Parent and Adolescent Knowledge of HPV and Subsequent Vaccination

WHAT’S KNOWN ON THIS SUBJECT: Vaccinating youth is among the nation’s highest health care priorities. Despite proven health benefits, human papillomavirus vaccination rates remain low.

WHAT THIS STUDY ADDS: This is the first known study to test whether vaccination of high-risk adolescents is related to their or their parents’ previous knowledge levels. In the results presented, neither parental nor adolescent knowledge is related to subsequent adolescent vaccination.

OBJECTIVE: Human papillomavirus (HPV) vaccination has been shown to have important health benefits, but vaccination rates are low. Parental and adolescent knowledge could possibly promote vaccination, but the relationship between knowledge and subsequent vaccination is unclear. This study examines how strongly HPV vaccination among high-risk adolescents is related to their or their parents’ previous knowledge.

METHODS: A longitudinal cohort study enrolled participants from low-income, predominantly African American neighborhoods. Baseline questionnaires measuring knowledge of HPV and HPV vaccination, as well other variables, were completed by 211 adolescents and 149 parents of another adolescent sample. Adolescent vaccination was tracked prospectively for 12 months after baseline by using clinic reporting data. Analyses tested if parent or adolescent knowledge was associated with or predictive of adolescent HPV vaccination.

RESULTS: On average, parents and adolescents answered slightly less than 50% of knowledge items correctly at baseline, with 5% of parents and 10% of adolescents not answering any knowledge items correctly. Within 12 months, 20 of 149 (13.4%) of the parents’ daughters received an HPV vaccination and 32 of 211 (15.2%) of the other adolescent sample did so. Neither parental nor adolescent knowledge was associated with or predictive of adolescent HPV vaccination.

CONCLUSIONS: Those with higher levels of knowledge were not more likely to obtain vaccination for themselves or their daughters. Ideally, future interventions will target factors related to vaccination.
Almost all cervical cancer is caused by infection with the human papillomavirus (HPV), a common sexually transmitted disease. Available HPV vaccines have the potential to dramatically reduce cervical cancer rates. For these reasons, national immunization programs in the United States have recommended HPV vaccination for adolescents. However, vaccination rates have been low. In response, there has been much interest in learning which modifiable factors influence vaccination. Conceivably, knowledge of HPV and HPV vaccination could influence vaccination, and nearly all published studies have measured knowledge. As one review of the large HPV vaccine literature concluded, knowledge was “by far the most frequently assessed construct.” However, we are not aware of published studies focused on empirically evaluating if knowledge is related to actual future HPV vaccination in the United States. Among studies that used a longitudinal design to track vaccination, it is unclear if or how knowledge was measured. Cross-sectional studies have generated mixed reports as to whether knowledge had a relationship with outcomes, which rarely included actual vaccination. Moreover, a cross-sectional study can be misleading because it cannot establish the direction of a possible relationship. If knowledge levels do influence the likelihood of obtaining vaccination, clinical trials to increase knowledge would be warranted, and it may be wise for interventions to focus on education, as has been common practice.

The current study tests how strongly knowledge of parents and adolescents is associated with and predictive of future adolescent vaccination. This longitudinal study design allowed us to assess the outcome prospectively and to establish temporality in the relationship between knowledge and vaccination. Because a previous vaccination dose could lead to increased knowledge (eg, from a clinic’s informational handout describing the vaccine given), this design has major advantages over cross-sectional studies. This study is also unique because it was conducted among a high-risk population. Although other studies have enrolled mostly white and well-educated populations, this study was conducted in low-income African American communities because they have low rates of HPV vaccination and are disproportionately affected by HPV-associated cancers, including cervical cancer.

African American women have been twice as likely as white women to be diagnosed with cervical cancer and up to 3 times more likely to die of their disease. Among low-income African American urban populations, cervical cancer has accounted for ∼25% of cancer deaths, making prevention especially important.

**METHODS**

**Study Design**

By using a longitudinal cohort study design, we assessed baseline knowledge among adolescents and parents of a separate adolescent sample. For 12 months, we followed adolescents to examine if receipt of an HPV vaccine was related to their or their parents’ baseline knowledge. The study did not include an intervention but it still measured if knowledge changed substantially over time. Such change was not expected but possible given the existence of multiple mass-media and interpersonal modes of knowledge transmission that were not monitored. (For additional study information, see Supplement 1.)

**Study Population**

This study was conducted in adolescent females and their parents/guardians (referred to as “parents”) because both influence the vaccination decision. The study enrolled parents who reported meeting all of the following eligibility criteria: (1) a parent of a girl aged 9 to 18 years old who was not vaccinated against HPV, (2) residents of a targeted low-income African American neighborhood, and (3) able to communicate in English. The study population also included adolescents who met criteria 2 and 3 above and were 13 to 18 years and not vaccinated against HPV and did not report being pregnant or breastfeeding.

**Adolescent Vaccination**

Because vaccinations are commonly administered during well-visits, which are recommended annually, we tracked adolescents for a total of 1 year. The outcome was defined as receipt of at least 1 HPV vaccine dose during a follow-up period for each adolescent who either responded to the questionnaire measuring knowledge themselves or had a parent who did so. Whether each adolescent received at least 1 HPV vaccine dose during a follow-up period was determined by using clinic records tracked through Philadelphia's Kids Immunization Database/Tracking System (KIDS) and Immunization Information System, which require reporting for all vaccinations to the secure, up-to-date electronic database. To determine vaccination status, a deterministic, hierarchical search was performed by using identifying data (including names, dates of birth, and addresses). The Philadelphia Department of Health provided the HPV vaccination status (yes, with dates of immunizations, or no), and transferred back deidentified data.

**Knowledge Measured**

Self-administered questionnaires included 18 items measuring knowledge of HPV and the HPV vaccine. Reflecting the domains examined by published studies, items measured the following: (1) health consequences and
symptoms of HPV; (2) HPV and cervical screening; (3) HPV causes, risk factors, and transmission; (4) HPV prevalence; and (5) HPV vaccination and cervical cancer prevention.4–8 The items included statements such as “HPV causes most cases of cervical cancer,” and for each item respondents selected “True,” “False,” or “Don’t Know.” Items were worded in a clear and brief manner by using language appropriate for a range of literacy levels.

Face and Content Validity
The knowledge items appeared previously in other studies4–8 and were also judged by a panel of 8 HPV experts to be relevant (eg, representing various facets and potentially sensitive to differences between persons vaccinated versus those not vaccinated).

Discriminant Validity
Discriminant validity was also reported between knowledge items and those measuring subjective constructs (r<0.55).

Reliability
The items had high internal consistency (Cronbach’s coefficient $\alpha = 0.84$ and 0.81 for parents and adolescents, respectively), which supported generating a summary score. Similarly, test-retest reliability was high.

Scoring
Correct responses were scored 1, and other responses were scored 0. When generating the summary score, the number of correct items was summed.

Item Analysis
The range of item difficulty (ie, the percentage getting an item correct) spanned 12% to 63% correct for adults and 11% to 70% correct for adolescents. Given the items’ high internal consistency and range of item difficulty, they should provide valid discriminations at all knowledge levels.22

### Additional Variables
Population characteristics (Table 1) included standard demographic characteristics. The available potential confounders specifically included parent age, income, adolescent age, adolescent sexual debut age, and their number of sexual partners.

<table>
<thead>
<tr>
<th>TABLE 1 Population Characteristics</th>
<th>Value</th>
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<tbody>
<tr>
<td>Parent/guardian (self-reported by parent), $n$</td>
<td>149</td>
</tr>
<tr>
<td>Female gender, $n$ (%)</td>
<td>134 (90.5)</td>
</tr>
<tr>
<td>African American, $n$ (%)</td>
<td>140 (85.2)</td>
</tr>
<tr>
<td>Hispanic/Latino, $n$ (%)</td>
<td>4 (2.7)</td>
</tr>
<tr>
<td>Age, mean $\pm$ SD, y</td>
<td>14.17 $\pm$ 9.2</td>
</tr>
<tr>
<td>Household income, $n$ (%)</td>
<td>48 (36.6)</td>
</tr>
<tr>
<td>&lt;$10 000</td>
<td></td>
</tr>
<tr>
<td>$10 000–20 000</td>
<td>23 (17.6)</td>
</tr>
<tr>
<td>$20 001–30 000</td>
<td>26 (21.4)</td>
</tr>
<tr>
<td>$&gt;30 000</td>
<td>32 (24.4)</td>
</tr>
<tr>
<td>Household income for neighborhoods, median range, $^{a}$</td>
<td>13 906–37 714</td>
</tr>
<tr>
<td>Daughter received any (non-HPV) vaccine shots since she was 10 y, $n$ (%)</td>
<td>99 (76.2)</td>
</tr>
<tr>
<td>Adolescent females (self-reported by adolescent), $n$</td>
<td>211</td>
</tr>
<tr>
<td>African American, $n$ (%)</td>
<td>194 (91.9)</td>
</tr>
<tr>
<td>Hispanic/Latino, $n$ (%)</td>
<td>11 (5.3)</td>
</tr>
<tr>
<td>Age, mean $\pm$ SD, y</td>
<td>15.3 $\pm$ 1.5</td>
</tr>
<tr>
<td>Have had vaginal, anal, or oral sex, $n$ (%)</td>
<td>92 (44.0)</td>
</tr>
<tr>
<td>Age when first had sex, $n$ (%)</td>
<td></td>
</tr>
<tr>
<td>$\leq$13 years</td>
<td>17 (20.5)</td>
</tr>
<tr>
<td>14 years</td>
<td>16 (19.3)</td>
</tr>
<tr>
<td>15 years</td>
<td>26 (31.3)</td>
</tr>
<tr>
<td>$\geq$16 years</td>
<td>24 (28.9)</td>
</tr>
<tr>
<td>Number of sex partners, $n$ (%)</td>
<td></td>
</tr>
<tr>
<td>1–3</td>
<td>70 (76.9)</td>
</tr>
<tr>
<td>4–6</td>
<td>17 (18.7)</td>
</tr>
<tr>
<td>$&gt;6$</td>
<td>4 (4.4)</td>
</tr>
<tr>
<td>Currently smokes cigarettes, $n$ (%)</td>
<td>10 (4.8)</td>
</tr>
</tbody>
</table>

* Reported by the US Census.
of getting a vaccination on the basis of knowledge level, whereas the $R^2$ statistic describes the percentage of variance in vaccination behavior that can be explained by knowledge level. The area under the receiver operating characteristic curve, or C-statistic, assessed the model’s overall prediction accuracy. We tested all available potential confounders (specified above) by correlating each with the knowledge score and vaccination behavior. Variables related to both knowledge and vaccination would be adjusted for when examining the relationship between knowledge and vaccination. In secondary analyses, we examined (1) if knowledge changed between baseline and follow-up periods by using paired $t$ tests and (2) the percentage correct for each knowledge item and the relationship between getting a specific item correct and being vaccinated.

**RESULTS**

Those who responded to the baseline knowledge questionnaire included 211 adolescents and 149 parents of other adolescents. The adolescents ranged in age from 13 to 18 years, with a mean age of 15 years (SD = 1.5 years). Parents, who were mostly female, ranged in age from 23 to 71 years (mean age = 42 years; SD = 9.2 years) due to older guardian caretakers. All adolescents had received vaccination of some kind in their lifetime, and 76% had received a vaccination since age 10. The sample was characterized as low income and predominantly African American. Table 1 summarizes additional characteristics, including adolescent sexual experience, and other risk factors for HPV.

**Knowledge**

Among parents, the baseline knowledge scores ranged from 0 to 18, with 10% of adolescents not answering any questions correctly and a mean of 6.4 correct answers (SD = 4.1). For groups of adolescents who did and did not receive an HPV vaccine, the distribution of the parents’ knowledge scores was similarly uniform. However, the adolescents’ knowledge score distribution of those vaccinated versus not vaccinated varied slightly. During this study, there were no known historical events (eg, new vaccination campaigns or news coverage shifts) that would be expected to change knowledge. Given this, knowledge was not expected to change substantially during follow-up, which was confirmed at 3-month intervals by tracking a subsample of ~60% of the baseline respondents.

**Vaccination**

Vaccination status was determined for all adolescents. Among the parents enrolled, 20 of 149 (13.4%) of their daughters received at least 1 HPV vaccination within 12 months. Among the separate sample of adolescents, 32 of 211 (15.2%) received an HPV vaccination within 12 months (Table 2).

**Relationship Between Parents’ Knowledge and Daughters’ Vaccination**

Parents’ knowledge scores were not curvilinearly related to their daughters’ subsequent vaccination status at any time points. None of the potential confounders were significantly related to parent knowledge scores and vaccination for daughters and were therefore not adjusted for in the remaining analyses.

Logistic regression results show that the likelihood of daughters receiving a vaccination was not related to parents’ baseline knowledge (Table 3). All $R^2$ values were negligible, indicating that the variance in knowledge did not explain vaccination behavior. By using $t$ tests, the difference between the mean baseline knowledge score of parents whose daughters obtained vaccination and those parents whose daughters did not, during each follow-up period, was not statistically significant (Table 3). Furthermore, vaccination during each follow-up period had very low and often negative correlations with aspects of knowledge and single knowledge items (ranging from $r = −0.11$ to $r = 0.09$).

**Relationship Between Adolescents’ Knowledge and Vaccination**

Adolescent knowledge was not curvilinearly related to vaccination during any follow-up periods. None of the available potential confounder variables were significantly related to adolescent knowledge and HPV vaccination and were therefore not adjusted for in the remaining analysis. The proportion of variance in knowledge related to receiving an HPV vaccination was negligible for each follow-up period (Table 4).
TABLE 3 Relationship Between HPV Vaccination Status at 3, 6, 9, and 12 Months and Parents’ Baseline Knowledge

<table>
<thead>
<tr>
<th>Follow-up Time Points</th>
<th>Adolescent Vaccinated at Least Once, n (%)</th>
<th>Adolescent Not Vaccinated at Least Once, n (%)</th>
<th>Mean (95% CI) Knowledge Scores</th>
<th>t Test</th>
<th>P value</th>
<th>$R^2$</th>
<th>Exact Log Reg OR (95% CI)</th>
<th>C-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-month</td>
<td>8 (5.37)</td>
<td>141 (94.63)</td>
<td>7.13 (6.29–8.39)</td>
<td>3.3</td>
<td>.0008</td>
<td>0.37 (0.35–0.39)</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>Six-month</td>
<td>15 (10.07)</td>
<td>134 (89.93)</td>
<td>7.80 (6.10–9.87)</td>
<td>0.34</td>
<td>.004</td>
<td>0.95 (0.90–1.00)</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>Nine-month</td>
<td>18 (12.08)</td>
<td>131 (87.92)</td>
<td>7.28 (4.80–9.75)</td>
<td>0.36</td>
<td>.0009</td>
<td>0.979 (0.88–1.10)</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>Twelve-month</td>
<td>20 (14.32)</td>
<td>129 (85.68)</td>
<td>7.70 (5.35–10.05)</td>
<td>-0.08</td>
<td>0.94</td>
<td>0.0000 (0.90–1.12)</td>
<td>0.51</td>
<td></td>
</tr>
</tbody>
</table>

N = 149 parents. “Vaccinated” refers to whether the adolescent had received at least 1 HPV vaccination dose during the follow-up period. CI, confidence interval; Exact Log Reg OR, exact logistic regression odds ratio.

Additionally, logistic regression models were run for each follow-up time point to evaluate the ability to predict adolescent vaccination status on the basis of parents’ knowledge. The concordance index (C-statistic) is comparable to the area under the receiver operating characteristic curve.

**DISCUSSION**

In this high-risk population, few adolescents received HPV vaccination during each follow-up period (Table 4). Additionally, the ability of vaccination to predict adolescents’ vaccination status was very low ($C = 0.51$–0.62). The ability to predict adolescents’ vaccination status on the basis of parents’ knowledge levels was also low ($C = 0.51$–0.62).

**Prediction Accuracy**

From the observed area under the receiver operating characteristic curve ($A = 0.16$), which modulates the ability of knowledge and vaccination during each follow-up period, it is evident that knowledge levels were not significantly related to knowledge and vaccination behavior and were therefore not adjusted for.

Of the potential confounder variables, knowledge was neither necessary nor sufficient. Visual inspection of the data did not reveal any relationship between vaccination and knowledge, nor adolescent knowledge was related to adolescent vaccination status at each time point. The ability of vaccination to predict adolescents’ vaccination status was very low ($C = 0.51$–0.62). The ability to predict adolescents’ vaccination status on the basis of parents’ knowledge levels was also low ($C = 0.51$–0.62).

In each case, the difference between the vaccinated and nonvaccinated groups was not statistically significant. In the vaccinated group, the C-statistic was 0.55, which means that 55% of the time, the vaccinated group and the nonvaccinated group were not differentiated by knowledge and vaccination status.

**Prediction Accuracy**

Prediction accuracy was very low, indicating that knowledge did not predict vaccination. The ability of vaccination to predict adolescents’ vaccination status was very low ($C = 0.51$–0.62). The ability to predict adolescents’ vaccination status on the basis of parents’ knowledge levels was also low ($C = 0.51$–0.62).

In conclusion, while knowledge is a prerequisite of healthy behavior, it does not necessarily predict vaccination behavior. Further research is needed to understand the role of knowledge in decision-making processes and to develop more effective strategies to increase vaccination rates.
TABLE 4
Baseline Knowledge Among Those Vaccinated and Not Vaccinated

<table>
<thead>
<tr>
<th>Follow-up Time Points</th>
<th>Adolescent Vaccinated at Least Once, n (%)</th>
<th>Adolescent Not Vaccinated at Least Once, n (%)</th>
<th>Mean (95% CI) Knowledge Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-month</td>
<td>23 (36.6)</td>
<td>19 (63.4)</td>
<td>11.18 (6.33-16.0)</td>
</tr>
<tr>
<td>Six-month</td>
<td>25 (41.3)</td>
<td>31 (58.7)</td>
<td>13.18 (6.33-16.0)</td>
</tr>
<tr>
<td>Nine-month</td>
<td>20 (40.8)</td>
<td>30 (59.2)</td>
<td>13.66 (6.33-16.0)</td>
</tr>
<tr>
<td>Twelve-month</td>
<td>25 (45.5)</td>
<td>30 (54.5)</td>
<td>13.66 (6.33-16.0)</td>
</tr>
</tbody>
</table>

Note: The low agreement (0.17) refers to whether the adolescent had received at least 1 HPV vaccination dose during the follow-up period. The concordance index (C-statistic) is comparable to the area under the receiver operating characteristic curve.

CONCLUSIONS
In summary, this longitudinal study tested if knowledge levels were related to subsequent HPV vaccination. Among a high-priority population, knowledge was neither associated with nor predictive of adolescent vaccination. Due to the limitations of a single study, additional research should consider various study designs and populations. Future studies should identify which modifiable factors discriminate between those who have not measured vaccination, and almost all that did have measured self-reported vaccination, which is subject to recall bias and shown in other vaccine studies to be inaccurate. In this study, the outcome, actual vaccination, was objectively measured rather than self-reported. Most studies have not measured vaccination, and almost all that did have measured self-reported vaccination, which is subject to recall bias and shown in other vaccine studies to be inaccurate. In addition, the relationship between knowledge and vaccination intention should be considered when developing interventions, because intentions are necessary (although not sufficient) for voluntary immunization. Future studies can address several other current limitations. For example, although this study focuses on a population disproportionately affected by HPV-related disease burden, the findings may not be generalizable to others (e.g., male adolescents). This study used an extensive measure of knowledge that displayed sound measurement characteristics and included items commonly used in studies, but it is possible that if additional knowledge items were included, an association may have been detected. Future studies can also evaluate additional potential confounders. The study design tracked adolescents over 12 months because vaccinations are common during annual well-visits, but future studies can also include longer follow-up periods.
do and do not vaccinate so that interventions can target them. Given that public health campaigns and other communication interventions can relay only a limited set of messages, it is important to determine the extent to which they should continue to focus resources on knowledge transmission. Fortunately, numerous studies about other health behaviors have documented the positive impact of evidence-based communication interventions.

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## Parent and Adolescent Knowledge of HPV and Subsequent Vaccination

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