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Short communication

Up-to-date coverage with meningococcal vaccine among adolescents age 17 years: Patterns and correlates in the United States, 2017

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ABSTRACT

Limited research has explored reasons for low up-to-date coverage with meningococcal vaccine (UTD MenACWY) among adolescents at age 17 years. This analysis used National Immunization Survey–Teen data from 2017 to examine patterns of UTD MenACWY coverage. Correlates of higher UTD MenACWY coverage included black race and Hispanic ethnicity, residing in Northeast census region, recent health care visits, and receipt of recommendation for HPV vaccine. Median UTD MenACWY coverage was significantly higher in states with 1 and 2-dose requirements for school entry compared to no requirement; exemption policies were not associated. Approximately 13% of adolescents had a missed opportunity for UTD MenACWY. Future research should examine barriers to coverage at the patient, parent, provider and structural (clinic, social, policy) levels so that programs and interventions can be designed and implemented to increase coverage.

1. Introduction

Meningococcal disease includes several clinical manifestations of infection with *Neisseria meningitidis* including meningitis, bacteremia, and pneumonia [1]. Though meningococcal disease has declined in the US since the 1990s, it remains an important concern due to rapid onset of disease, high case-fatality rate, and severe sequalae among survivors [2–4]. Older adolescents and young adults face increased risk during outbreaks that often occur in university settings.

Since 2005, the US Advisory Committee on Immunization Practices (ACIP) has recommended routine administration of one dose of meningococcal conjugate vaccine (MenACWY) for all adolescents at ages 11–12 years; in 2010, a recommendation for administration of a second dose at age 16 years was added [1]. Coverage with at least 1 dose of MenACWY among adolescents age 13–17 years has increased steadily to 85.1% in 2017, yet coverage with a second dose by age 17 remains low at 44.3% [5]. Notably, this level of coverage is lower than that of all other vaccines that are recommended for routine administration to adolescents, including tetanus, diphtheria, and acellular pertussis (Tdap) vaccine (88.7%), at least 1 dose of human papillomavirus (HPV) vaccine (65.5%), and completion of the 2 or 3 dose series for HPV (48.6%).

Extensive research has focused on uptake of HPV vaccine [6–9], yet limited attention has been given to the reasons for low up-to-date (UTD) MenACWY coverage. Therefore, the goal of this study was to describe correlates of UTD MenACWY among adolescents age 17 years in the US using data from the National Immunization Survey (NIS) – Teen.

2. Methods

Methods for NIS – Teen have been previously described [10]. Briefly, NIS-Teen samples adolescents ages 13–17 years living in the US for a two-phase survey that includes a random digit dialing telephone survey followed by a medical record review in which healthcare providers complete an immunization grid. For this analysis, we considered an adolescent to be UTD for MenACWY if they either received two doses by age 17 or one dose at age 16 or 17 years per ACIP recommendations [1]. To examine correlates of UTD MenACWY among adolescents age 17 years in 2017, we considered sociodemographic characteristics and health care factors. Sociodemographic characteristics included sex, race/ethnicity, poverty level, language of the interview, maternal age, maternal education, maternal marital status, and census region. Health care factors included type of health insurance, continuous health insurance since age 11 years, health care facility type, checkup at age 16 or 17, number of health care visits in past 12 months, and whether the adolescent had received a recommendation for HPV

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Table 1
Correlates of up-to-date MenACWY coverage among adolescents age 17 years in US, NIS–Teen 2017 (n = 3807).

	N	UTD MenACWY (51.4%)	Unadjusted OR (95% CI)	Model 1 Adjusted OR (95% CI)	Model 2* Adjusted OR (95% CI)
Sex					
Male	2008	49.8	1.0	–	–
Female	1799	53.3	1.15 (0.91, 1.46)		
Race/Ethnicity					
White	2424	48.3	1.0	1.0	1.0
Hispanic	649	51.0	1.11 (0.78, 1.60)	1.63 (1.11, 2.39)	1.39 (0.91, 2.10)
Black	325	59.8	1.60 (1.15, 2.22)	1.81 (1.26, 2.60)	1.78 (1.19, 2.67)
Other/mixed	409	58.6	1.51 (1.02, 2.26)	1.49 (0.98, 2.28)	1.51 (0.95, 2.40)
Poverty					
Above >75K	1894	50.7	0.86 (0.60, 1.22)	–	–
Above ≤75K	1189	47.3	0.75 (0.52, 1.08)		
Below	590	54.6	1.0		
Language of interview					
English	3457	50.2	1.0	–	–
Spanish/Other	350	60.9	1.37 (0.86, 2.18)		
Maternal age (years)					
≤34	89	52.3	1.01 (0.73, 1.22)	–	–
35–44	1260	50.6	0.94 (0.73, 1.23)		
≥45	2458	52.1	1.0		
Maternal education					
<12 years	453	49.0	1.0	–	–
12 years	558	55.4	1.29 (0.81, 2.05)		
Non-college	957	47.7	0.95 (0.61, 1.49)		
College graduate	1839	52.9	1.17 (0.78, 1.75)		
Maternal marital status					
Married	2683	53.6	1.0	–	–
Not married	1124	48.0	0.80 (0.62, 1.03)		
Census region					
Northeast	759	68.9	1.0	1.0	1.0
Midwest	824	59.2	0.65 (0.48, 0.88)	0.72 (0.52, 0.99)	0.71 (0.50, 1.01)
South	1404	44.9	0.37 (0.28, 0.49)	0.36 (0.27, 0.49)	0.37 (0.26, 0.51)
West	820	42.8	0.34 (0.22, 0.52)	0.35 (0.28, 0.54)	0.36 (0.22, 0.59)
Health insurance					
Private	2230	50.6	0.92 (0.73, 1.17)	–	–
Medicaid/other/uninsured	1577	52.6	1.0		
Continuously insured since age 11					
Yes	3346	53.0	1.50 (1.07, 2.12)	–	–
No	452	42.9	1.0		
Facility type					
Private	1697	54.7	1.29 (1.01, 1.66)	–	–
Other	1735	48.3	1.0		
Checkup at age 16 or 17					
Yes	3289	55.6	4.26 (2.76, 6.57)	3.12 (1.96, 4.95)	
No	438	22.7	1.0	1.0	
Health care visits in past 12 months					
≥1	3301	54.6	2.57 (1.75, 3.76)	1.93 (1.29, 2.91)	
None	465	31.9		1.0	
Received recommendation for HPV vaccine					
Yes	2729	55.1	1.59 (1.22 2.07)	1.51 (1.14 2.00)	1.49 (1.10, 2.04)
No	1078	43.6	1.0	1.0	1.0

* Model 2 excluded adolescents who did not have a checkup at age 16 or 17 years or a health care visit in the past 12 months to control for opportunity for UTD MenACWY coverage. OR, odds ratio. CI, confidence interval.

vaccination (a proxy measure for providers' practices related to vaccines; this question was not asked for other vaccines). All covariates were initially entered in a full multivariable model. Manual backward selection eliminated covariates starting with the largest p value until all covariates retained in the model were associated at $p < .05$. Secondary analyses repeated this modeling procedure for teens who had a check-up at age 16 or 17 years, thus having had an opportunity to be vaccinated.

State-level immunization policies were analyzed as follows. Information about school entry requirements was obtained from the Immunization Action Coalition [11]. This measure was classified as having no requirements for MenACWY (27 states), requiring 1 dose (16 states), or requiring 2 doses (8 states) in place during 2016–2017 school year. Exemption policies were obtained from state immunization websites and CDC's Public Health Law Program [12]. Policies related to types of allowable exemptions were classified as religious and philosophical (17 states), religious (31 states), and neither (3 states). Ease of obtaining an exemption was based on four criteria: need for a written letter, need to return form/letter to a local or state health department, requirement for notarization or authorized signature, and annual renewals. States were classified as easy (13 states), moderate (10 states), or difficult (28 states including the 3 states that did not allow religious or philosophical exemptions) using a modified version of an established approach

[13]. To examine the relationship between these policies and state-level estimates of UTD MenACWY coverage, box plots depicting the medians, 25th and 75th percentiles, and minimum and maximum estimates were plot, and medians were compared with Kruskall-Wallis tests.

Association between UTD MenACWY and other vaccines were assessed in a separate analysis by chi-square p-values for ≥1 Tdap, ≥1 HPV, UTD HPV, and ≥1 influenza vaccination in the past 3 years. A missed opportunity for UTD MenACWY was defined as receipt of another vaccine (Tdap, HPV, or influenza) at age 16 or 17 but not being UTD MenACWY. All statistical analyses used weights to account for the sampling frame and response rates in NIS – Teen.

3. Results

A total of 3807 adolescents who were 17 years old and had adequate provider data in 2017 NIS – Teen were included in this analysis. Correlates of UTD MenACWY presented in Table 1. In the bivariate analyses, UTD MenACWY was associated with race/ethnicity, census region, checkup at age 16 or 17 years, health care visit in past 12 months, and provider recommendation for HPV vaccine. In multivariable models, the following factors remained significantly associated with UTD MenACWY coverage: black race and Hispanic ethnicity compared to white (adjusted odds ratio aOR = 1.81, 95% CI: 1.26, 2.60 and aOR = 1.63, 95% CI: 1.11, 2.39, respectively), checkup at age 16 or 17 years (aOR = 3.12, 95% CI: 1.96, 4.95), health care visit in the past 12 months (aOR = 1.93, 95% CI: 1.29, 2.91), and receipt of recommendation for HPV vaccine (aOR = 1.51, 95% CI: 1.14, 2.00). Coverage was lower in the Midwest, South and West regions compared to Northeast (aOR = 0.72, 95% CI: 0.52, 0.99, aOR = 0.36, 95% CI: 0.27, 0.49 and aOR = 0.35, 95% CI: 0.28, 0.54, respectively). When the model was restricted to those who had a checkup at age 16 or 17 years or a health care visit in the past 12 months (e.g., the opportunity to be vaccinated with a second dose of MenACWY vaccine), results were similar (Table 1).

Median state-level UTD MenACWY coverage was higher in states with a 1-dose requirement (54.1%) and a 2-dose requirement (63.6%) compared to no requirement (41.5%) (p = .001) (Fig. 1). There was no statistically significant difference in median coverage between states with religious and personal belief exemptions (50.2%), religious exemptions only (47.9%), and no non-medical exemptions (43.2%) (p = .548). There was also no statistically significant difference in median coverage between states with easy (57.1%), moderate (42.7%), and difficult (47.6%) procedures for obtaining an exemption (p = .149).

UTD MenACWY was significantly associated with receipt of other vaccines (p < .001 for each). Compared to 51.4% coverage overall, UTD MenACWY coverage among adolescents who received ≥1 Tdap was 58.0%, ≥1 HPV was 63.7%, and influenza (in the past 3 years) was 68.3%. A total of 45.9% of adolescents received either Tdap (4.5%), HPV (21.3%) or influenza (32.3%) vaccine at age 16 or 17 years, of whom 28.6% were not UTD MenACWY (Fig. 2). If these adolescents had received MenACWY at age 16 or 17 years, overall coverage would be increased to 64.5% (13.1 percentage points higher).

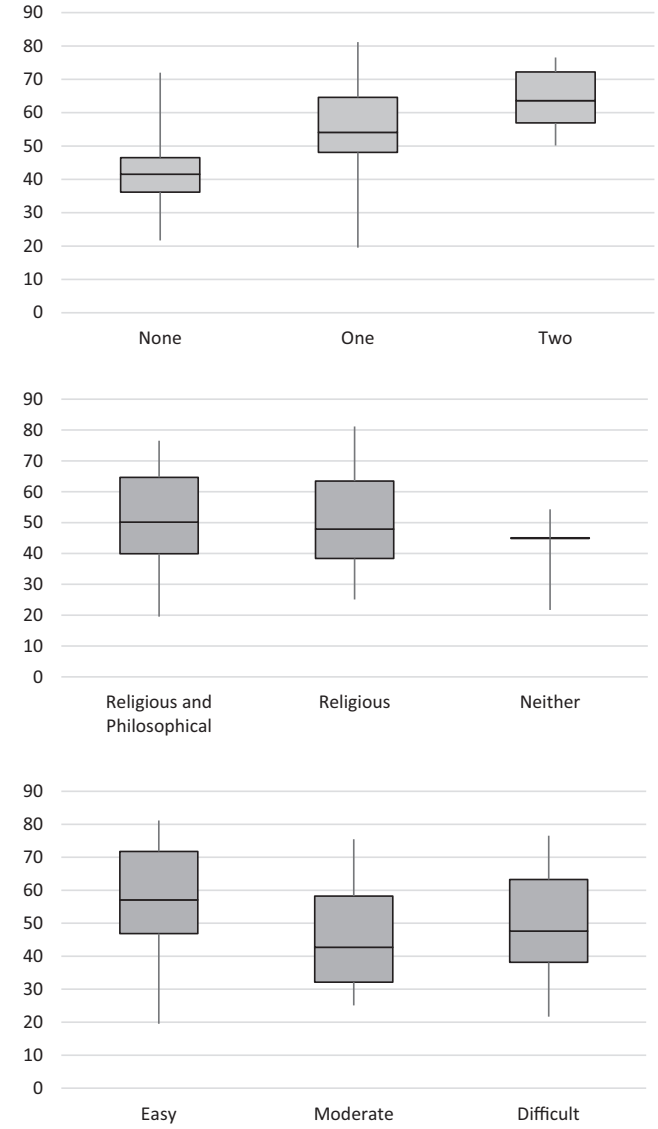

Fig. 1. a–c. Up-to-date MenACWY coverage among adolescents age 17 years by (a) school entry requirement policies for number of doses, (b) types of allowable exemptions from school requirement, and (c) ease of exemption policies; National Immunization Survey – Teen, 2017. States not requiring any MenACWY doses: AL, AK, CA, CO, FL, HI, IA, KS, KY, ME, MA, MS, MT, NE, NV, NH, NM, ND, OK, OR, SC, TN, VT, VA, WA, WI, WY. States requiring 1 dose: AZ, CT, DE, DC, GA, ID, LA, MD, MI, NJ, NY, NC, PA, SD, TX, UT. States requiring 2 doses: AR, IL, IN, MN, MO, OH, RI, WV. States allowing religious and philosophical exemptions: AZ, AR, CO, ID, LA, ME, MI, MN, ND, OH, OK, OR, PA, TX, UT, WA, WI. States allowing religious exemptions: AL, AK, CT, DE, DC, FL, GA, HI, IL, IN, IA, KS, KY, MD, MA, MO, MT, NE, NV, NH, NJ, NM, NY, NC, RI, SC, SD, TN, VA, VT, WY. States that do not allow non-medical exemptions: CA, MS, WV. States with easy exemption procedures: AZ, HI, ID, MD, MO, NY, ND, OH, OK, PA, RI, SD, WI. States with moderate exemption procedures: AL, CO, DC, KS, LA, NV, NJ, NC, VT, WY. States with difficult exemption procedures: AK, AR, CT, DE, FL, GA, IL, IN, IA, KY, ME, MA, MI, MN, MT, NE, NH, NM, OR, SC, TN, TX, UT, VA, WA (CA, MS, WV also included in this group).

4. Discussion

This analysis presents the first examination of patterns of UTD MenACWY coverage in the US since the recommendation for routine administration of a second dose at age 16 years in 2010. Several factors were significantly associated with UTD MenACWY coverage. Black and Hispanic adolescents and those residing in the Northeast census region had higher UTD MenACWY coverage. These demographic results are largely consistent with NIS-Teen results for other vaccines including HPV and influenza [14,15]. This finding suggests that social and contextual factors related to race/ethnicity and geography may be contributing to differences in coverage, and future research should explore these possible reasons further.

Not surprisingly, having continuous health care coverage since age 11 and having had a checkup at age 16 or 17 were both associated with UTD MenACWY coverage, reflecting the importance of

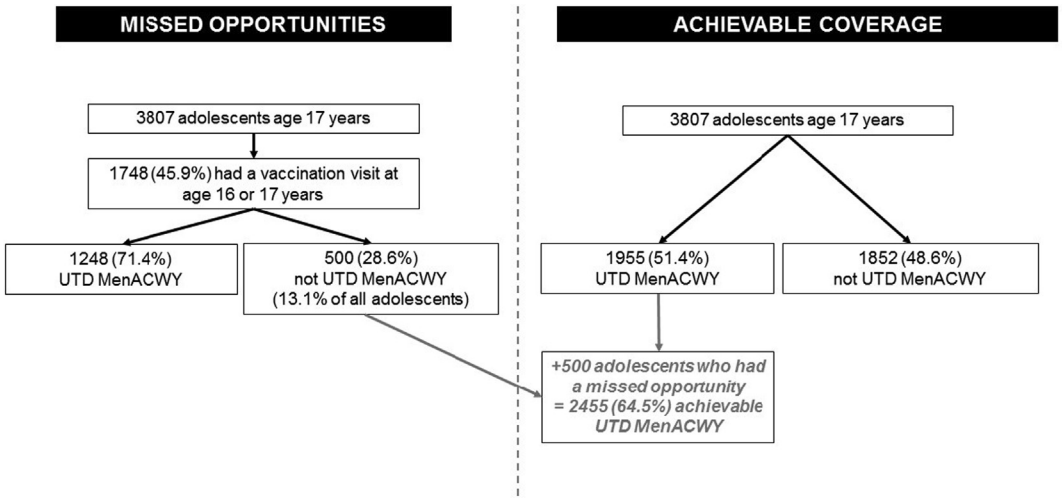

Fig. 2. Missed opportunities and achievable coverage for up-to-date MenACWY coverage among adolescents age 17 years; National Immunization Survey – Teen, 2017.

access to care and the opportunity for vaccination. However, other factors remained associated when the analysis was restricted to adolescents who had a recent health care visit. While adolescents may be less likely to have well-child visits compared to younger children, and lack of access to health care is clearly a significant barrier for vulnerable adolescents (e.g., undocumented immigrants), many adolescents do have annual preventive health care visits (43–81%) [16], and this factor alone does not account for the large number of under-immunized adolescents. Furthermore, substantial missed opportunities exist for UTD MenACWY as noted by the gap in actual coverage (51%) and what could be achieved (64%) if MenACWY were administered at visits where adolescents age ≥16 years received other recommended vaccines. Best clinical practices for immunization, such as use of electronic medical records or immunization information systems, standing orders, and/or provider prompts, could help to reduce these missed opportunities [17].

UTD MenACWY was significantly associated with coverage for all other adolescent vaccines including Tdap, HPV, and influenza. This may reflect access to care and opportunity for vaccination, strength of provider endorsement for vaccines overall (supported by the finding that having received a recommendation for HPV vaccine was associated with UTD MenACWY), or parental acceptance of vaccines in general. Efforts to strengthen general vaccine attitudes and acceptance by providers and parents could have broad effects on multiple vaccines.

School entry requirements for both ≥1 and ≥2 doses of MenACWY were associated with UTD MenACWY coverage. School entry requirements for vaccines have been an important component of immunization programs in the United States, and this finding supports a growing body of research about the impact of school entry requirements on increasing coverage for adolescent vaccines [18,19]. States without requirements for MenACWY may consider the feasibility of and their readiness for this policy option. Interestingly, exemption policies were not associated with UTD MenACWY coverage. Given the relatively small number of people who obtain exemptions for their children, generally less than 3% [20], it is possible that exemption policies are not large drivers of population levels of vaccination coverage.

This analysis is subject to some limitations worth noting. First, teens who received MenACWY at age ≥18 years are not captured in NIS-Teen. Some providers or patients may choose to delay this vaccination until a time closer to college entry (a period of increased risk). Furthermore, though NIS-Teen is population-based and nationally representative, there may be a bias toward inclusion of adolescents who received immunizations as the sample may over-represent those with access to care, though this should be mitigated by use of the sampling weights.

5. Conclusions

Barriers to HPV vaccination, for which coverage has been suboptimal, have been well studied, yet scant attention has been paid to UTD MenACWY that has been comparably low. A deeper understanding of how factors at the patient/parent, provider, clinic, and broader structural levels affect UTD MenACWY is an important focus for future research. Given that UTD MenACWY involves a health care visit at ages 16 or 17 years, considering the role that adolescents may play as they become more involved in health care decision making will be important. Programs and interventions with proven effectiveness for increasing HPV vaccination coverage, such as strengthening provider recommendations and clinic-based protocols [21,22], may warrant exploration for UTD MenACWY.

Declaration of Competing Interest

Dr. Niccolai has served as Scientific Advisor from Merck.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2019.08.015.

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