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# Correlates of Human Papillomavirus Vaccination Rates in Low-Income, Minority Adolescents: A Multicenter Study

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## Abstract

***Background:*** Low rates of human papillomavirus (HPV) vaccination in low-income, minority adolescents may exacerbate racial disparities in cervical cancer incidence.
***Methods:*** Using electronic medical record data and chart abstraction, we examined correlates of HPV vaccine series initiation and completion among 7702 low-income and minority adolescents aged 11–21 receiving primary care at one of seven medical centers between May 1, 2007, and June 30, 2009. Our population included 61% African Americans, 13% Caucasians, 15% Latinas, and 11% other races; 90% receive public insurance (e.g., Medicaid). We used logistic regression to estimate the associations between vaccine initiation and completion and age, race/ethnicity, number of contacts with the healthcare system, provider documentation, and clinical site of care.
***Results:*** Of the 41% of adolescent girls who initiated HPV vaccination, 20% completed the series. A higher proportion of girls aged 11–<13 (46%) and 13–<18 (47%) initiated vaccination than those aged 18–21 (28%). In adjusted analyses, receipt of other recommended adolescent vaccines was associated with vaccine initiation, and increased contact with the medical system was associated with both initiation and completion of the series. Conversely, provider failure to document risky health behaviors predicted nonvaccination. Manual review of a subset of unvaccinated patients' charts revealed no documentation of vaccine discussions in 67% of cases.
***Conclusions:*** Fewer than half of low-income and minority adolescents receiving health maintenance services initiated HPV vaccination, and only 20% completed the series. Provider failure to discuss vaccination with their patients appears to be an important contributor to nonvaccination. Future research should focus on improving both initiation and completion of HPV vaccination in high-risk adolescents.

## Introduction

Nearly one quarter of 14–19-year-olds are infected with human papillomavirus (HPV),[1] with the highest prevalence documented among low-income and minority women.[2] Because of higher rates of HPV infection and lower use of screening and treatment services,[3] cervical cancer incidence and mortality rates are nearly twice as high in Latina and African American women as in white women.[4] HPV vaccination has the potential to prevent nearly all HPV 16 and HPV 18 infections[5] and 70% of cervical cancers,[6] even in the absence of Pap test screening. Thus, vaccinating minority adolescents could reduce racial disparities in cervical cancer incidence,[6–8] similar to reductions in health disparities following widespread vaccination for childhood diseases.[7] However, failure to vaccinate high-risk adolescents could potentially worsen disparities in cervical cancer rates.

Recent data from the U.S. National Immunization Survey indicate that only 49% of 13–17-year-olds received one or more doses of HPV vaccine, and 32% received all three recommended doses.[9] Factors contributing to these low vaccination rates are not well elucidated. Effects of demographic factors, including race and socioeconomic status, are inconsistent. The National Immunization Survey indicated slightly higher vaccination rates among impoverished U.S. adolescents,[9] whereas a study from a large managed care population

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indicated higher rates among higher-income enrollees.[10] Currently available data indicate that race does not predict initiation of the HPV vaccine series[9] but consistently show that minorities are less likely than whites to complete the series in the United States.[9,11,12] Other factors, such as provider reluctance to discuss vaccination with patients[13–15] or differences in clinic systems,[16] may also play a role in low or inconsistent vaccination rates. We examined patient, provider, and clinic correlates of both initiating and completing the HPV vaccine series in a cohort of urban adolescents attending seven independent medical centers.

## Material and Methods

### Study setting and subjects

Boston Medical Center, which serves the largest population of Medicaid patients in Massachusetts, is affiliated with a network of seven federally qualified community health centers that serve Boston's low-income and minority populations. Community health centers vary in size and primary ethnic groups served, and each has its own staff, including both physicians and nurse practitioners (Table 1). All community health centers are located in low-income, urban neighborhoods and have approximately 90% Medicaid or publicly insured patients. To facilitate data retrieval, this study included the academic medical center and the six community health centers that used the same electronic medical record platform (Centricity GE). In all study clinics, noted subsequently as hospital or community health clinic sites 1–6, HPV vaccination must be initiated by a primary care provider (either nurse practitioner or physician); no clinics have standing orders for HPV vaccination. Follow-up vaccinations are generally scheduled as nurse-only visits unless the patient has another medical problem requiring follow-up. Same day walk-in appointments for HPV vaccination are available in community health clinic sites 4, 5, and 6, but visits must be scheduled ahead of time at sites 1, 2, and 3 and at the hospital-based clinic.

The study population included females aged 11–21 with at least one health maintenance visit at Boston Medical Center or one of the six community health centers during the study period (May 1, 2007, to April 30, 2008) who had not previously initiated HPV vaccination. A visit was considered a health maintenance visit if provider documentation designated it as such in the medical record. We chose to include only subjects seen for routine health maintenance because providing immunizations at health maintenance visits is considered standard of care, whereas adolescents seen in specialty care or urgent care may have their primary care physician and, thus, their complete vaccination record maintained at another site. Review of medical records for this study was approved by the Boston Medical Center Institutional Review Board.

### Data

Data for all patients were retrieved as a single data pull that simultaneously gathered electronic medical record data from all sites. Clinic policies dictate that immunization dates be entered into the electronic medical record by nurses at each visit at which vaccines are administered or the patient brings record of a vaccine administered at another site. Thus, the medical record includes both vaccinations received at the clinic and those received at other sites (such as private offices). HPV vaccination dates recorded in the medical record were used to indicate initiation and completion. The outcomes of interest included (1) initiation of the HPV vaccine series (receipt of at least one dose of vaccine) and (2) completion of all three injections of the vaccine series. HPV vaccination became available to the sites in our study through the Department of Public Health in April 2007, and we examined initiation of HPV vaccination occurring during the period of May 1, 2007, through April 30, 2008. To explore the timeliness of subsequent doses, HPV vaccine completion could occur up to the date that the data were retrieved from the medical records, June 30, 2009.

Information was considered only on potential correlates of HPV vaccination from May 1, 2007, through April 30, 2008. Patient-level correlates of vaccination included race, age, number of documented visits to a care provider during the study period, and receipt of the meningococcal vaccine and tetanus, diphtheria, and pertussis (Tdap) booster. Additional variables included the clinic at which vaccination was initiated and provider documentation of health maintenance elements in the medical record. To determine which health maintenance elements were documented most accurately, we performed manual review of 400 randomly selected charts from the academic medical center (5% of total charts). We

Table 1. Patient Populations and Provider Characteristics of Clinical Sites

| | *Hospital-based clinic* | *Community site 1* | *Community site 2* | *Community site 3* | *Community site 4* | *Community site 5* | *Community site 6* |
|---|---|---|---|---|---|---|---|
| Number of 11–21-year-old female patients | 2424 | 1673 | 1178 | 559 | 537 | 791 | 540 |
| Racial/ethnic characteristics of patient population | | | | | | | |
| Black | 71% | 84% | 32% | 83% | 91% | 8% | 38% |
| Latina | 14% | 8% | 18% | 8% | 2% | 13% | 49% |
| Caucasian | 5% | 2% | 18% | 6% | 1% | 74% | 1% |
| Other | 10% | 6% | 32% | 2% | 7% | 5% | 12% |
| Number of pediatric providers[a] | 32 | 5 | 10 | 3 | 4 | 3 | 2 |
| Number of family medicine providers[a] | 50 | 9 | 6 | 6 | 2 | 19 | 3 |

[a]Includes physicians and nurse practitioners; includes patients and staff during entire study period.

found that history of sexually transmitted infection (STI) and current alcohol use were reliably recorded, with >90% concordance between the results of electronic data retrieval and manual record review. Therefore, these variables were used to represent provider documentation of health maintenance discussions in our statistical analyses.

To ensure that we accurately captured the characteristics of each subject at the time that she was vaccinated, variables that could change over time (e.g., age, receipt of the Tdap booster or the meningococcal vaccine, provider documentation of health maintenance elements) were selected to be before or on the date of HPV initiation for girls who were vaccinated. For each girl who did not receive vaccination, data from one of her documented clinic visits were used. Girls who initiated the HPV vaccine series may have done so on their first, second, or later visits during the study period. Because we were interested in variables that change over time, we wanted the distribution of clinic visit number for unvaccinated girls (i.e., first, second, or later visits) to match that of vaccinated girls. Therefore, we selected the visit used for analysis for unvaccinated girls such that the distribution of clinic visit number was similar to that of vaccinated girls.

Reasons for nonvaccination could include patients declining vaccination, physicians failing to offer the vaccine, or other reasons. Because these data are difficult to capture via electronic data pull, we performed manual chart review. Because of data-sharing and patient confidentiality restrictions, we were able to manually review all records from unvaccinated patients at the academic medical center ($n=375$, 12% of unvaccinated charts) but not from the community sites. Reasons for nonvaccination were coded as patient declined, vaccine discussed but deferred to a subsequent visit, and no documentation of discussion.

### *Statistical methods*

Separate analyses were performed to identify correlates of (1) initiation of HPV vaccination (the first vaccine in the series) and (2) completion of all three shots in the HPV vaccine series. Differences in the sociodemographic and clinic characteristics of subjects according to HPV vaccination were assessed using the chi-square test. To allow comparison of vaccination rates in this cohort with current Advisory Committee on Immunization Practices (ACIP) recommendations and data from the National Immunization Survey, we report models stratified by age (11–<13 years, 13–<18 years, and 18–21 years of age). Hierarchical logistic regression initially was used to account for possible clustering within clinic. As a strong effect of clinic was not found, the results of multiple logistic regression are reported; these results are nearly identical to those found using hierarchical modeling. All variables presented were included in the multivariate model. Analyses were conducted with SAS 9.2.

## Results

A total of 8163 female adolescents aged 11–21 had at least one health maintenance visit at one of the seven study sites during the period of May 1, 2007, to April 30, 2008. Of these, 461 girls who initiated vaccination before May 1, 2007, were excluded, leaving 7702 girls who constituted the study population. As expected based on vaccination guidelines, more girls in the younger age categories initiated HPV vaccination: 45.9% ($n=629$) among girls 11–<13 years, 46.6% ($n=1830$), among girls 13–<18 years, and 27.7% ($n=666$) among girls 18–21 years (Table 2). Likewise, significantly more younger girls who initiated vaccination completed the three vaccine series: 50.2% ($n=316$) of girls 11–<13 years, 50.9% ($n=932$) of girls 13–<18 years, and 44.3% ($n=295$) of girls 18–21 years.

The median time between the first and the last injection in the series was 10.4 months (range 4.2–24.6 months) for 11–<13-year-olds, 8.9 months (range 4.3–25.1 months) for 13–<18-year-olds, and 8.2 months (range 4.3–23.2 months) for 18–21-year-olds. The majority of follow-up injections occurred later than the recommended dosing schedule for the quadrivalent HPV vaccine: 0, 2, and 6 months.[17] Even allowing for a 1-month grace period for completion of each dose, only 41.6% of 11–<13-year-olds, 45.2% of 13–<18-year-olds, and 49.3% of 18–21-year-olds who completed their second injection did so within 3 months of the first injection. Among girls who completed the series, 40.5% of 11–<13-year-olds, 49.3% of 13–<18-year-olds, and 50.9% of 18–21-year-olds completed the third dose within 5 months of the second dose. Girls who completed two doses had more clinic visits than girls who completed only one dose and were more likely to be in the younger two age categories (data not shown). No difference was noted in race, site of care, or receipt of meningococcal or Tdap vaccines. Of the 1582 girls who completed doses 1 and 2 but not 3, 651 (41%) completed dose 1 only, and 931 (59%) completed two doses.

Correlates of HPV vaccine initiation and completion are shown in Tables 3 and 4, stratified by age. Three variables were positively associated with vaccine initiation in all age groups: more visits during the study period and receipt of meningococcal and Tdap vaccines. Provider documentation of alcohol use and STIs was also associated with vaccine receipt in adolescents aged ≥13. No consistent effects on vaccine initiation were noted for race or clinical site of care. Completion of the HPV vaccine series was associated with a higher number of clinic visits and attending community clinic site 2, and younger girls who received the meningococcal vaccine were less likely to complete the series.

Manual review of 12% of cases in which HPV vaccination was not initiated indicated that 28% ($n=108$) of patients declined vaccination, 5% ($n=17$) of patients discussed vaccination with their provider but chose to defer vaccination at that visit, and there was no documentation of vaccine discussion for the remaining 67% of patients ($n=250$). The proportion of girls declining vaccination decreased with increasing age: 41.9% of girls <13 years of age, 31.7% of girls 13–18 years of age, and 11.3% of girls 18–21 years of age declined vaccination. There was no difference in vaccine declination by race or ethnicity.

## Discussion

We found low HPV vaccine initiation and completion rates among a cohort of 7702 low-income and minority adolescents aged 11–21 seeking primary care in seven institutions serving Boston's urban poor. Approximately half of girls aged 11–<18 and only one quarter of 18–21-year-olds initiated vaccination during the 1-year study period. Among those initiating vaccination, only half completed the three-dose series, and the majority of follow-up injections were given late. Unfortunately, these low rates of initiating and completing the

Table 2. Characteristics of 7702 Urban Adolescents Aged 11–21 by Human Papillomavirus Vaccine Receipt

| *Variable* | *No HPV vaccination* n *(%)* | *1 or 2 HPV vaccinations* n *(%)* | *All 3 HPV vaccinations* n *(%)* |
|---|---|---|---|
| Total | 4577 (59) | 1582 (21) | 1543 (20) |
| Age | | | |
| 11–<13 | 742 (54) | 313 (23) | 316 (23) |
| 13–<18 | 2093 (54) | 898 (23) | 932 (24) |
| 18–21 | 1742 (72) | 371 (15) | 295 (12) |
| Location of care | | | |
| Hospital-based clinic | 1349 (56) | 657 (27) | 418 (17) |
| Community site 1 | 1012 (60) | 299 (18) | 362 (22) |
| Community site 2 | 586 (50) | 183 (16) | 409 (35) |
| Community site 3 | 391 (70) | 94 (17) | 74 (13) |
| Community site 4 | 387 (72) | 107 (20) | 43 (8) |
| Community site 5 | 579 (73) | 115 (15) | 97 (12) |
| Community site 6 | 273 (51) | 127 (24) | 140 (26) |
| Number of visits in study period | | | |
| 1–2 | 2759 (62) | 1019 (23) | 660 (15) |
| >2 | 1818 (56) | 563 (17) | 883 (27) |
| Race | | | |
| Black | 2831 (60) | 1015 (22) | 873 (19) |
| White | 672 (68) | 154 (16) | 167 (17) |
| Latina | 599 (54) | 235 (21) | 285 (25) |
| Other | 475 (55) | 178 (20) | 218 (25) |
| Provider documentation of STI or alcohol use | | | |
| No | 2462 (68) | 556 (15) | 612 (17) |
| Yes | 2115 (52) | 1026 (25) | 931 (23) |
| Received meningococcal vaccine | | | |
| No | 3737 (76) | 536 (11) | 642 (13) |
| Yes | 840 (30) | 1046 (38) | 901 (32) |
| Received Tdap booster | | | |
| No | 2838 (72) | 546 (14) | 577 (15) |
| Yes | 1739 (46) | 1036 (28) | 966 (26) |

STI, sexually transmitted infection; Tdap, tetanus, diphtheria, and pertussis.

series among low-income and minority adolescents are below the Massachusetts average (66% initiation and 71% completion).[9] Nationwide rates of vaccination are lower than Massachusetts rates, with 49% of 13–17-year-olds initiating and 32% completing the HPV vaccine series in 2010; low-income and minority adolescents were less likely to complete the series.[9,11,12] Our study is consistent with national trends documenting lower rates of complete vaccination among low-income and minority women. If these disparities in HPV vaccination persist, racial disparities in cervical cancer incidence could be exacerbated in the future.

We found that more patients who did not initiate vaccination were seen by providers who also did not document health behaviors, such as alcohol use and history of STIs. Although medical documentation is inherently imperfect, the negative association between provider documentation of health behaviors and initiating HPV vaccination may imply that providers who did not discuss risky health behaviors with their patients were also not discussing HPV vaccination. Manual review of medical records supports this hypothesis: we found no documentation of a vaccine discussion in the records of two thirds of unvaccinated girls. These data may indicate that in older adolescents, fewer discussions of risky health behaviors may be associated with lower vaccination rates.

Although most physicians nationwide do offer HPV vaccines,[13,15] fewer than half of physicians routinely offer HPV vaccination to their younger adolescent patients,[14] and some describe a reluctance to vaccinate younger girls because they feel uncomfortable discussing issues related to sexuality[13] or are concerned about parents' negative reactions.[15] Unlike such patient factors as race and socioeconomic status that receive much attention but cannot be changed in the context of a single healthcare visit, provider actions are potentially modifiable, and interventions to improve provider communication around HPV vaccination may be an effective way to raise vaccination rates.

Contact with the medical system and receipt of other adolescent vaccines were also associated with HPV vaccination. Consistent with prior literature,[11] more medical visits were associated with higher rates of both initiation and completion of the vaccine series. Receipt of meningococcal vaccination and the Tdap booster were both associated with initiation of HPV vaccination, but perhaps because both of these vaccines are given as a single dose, no consistent effect was noted on completion of the three-shot HPV vaccine series. Clinical site did not have a consistent effect on vaccine initiation, but community site 2 was consistently better at series completion in all age groups. This site used a designated nurse who tracked all HPV vaccinations and contacted patients with incomplete series by phone and letter as well as placing a notification in the electronic medical record. These findings may imply that such factors as provider-patient communication more strongly influence vaccine initiation, whereas

Table 3. Correlates of Human Papillomavirus Vaccine Initiation Among Adolescent Girls 11–21 Years of Age

| *HPV vaccine initiation* | *Ages 11–<13 (n=1371)* | | *Ages 13–<18 (n=3923)* | | *Ages 18–21 (n=2408)* | |
|---|---|---|---|---|---|---|
| *Correlate* | *Unadjusted OR (95% CI)* | *Adjusted OR (95% CI)*[a] | *Unadjusted OR (95% CI)* | *Adjusted OR (95% CI)*[a] | *Unadjusted OR (95% CI)* | *Adjusted OR (95% CI)*[a] |
| Location of care | | | | | | |
| Hospital-based clinic | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Community site 1 | 1.14 (0.84-1.54) | 1.18 (0.83-1.68) | 1.03 (0.86-1.23) | 1.37 (1.11-1.69) | 0.52 (0.40-0.66) | 0.53 (0.40-0.71) |
| Community site 2 | 0.55 (0.40-0.76) | 1.07 (0.71-1.60) | 1.52 (1.25-1.85) | 1.95 (1.53-2.49) | 1.69 (1.30-2.19) | 1.44 (1.04-1.99) |
| Community site 3 | 0.39 (0.25-0.60) | 1.03 (0.63-1.71) | 0.75 (0.58-0.97) | 1.66 (1.24-2.24) | 0.30 (0.19-0.48) | 0.33 (0.19-0.55) |
| Community site 4 | 0.42 (0.27-0.68) | 0.69 (0.40-1.18) | 0.64 (0.49-0.83) | 0.80 (0.58-1.09) | 0.24 (0.15-0.41) | 0.33 (0.19-0.59) |
| Community site 5 | 0.43 (0.28-0.65) | 0.75 (0.41-1.38) | 0.47 (0.37-0.60) | 0.68 (0.48-0.98) | 0.51 (0.37-0.71) | 0.47 (0.29-0.76) |
| Community site 6 | 1.31 (0.80-2.12) | 1.79 (0.99-3.24) | 1.91 (1.47-2.48) | 2.20 (1.61-3.01) | 0.54 (0.36-0.80) | 0.54 (0.34-0.86) |
| Number of visits in study period | | | | | | |
| 1–2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| >2 | 1.25 (0.99-1.57) | 1.39 (1.06-1.81) | 1.51 (1.33-1.72) | 1.75 (1.5-2.04) | 1.58 (1.32-1.90) | 1.83 (1.47-2.27) |
| Race | | | | | | |
| Black | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| White | 0.57 (0.40-0.82) | 0.72 (0.42-1.22) | 0.66 (0.54-0.81) | 0.79 (0.58-1.08) | 1.01 (0.78-1.32) | 1.07 (0.71-1.60) |
| Latina | 1.38 (1.00-1.90) | 1.46 (0.96-2.19) | 1.37 (1.14-1.64) | 1.29 (1.03-1.61) | 1.13 (0.86-1.47) | 1.08 (0.78-1.50) |
| Other | 1.10 (0.80-1.52) | 1.11 (0.75-1.64) | 1.13 (0.92-1.39) | 1.00 (0.77-1.20) | 1.66 (1.26-2.19) | 1.21 (0.85-1.72) |
| Provider documentation of STI or alcohol use | | | | | | |
| No | 1.0[b] | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 1.53 (0.76-3.11) | 1.23 (0.56-2.72) | 2.46 (2.14-2.82) | 2.06 (1.75-2.43) | 3.65 (2.96-4.51) | 2.32 (1.83-2.95) |
| Received meningococcal vaccine | | | | | | |
| No | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 6.91 (5.45-8.76) | 5.05 (3.78-6.73) | 7.30 (6.31-8.44) | 7.63 (6.48-8.97) | 7.07 (5.79-8.64) | 5.17 (4.13-6.48) |
| Received Tdap vaccine | | | | | | |
| No | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 5.10 (3.93-6.63) | 2.85 (2.11-3.83) | 2.52 (2.12-2.87) | 1.77 (1.50-2.06) | 3.39 (2.81-4.09) | 1.84 (1.47-2.30) |

[a]Adjusted model is multivariable logistic regression including all variables in the table.
[b]Only 32 subjects ages 11–<13 had documentation of discussions of STI or alcohol use, likely due to lower relevance of these topics in this age group.
CI, confidence interval; OR, odds ratio.

Table 4. Correlates of Human Papillomavirus Vaccine Completion Among Adolescent Girls 11–21 Years of Age

| *HPV vaccine completion* | *Ages 11–<13 (n=316)* | | *Ages 13–<18 (n=932)* | | *Ages 18–21 (n=295)* | |
|---|---|---|---|---|---|---|
| *Correlate* | *Unadjusted OR (95% CI)* | *Adjusted OR (95% CI)*[a] | *Unadjusted OR (95% CI)* | *Adjusted OR (95% CI)*[a] | *Unadjusted OR (95% CI)* | *Adjusted OR (95% CI)*[a] |
| Location of care | | | | | | |
| Hospital-based clinic | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Community site 1 | 1.20 (0.80-1.81) | 1.30 (0.84-1.99) | 2.33 (1.79-3.03) | 2.15 (1.64-2.84) | 1.77 (1.14-2.74) | 1.75 (1.10-2.77) |
| Community site 2 | 4.61 (2.62-8.14) | 3.38 (1.76-6.55) | 4.09 (3.07-5.46) | 3.84 (2.79-5.29) | 2.62 (1.74-3.94) | 2.71 (1.70-4.31) |
| Community site 3 | 1.11 (0.54-2.29) | 0.46 (0.20-1.07) | 1.52 (1.02-2.29) | 1.31 (0.83-2.05) | 0.40 (0.13-1.22) | 0.40 (0.13-1.25) |
| Community site 4 | 0.31 (0.12-0.79) | 0.22 (0.08-0.62) | 0.68 (0.43-1.08) | 0.81 (0.50-1.30) | 1.15 (0.43-3.06) | 1.30 (0.46-3.65) |
| Community site 5 | 1.19 (0.60-2.34) | 1.26 (0.50-3.19) | 1.70 (1.14-2.53) | 1.35 (0.81-2.27) | 0.90 (0.49-1.66) | 0.93 (0.43-2.02) |
| Community site 6 | 1.43 (0.76-2.71) | 1.23 (0.59-2.60) | 1.84 (1.32-2.57) | 1.65 (1.14-2.38) | 1.71 (0.85-3.42) | 1.40 (0.67-2.90) |
| Number of visits in study period | | | | | | |
| 1–2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| >2 | 2.87 (2.03-4.06) | 3.09 (2.13-4.50) | 2.58 (2.14-3.12) | 2.45 (2.01-2.99) | 2.42 (1.75-3.36) | 2.52 (1.77-3.57) |
| Race | | | | | | |
| Black | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| White | 1.13 (0.63-2.04) | 0.58 (0.25-1.35) | 1.50 (1.09-2.06) | 1.12 (0.73-1.74) | 1.00 (0.63-1.59) | 0.89 (0.48-1.65) |
| Latina | 1.66 (1.06-2.58) | 0.94 (0.55-1.62) | 1.36 (1.06-1.75) | 1.20 (0.89-1.61) | 1.31 (0.83-2.05) | 1.13 (0.69-1.86) |
| Other | 1.82 (1.14-2.91) | 1.10 (0.63-1.93) | 1.44 (1.07-1.94) | 0.97 (0.69-1.36) | 1.16 (0.74-1.81) | 0.93 (0.56-1.57) |
| Provider documentation of STI or alcohol use | | | | | | |
| No | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 2.02 (0.75-5.45) | 1.13 (0.38-3.39) | 0.71 (0.57-0.88) | 0.71 (0.56-0.90) | 0.81 (0.55-1.17) | 0.76 (0.51-1.15) |
| Received meningococcal vaccine | | | | | | |
| No | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 0.44 (0.31-0.63) | 0.43 (0.27-0.68) | 0.71 (0.59-0.86) | 0.87 (0.70-1.08) | 1.03 (0.76-1.41) | 1.19 (0.84-1.69) |
| Received Tdap vaccine | | | | | | |
| No | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 0.89 (0.58-1.38) | 1.05 (0.62-1.77) | 0.78 (0.65-0.94) | 0.91 (0.75-1.11) | 1.32 (0.95-1.82) | 1.55 (1.07-2.25) |

[a]Adjusted model is multivariable logistic regression including all variables in the table.

clinical systems, such as patient reminder/recall or tracking systems, play a very important role in series completion and may contribute to series initiation as well.

This study has several limitations. We used data abstracted from the medical record, which is subject to the limitations of nonresearch databases. Medical records may not include all vaccinations, vaccines received off-site have incomplete visit information, patient-provider discussions about risk-behavior or vaccination may not be documented, and data may be entered in ways that renders electronic retrieval unreliable. Because electronic retrieval of medical data may not accurately obtain all information, we corroborated medical record data retrieved electronically with manual chart review in a subset of patients. In addition, we could not include individual providers as variables in logistic regression models because of the large numbers of providers at each clinic (Table 1). Other potentially important contributors to vaccination, including provider specialty (pediatrics, family medicine, or internal medicine) and training (attending physician, resident physician, nurse practitioner) and parental availability during the visit (i.e., physically present, available by phone), were also unavailable for all visits. Nor were insurance data available for patients corresponding to the date that vaccines were given. However, all sites included in this study are federally qualified safetynet institutions, and current insurance data indicate that >90% of enrollees aged ≤21 have Medicaid or other public insurance. Finally, manual record review was limited to the academic medical center, which introduces the possibility of selection bias, as documentation of discussions of vaccination may have been different among girls attending community health centers.

## Conclusions

Fewer than half of low-income and minority adolescents receiving health maintenance services initiated HPV vaccination, and only 20% received all three doses. Lack of discussion between providers and patients about HPV vaccination appears to be an important contributor to nonvaccination. As provider recommendation seems to have an important role in HPV vaccine uptake,[18,19] additional research should focus on interventions designed to facilitate providers' discussions of HPV vaccines with their patients. Such interventions might focus on structural and organizational changes (e.g., a clinic policy to vaccinate at all sick visits[20] or a vaccine prompt in the medical record[21]) or include personalized education strategies with feedback (e.g., academic detailing[22] or performance improvement continuing medical education programs[23,24]).

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