Using the Theory of Planned Behavior to Identify Correlates of HPV Vaccination Uptake among college students attending a rural university in Alabama

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1. Introduction

Human Papillomavirus (HPV) vaccine has the potential to prevent most of the cervical, oropharyngeal, anal, penile, vaginal and vulvar cancer cases in the U.S. [1]. The Advisory Committee on Immunization Practices (ACIP) recommends that all boys and girls receive the HPV vaccine at age 11 or 12, though vaccination can begin at age 9 [2]. Routine catch-up vaccination is also recommended to anyone aged 13-26 years who did not start or complete the HPV vaccine series by age12. Recently, the ACIP issued a shared clinical decision-making recommendation for HPV vaccination of adults aged 17-45 years [2], indicating that the vaccine can be administered to individuals in this age range based on a provider-patient discussion of the relative benefits of vaccination for that patient. If administered before the 15th birthday, individuals need to complete a series of two doses of the vaccine over six months, otherwise they should complete a series of three doses of the vaccine [3].

Despite the evidence about the HPV vaccine’s safety and efficacy [4, 5], the series completion rate nationwide is well below the 80% Healthy People 2020 goal [6], with notable geographic inequities in the uptake of the vaccine [7, 8]. In view of these geographic inequities, understanding the barriers and facilitators to HPV vaccine in different communities, with a focus on those with lower uptake is essential for informing effective interventions.

Our study examines both current HPV vaccination status and intention to get vaccinated among students attending a rural state university in Alabama. Specifically, we examine the relationship between HPV-related knowledge and religious beliefs and vaccination status, as well as predictors of HPV vaccination intentions using the Theory of Planned Behavior (TPB). TPB postulates that an individual’s decision-making process is a function of three factors: attitudes, subjective norms, and perceived behavioral control [37]. These three factors influence an
individual’s behavioral intention towards performing a specific behavior, and subsequently the behavior itself [37, 38].

Alabama ranks third in the country for cervical cancer incidence and first for cervical cancer mortality [9, 10]. Despite national and targeted efforts by the Alabama Department of Public Health including the creation of the Alabama Adolescent Vaccination Task Force, Alabama remains a state with one of the lowest HPV vaccination rates in the country [7]. Only 52.9% of males and females aged 13 to 17 in Alabama are up-to-date (i.e., 2- or 3-dose series completion) with HPV vaccine compared to 58.6% nationally [7]. This inequity is shown in females (57% vs. 61.4% nationally) and males (49.1% vs. 56% nationally). However, counties where the Black population have been disproportionately impacted by cervical cancer have relatively higher rates of HPV vaccination compared to other counties in the state [8]. Rurality is an important factor in individuals’ health nationally, and in Alabama. About one in five people in Alabama lives in rural communities. Alabama is ranked 46th in the nation in per capita income, with average per capita income of $42,238. Rural residents have even lower per capita income of $35,765 and higher poverty rates compared to urban areas of the state [11]. Studies have explored parental and pediatricians’ perceptions of HPV vaccine in Alabama and identified barriers to HPV vaccination such as lack of information about vaccine safety, no recommendation by their healthcare provider, and the link between vaccine and sexuality [12, 13]. Some studies have examined students from rural communities who attended large research intensive universities in Alabama [14-17]. These studies showed that attitude and subjective norms were strong predictors of HPV vaccination intention [14, 15, 17] that females had higher odds of completing HPV vaccine series [15], and that a majority of the unvaccinated college students had considerably low knowledge of HPV and HPV vaccine and were not interested in
increasing their knowledge of these topics [16]. Moreover, these studies were important in focusing on rural students. Nationally, studies of college students’ HPV-related behaviors focused on students in large, research-intensive universities, representing largely urban/suburban student populations [18, 20]. Although students in research intensive universities might differ from students who attend smaller, teaching universities in rural areas, no past studies examined rural Alabama state college students’ HPV-related knowledge and behavior. Given the inequities and resulting different experiences between these student populations, it is important to examine HPV-related knowledge, perceptions and behavior among students attending rural state universities.

1.1. Knowledge of HPV among college students

College students who did not receive HPV vaccination as children remain at risk of being infected with HPV and developing HPV-related cancers, but, as many are legal adults (age 19 in Alabama), they also have the opportunity to make their own decision about HPV vaccination. In addition, they might have access to more resources such as information and on-site health centers with no or low cost. Studies show that HPV-related knowledge is positively related to vaccination status, [18] including among college students [19]. Although most college students have basic knowledge about HPV, such as mode of transmission [20-22], they lack detailed knowledge of the virus and the vaccine [23], including the fact that HPV can cause cancer, and that condoms do not completely protect against HPV [21, 22]. Inequities in HPV-related knowledge among college students include greater knowledge among women compared to men, [20, 24, 25] and lower knowledge among students who are more religious or practice religion regularly [26, 27]. However, past research has not examined the relationship between HPV-related knowledge and intentions to vaccinate among college students in rural Alabama.
Moreover, the relationship between specific knowledge items (e.g., contagiousness, mode of transmission, and relationship with cervical cancer) and students’ vaccination behaviors is largely unknown. Our study fills these gaps by: 1) examining the level of specific HPV knowledge among students in a state university located in a rural area of Alabama; 2) exploring the differences in specific knowledge items between students who had at least one shot of HPV vaccine and students who never received HPV vaccine in this population. Understanding specific knowledge items is important in informing message designs, educational efforts and interventions.

1.2. Religiosity

Alabama ranks first in the nation in religiosity, with 77 percent of respondents stating that religion is "very important" or "somewhat important" to their lives [28]. Religiosity plays a critical role in sexual behaviors and attitudes [29-31]. Overall, studies have found a positive association between religiosity and safer sexual behaviors among college students [31, 32]. However, some studies show that religiosity negatively impacts HPV vaccine uptake, especially among women [26] and that college students who had regularly practiced an organized religion had less knowledge of HPV or HPV vaccine, and were less likely to have initiated or completed the HPV vaccine series [27, 33]. In contrast, a more recent study did not find a correlation between religious beliefs and HPV vaccine initiation among college women in Florida [34].

Hence, past research about the relationship between religiosity and HPV vaccination is equivocal. Moreover, religiosity is a complex concept and previous studies examined different aspects of religiosity. For example, two studies used just a single item to measure religiosity [33, 34], and one study used the Religious Commitment Inventory to measure religious beliefs [27]. Furthermore, these studies mostly focused on females. There is a lack of literature on the role of
religious beliefs in HPV vaccination acceptance or hesitancy among college students of both sexes in general, and among rural students at regional universities in particular. We examine the relationship between religious beliefs (religiosity) and HPV vaccination uptake status among college students in the highly religious, rural areas of Alabama [28].

1.3. Theory of Planned Behavior

This study aims to explore the potential of the theory of planned behavior in predicting HPV vaccination uptake in our sample. Behavior change theories help guide the way we develop our communication campaigns by helping us understand how and why individuals engage in specific health behaviors [35, 36]. The Theory of Planned Behavior (TPB) has been extensively used in health communication campaigns due to its strong ability to predict human behavior [37]. The theory posits that an individual’s decision-making process is guided by three factors: attitudes, subjective norms, and perceived behavioral control. These factors influence an individual’s behavioral intention towards performing a specific behavior, and subsequently, the behavior itself [37-39].

Studies have shown that TPB can predict vaccination uptake among young adults [40]. In particular, recent studies show that attitudes and subjective norms are strong predictors of intent to get HPV vaccination among college populations [14, 17]. Recently conducted studies using TPB to predict HPV vaccination intentions among college students in Alabama were conducted at large research universities [14, 15], and were limited to people who had previously heard of the vaccine [15]. That research did not examine predictors of intentions to vaccinate among students who had not heard about the vaccine before, or who were attending a rural state university. Our study expands on previous research by testing the effectiveness of TPB in predicting college students’ intentions to get HPV vaccine in a university located in a rural area
of Alabama and using a sample that includes students who have never heard of the vaccine. Past literature has also not explored how TPB constructs may vary based on the knowledge of the individuals. Therefore, we also examined how the TPB variables vary based on HPV knowledge.

2. Methods

2.1. Participants

This study was conducted from January 2019 through March 2019. It was approved by the university’s Institutional Review Board. We used a cross-sectional survey design and a convenience sample for this study. The participants were college students enrolled in a rural state university in Alabama who ranged from 18 to 26 years old. The students were recruited through several means. We contacted professors, department chairs, and deans across campus, asking them to share the survey with students in their classes, or to share the survey with professors in their units. A number of professors agreed to share the survey, either in class or via email, with their students. Furthermore, the university’s social media manager agreed to post links to the survey on the official university Facebook, Twitter, and Instagram accounts. Triangulations of recruitment methods has shown effectiveness in recruitment, and social media provide a rapid and cost-effective data collection method. Because students were recruited in multiple ways, it is impossible to know how many students had the opportunity to participate. For this reason, we did not attempt to calculate a response rate.

The students who consented to participate in the study completed an online questionnaire. A total of 292 responses were returned. Due to extensive missing data, 35 responses were excluded and the final number of usable responses was 257. The researchers did not provide any monetary compensation for participation.
2.2. Measures

The questionnaire included 11 demographic questions. Participants were asked to provide information about race, year in college, major, age, primary source of health insurance, name of health insurance company, biological sex, sexual orientation, relationship status, father’s education, and mother’s education.

2.2.1. Knowledge

To measure the participants’ HPV knowledge, we utilized items from a previously validated questionnaire [41]. This questionnaire was selected because it covered a wide range of knowledge about HPV. The questions related to knowledge of HPV before participation, source(s) of HPV information, knowledge about HPV being contagious, modes of HPV transmission, that it can cause genital warts, self-protection, and beliefs about the effectiveness of the HPV vaccine. For example, one of the questions was “can HPV cause cancer?” The answer options were “yes,” “no,” and “I don’t know.” See table 1 for additional information on the knowledge scale.

2.2.2. Theory of Planned Behavior

To measure the relationship of HPV vaccine attitudes, subjective norms, and perceived behavioral control on behavioral intention to received HPV vaccination, we used items from a previously published instrument [14]. We selected items from this questionnaire as it was rigorously tested and has been validated with student populations [14, 15]. Since the purpose of this study was to test the ability of the TPB constructs to predict HPV vaccine intentions among the participants, we excluded participants who had already completed all the required doses of HPV vaccine. The 206 respondents who had either not been vaccinated or not completed all three vaccine injections were given questionnaire items to measure four variables from the
Theory of Planned Behavior. Due to missing data from one respondent the sample size was 205.

Responses were measured on 7-point scales. All four scales demonstrated excellent internal reliability. See Table 2 for exact questions of TPB scales.

2.2.3. Religion

To assess the religiosity of the participants we utilized three items from the Duke Religion Index [42] to measure the frequency of participants’ attendance at church/religious meetings, frequency of participants’ private religious activities such as prayer or Bible study, and the extent to which religious beliefs are intrinsic to their lives. We also explored participants’ perceptions of the influence of their religious beliefs on their health actions by creating an additional item: “My religious beliefs influence decisions about my health.” Participants could choose their answer from the following options: 1) Definitely true of me; 2) Tends to be true; 3) Unsure; 4) Tends not be true; 5) Definitely not true of me.

2.3. Data analysis

Chi-square tests of independence were used to test for group comparisons, such as demographic variables and getting vaccinated, as well as knowledge items and vaccination status. A series of Mann-Whitney U tests were conducted to compare attitude, subjective norms, perceived behavioral control, and behavioral intention scores between those who had received some HPV vaccine shots and those who had received none. Additional Mann-Whitney U tests were conducted to measure how attitudes and other TPB variables might vary based on each HPV knowledge item. We carried out a multiple regression analysis to test the relationship among TPB constructs and a moderation analysis (PROCESS Model 1) [50] with 10,000 bootstrapped samples to test whether students’ perception that religious beliefs influence their
heath decisions would moderate the effects of the predictor variables in the TPB model on behavioral intention [43].

3. Results

3.1. Respondent Profile

The final number of usable responses was 257. Of these, 159 respondents (61.9%) had not received any doses of the HPV vaccine, 47 (18.2%) had received one or two doses, and 51 (19.8%) had received three doses. The majority of participants were White ($n = 213, 89.2$%), followed by Black ($n = 23, 8.9$%), and biracial ($n = 11, 4.3$%). University statistics indicated that in Spring 2019 the student population was approximately 73% White and 18% Black and therefore White students were oversampled in this study. Females made up approximately two-thirds of the sample ($n = 174, 67.7$%), a higher rate than their representation in the student population in Spring 2019 (59.3%). Respondents’ ages ranged from 18 to 26 years old, with a mean age of 21.16 ($SD = 1.85$). Most respondents had health insurance through a parent or legal guardian ($n = 218, 84.8$%), while 21 had insurance from some other source (8.2%) and 18 reported they were either uninsured or did not know if they had insurance (7%). The majority of respondents identified as heterosexual ($n = 219, 85.2$%), followed by gay or lesbian ($n = 8, 3.1$%), bisexual ($n = 23, 8.9$%), asexual ($n = 6, 2.3$%) and other ($n = 1, 0.4$%). When asked about relationship status, 54.9% reported that they were in a relationship but not living with their partner ($n = 141$). The other 45.1% of respondents said they were not in a relationship ($n = 116$). No respondents reported being in a relationship and living together with partner. Most students said they had engaged in sexual activity in the past ($n = 179, 69.6$%) and a plurality said they had been sexually active in the past 30 days ($n = 117, 45.5$%). About a third reported their father’s education as at least a bachelor’s degree ($n = 83, 32.3$%) and 43.6% said their mother had at least
a bachelor’s degree \((n = 112)\). Overall, 21.9% of respondents \((n = 56)\) said both of their parents had a college degree, and 45.7% reported that neither parent had finished college \((n = 117)\).

3.2. Group comparisons

Chi-square tests showed significant associations of sex assigned at birth \((\chi^2 = 5.64, p = .018)\) and race/ethnicity \((\chi^2 = 12.15, p < .01)\) with getting vaccinated. The odds of getting at least one HPV shot were 1.98 times higher for females than for males and 3.18 times higher for Black and biracial students than for White students. There was no significant association between getting vaccinated and sexual orientation, having insurance, or parents’ education.

3.3. Knowledge and beliefs

A majority of students, including those who had received at least one dose of the HPV vaccine and those who had not received any doses of vaccine, knew that HPV is contagious and that it can affect both women and men (see Table 1). However, less than 40% of each group knew how HPV is transmitted. When asked whether HPV causes cancer, most of those who had been vaccinated \((61.2\%)\) answered correctly that it does, compared to 44% of respondents who had not been vaccinated. This difference was statistically significant, \(\chi^2 = 6.292, p = .008\).

Differences in knowing that HPV causes genital warts were not statistically significant between HPV vaccinated respondents \((55.1\%)\) compared to those who had not been vaccinated \((43.4\%)\), \(\chi^2 (1, N = 257) = 3.329, p = .068\). Similarly, the difference in self-efficacy in HPV self-protection between HPV vaccinated respondents \((77.6\%)\) and those who had not been vaccinated \((66.7\%)\) did not reach statistical significance, \(\chi^2 (1, N = 257) = 3.476, p = .062\). By contrast, a significantly higher percentage of HPV vaccinated respondents \((46.9\%)\) believed that the HPV vaccine was effective at protecting them from the virus, as compared to just 30.8% of those who had not been vaccinated, \(\chi^2 (1, N = 257) = 6.763, p = .009\). Interestingly, fewer than half of the
respondents who had been vaccinated believed the vaccine was effective. About a quarter of vaccine recipients said they did not believe the vaccine was effective (24.5%) and 28.4% said they did not know. A fifth of those who had not received the vaccine (20.8%) did not believe it was effective and 48.4% did not know.

[Insert Table 01 Here]

3.4. Theory of Planned Behavior

Students who had already received at least one HPV vaccine injection indicated a stronger intent to get another injection ($Mdn = 4.00$), as compared to students who had not received any injections yet ($Mdn = 1.67$), $U = 4339.5$, $z = 2.37$, $p = .018$, $r = .17$. According to TPB, intent is predicted by attitudes, subjective norms, and perceived behavioral control. There were significant differences on attitude and subjective norm scores between students who had and had not received at least one HPV shot already. Those who had already gotten at least one shot had a more positive attitude toward the vaccine ($Mdn = 4.93$) than those who had not received any shots ($Mdn = 4.00$), $U = 4646$, $z = 2.88$, $p = .004$, $r = .20$. Those who had already gotten a shot also reported that subjective norms favored the vaccine ($Mdn = 4.50$) more than those who had not gotten any shots ($Mdn = 2.00$), $U = 5623.5$, $z = 6.03$, $p < .001$, $r = .42$. In contrast, there was no statistically significant difference of perceived behavioral control between the groups.

[Insert Table 02 here]

3.4.1. Knowledge and TPB variables

Additional Mann-Whitney U tests were conducted to measure the relationship between attitudes and other TPB variables and HPV knowledge. Students who knew HPV is contagious reported higher levels of perceived behavioral control ($Mdn = 5.83$) than students who did not
know \((Mdn = 4.83), U = 5932, z = 2.97, p = .003, r = .21\). However, there was no statistically
significant difference between the groups on attitude, subjective norms, or behavioral intention.

Students who were aware that HPV can affect both women and men had more positive attitudes
toward the vaccine \((Mdn = 4.57)\) than students who were unaware \((Mdn = 4.00, U = 5725, z =
2.42, p = .015, r = .17\). There was no statistically significant difference between the groups on
subjective norms, perceived behavioral control, or behavioral intention. Nor was there a
statistically significant difference on any TPB variables such as attitude, subjective norms,
perceived behavioral control, or behavioral intention between students who knew how HPV is
transmitted and students who did not.

Students who correctly identified that HPV can cause cancer reported higher average scores for
perceived behavioral control \((Mdn = 6.17)\) than students who did not \((Mdn = 4.83), U = 6626.5,
z = 3.78, p < .001, r = .22\). There was no statistically significant difference between the groups on
attitude, subjective norms, or behavioral intention. Furthermore, students who knew HPV causes
genital warts had a more positive attitude toward the vaccine \((Mdn = 5.00)\) than students who did
not know \((Mdn = 4.00), U = 6478, z = 3.23, p = .001, r = .23\). They also had higher average
scores on perceived behavioral control \((Mdn = 6.17)\) than students who did not know HPV
causes genital warts \((Mdn = 4.83), U = 6502.5, z = 3.46, p = .001, r = .24\). Neither subjective
norms nor behavioral intention varied significantly between these groups.

When students were asked whether they thought the HPV vaccine is protective for those
who encounter the human papillomavirus, those who said yes had a more positive attitude
toward the vaccine \((Mdn = 4.86)\) than those who said no or who did not know \((Mdn = 4.00), U =
5900, z = 3.42, p = .001, r = .24\). Other TPB variables were not significantly different between
these two groups.
3.4.2. **TPB model testing**

To test if attitudes, subjective norms, and perceived behavioral control (PBC) predict participants’ behavioral intention to get the HPV vaccine, we conducted a multiple regression analysis with behavioral intention as the dependent variable and attitude, subjective norms, and PBC as the predictor variables. Since our group comparisons indicated a difference in behavioral intention between students who had and had not gotten shots previously, we also included a dummy-coded variable for whether students had previously gotten at least one HPV shot (1 = yes, 0 = no). Because the data were not normally distributed, we used Stata 16 to generate 10,000 bootstrap samples and calculate 95% confidence intervals for the regression coefficients (see Table 3). The model accounted for 54% of the variance in behavioral intention (Adjusted $R^2 = .53$). Attitude was a significant predictor of intention, $b = .29 \ [ .15 - .42 ], \ z = 4.19, \ p < .001,$ as was subjective norms, $b = .57 \ [ .44 - .70 ], \ z = 8.81, \ p < .001.$ PBC was not a significant predictor of intention, $b = -.08 \ [ -.20 - .04 ], \ z = -1.37, \ p = .17,$ and neither was having previously received an HPV vaccine injection, $b = -.50 \ [ -1.07 - .07 ], \ z = -1.71, \ p = .09.$

[Insert Table 03 here]

3.5. **Religiosity**

A majority of students said they attended religious services such as church services at least a few times a month ($n = 141, \ 54.9\%$). Only 17.5% ($n = 45$) said they never attended religious services. A chi-square test of independence found no association between attending religious services and getting at least one HPV vaccine injection.

A little more than half of participants ($n = 136, \ 53\%$) engaged in some private religious activities from two or more times a week to more than once a day. About a quarter of the
students \((n = 68, 26.5\%)\) reported no private religious activities. A chi-square test found no significant association between private religion activities and getting vaccinated. A majority of students \((n = 170, 66.2\%)\) agreed with the statement “My religious beliefs are what really lies behind my whole approach to life,” compared to 23.4% \((n = 60)\) who did not. A Mann-Whitney U test found no significant difference on this item between students who had gotten at least one HPV vaccine shot and students who had not been vaccinated.

Additionally, roughly equal numbers of students reported that religion influenced their health beliefs \((n = 106, 41.4\%)\), compared to those who rejected this statement \((n = 105, 40.9\%)\) \((M = 2.96, SD = 1.51)\). A Mann-Whitney U test found a significant difference between students who had not been vaccinated and those who had received at least one HPV vaccine shot, \(U = 6350, z = -2.22, p = .026, r = -.14\). Students who were not vaccinated were more likely to report that religion influenced their health beliefs. The median for each group was 3.00, but the mean for students who had not been vaccinated was 3.12 \((SD = 1.53)\) and for student who had received at least one shot was 2.70 \((SD = 1.44)\). Using Hayes’ PROCESS macro (v. 3.3) for SPSS [50], we conducted a moderation analysis (PROCESS Model 1) with 10,000 bootstrapped samples to see whether students’ perception that religious beliefs influence their health decisions would moderate the effects of the predictor variables in the TPB model on behavioral intention. We focused only on the students who had not received any HPV vaccine injections \((N = 161^1)\). There was no significant interaction effect between perceptions of religious influence on health decisions and (a) attitude, (b) subjective norms, or (c) PBC. We ran the same type of analysis to check for a moderation effect of student’s general religiosity (i.e., students’ perception that their religious beliefs are behind their whole approach to life) on the TPB predictors relationship with

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1 Although there were 163 respondents in the study who had not been vaccinated, only 161 answered all questionnaire items for the variables in this analysis.
behavioral intention. Once again, there were no significant interaction effects. Thus, we concluded that these measures of religiosity did not influence the way attitude, subjective norms, or PBC affect behavioral intention.

4. Discussion

This study examined key factors associated with college students’ current vaccination status as well as their intention to get vaccinated. Consistent with past studies, we found that the odds of getting vaccinated were higher among female students than male students [15, 46]. We also found a statistically significant association between race/ethnicity and getting vaccinated. Minority or non-White students were more likely to get vaccinated than White students. This finding was consistent with recent studies done in Alabama that showed higher HPV vaccination uptake rate among Blacks and other minority populations [8, 47].

This study also finds that TPB can help predict intentions to get vaccinated among students at a rural university. Consistent with past studies that tested TPB in the context of HPV vaccination among college students, (though, students demographically different from those in the present study) [14, 17, 40], we found that attitudes and subjective norms were statistically significant predictors of behavioral intentions, whereas perceived behavioral control did not predict behavioral intentions. It is important to note that students at a rural, Southern state university overwhelmingly indicated that they felt capable of getting the HPV vaccine if they tried, which suggests that perceived access to HPV vaccination is not a barrier for this population. Moreover, consistent with past studies [18, 19], we found that accurate knowledge about HPV and the vaccine was related to more positive attitudes about the vaccine.

A unique contribution of our study is that we examined how the TPB variables such as attitudes, subjective norms, behavioral controls, and behavioral intentions vary based on specific
HPV knowledge. We found that different types of knowledge items have different association with TPB variables and with the decision to receive HPV vaccine. For example, knowing that (1) both sexes can experience HPV-related health problems, (2) HPV can cause genital warts, and (3) the vaccine protects against HPV were each associated with higher attitude scores. In contrast, other knowledge items, such as knowing that that HPV causes cancer, were not related to positive attitudes regarding HPV vaccination. This is important, as many public health campaigns focus on the appeal of HPV vaccine as cancer preventative measure to promote uptake [44]. Our findings suggest that public health campaigns targeting college students may be more persuasive if they focus more on the messages of vaccine efficacy and its impact on both sexes and the facts that it causes genital warts to change individual attitudes towards HPV vaccine.

Three knowledge items were related to significantly different scores on perceived behavioral control: knowledge that HPV is contagious, knowledge that HPV can cause cancer, and knowledge that HPV can cause genital warts. Past studies [45] have found that message framing such as preventing genital warts compared to cancer prevention significantly increased perceptions of self-efficacy or perceived behavioral control among college-age females. Conversely, our study indicates that combining both these message framings (prevention of genital warts and prevention of cancer) could be more effective in increasing perceived behavioral control or self-efficacy.

These findings suggest that respondents who perceived HPV as a more serious health threat also perceived themselves as more able to get vaccinated. Students who knew how HPV is transmitted reported lower subjective norm scores than other students. A possible explanation is that students who knew HPV is transmitted through sexual activity felt that their family would
not want them engaging in sexual activity and, thus, would not see any reason to get the vaccine.

It is important to note that our study did not find any statistically significant difference in sexual activity between vaccinated and unvaccinated students. Moreover, research documented that there was no relationship between sexual initiation following HPV vaccination and risk perceptions. However, it may be that some students feel that people in their social networks would perceive getting vaccinated as a sign that they intended to engage in sexual activity and would therefore oppose vaccination. Past research has documented that parental concerns about their children’s sexual risk perceptions following HPV vaccine pose a barriers to HPV vaccination [48], despite the overwhelming evidence that HPV vaccination does not lead to risky sexual behavior.

Our study was important in examining the influence of religion on TPB and getting vaccinated in a state with high religiosity [49]. In contrast to past studies that reported organizational religiosity and non-organizational religiosity were associated with low vaccination uptake among college-aged students [27, 33], our study indicates that the relationship of religiosity to HPV-related attitudes and behavior is complex. There was no statistically significant difference between vaccinated and unvaccinated students in how much they agreed with this general statement: “My religious beliefs are what really lies behind my whole approach to life.” In contrast, students who were not vaccinated reported significantly higher agreement with the item that stated, “My religious beliefs influence decisions about my health,” than the students who were vaccinated. This set of results indicates that religion may only play a critical role in the vaccination decision making, if someone sees it as having relevance to their health decisions. To our knowledge, this is a unique finding that has not been previously reported and may be worth exploring further. Perhaps, working with churches and
other religious centers in Alabama may help increase vaccination rates among people whose
health decisions are influenced by their religious beliefs. Furthermore, scores on these items did
not have any interaction effects with the TPB variables in predicting students’ intention to get the
HPV vaccine.

4.1. Recommendations

Our study has significant implications for improving vaccination uptake among college
students in rural, religious areas. Our study shows that specific knowledge items such as the fact
that HPV can cause genital warts and that HPV can be prevented through vaccines are associated
with vaccination status and students’ intention to get vaccinated. Future intervention should
include testing of these message frames in their communication campaigns to examine whether
this association represents causality. Despite most of the students having slightly favorable
attitudes toward HPV vaccination, many did not believe that HPV vaccination was necessary.
Communication and education interventions are needed to change this belief. Our findings
indicate that most of the college students who participated in this study did not perceive much
external support for HPV vaccination from their family or other important people in their lives.
We also found a significant association between these subjective norms and students’ intention
to get vaccinated. It is therefore imperative that interventions target students’ family members
and important others with pro-vaccination messages to increase favorable subjective norms. Our
findings show that students who had knowledge of the mode of transmission of HPV scored low
on subjective norms. Perhaps, the students thought that getting vaccinated against HPV may be
perceived by their family members or others as an intention to engage in sexual activity.
Therefore, they perceived that their family members would not support their decision to get
vaccinated. Family support for the HPV vaccine could help improve students’ behavioral intentions towards HPV vaccine.

4.2. Limitations

It is important to note the limitations of our study. First, this was a cross-sectional study, which prevented us from assessing causal relationships among variables. Future researchers should conduct longitudinal studies and randomized trials to better understand the relationship among these variables. In addition, this study used a relatively small convenience sample, which overrepresented White students and female students. Given that students self-selected into this study, the findings may not generalize to students who chose not to participate. Furthermore, this study’s sample was collected from a single college campus in a rural part of an especially religious state [49], thus limiting the generalizability of the results. It would be useful to replicate the findings among students from other, similar colleges and to use a representative sample of students, rather than a convenience sample.

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Conflict of interest statement
Outside of the present work GZ has served as an external advisory board member for Merck and Moderna and as a consultant to Merck. In addition, he has received investigator-initiated research funding from Merck administered through Indiana University. The other authors have no conflicts of interest to report.

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None.
References


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Table 1

Comparison of HPV Knowledge Between Vaccine Recipients and Non-recipients (N = 257)

<table>
<thead>
<tr>
<th>HPV Knowledge</th>
<th>Correct answers from those with at least one HPV vaccine shot (n = 98)</th>
<th>Correct answers from those who have never received an HPV vaccine shot (n = 159)</th>
<th>$\chi^2$</th>
<th>Sig.</th>
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<tbody>
<tr>
<td>Do you think human papillomavirus (HPV) is contagious? (Correct answer: Yes)</td>
<td>68 (69.4%)</td>
<td>101 (63.5%)</td>
<td>1.586</td>
<td>.452</td>
</tr>
<tr>
<td>In which gender can human papillomavirus cause health problems? (Correct answer: In both women and men)</td>
<td>67 (68.4%)</td>
<td>101 (65.5%)</td>
<td>.629</td>
<td>.428</td>
</tr>
<tr>
<td>What are modes of transmission of HPV? (Correct answers: Sexual intercourse or From mother to baby during birth)</td>
<td>27 (27.6%)</td>
<td>56 (35.2%)</td>
<td>1.631</td>
<td>.202</td>
</tr>
<tr>
<td>Can HPV cause cancer? (Correct answer: Yes)</td>
<td>60 (61.2%)</td>
<td>70 (44.0%)</td>
<td>6.929</td>
<td>.008*</td>
</tr>
<tr>
<td>Can HPV cause genital warts? (Correct answer: Yes)</td>
<td>54 (55.1%)</td>
<td>69 (43.4%)</td>
<td>3.329</td>
<td>.068</td>
</tr>
</tbody>
</table>

*$\chi^2 (1, N = 256) = 6.292, p = .008$
Table 2: Means, Standard Deviations, and Alphas for Theory of Planned Behavior Items Among Respondents Not Fully Vaccinated.

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude Scale</td>
<td>4.39</td>
<td>1.70</td>
<td>.94</td>
</tr>
<tr>
<td>I think getting HPV vaccine in the next 12 months would be very bad/very good.</td>
<td>4.50</td>
<td>1.96</td>
<td></td>
</tr>
<tr>
<td>I think getting HPV vaccine in the next 12 months would be not protective at all/extremely protective.</td>
<td>4.68</td>
<td>1.95</td>
<td></td>
</tr>
<tr>
<td>I think getting HPV vaccine in the next 12 months would be unnecessary/necessary.</td>
<td>3.79</td>
<td>2.10</td>
<td></td>
</tr>
<tr>
<td>I think getting HPV vaccine in the next 12 months would be very unhealthy/healthy.</td>
<td>4.65</td>
<td>1.98</td>
<td></td>
</tr>
<tr>
<td>I think getting HPV vaccine in the next 12 months would be disadvantageous/advantageous.</td>
<td>4.47</td>
<td>2.02</td>
<td></td>
</tr>
<tr>
<td>I think getting HPV vaccine in the next 12 months would be extremely painful/painless.</td>
<td>4.35</td>
<td>1.73</td>
<td></td>
</tr>
<tr>
<td>I think getting HPV vaccine in the next 12 months would be extremely harmful/extremely beneficial.</td>
<td>4.53</td>
<td>1.82</td>
<td></td>
</tr>
<tr>
<td>Subjective Norms</td>
<td>3.21</td>
<td>1.98</td>
<td>.95</td>
</tr>
<tr>
<td>Most people who are important to me think that I should get HPV vaccine in the next 12 months (completely disagree/completely agree).</td>
<td>3.27</td>
<td>2.10</td>
<td></td>
</tr>
<tr>
<td>My parent(s) or legal guardian(s) would like me to get HPV vaccine in the next 12 months (completely disagree/completely agree).</td>
<td>3.24</td>
<td>2.12</td>
<td></td>
</tr>
<tr>
<td>Family members other than my parent(s) or legal guardian(s) (for example, siblings aunts, uncles, grandparents, etc.) would like me to get HPV vaccine in the next 12 months (completely disagree/completely agree).</td>
<td>3.15</td>
<td>2.01</td>
<td></td>
</tr>
</tbody>
</table>

All items measured on 7-point scales.
<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Behavior Control Scale</td>
<td>5.29</td>
<td>1.54</td>
<td>.93</td>
</tr>
<tr>
<td>If I wanted to, I am sure I could get HPV vaccine in the next 12 months (completely disagree/completely agree).</td>
<td>5.79</td>
<td>1.69</td>
<td></td>
</tr>
<tr>
<td>For me to get HPV vaccine in the next 12 months would be extremely difficult/extremely easy.</td>
<td>5.26</td>
<td>1.73</td>
<td></td>
</tr>
<tr>
<td>How much control do you have to get HPV vaccine in the next 12 months (no control/complete control)?</td>
<td>5.52</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>I am confident I can get HPV vaccine in the next 12 months, even if there is a financial cost (very unconfident/very confident).</td>
<td>5.01</td>
<td>1.84</td>
<td></td>
</tr>
<tr>
<td>I am confident I can get HPV vaccine in the next 12 months even if my schedule is busy (very confident/very unconfident).</td>
<td>4.97</td>
<td>1.90</td>
<td></td>
</tr>
<tr>
<td>I am confident I can find a healthcare provider (for example, clinic, health center, physician’s office) where I can get HPV vaccine in the next 12 months (very unconfident/very confident).</td>
<td>5.42</td>
<td>1.72</td>
<td></td>
</tr>
<tr>
<td>Behavioral Intention Scale</td>
<td>2.68</td>
<td>1.90</td>
<td>.98</td>
</tr>
<tr>
<td>I intend to get HPV vaccine in the next 12 months (completely disagree/completely agree).</td>
<td>2.62</td>
<td>1.88</td>
<td></td>
</tr>
<tr>
<td>I will try to get HPV vaccine in the next 12 months (completely disagree/completely agree).</td>
<td>2.76</td>
<td>1.98</td>
<td></td>
</tr>
<tr>
<td>I plan to get HPV vaccine in the next 12 months (completely disagree/completely agree).</td>
<td>2.67</td>
<td>1.98</td>
<td></td>
</tr>
</tbody>
</table>

1All items measured on 7-point scales.
<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>Bootstrap S.E.</th>
<th>z</th>
<th>95% CI</th>
<th>BCa CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.14</td>
<td>.31</td>
<td>.44</td>
<td>[-.48, .76]</td>
<td>[-.47, .78]</td>
</tr>
<tr>
<td>Attitude</td>
<td>.29***</td>
<td>.07</td>
<td>4.19</td>
<td>[.15, .42]</td>
<td>[.16, .43]</td>
</tr>
<tr>
<td>Subjective norms</td>
<td>.57***</td>
<td>.06</td>
<td>8.81</td>
<td>[.44, .70]</td>
<td>[.43, .69]</td>
</tr>
<tr>
<td>Perceived behavioral control</td>
<td>-.08</td>
<td>.06</td>
<td>-1.37</td>
<td>[-.20, .04]</td>
<td>[-.20, .04]</td>
</tr>
<tr>
<td>Previous HPV vaccine injection</td>
<td>-.50</td>
<td>.29</td>
<td>-1.71</td>
<td>[-1.07, .07]</td>
<td>[-1.07, .07]</td>
</tr>
<tr>
<td>R^2</td>
<td>.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. N = 202. CI = confidence interval. BCa = bias-corrected and accelerated.*** p < .001