Legislation to Increase Uptake of HPV Vaccination and Adolescent Sexual Behaviors

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BACKGROUND: Despite preventive health benefits of the human papillomavirus (HPV) vaccination, uptake in the United States remains low. Twenty-four states have enacted legislation regarding HPV vaccination and education. One reason these policies have been controversial is because of concerns that they encourage risky adolescent sexual behaviors. Our aim in this study is to determine if state HPV legislation is associated with changes in adolescent sexual behaviors.

METHODS: This is a difference-in-difference study in which we use data on adolescent sexual behaviors from the school-based state Youth Risk Behavior Surveillance System from 2001 to 2015. Sexual behaviors included ever having sexual intercourse in the last 3 months and condom use during last sexual intercourse. We compared changes in sexual behaviors among high school students before and after HPV legislation to changes among high school students in states without legislation.

RESULTS: A total of 715 338 participants reported ever having sexual intercourse in the last 3 months, and 217 077 sexually active participants reported recent condom use. We found no substantive or statistically significant associations between HPV legislation and adolescent sexual behaviors. Recent sexual intercourse decreased by 0.90 percentage points ($P = .21$), and recent condom use increased by 0.96 percentage points ($P = .32$) among adolescents in states that enacted legislation compared with states that did not. Results were robust to a number of sensitivity analyses.

CONCLUSIONS: Implementation of HPV legislation was not associated with changes in adolescent sexual behaviors in the United States. Concern that legislation will increase risky adolescent sexual behaviors should not be used when deciding to pass HPV legislation.

WHAT'S KNOWN ON THIS SUBJECT: Despite preventive health benefits of human papillomavirus vaccination, uptake in the United States remains low. Twenty-four states have enacted legislation to raise vaccine uptake via financial incentives and school-based education. However, 1 concern is that these policies may encourage risky sexual behaviors.

WHAT THIS STUDY ADDS: Enacting legislation regarding human papillomavirus was not associated with changes in recent sexual intercourse or condom use during last sexual intercourse in United States adolescents.
Human papillomavirus (HPV) is the most common sexually transmitted infection in the United States. Persistent infection with a high-risk strain can lead to serious health problems including cervical, anal, penile, vaginal, vulvar, and oropharyngeal cancers as well as genital warts in both men and women. Currently, there are 3 US Food and Drug Administration–approved HPV vaccines, for which multiple doses are recommended. The Centers for Disease Control and Prevention has recommended routine HPV vaccination for girls ages 11 to 12 since 2006 and for boys ages 11 to 12 since 2009, with catch-up vaccination for older adolescents and young adults. However, despite the availability of the vaccines, uptake remains low, with only 49.5% of girls and 37.5% of boys having up-to-date HPV vaccinations in 2016.

Many reasons for the low uptake of the HPV vaccine have been proposed, including high costs and poor access, difficulty completing the multidose regimen, safety and health concerns, and worries that the vaccine will promote unsafe sexual activity among adolescents. These policies vary in terms of leniency and include requiring schools to provide information about HPV vaccination to students, subsidizing costs and incentivizing insurers to cover the vaccine, and mandating vaccination (Supplemental Table 4). Further adoption of these policies has been hampered by a number of concerns. One concern is that encouraging adoption of the HPV vaccination may encourage risky sexual behaviors among adolescents, and it may be seen as conflicting with abstinence only sexual education. Consequently, many states have had to defer vaccination mandates and instead pass related legislation focusing on HPV education or cost. Although in recent research no changes in sexually transmitted infections among privately insured individuals receiving the HPV vaccine have been found, the broader impacts of policies to increase vaccine uptake on sexual behaviors in the general adolescent population have not been examined. Rigorous evidence in this domain will be critical as policymakers continue to grapple with strategies to raise vaccination rates.

In this study, we examined the impact of state-level legislation aiming to raise awareness and uptake of HPV vaccination on adolescent sexual behaviors. We used a quasi-experimental difference-in-difference approach to assess how the policy is associated with the number of sexual partners and condom use during last sexual intercourse.

**METHODS**

Data on the outcomes of adolescent sexual behaviors were collected from the 2001 to 2015 state Youth Risk Behavior Surveillance System (YRBSS). The state YRBSS is a large, state-representative, biannual, school-based survey of ninth- to 12th-grade students from the United States. Underrepresented minorities were purposely oversampled at each stage of the 3-stage sampling procedure. The state YRBSS survey collected information from students in 25 states without HPV legislation and 16 states with HPV legislation (Supplemental Table 4). States could choose when they wanted to publicly report their results, so the coverage of states differed each year during our study period.

The YRBSS asked students to report if they ever had sexual intercourse in the last 3 months and if they used a condom the last time they had sexual intercourse. Ever having sexual intercourse during the last 3 months was a binary yes or no variable (0 for people who never had sex or did not have sex in the last 3 months, 1 for people who had sex during the last 3 months). Condom use during last sexual intercourse was a binary yes or no variable that was conditional on ever having had sex in the last 3 months. As a secondary outcome, we looked at the number of sexual partners during the last 3 months as a continuous variable from 0 (people who never had sex or did not have sex in last 3 months) to 6 (6 or more partners in the last 3 months).

The main exposure was whether respondents’ state of residence had legislation aiming to raise HPV vaccination rates in place during the year of the interview. Information on the type of policy and year of passage was obtained from the National Conference of State Legislatures (Supplemental Table 4). The exposure was then further categorized by the type of legislation that was passed: vaccination mandates, HPV education (in schools, for parents, general awareness, research funds), and vaccine cost and accessibility (cost of vaccine, insurance coverage, prescription requirements).

We used difference-in-difference models to study the association of the legislation with adolescent sexual behaviors. We compared changes in sexual behavior for adolescents living in states that passed HPV legislation before and after policy implementation against the same changes in states that did not pass legislation. In our model, we adjusted for respondent age, sex, race, and grade. To adjust for potential confounders for the association between the states with legislation and adolescent sexual health behaviors, we added state-year factors to the model, including state-specific linear time trends. In our models, we include state effects that account for any fixed differences between states.
correlation in the outcome
the state level to account for serial
we corrected SEs for clustering at
PEDIATRICS Volume 142, number 3, September 2018
least squares regression to estimate
binary variables, we used ordinary
Although our main outcomes were
binary variables, we used ordinary
least squares regression to estimate
our models. This is because there
are well-known biases in limited
dependent variable estimators in
fixed effect models.23 For all models,
we corrected SEs for clustering at
the state level to account for serial
correlation in the outcome.24 Survey
weights were used when examining
the descriptive characteristics of
states with legislation compared with
states without legislation.
Survey weights were not used in
the difference-in-difference models
because individual-level error terms
clustered within a larger group (each
state) could yield inappropriately
inflated SEs.25 Additionally, we
did not a priori expect large
heterogeneous effects because the
survey was not sampled by the
outcome of interest.25 However, we
still ran the main models using the
survey weights to compare with our
main models that did not include
survey weights.

We estimated several additional
models. First, we assessed potential
violations of the parallel trends
assumption of the difference-in-
difference model.20 Specifically,
we examined whether trends in
sexual behavior before policy
implementation differed in states
passing policies versus those that
did not. Second, we estimated our
main models by subgroups of age,
sex, grade, and race and/or ethnicity.
Bonferroni corrections were used to
account for multiple testing. With 18
main regressions run for the analysis,
results were considered statistically
significant when the P value was <.003.
Third, because an assumption of
this model is that the effects are
immediate, we did a lagged analysis
to see what happened when we
looked at the effect of the legislation
among students years after it was
passed. The idea of the lag is that
most HPV vaccination education and
coverage should be affecting 11- to
12-year-olds, and our YRBSS data are
taken from older students (mainly
15–18-year-olds), so looking at a
lagged timing of legislation will let
us see if the effect of the legislation
was limited to kids who were age 11
to 12 at the time of the legislation.
Additionally, in the lagged analysis,
we also account for the fact that
implementation of the legislation
most often happened the year after
the policy was passed. However,
because states did not always report	heir data for every survey year, we
do not have as many states reporting	heir data after 2011, and lagged
results should be interpreted with
caution. Fourth, as a prespecified
falsification test, we also examined
lead effects because the first HPV
vaccine was approved in 2006.26 This
study is exempt from human subjects
review by the institutional review
board given the use of publicly
available, deidentified data.

RESULTS
From 2001 to 2015, 886,981 high
school students participated in the
state YRBSS surveys. Of those
respondents, 224,177 (25.3%) reported
having sexual intercourse in the last 3 months, 491,161
(55.4%) reported that they did not
have sexual intercourse in the last
3 months, and 171,643 (19.4%) did
not respond to that question. A total
of 715,338 high school students
reported the number of sexual
partners during the last 3 months
(80.6% of all students participating),
and 217,077 high school students
who ever had sexual intercourse in
the last 3 months reported condom
use during last sexual intercourse in
the YRBSS (96.8% of students who
reported having sexual intercourse
in the last 3 months). Students in
states with HPV legislation were
similar to students in states without
HPV legislation in terms of sex,
grade, race, smoking, and alcohol use
before and after most states passed
legislation in 2007 (Table 1). The
average age of students in states
with legislation was 16.0 years old,
and the average age of students in
states without legislation was 16.1
years old. States with legislation
and states without legislation had a
similar percentage of students who
ever had been taught about AIDS in
school, with a greater percentage
being taught about AIDS in school
before 2007 (91.8%) than after 2007
(89.2%). The percentage of students
ever having sexual intercourse in the
last 3 months and the percentage
of students reporting condom use
during last sexual intercourse was

(such as political, educational, or
teen-aged pregnancy differences)
and also include year effects that
account for any trends in the risky
teenager sexual behaviors over time
that are similar across all states.
As a secondary analysis, we also
adjusted for rates of unemployment,
teen-aged pregnancies, and sexually
transmitted diseases among
teenagers ages 15 to 19 as well as the
Children’s Health Insurance Program
(CHIP) and the Medicaid program
of the states, the majority political
party of the state legislature, and
the political party of the governor. CHIP
and Medicaid were included in case
any changes to health care coverage
for adolescents or vaccinations
occurred around the same time that
legislation was passed and could
be acting as a confounder for the
relationship between legislation
and adolescent sexual behaviors.
We estimated models, defining the
exposure as passage of any policy
as well as passage of specific types
of legislation, including mandates,
legislation about vaccine cost
or access, and legislation about
education. Because of the small
number of states with mandates and
the timing of the mandates, we were
not able to examine the effect of the
mandates separately and instead,
they are only included in the any
policy analysis.

Although our main outcomes were
binary variables, we used ordinary
least squares regression to estimate
our models. This is because there
are well-known biases in limited
dependent variable estimators in
fixed effect models.23 For all models,
we corrected SEs for clustering at
the state level to account for serial
correlation in the outcome.24 Survey
weights were used when examining
the descriptive characteristics of
states with legislation compared with
states without legislation.
Survey weights were not used in
the difference-in-difference models
because individual-level error terms
similar for states with and without HPV legislation and decreased slightly from before 2007 to after 2007.

Difference-in-difference models revealed no substantive or statistically significant changes in recent sexual intercourse or condom use (Table 2). In Fig 1, we plot trends in adolescent sexual behaviors from 2001 to 2015, in which most legislation was enacted in 2007, and it reveals no difference in risky sexual behaviors in states with legislation compared with states without legislation. The difference-in-difference estimates were consistent with this. Students in states passing HPV legislation decreased recent sexual intercourse by 0.90 percentage points (95% confidence interval [CI]: −2.33 to 0.52) and increased condom use during last sexual encounter by 0.96 percentage points (95% CI: −0.97 to 2.89) compared with students in states without legislation. When the results were separated by the type of legislation, there continued to be no significant difference in sexual intercourse or condom use for states with HPV legislation compared with states without legislation. For legislation regarding education, recent sexual intercourse decreased by 0.73 percentage points (95% CI: −2.20 to 0.74), and condom use decreased by 0.55 percentage points (95% CI: −4.49 to 3.39). For legislation regarding vaccination cost, recent sexual intercourse increased by 0.29 percentage points (95% CI: −1.96 to 2.54), and condom use increased by 0.63 percentage points (95% CI: −1.23 to 2.48).

In additional analyses, we did not find evidence that the parallel trends assumption was violated (Supplemental Table 5). Subgroup analyses revealed some difference by age, sex, and ethnicity, but no group showed statistically significant increases in any sexual behaviors after the policy. It appeared that girls had larger decreases in recent sexual intercourse and had larger increases in condom use than boys. Students under age 17 had larger decreases in recent sexual intercourse and had larger increases in condom use than students ages 17 or 18. There were no differences seen by race and/or ethnicity for the number of sexual partners. White students saw a smaller percentage point increase in condom use than African American, Hispanic, and other race and/or ethnicity students. There was no difference when CHIP, Medicaid,

### Table 1

| Characteristics of Students in States With HPV Legislation and States Without HPV Legislation Overall and by Prelegislation and Postlegislation Time Periods |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| ≤14             | 11.1            | 9.7             | 11.7            | 10.4            | 11.9            |
| 15              | 25.7            | 26.3            | 26.5            | 25.2            | 25.6            |
| 16              | 25.8            | 26.2            | 25.7            | 25.6            | 25.7            |
| 17              | 23.3            | 22.7            | 22.3            | 23.9            | 23.3            |
| 18              | 14.2            | 15.1            | 15.9            | 14.8            | 13.4            |
| Sex             | Male            | 50.8            | 50.8            | 50.7            | 50.9            | 50.8            |
|                | Female          | 49.2            | 49.3            | 48.3            | 49.2            | 49.2            |
| Grade           | 9               | 28.7            | 30.4            | 30.2            | 27.8            | 28.2            |
|                | 10              | 25.8            | 25.8            | 26.0            | 25.9            | 25.8            |
|                | 11              | 23.5            | 23.0            | 22.9            | 23.8            | 23.6            |
|                | 12              | 22.0            | 20.9            | 20.9            | 22.3            | 22.5            |
| Race            | White           | 58.4            | 65.7            | 63.4            | 56.9            | 55.0            |
|                | African American or Hispanic or other | 41.6 | 34.3 | 36.6 | 43.1 | 45.0 |
| Smoking in last 3 mo | Yes            | 17.5            | 22.6            | 22.5            | 15.8            | 15.3            |
|                | No              | 82.5            | 77.4            | 77.5            | 84.2            | 84.7            |
| Alcohol use in last 3 mo | Yes            | 38.5            | 43.5            | 43.8            | 35.6            | 36.8            |
|                | No              | 61.5            | 56.5            | 56.2            | 64.4            | 63.2            |
| Taught about AIDS in school | Yes           | 90.1            | 91.9            | 91.8            | 89.3            | 89.1            |
|                | No              | 9.9             | 8.1             | 8.2             | 10.7            | 10.9            |
| Condom use during last sexual intercourse | Yes           | 60.8            | 63.0            | 62.8            | 60.0            | 59.8            |
|                | No              | 39.2            | 37.0            | 37.2            | 40.0            | 40.2            |
| Sexual intercourse in last 3 mo | Yes           | 33.3            | 35.2            | 33.7            | 33.0            | 32.7            |
|                | No              | 66.7            | 64.8            | 66.3            | 67.0            | 67.4            |

Percentages are adjusted for survey weights; the question regarding being taught about AIDS in school is not available for states that participated in the 2015 sample (n = 461,218 for 2001–2015). Condom use is restricted to students who reported having sexual intercourse in the last 3 mo.
Among all students

<table>
<thead>
<tr>
<th>Change (95% CI)</th>
<th>P</th>
<th>Change (95% CI)</th>
<th>P</th>
</tr>
</thead>
</table>
| Among all students
| Any legislation | −0.90 (−2.33 to 0.52) | 0.21 | 0.96 (−0.97 to 2.88) | 0.32 |
| Legislation about vaccine cost and accessibility | 0.29 (−1.96 to 2.54) | 0.80 | −0.55 (−4.49 to 3.38) | 0.78 |
| Legislation about HPV education | −0.73 (−2.20 to 0.74) | 0.32 | 0.63 (−1.23 to 2.48) | 0.50 |
| Among different student populations (any legislation)
| Sex
| Male | −0.67 (−2.47 to 1.14) | 0.46 | 0.047 (−2.41 to 2.51) | 0.97 |
| Female | −1.11 (−2.59 to 0.37) | 0.14 | 1.78 (−0.82 to 4.37) | 0.18 |
| Age, y
<17 | −1.07 (−2.49 to 0.34) | 0.13 | 1.64 (−0.94 to 4.23) | 0.21 |
17 or 18 | −0.52 (−2.67 to 1.64) | 0.63 | 0.44 (−1.97 to 2.86) | 0.71 |
| Race and/or ethnicity
| White | −0.96 (−2.85 to 0.73) | 0.26 | 0.83 (−1.59 to 3.25) | 0.49 |
| African American or Hispanic or other | −0.55 (−2.28 to 1.18) | 0.52 | 2.06 (−0.76 to 4.87) | 0.15 |

Each cell represents a separate regression with the dependent variables noted in the columns. For each dependent variable, the model includes survey year fixed effects, age, sex, and current grade fixed effects. Models include state-specific linear time trends and state fixed effects.

Political party, unemployment, teen-aged pregnancy rates, and sexually transmitted disease rates were included in the models (Supplemental Table 6). Analyses in which we examined lagged impacts suggested a substantive, but not statistically significant, 6.1% point decrease (P = .009) in recent sexual intercourse and a 5.9% point increase (P = .046) in condom use (prespecified P value threshold of P < .003) (Supplemental Table 7). Results did not differ for the secondary outcome examined of number of sexual partners during the last 3 months. For the secondary outcome of number of sexual partners in the last 3 months, there was a nonsignificant decrease in the number of sexual partners by 0.02 (P = .18) in states that enacted HPV legislation compared with states that did not enact HPV legislation (Table 3). Lastly, as expected, the estimates from models in which we included the YRBSS sample weights were less precisely estimated, but the interpretation of the main effects was similar (Supplemental Table 8).

**DISCUSSION**

In this national study, we found no association between the passage of legislation designed to increase uptake of the HPV vaccine and sexual behaviors among high school–going adolescents in the United States. This finding was consistent across subgroups and robust to different specifications and sensitivity tests.

Despite long-standing knowledge of the protective benefits of the HPV vaccine, vaccination rates in the United States remain low.27 Even among those receiving the vaccine, the timing of HPV vaccination often occurs after sexual debut and HPV exposure, reducing its potential efficacy. A study conducted in the NHANES found that 43% of girls with at least 1 dose of the HPV vaccine had sex before or during the same year as their first HPV vaccination.28 Ensuring that adolescents receive the HPV vaccination before their first sexual experience is important to helping prevent the negative health effects of HPV infections. Policies to educate adolescents and their families about the benefits of vaccination and increase access will likely be an important part of the policy response to improve vaccination rates.

Thus far, researchers have found minimal, if any, benefits of these policies on vaccination rates.29–32 In states that have implemented these policies, the ultimate legislation passed was often less expansive than other debated options. The less-expansive options passed included additions such as opt-out options for vaccine mandates that may have reduced the number of adolescents vaccinated and weakening of the policy to just be educational.29 The weakening of the legislation was in part due to concerns about behavioral responses to the policy in addition to a number of other concerns around ethics, health benefits, and side effects.14–16 In our study, we show that the policy options implemented thus far have not raised the risk of risky sexual activity. Additionally, adolescents appear to be engaged in less sexual intercourse over time, even with increasing availability of HPV vaccination. The percentage of...
adolescents that have ever had sex, that had sex before age 13, and that had sex with 4 or more people has decreased from 1991 to 2015, and adolescent pregnancy rates have dropped from 1990 to 2014.33,34 However, we found that condom use during last sexual intercourse appeared to decrease slightly from 2001 to 2015. Our findings and this broader context both can be used to support calls to adopt stronger vaccination education and access policies.

This study is subject to a number of limitations. First, we considered the effects of passage of HPV-related legislation, which may differ from the actual consequences of policy implementation. Second, similar policies in different states may have been implemented differently. Data on exact implementation were not available, and therefore we were not able to assess heterogeneity in policy effects across states. Third, we only examined legislative rulings regarding HPV vaccination. Many states may be providing HPV education and funding through state public health departments that do not require legislation. Nonlegislative HPV initiatives were not accounted for in our analysis because of the difficulty in finding these data. Fourth, any unobserved or omitted state-year confounders that are correlated with both the HPV legislation and the adolescent sexual behavior outcomes could bias our analysis. We attempted to adjust for these potential confounders in a variety of ways and conducted several sensitivity checks. However, we cannot fully rule out the possibility of residual bias.

Fifth, there are missing data on the number of sexual partners (19.4%) and condom use (3.2%), which may create a selection bias if students not reporting their sexual behaviors did so in a way that was also related to their state’s HPV legislation policy. For example, if students with riskier behaviors are less likely to report their behaviors on the survey, and they are more likely to live in states that passed HPV legislation, we may be worried about selection bias. However, it seems that teenagers’ reporting of their sexual behaviors may not be related to their state’s HPV legislation policy, so we are not strongly concerned about this bias. Sixth, we also do not have complete information on all states with HPV legislation policies in the YRBSS state survey sample, so with our results, although coming from a wide regional distribution in the United States, we should take into account that results may not be generalizable to states not included in the analysis.

CONCLUSIONS
HPV legislation does not appear to have a detrimental effect on adolescent sexual behaviors. This study, taken with the other studies in which researchers look at the impact of HPV vaccines on adolescent sexual behavior and the low vaccination rates in the United States, may support stronger vaccination education and access policies.
TABLE 3 Change in the Average Number of Sexual Partners in the Last 3 Months in States With Legislation Compared With States Without Legislation

<table>
<thead>
<tr>
<th>No. Sexual Partners in Last 3 Mo</th>
<th>Average No. Change</th>
<th>(95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among all students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any legislation</td>
<td>−0.020</td>
<td>(−0.050 to 0.010)</td>
<td>.18</td>
</tr>
<tr>
<td>Legislation about vaccine cost and accessibility</td>
<td>−0.016</td>
<td>(−0.066 to 0.035)</td>
<td>.54</td>
</tr>
<tr>
<td>Legislation about HPV education</td>
<td>0.0097</td>
<td>(−0.042 to 0.022)</td>
<td>.54</td>
</tr>
<tr>
<td>Among different student populations (any legislation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>−0.032</td>
<td>(−0.080 to 0.016)</td>
<td>.18</td>
</tr>
<tr>
<td>Female</td>
<td>−0.0096</td>
<td>(−0.030 to 0.011)</td>
<td>.55</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;17</td>
<td>−0.022</td>
<td>(−0.052 to 0.0082)</td>
<td>.15</td>
</tr>
<tr>
<td>17 or 18</td>
<td>−0.013</td>
<td>(−0.056 to 0.030)</td>
<td>.55</td>
</tr>
<tr>
<td>Race and/or ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>−0.013</td>
<td>(−0.047 to 0.022)</td>
<td>.47</td>
</tr>
<tr>
<td>African American or Hispanic or other</td>
<td>−0.025</td>
<td>(−0.065 to 0.016)</td>
<td>.22</td>
</tr>
</tbody>
</table>

Each cell represents a separate regression with the dependent variables noted in the columns. For each dependent variable, the model includes survey year fixed effects, age, sex, and current grade fixed effects. Models include state-specific linear time trends and state fixed effects.

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REFERENCES


States, can be used to provide support for the reintroduction and strengthening of legislation regarding the HPV vaccine. Concern that legislation will increase risky adolescent sexual behaviors should not be used when deciding to pass legislation regarding HPV vaccination.

ABBREVIATIONS

CHIP: Children’s Health Insurance Program
CI: confidence interval
HPV: human papillomavirus
YRBSS: Youth Risk Behavior Surveillance System


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