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.

abstract

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. Pediatrics 2014;134:e1049–e1056
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 (Supplement 2). 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 α = 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.

Statistical Analyses
The analytic goal was to examine how strongly knowledge among independent samples of adolescents and parents was related to future HPV vaccination among adolescents. The primary outcome variables were receipt of a vaccination dose during 3, 6, 9, and 12 months postbaseline follow-up periods. Summary statistics were computed for the primary outcome variables and the baseline knowledge score. For each follow-up period, stratifying by vaccination status, boxplots were used for visually comparing the distribution of knowledge for the vaccinated group versus the non-vaccinated group. To visually examine if knowledge and vaccination had a curvilinear relationship, we plotted for each knowledge level (0–1, 2–3, 4–5, etc) the percentage of persons vaccinated, with 95% confidence limits. We then computed and compared the correlation coefficient to the Pearson correlation coefficient, and obvious negligible differences would support a noncurvilinear relationship.25

To assess the relationship between knowledge scores and vaccination behavior, we used a t test, and a logistic regression model (binary logit link) with maximum likelihood estimates, Wald’s 95% confidence interval, R² statistic, and the C-statistic. The t Tests assessed mean differences in the number of correct knowledge items between persons vaccinated and those not vaccinated. From the regression model, an odds ratio was used to describe the magnitude of the likelihood

<table>
<thead>
<tr>
<th>TABLE 1 Population Characteristics</th>
<th>Value</th>
</tr>
</thead>
<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 (95.2)</td>
</tr>
<tr>
<td>Hispanic/Latino, n (%)</td>
<td>4 (2.7)</td>
</tr>
<tr>
<td>Age, mean ± SD, y</td>
<td>41.7 ± 9.2</td>
</tr>
<tr>
<td>Household income, n (%)</td>
<td></td>
</tr>
<tr>
<td>&lt;$10 000</td>
<td>48 (36.6)</td>
</tr>
<tr>
<td>$10 000–20 000</td>
<td>23 (17.6)</td>
</tr>
<tr>
<td>$20 001–30 000</td>
<td>28 (21.4)</td>
</tr>
<tr>
<td>$&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 ± SD, y</td>
<td>15.3 ± 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>≤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>≥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>

*a 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 Adolescents’ 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 2 Number of Individuals Receiving 0 to 3 Shots During Each Follow-up Period**

<table>
<thead>
<tr>
<th>Follow-up period</th>
<th>0 shots</th>
<th>1 shot</th>
<th>2 shots</th>
<th>3 shots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents’ adolescent daughters ($n = 149$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mo</td>
<td>144 (99.63)</td>
<td>9 (6.37)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 mo</td>
<td>134 (91.93)</td>
<td>13 (8.72)</td>
<td>2 (1.34)</td>
<td>0</td>
</tr>
<tr>
<td>9 mo</td>
<td>131 (87.82)</td>
<td>15 (10.07)</td>
<td>3 (2.01)</td>
<td>0</td>
</tr>
<tr>
<td>12 mo</td>
<td>129 (86.58)</td>
<td>15 (10.07)</td>
<td>4 (2.68)</td>
<td>1 (0.67)</td>
</tr>
</tbody>
</table>

| Additional adolescents ($n = 211$) |         |        |         |         |
| 5 mo             | 204 (86.68) | 7 (3.32) | 0 | 0 |
| 6 mo             | 193 (81.47) | 17 (7.06) | 1 (0.47) | 0 |
| 9 mo             | 186 (88.15) | 22 (10.43) | 3 (1.42) | 0 |
| 12 mo            | 179 (84.83) | 25 (11.85) | 7 (3.32) | 0 |

Data are presented as n (%).
TABLE 3

<table>
<thead>
<tr>
<th>Follow-up Time Points</th>
<th>Adolescent Vaccinated at Least Once, Among Those Vaccinated</th>
<th>Adolescent Not Vaccinated, Among Those Not Vaccinated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (95% CI) Knowledge Scores</td>
<td>Mean (95% CI) Knowledge Scores</td>
</tr>
<tr>
<td>Three-month</td>
<td>8 (5.37)</td>
<td>141 (94.63)</td>
</tr>
<tr>
<td>Six-month</td>
<td>15 (10.07)</td>
<td>134 (89.93)</td>
</tr>
<tr>
<td>Nine-month</td>
<td>18 (12.08)</td>
<td>131 (87.92)</td>
</tr>
<tr>
<td>Twelve-month</td>
<td>20 (13.42)</td>
<td>128 (86.58)</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. R² Exact Log Reg OR, exact logistic regression odds ratio.

None of the potential confounder variables were significantly related to knowledge and vaccination during each follow-up period (Table 4). Additionally, vaccination during each follow-up period had low, and often negligible, correlations with aspects of knowledge and single knowledge items (r = −0.09 to 0.16).

**Prediction Accuracy**

From the observed area under the receiver operating characteristic curve, the ability to predict adolescent vaccination on the basis of parents’ knowledge was low (C = 0.53–0.56). The ability to predict adolescents’ vaccination status on the basis of their knowledge was also low (C = 0.51–0.63).

**DISCUSSION**

In this high-risk population, few adolescents received HPV vaccination, highlighting the need to understand which modifiable factors explain why some patients obtain recommended vaccinations, whereas others do not. Although it is conceivable that knowledge is a prerequisite of healthy choices, it has been unclear if knowledge is indeed related to vaccination. In turn, this longitudinal study examined how strongly knowledge is associated with and predictive of subsequent vaccination.

This study found that neither parental nor adolescent knowledge was related to adolescent vaccination, as measured objectively at prospective time points. Some with low knowledge did get vaccinated and others with high knowledge did not get vaccinated, suggesting that, for many, knowledge was neither necessary nor sufficient. Visual inspection of the data did not reveal any relationships, and the measures of association between vaccination and knowledge scores, as well as single knowledge items, were very low. Additionally, knowledge did not predict vaccination. Prediction accuracy, based on the association between the predicted probability of vaccination and the observed response, was very near 0.50, indicating an essentially random chance (e.g., by coin flip) of predicting future vaccination on the basis of knowledge levels.

The current findings need not be viewed as negating data from surveys, such as the National Immunization Survey–Teen, in which knowledge levels were not actually measured. Respondents who report, for example, wanting more information, cannot be assumed to have low knowledge levels, because these are distinct constructs. (Individuals with low knowledge levels can lack interest in learning more. Those with higher levels can express interest in learning even more.) Neither the National Immunization Survey study nor ours tested whether increasing knowledge levels will improve vaccine acceptance, but several other studies testing this possibility have not shown an effect. Collectively, these results do not suggest that knowledge is a primary determinant of vaccination.

More generally, the current findings are consistent with the causal pathways of the most extensively validated behavioral prediction models, such as the Theory of Reasoned Action and Theory of Planned Behavior. In these models, correct factual information plays no direct role and is considered generally immaterial to behavioral prediction. Many studies of several health behaviors also find knowledge to be unrelated. For example, given small effect sizes relating HIV/AIDS knowledge and condom use, meta-analyses have reasoned that knowledge does not influence safe sex behavior and...
Follow-up Time Points | Adolescent Vaccinated at Least Once, n (%) | Adolescent Not Vaccinated at Least Once, n (%) | Mean (95% CI) Knowledge Scores | t Test | P | R² | Exact Log Reg OR (95% CI) | C-statistic
---|---|---|---|---|---|---|---|---|---
Three-month | 7 (3.32) | 204 (96.68) | 8.14 (5.10–11.18) | −1.17 | .25 | 0.006 | 1.12 (0.92–1.36) | 0.63
Six-month | 18 (8.33) | 193 (91.67) | 6.56 (4.86–8.26) | −1.8 | .06 | 0.0001 | 1.01 (0.90–1.14) | 0.51
Nine-month | 25 (11.85) | 186 (88.15) | 7.20 (5.74–8.66) | −1.07 | .29 | 0.0054 | 1.07 (0.90–1.14) | 0.36
Twelve-month | 32 (15.17) | 179 (84.83) | 7.03 (5.68–8.38) | −0.87 | .93 | 0.0045 | 1.047 (0.954–1.149) | 0.55

N = 211 adolescents. "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.

None of the potential confounder variables were significantly related to knowledge and vaccination behavior and were therefore not adjusted for.

* Association between predicted probabilities and observed response. The concordance index (C-statistic) is comparable to the area under the receiver operating characteristic curve.

In summary, this longitudinal study revealed that knowledge is not the most important factor in influencing behavior. Rather, beliefs about who approves/disapproves of HPV vaccination may be more influential than knowledge levels overall. Fortunately, beliefs are flexible and in turn, theory-based interventions can successfully change behavior by targeting specific beliefs and norms. Self-efficacy and attitudes are also important to consider when developing interventions to increase HPV vaccination rates. In addition, the relationship between knowledge and vaccination intention should be considered when developing interventions. This study allows for additional research into the relationship between knowledge and vaccination behavior.
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.35,39,40

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