

Rhode Island Human Papillomavirus Vaccine School Entry Requirement Using Provider-Verified Report

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Introduction: Human papillomavirus vaccine school entry requirements may be an opportunity to improve the low rates of human papillomavirus vaccination among adolescents. This study evaluates changes in provider-verified human papilloma vaccine uptake by age 13 years for adolescents in Rhode Island compared with all other states from 2011 through 2017.

Methods: The National Immunization Survey-Teen 2011–2017, a population-based cross-sectional survey, was analyzed in 2019. The survey includes telephone interviews and provider-verified reports of vaccination among U.S. adolescents aged 13–17 years. The sample was subset to participants with provider-verified human papillomavirus vaccination reports (N=145,153). A difference-in-differences approach evaluated the Rhode Island human papillomavirus vaccination school entry requirement enacted in 2015. The main outcome was provider-verified human papillomavirus vaccine uptake by age 13 years.

Results: Compared with boys in other states, boys in Rhode Island had an increase in the probability of uptake of human papillomavirus vaccination by age 13 years of 14 percentage points ($\beta=0.139$, 95% CI=0.073, 0.205). No such differences were observed comparing girls in Rhode Island to girls in other states ($\beta=0.009$, 95% CI= -0.068, 0.086).

Conclusions: The Rhode Island school entry requirement for human papillomavirus vaccination improved rates of vaccine uptake among boys, and may be a useful option for improving human papilloma vaccination nationally.

INTRODUCTION

With the routine recommendation for the human papillomavirus (HPV) vaccine in 2006 for female patients and 2011 for male patients, a new opportunity for the prevention of cervical and other anogenital cancers arose.¹ In fact, globally, the HPV vaccine has had substantial population-level impact on HPV-related disease.² Currently in the U.S., the HPV vaccine is recommended for adolescents aged 11–12 years with catch-up vaccination available until age 26 years.¹ Unfortunately, the U.S. has made disappointing progress in vaccinating adolescents for HPV; in 2018, 68.1% of adolescents received at least one dose and 51.1% were up-to-date on the HPV vaccine series.³

A potential strategy for promoting HPV vaccination in the U.S. is through school entry requirements—similar to other adolescent vaccines. Implementation of adolescent school entry requirements for tetanus, diphtheria, and acellular pertussis and meningococcal vaccines has shown success in improving vaccination rates.⁴ Yet, only Virginia, the District of Columbia (DC), Puerto Rico, and Rhode Island (RI) currently have HPV vaccine school entry requirements. Puerto Rico had the most recent mandate in 2017.⁵ The mandates in Virginia and DC have parental opt-out language specifically for HPV vaccination, whereas RI does not have easy-to-obtain opt-out options.^{6,7} Previous evaluations of HPV vaccine school entry requirements have produced mixed results^{4,8–11}; yet, early evaluation of the policy implementation in 2015 using parental report of HPV vaccination status demonstrated improvements in vaccination for male patients.⁸ Continued evaluation of the policy implementation in RI is needed, including narrowing the outcome evaluation to HPV vaccination by age 13 years and utilization of provider-verified HPV vaccination. The objective of this study is to evaluate changes in

provider-verified HPV vaccine uptake by age 13 years for adolescents in RI compared with all other states from 2011 through 2017 using a difference-in-differences approach.

METHODS

Study Sample

Provider-verified reports of HPV vaccination status initiation were obtained from the National Immunization Survey-Teen (NIS-Teen; user guide provides for more information)¹²⁻¹⁴ from 2011 through 2017 to estimate the sex-specific effects of RI's school entry HPV vaccination policy with a difference-in-differences design. This design compared changes in provider-reported HPV vaccination status among adolescents in RI with the change in HPV vaccination in a control group of all other states before and after RI's implementation of the school-entry policy. Because vaccination patterns over time may vary by sex, differential baseline means and trends over time for adolescent boys and girls were allowed. Individual-level potential confounders of the policy effect were controlled in the analysis. This study was exempt from (blinded institution name) IRB.

Measures

Individual, provider-verified data were used from the NIS-Teen, an annual, random-digit-dial telephone, cross-sectional study of adolescents aged 13–17 years to examine the following outcomes: adolescent receipt of any immunization for HPV, and HPV vaccination uptake (at least one dose) by age 13 years. Sex was coded as male or female. Age was coded in years. Race/ethnicity was coded as non-Hispanic white, non-Hispanic black, Hispanic, or other. Annual income was coded as >\$75 000, from the poverty line to \$75,000, and below the poverty line.

The policy indicator was coded to indicate that adolescents surveyed in 2016 and 2017 as being subject to the mandate.

Statistical Analysis

To evaluate the sex-specific effects of RI's HPV vaccination requirement within a difference-in-difference framework,¹⁵ linear probability models were estimated with policy \times sex interactions to estimate sex-specific effects of RI's school entry requirement. For all models, sex-specific state and year fixed effects were included to allow for differential baseline HPV vaccination patterns for boys and girls in each state, as well as sex-specific nonlinear trends over time. Additionally, individual-level age, race, and poverty were controlled for. All models accounted for the complex survey design of NIS-Teen¹⁴ by using PROC SURVEYREG in SAS, version 9.4. Linear probability models were used to aid in the interpretation of the interaction term. The interaction term in models such as logistic and probit models does not reliably estimate the policy effect.¹⁶ Regression coefficients and the predicted probabilities for the outcomes in RI and the control group of all other states by sex and year were estimated. To assess the impact of modeling decisions on the results, the raw vaccination rates by sex in both RI and the control group 2 years before the RI policy, the year of enactment, and 2 years after enactment were estimated using PROC SURVEYFREQ in SAS.

RESULTS

In 2011–2017, a total of 145,153 adolescents aged 13–17 participated. Statistically significant differences by sex were observed for whether an adolescent had initiated HPV vaccination by age 13 years ($F=6.38$, $p=0.0116$). Compared with boys in other states, boys in RI had an increase

in the probability of uptake of HPV vaccination by age 13 years of nearly 14 percentage points ($\beta=0.139$, 95% CI=0.073, 0.205). No such differences were observed comparing adolescent girls in RI to adolescent girls in other states ($\beta=0.009$, 95% CI= -0.068, 0.086). However, girls in RI had the highest rate of initiation of the vaccine by age 13 years, with boys in RI approaching their rate only after the implementation of the school mandate (Figure 1). Similar patterns were seen when examining the raw estimates (Table 1).

DISCUSSION

This study found that, since the implementation of the RI HPV vaccine school entry requirement in 2015, improvements in HPV vaccination among boys has been observed; specifically, a 14 percentage point increase in HPV vaccination by age 13 years utilizing provider-verified report. Significant changes in RI girls' HPV vaccination were not found; however, 76.0% and 87.9% of RI girls had received at least one dose of the HPV vaccine in 2014 and 2015, respectively (highest rates for all states), suggesting the presence of a ceiling effect.^{17,18} Similar findings were observed for the initial policy analysis with 2016 data based on parental report of HPV vaccination,⁸ and an analysis of 2009–2013 data examining the Virginia and DC mandates for girls found no significant effect.¹⁰ Moreover, this study was not able to fully assess whether the age at vaccination for girls may have decreased because of the school entry requirement implementation, and may be able to be assessed in future years.

This analysis indicates that since the HPV vaccine school entry requirement enactment in RI, vaccine uptake between boys and girls has narrowed (Table 1). Given the ongoing, yet

diminishing, disparities in HPV vaccine uptake by sex, a school entry requirement presents an opportunity for equitable HPV vaccine delivery.¹⁹

Limitations

Limitations for this analysis include the inability to estimate the impact school entry requirements in Virginia and DC owing their policies being enacted prior to NIS-Teen collecting HPV vaccination, and to evaluate spillover effect from other mandated vaccines. The outcome of vaccine uptake by age 13 years was used because the RI vaccine requirement is for 7th grade; however, series completion was not evaluated given the still early implementation of this policy.

CONCLUSIONS

This analysis, based on rigorous provider-verified HPV vaccination data, provides support that RI's school entry requirement was associated with increased uptake of HPV vaccine for boys by age 13 years. This finding provides evidence that school entry requirements may improve HPV vaccine coverage. School entry policy initiatives should be considered alongside other approaches for increasing HPV vaccination rates, while also recognizing the potentially fierce political opposition that may be present in some states and the required political will needed to implement such policies.

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LIST OF FIGURES

Figure 1. Predicted probability of HPV vaccination uptake by age 13 years in Rhode Island and all other states, National Immunization Survey-Teen 2011–2017.^{a,b}

^aSensitivity analysis removing states that had already enacted school entry requirements (Virginia and Washington, DC) from the control group provided similar results.

^bDifference in difference for boys: ($\beta=0.139$, 95% CI=0.073, 0.205); Difference in difference for girls: ($\beta=0.009$, 95% CI= -0.068, 0.086).

HPV, x; RI, x.

Table 1. Proportion of U.S. Adolescents Vaccinated for HPV by Age 13 Years, National Immunization Survey-Teen 2011–2017

| Year | Rhode Island | | | Control | | |
|------|-------------------|-------------------|------------------------------|-------------------|-------------------|------------------------------|
| | Male % (95% CI) | Female % (95% CI) | <i>p</i> -value ^a | Male % (95% CI) | Female % (95% CI) | <i>p</i> -value ^a |
| 2011 | 2.8 (0.0, 6.2) | 41.5 (32.2, 50.8) | <0.001 | 1.3 (0.9, 1.8) | 25.8 (24.4, 27.3) | <0.001 |
| 2012 | 4.9 (1.8, 8.0) | 49.4 (39.6, 59.2) | <0.001 | 3.9 (3.2, 4.7) | 30.6 (28.9, 32.3) | <0.001 |
| 2013 | 16.9 (10.1, 23.8) | 49.5 (40.1, 58.9) | <0.001 | 9.8 (8.4, 11.1) | 36.7 (34.7, 38.6) | <0.001 |
| 2014 | 18.9 (12.3, 25.4) | 46.7 (38.3, 55.1) | <0.001 | 15.3 (13.9, 16.7) | 38.1 (36.2, 39.9) | <0.001 |
| 2015 | 32.1 (24.8, 39.3) | 54.3 (46.4, 62.2) | <0.001 | 24.1 (22.5, 25.7) | 40.9 (39.1, 42.7) | <0.001 |
| 2016 | 46.8 (38.1, 55.4) | 59.6 (50.4, 68.7) | 0.0478 | 29.8 (28.2, 31.5) | 43.9 (42.0, 45.9) | <0.001 |
| 2017 | 57.5 (48.8, 66.3) | 61.5 (52.1, 70.9) | 0.5463 | 38.2 (36.5, 39.9) | 47.7 (45.8, 49.6) | <0.001 |

Note: Boldface indicates statistical significance ($p < 0.05$).

^a*p*-value is for the difference between male and female vaccination rate within each group and year using a Rao-Scott Chi Square test.

HPV, x.

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