intervention to promote breast and cervical cancer screening in a rural community along the U.S.-Mexico border: a randomized controlled trial. Cancer Causes Control 22 (3), 367–374.
O'Brien, M.J., Halbert, C.H., Bixby, R., Pimentel, S., Shea, J.A., 2010. Community health worker intervention to decrease cervical cancer disparities in Hispanic women. J. Gen. Intern. Med. 25 (11), 1186–1192.
Parra-Medina, D., Morales-Campos, D.Y., Mojica, C., Ramirez, A.G., 2015. Promotora outreach, education and navigation support for HPV vaccination to Hispanic women with unvaccinated daughters. J. Cancer Educ. 30 (2), 353–359.
Patel, D.A., Zochowski, M., Peterman, S., Dempsey, A.F., Ernst, S., Dalton, V.K., 2012. Human papillomavirus vaccine intent and uptake among female college students. J. Am. Coll. Heal. 60 (2), 151–161.
Penaranda, E., Molokwu, J., Hernandez, I., Salaiz, R., Nguyen, N., Byrd, T., et al., 2014. Attitudes toward self-sampling for cervical cancer screening among primary care attendees living on the US-Mexico border. South. Med. J. 107 (7), 426–432.
Perkins, R.B., Pierre-Joseph, N., Marquez, C., Iloka, S., Clark, J.A., 2010. Why do low-income minority parents choose human papillomavirus vaccination for their daughters? J. Pediatr. 157 (4), 617–622.
Pomfret, T.C., Gagnon, J.M., Gilchrist, A.T., 2011. Quadrivalent human papillomavirus (HPV) vaccine: a review of safety, efficacy, and pharmacoeconomics. J. Clin. Pharm. Ther. 36 (1), 1–9.
Prevention. CfDCa. Human Papilloma Virus (HPV). September 30, Available from: https://www.cdc.gov/hpv/.
Rambout, L., Tashkandi, M., Hopkins, L., Tricco, A.C., 2014. Self-reported barriers and facilitators to preventive human papillomavirus vaccination among adolescent girls and young women: a systematic review. Prev. Med. 58, 22–32.
Rand, C.M., Szilagyi, P.G., Albertin, C., Auinger, P., 2007. Additional health care visits needed among adolescents for human papillomavirus vaccine delivery within medical homes: a national study. Pediatrics 120 (3), 461–466.
Reagan-Steiner, S., Yankey, D., Jeyarajah, J., Elam-Evans, L.D., Curtis, C.R., MacNeil, J., et al., 2016. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years - United States, 2015. MMWR Morb. Mortal. Wkly Rep. 65 (33), 850–858.
Reiter, P.L., Stubbs, B., Panozzo, C.A., Whitesell, D., Brewer, N.T., 2011. HPV and HPV vaccine education intervention: effects on parents, healthcare staff, and school staff. Cancer Epidemiol. Biomark. Prev. 20 (11), 2354–2361.
Rickert, V.I., Auslander, B.A., Cox, D.S., Rosenthal, S.L., Rickert, J.A., Rupp, R., et al., 2014. School-based vaccination of young US males: impact of health beliefs on intent and first dose acceptance. Vaccine 32 (17), 1982–1987.
Rickert, V.I., Auslander, B.A., Cox, D.S., Rosenthal, S.L., Rupp, R.E., Zimet, G.D., 2015. School-based HPV immunization of young adolescents: effects of two brief health interventions. Hum. Vaccin. Immunother. 11 (2), 315–321.
Satterwhite, C.L., Torrone, E., Meites, E., Dunne, E.F., Mahajan, R., Ocfemia, M.C., et al., 2013. Sexually transmitted infections among US women and men: prevalence and incidence estimates, 2008. Sex. Transm. Dis. 40 (3), 187–193.
Shokar, N.K., Byrd, T., Salaiz, R., Flores, S., Chaparro, M., Calderon-Mora, J., et al., 2016. Against colorectal cancer in our neighborhoods (ACCION): a comprehensive community-wide colorectal cancer screening intervention for the uninsured in a predominantly Hispanic community. Prev. Med. 91, 273–280.
Siegel, R., Ward, E., Brawley, O., Jemal, A., 2011. Cancer statistics, 2011: the impact of eliminating socioeconomic and racial disparities on premature cancer deaths. CA Cancer J. Clin. 61 (4), 212–236.
Society AC, 2017. Cancer Facts & Figures 2017. American Cancer Society, Atlanta.
Viens, L.J., Henley, S.J., Watson, M., Markowitz, L.E., Thomas, C.C., Thompson, T.D., et al., 2016. Human papillomavirus-associated cancers - United States, 2008–2012. MMWR Morb. Mortal. Wkly Rep. 65 (26), 661–666.
Walker, T.Y., Elam-Evans, L.D., Singleton, J.A., Yankey, D., Markowitz, L.E., Fredua, B., et al., 2017. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years - United States, 2016. MMWR Morb. Mortal. Wkly Rep. 66 (33), 874–882.
Wilson, A.R., Hashibe, M., Bodson, J., Gren, L.H., Taylor, B.A., Greenwood, J., et al., 2016. Factors related to HPV vaccine uptake and 3-dose completion among women in a low vaccination region of the USA: an observational study. BMC Womens Health 16, 41.