State-Level Voting Patterns and Adolescent Vaccination Coverage in the United States, 2014

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Objectives. To examine state-level associations between voting patterns and adolescent coverage for at least 1 dose of human papillomavirus (HPV), tetanus-containing (Tdap), and meningococcal (MCV4) vaccination.

Methods. We classified states as "blue" (Democratic affiliation) or "red" (Republican affiliation) based on the Presidential election results in 2012. We used multivariable models to adjust for potential confounding by sociodemographic and health care access characteristics and vaccination policies. For HPV, separate models were fitted for boys and girls.

Results. Adolescent vaccination coverage was significantly higher in blue states than red states for each vaccine ($P < .05$). The adjusted percent differences between blue and red states were 10.2% for HPV among girls, 24.9% for HPV among boys, 6.2% for tetanus-containing vaccine, and 14.1% for MCV4.

Conclusions. State-level voting patterns are independently and significantly associated with coverage for routinely recommended adolescent vaccines. These differences may reflect population-level differences in cultural norms and social values.

Public Health Implications. Strategies to increase coverage at the individual, community, or structural level should consider local political settings that may facilitate or hinder effectiveness. (*Am J Public Health.* 2016;106:1879–1881. doi:10.2105/AJPH.2016.303381)

State-level voting patterns that reflect the predominant political ideology in an area have previously been found to be associated with numerous health outcomes, including obesity, injury fatality rates, women's reproductive health, and identifying students with emotional disturbance.[1–4] Although the mechanisms behind these associations are not always clear, these differences may reflect cultural norms and values associated with political beliefs. For example, it has been suggested that social conservatism,[1,2] economic conditions,[3] and views on the role of government[4] could be mediating factors in these associations.

Vaccination recommendations are grounded on safety and efficacy data as well as clinical and epidemiological considerations, but public acceptance of those recommendations is influenced by a complex mix of psychological, sociocultural, and political factors.[5] Three vaccines are currently recommended for routine use in adolescents aged 11–12 years: tetanus–diphtheria–acellular pertussis (Tdap),

meningococcal conjugate (MCV4), and human papillomavirus (HPV); however, immunization rates for HPV remain substantially lower than those for Tdap and MCV4.[6]

We hypothesized that fewer adolescents would be vaccinated against HPV in conservative-leaning, Republican states than in liberal-leaning, Democratic states, perhaps owing to parental concerns about the sexually transmitted nature of HPV.

METHODS

We classified states as "blue" (Democratic) or "red" (Republican) on the basis of results of

the presidential election of 2012. We obtained state-level vaccination coverage estimates for adolescents from the 2012 National Immunization Survey-Teen.[6] For HPV, we considered vaccination with at least 1 dose for comparability to Tdap and MCV4, and we considered girls and boys separately because of the later recommendation for routine vaccination of boys (2011) compared with those of girls (2006).

Sociodemographic factors we obtained from the US Census Bureau included median household income, Gini index of income inequality, percentage of the population below the federal poverty level, percentage of the population with a bachelor's degree or higher, and percentage of the population that is African American or Hispanic. Measures of access to care included percentage of uninsured children aged 0 to 18 years, physicians per capita, and having a usual source of care among children. Vaccine policies included middle school requirements; nonmedical exemption policies, procedures, and effectiveness; nonmedical exemption rates among kindergarten students; and state vaccine financing policies.[7–9]

We compared median coverage using the Kruskal–Wallis test. We then used multivariable linear regression modeling to determine the independent association between state-level voting patterns and vaccination coverage (log transformed to increase normality) while controlling for the effects of the covariates in the model. We ran 4 separate models, 1 for each of the 4 vaccination outcomes. We began with a full model

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that included state-level voting patterns and all possible covariates.

To arrive at the most parsimonious model while adjusting for potential confounding, we performed backward elimination (keeping voting patterns in each model as the primary predictor of interest) to arrive at the final model, in which all included covariates were statistically significant at $P < .05$. We then reentered excluded covariates in the final model 1 at a time to confirm that they were not significantly associated with immunization outcomes. We calculated adjusted percentage differences by exponentiating the beta coefficient from the model with log-transformed outcomes to increase normality. We conducted statistical analyses using SPSS version 21 (IBM, Somers, NY).

RESULTS

In unadjusted analyses, blue states had significantly higher median coverage than did red states for HPV among girls (63% vs 56%; $P < .001$), HPV among boys (47% vs 34%; $P < .001$), Tdap (90% vs 85%; $P = .007$), and MCV4 (79% vs 73%; $P = .007$; Table A, available as a supplement to the online version of this article at http://www.ajph.org, provides state-level results).

In multivariable linear regression models that we adjusted for confounders (Table 1), state-level voting patterns remained significantly associated with coverage rates for each vaccine. The adjusted percentage differences between blue and red states were statistically significant for each outcome as follows: 10.2% for HPV among girls ($P = .012$), 24.9% for HPV among boys ($P < .001$), 6.2% for Tdap ($P = .004$), and 14.1% for MCV4 ($P < .001$).

We ran secondary analyses, replacing the independent variable with state's political affiliation on the basis of elections for governor, state senators, and state representatives. Results were consistent (i.e., showing comparable differences) for all vaccination outcomes for each election (results not shown).

DISCUSSION

In this ecological study, we found that adolescents living in Democratic, blue states were significantly more likely than were

TABLE 1—Multivariable Associations Between State Voting Patterns and Vaccination Coverage for HPV (Girls and Boys Separately), Tdap, and MCV4: United States, 2014

Vaccination Outcome	Median % Coverage in Blue States	Median % Coverage in Red States	Adjusted % Difference (95% CI)[a]
≥ 1 HPV girls	63.4	56.0	10.2 (2.2, 18.6)
≥ 1 HPV boys	47.4	33.9	24.9 (11.3, 39.9)
Tdap	90.1	84.8	6.2 (2.1, 10.5)
MCV4	79.3	72.8	14.1 (7.5, 21.0)

Note. CI = confidence interval; HPV = human papillomavirus vaccine; MCV4 = meningococcal conjugate vaccine; Tdap = tetanus-containing vaccine. Red states: AK, AL, AR, AZ, GA, ID, IN, KS, KY, LA, MO, MS, MT, NC, ND, NE, OK, SC, SD, TN, TX, UT, WV, WY. Blue states: CA, CO, CT, Washington, DC, DE, FL, HI, IA, IL, MA, MD, ME, MI, MN, NH, NJ, NM, NV, NY, OH, OR, PA, RI, VA, VT, WA, WI.
[a]Each model included state voting patterns (primary predictor of interest) and considered potential confounding by state-level sociodemographic variables (income, Gini coefficient, poverty, education, racial/ethnic composition), access to care variables (uninsured, physicians per capita, and usual source of care for children), and state-level policy or practices associated with vaccination (mandate specific to each vaccine, exemption policies, exemption complexity, exemption effectiveness, kindergarten exemption rate, and state vaccine financing program type).

adolescents in Republican, red states to have received HPV (among girls and boys), Tdap, and MCV4 vaccines. Thus, even though we hypothesized differences between blue and red states for HPV vaccination only, we also found differences in vaccination coverage for the other adolescent vaccines of comparable magnitudes. Having controlled for demographic, health care access, and vaccination policy covariates, this finding suggests that other factors not easily measured are likely at play. Sociocultural norms and values associated with political affiliation that affect more general health care–seeking attitudes and behaviors may be influencing all immunization rates rather than more granular sexuality-related norms, as we had predicted for HPV vaccine.

The robustness of our results across all 4 adolescent vaccination outcomes when controlling for potential confounding suggests that state-level political affiliation is a significantly and independently important factor in adolescent immunization coverage. Because of the complex mix of psychological, sociocultural, and political factors that drive decisions about immunizations,[5] additional research will be required to gain a fuller understanding of these nuanced associations and their implications for attitudes, beliefs, and practices related to vaccination.

Political worldviews, including cultural norms and social values, personal versus collective responsibility, and trust in the government, may play a critical role in explaining differences in immunization

coverage. Population-based surveys, longitudinal studies, and qualitative approaches will likely be needed to elucidate the mechanisms of the disparity. Further research that identifies the most salient elements (social, religious, economic) of political worldviews that influence vaccination acceptance will be useful for developing targeted interventions and public health programs.

Our study had a few limitations. First, although our ecological analysis revealed a striking disparity, we cannot infer a causal association with this study design. Second, alternative approaches to categorizing state-level voting patterns exist, such as the proportion of voters affiliated with a specific party, and these measures may capture differences that are distinct from outcomes in presidential elections.

Third, our measure of state political affiliation does not capture the range of diversity of beliefs in a political party. Finally, we did not examine variability at smaller levels of geography, such as counties or cities, or how changes over time may be occurring.

PUBLIC HEALTH IMPLICATIONS

An adolescent's state of residence is an important, independent predictor of vaccination against preventable infectious diseases. After controlling for numerous covariates, we found that blue states have significantly higher coverage for the 3 recommended adolescent vaccines than do red states. Future

research that seeks a deeper understanding of the underlying reasons for this is an important public health priority.

State immunization officials routinely exchange information and experiences with their counterparts, activities intended in part to identify and disseminate best practices for promoting and sustaining high vaccination rates. Our findings suggest the potential value in directing heightened attention to the specific experiences of states sharing a common political affiliation during such interactions. Such a focus may yield insights and lessons that are especially well suited to implementation among politically similar states that are particularly capable of producing their intended benefits for vaccination coverage and public health. AJPH

CONTRIBUTORS
S. Bernstein conceptualized the study and wrote the first draft of the brief. L. M. Niccolai and A. North conducted statistical analyses. All authors contributed to the analytical plan, interpreted the results, and provided substantial revisions for the final version.

HUMAN PARTICIPANT PROTECTION
The study was considered exempt from review by the Yale University institutional review board for human participant research.

REFERENCES
1. Wiley A, Siperstein GN. Seeing red, feeling blue: the impact of state political leaning on state identification rates for emotional disturbance. *Behav Disord*. 2011; 36(3):195–207.

2. Kimball R, Wissner M. Religion, poverty, and politics: their impact on women's reproductive health outcomes. *Public Health Nurs*. 2015;32(6):598–612.

3. Shin ME, McCarthy WJ. The association between county political inclination and obesity: results from the 2012 presidential election in the United States. *Prev Med*. 2013;57(5):721–724.

4. Mannix R, Lee LK, Fleegler E. Red state blue state. *Acad Emerg Med*. 2013;20(8):858–859.

5. Larson HJ, Cooper LZ, Eskola J, Katz SL, Ratzan S. Addressing the vaccine confidence cap. *Lancet*. 2011; 378(9790):526–535.

6. Centers for Disease Control and Prevention. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years—United States, 2013. *MMWR Morb Mortal Wkly Rep*. 2014;63(29):625–633.

7. Blank NR, Caplan AL, Constable C. Exempting schoolchildren from immunizations: states with few barriers had highest rates of nonmedical exemptions. *Health Aff (Millwood)*. 2013;32(7):1282–1290.

8. Centers for Disease Control and Prevention. Vaccination coverage among children in kindergarten—United States, 2013–14 school year. *MMWR Morb Mortal Wkly Rep*. 2014;63(41):913–920.

9. Bradford WD, Mandich A. Some state vaccination laws contribute to greater exemption rates and disease. *Health Aff (Millwood)*. 2015;34(8):1383–1390.